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VOLUME 3. ANALYSES OF CHIPPED AND GROUND STONE ARTIFACTS

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THE CHIPPED STONE ANALYSIS

James L. Moore

This volume reports on the analysis of chipped stone artifacts from 25 sites in southwest New Mexico, representing a minimum of 2,600 years of human use. However, rather than providing an unbroken sequence of occupation and development, they supply a series of snapshots along that continuum. Thus, we are provided with glimpses of chipped stone technology and material use through time rather than the entire picture. This is probably preferable from an analytical standpoint. While a study of over 2,000 years of unbroken development in chipped stone technology from one or more continuously occupied or overlapping sites could be very illuminating, it could also be an analytical nightmare; an example of too much data. Such an assemblage could only be handled by sampling, provided one was able to adequately differentiate between deposits from various time periods. In effect, that would create a situation similar to the collection of sites examined by this project, though perhaps with closer correspondence between sample sizes from different analytical units and time periods. Considering that data recovery was specified by the client's needs rather than a statistically designed sample, we have a fair representation of sites from the Late Archaic period through the entire Mogollon sequence and into the protohistoric period. This should allow us to examine trends in chipped stone technology through time, and hopefully, to determine what those trends mean.

DISCUSSION OF THE ASSEMBLAGES

Chipped stone artifacts were available from all 25 sites, and in several cases multiple periods of occupation are represented. Unfortunately, of the 12 cases in which multiple components occurred on sites, occupations could only be differentiated for 4—LA 39972 contained separable Early Pithouse and Early Pueblo occupations, and Archaic occupations were separated from mixed assemblages at LA 43766, LA 70188, and LA 78439. While the array of occupations represented in the other 8 assemblages could not be adequately separated, it is hoped that comparison with unmixed assemblages will provide data that will allow us to assess the degree of mixing and whether or not they are dominated by materials from any single component.

A total of 63,131 chipped stone artifacts from 29 components was analyzed. Table 3.1 shows the distribution of artifacts by component. Nearly a third (29.2 percent) of the total assemblage occurred in mixed components, so only slightly more than two-thirds could be assigned to distinct temporal periods. The only exception was LA 70201, which contains materials from both the Early and Late Pithouse periods but can not be divided into separate components. This assemblage is not considered mixed because materials can still be assigned to a relatively discrete occupation rather than two or more widely separated periods.

The portion of the chipped stone assemblage that is assigned to unmixed components is dominated by the Archaic and Late Pueblo periods, which comprise 20.5 percent and 45.6 percent of the total, respectively. The three intervening periods are more evenly represented; the Early Pithouse assemblages contain 4.7 percent of the total, the Late Pithouse assemblages 9.8 percent, and the Early Pueblo assemblages 14.6 percent. The most underrepresented period is the protohistoric, which comprises only 3.1 percent of this assemblage. While possible protohistoric occupations are suspected for several sites, these were the only examples that did not appear to contain multiple components. The protohistoric occupation overlies debris from earlier uses in the other cases and could not be separated from those materials.

While the assemblages of chipped stone artifacts from different time periods vary widely in number and do not represent a series of statistically selected samples, we should still be able to derive useful information from these data sets. Hopefully, we will be able to isolate temporal and perhaps cultural trends in technology and material use that will allow us to assess the mixed assemblages, as well as to understand how adaptations to this region did or did not vary through time.

THE COMPONENTS SUMMARIZED

Ten sites contained single components, while the remainder contained up to four possible components. Fortunately, we could distinguish between occupations on some sites. In some cases very minor secondary components were discernable but were of little consequence, so those sites are considered single component. In other cases, deposits were so badly mixed that they could not be confidently separated. Unfortunately, this category includes whole site assemblages as well as parts of assemblages from sites with distinguishable components.

Table 3.1. Assemblage Data

PERIOD	COMPONENT	NUMBER OF ARTIFACTS
Archaic	LA 43766	2,001
	LA 45508	1,537
	LA 70188	5,108
	LA 78439	538
Early Pithouse	LA 39972	523
	LA 39975	1,580
Late Pithouse	LA 43786	93
	LA 45507	2,199
	LA 45510	1,233
	LA 70196	852
General Pithouse	LA 70201	544
Early Pueblo	LA 3563	1,663
	LA 39969	3,050
	LA 39972	716
Late Pueblo	LA 3279	13,810
	LA 9721	26
	LA 39968	4,306
	LA 70185	2,244
Protohistoric	LA 37917	666
	LA 37919	697
Mixed	LA 45508	969
	LA 70188	10,967
	LA 70189	322
	LA 70191	183
	LA 75791	145
	LA 75792	1,099
	LA 78439	242
	LA 89846	1,096
	LA 89847	402
	LA 43766	4,320
Total		63,131

Note: Sites with separable components appear more than once.

Sites Containing Minor Secondary Components

LA 3563, South Leggett Pueblo. Excavation at this site concentrated on a pithouse that was originally excavated by Martin et al. (1949). Analysis suggested that construction occurred during the Late Pithouse period, but the structure was never occupied as a residence, and there were some indications of later use for trash disposal during the Early Pueblo period. Reexcavation of this structure suggested that it refilled after the original excavation with surrounding deposits that date to the Early Pueblo period. Thus, this assemblage is assigned to the Early Pueblo period.

LA 37917, Rocky Hill. Radiocarbon samples date this site to the protohistoric period. However, the types of projectile points recovered suggest the presence of an Archaic component, and this possibility is partly supported by obsidian hydration dates. The presence of a single Mogollon sherd could also be evidence of an earlier occupation of uncertain date, but it could just as easily be an unrelated contaminant. While this assemblage may be mixed, the amount of contamination is unknown and could be minor (or nonexistent if the points were curated). Thus, it is included with the single component sites for comparative purposes, but the possibility that it might be mixed will be kept in mind. While it is considered a protohistoric component, most of the projectile points are included with the Archaic assemblage in that analysis.

LA 37919, Apache Woods. Radiocarbon samples date this site to the protohistoric period, but the presence of earlier sherds suggests that there could also be a small Mogollon occupation of uncertain date. However, the small number of sherds (n = 9) suggests that they may instead represent contaminants from LA 70189, a Pueblo period site across the highway. For now this site is considered protohistoric, with the caveat that a multicomponent situation remains possible.

Sites Containing Multiple Separable Components

LA 39972, SU Tanks. This contains materials from the Early Pithouse and Early Pueblo periods. Different zones appear to have been occupied during those times, though it is possible that there was a small amount of overlap. These areas are separated into different components. An Early Pithouse period occupation is reflected by materials from the south side of NM 12, which extend from the southern edge of the site to the Grid 105N line. An Early Pueblo period occupation is assigned to all other materials from this site.

LA 43766, Old Peralta. This site is primarily Archaic in date, however, some materials from a nearby Early Pueblo site washed onto it. Initially, the later materials were considered to be a minor surficial contaminant. However, analysis of the projectile point assemblage suggested that the degree of mixing might be more serious than was initially thought. Thus, LA 43766 was divided into two components, one containing Archaic materials only and a second containing a mixture of Archaic and Early Pueblo period materials. The Archaic assemblage comprises materials recovered from two use surfaces and the deposits separating them. Dates were supplied by radiocarbon samples from associated thermal features. All other materials from this site were assigned to the mixed component.

LA 45508, Humming Wire. Materials dating to both the Late Archaic and Early Pithouse periods were found at this site. Different zones appear to have been occupied during those periods, though it appears that the Early Pithouse occupation overlaps that of the Late Archaic in the southern part of the site. Thus, this assemblage is broken into two components, one dating to the Late Archaic and a second containing a mixture of Archaic and Early Pithouse materials.

LA 70188, Raven's Roost. Radiocarbon dates and temporally diagnostic artifacts suggest three periods of occupation for this site. The main occupation was during the Late Archaic, and it is likely that most of the artifacts date to that period. Unfortunately, the presence of Mogollon sherds and protohistoric radiocarbon dates suggest that it was reoccupied during at least two later periods. Since most of the later diagnostic contaminants were found on or near the surface, it seemed likely that materials below a certain depth were Archaic, and that surface and shallowly buried materials were a mixture of Archaic and later occupations. Thus, materials from this site were divided into two assemblages, one thought to reflect a purely Archaic occupation, and the other a mixture of materials from Archaic, Mogollon, and protohistoric occupations. However, as suggested by the projectile point analysis, our first division did not successfully remove all later contaminants from the Archaic assemblage. We had to reassess this assemblage and assign a much larger proportion to the mixed component. Thus, all materials from excavation units deeper than 10 cm below the surface were assigned to the Archaic component, and all units containing materials from levels beginning above this depth were placed in the mixed component.

LA 78439, Leaping Deer Ridge. Radiocarbon dates from this site suggest it was occupied during at least two periods, the Late Archaic and Late Mogollon. Ceramic analysis was only able to establish the presence of an indeterminate Mogollon use. One possible occupational zone was separated out and centered on a roasting pit. Using a Late Archaic date provided by the roasting pit, this component was assigned to that period. Unfortunately, materials from the rest of the site appear to consist of a mixture of artifacts from all occupational periods. Thus, they are classified as a mixture of Late Archaic and Mogollon materials.

Sites Containing Mixed Deposits from Multiple Occupations

LA 70189, Lightning Strike. This assemblage contains evidence of occupation during the Early Pueblo and protohistoric periods. Both components were inextricably mixed and could not be separated. Thus, the assemblage is considered mixed and is assigned to a single component.

LA 70191, The Black Hole. This site contained redeposited materials from one or more sites located upslope. While it is possible that all materials recovered at this locale were originally derived from a nearby Early Pithouse site, it is possible that artifacts from a nearby Early Pueblo period roomblock were also mixed in. Thus, this site is considered to contain a single mixed component.

LA 70201, Turkey Toes. Evidence of occupation during two periods was recovered from this site. Both components were inextricably mixed, and could not be separated out. Fortunately, the occupations were during the Early and Late Pithouse periods, so the mixed materials were assigned to the general Pithouse period.

LA 75791, Ladybug Junction. Radiocarbon dates for this site suggest occupation in the Late Pithouse and protohistoric periods. Both occupations were corroborated by the ceramic analysis, which also found evidence for a third occupation during the Pueblo period. Unfortunately, these materials were inextricably mixed and could not be separated. Thus, the assemblage is considered mixed and is assigned to a single component.

LA 89846, Haca Negra. While most artifacts from this site appear to have been washed downslope from a Late Pueblo site, radiocarbon dates indicated that Archaic and protohistoric occupations were also represented. Unfortunately, these materials were inextricably mixed and could not be separated. Thus, the assemblage is considered mixed and is assigned to a single component.

LA 89847, Red Ear. Evidence for Archaic, Pithouse, and Pueblo period occupations was recovered from this site, but materials from each period were mixed and could not be separated. Thus, the assemblage is considered mixed and is assigned to a single component.

Summary

Eleven sites contain single temporal components and three contain minor amounts of contaminants from other periods, but mostly seem to represent single components. Five sites contain materials from multiple occupational periods that could be separated, yielding six unmixed and four mixed components. Five sites contain materials from multiple time periods that could not be separated. Since Early and Late Pithouse period occupations are present in one case, that site (LA 70201) is considered to be a single component manifestation dating to the general Pithouse period. This yields a total of 21 essentially unmixed and 9 mixed components.

Problems Encountered During Analysis

Certain problems seem to be inherent in archaeological projects, particularly those that involve several field seasons and different periods of analysis. Perhaps the most prevalent is turnover in project personnel. None of the archaeologists who began this analysis was still employed by the OAS when data synthesis began. Fortunately, this turnover was less serious than it might have been. There were only two generations of analysts, and all were trained by the same supervisors. Thus, it is hoped that data recording remained fairly consistent.

Unfortunately, our field examination of specific material sources in the study area was undertaken after analysis was underway, so it was often not possible to link artifacts to specific sources. However, at a general level we were able to locate sources for most of the common materials encountered during analysis, allowing us to determine which were locally available and which were of exotic origin.

Other problems involved definitions of artifact types and inaccuracies in the data recording and entry processes. An example of the first concerns the artifact category "blade." Our analysis manual defined blades as flakes that are at least twice as long as wide, usually with straight parallel edges and dorsal scars perpendicular to and originating at the platform. While it was also noted that blades were usually struck from specially prepared pyramidal or single platform cores, some analysts simply focused on size characteristics. Since blades are associated with a specific reduction technique that generally is not found in the Southwest after the Paleoindian period, it is unlikely that they were occurring in our assemblages. When potential problems like this were encountered, efforts were made to reexamine artifacts and determine whether the attributes were correctly coded and correct the problem.

Inconsistencies can also creep in during the data recording and entry processes. While comparisons of data files against the original forms helped correct the latter, they were ineffective in accounting for the former. For that reason, programs that looked for logical errors were written and used to examine all data files. These errors were usually corrected by comparison against original data sheets or by reexamination of artifacts. When examination of the entire data string made the source of the error obvious, corrections were often made without returning to the original source. By following these procedures, it is hoped that most errors were purged from the system.

Another problem was our inability to directly date any of the chipped stone artifacts, particularly the projectile points. Though many of the points are obsidian and thus potentially dateable, we have our reservations concerning the accuracy of the obsidian hydration method. Early on, it was recognized that soil temperature affected hydration rates; artifacts from warm environments absorbed moisture at a much faster rate than those from colder climates (Friedman et al. 1970). In instances when soil temperature data were lacking, it was thought that estimates could be based on air temperature and soil conductivity (Friedman et al. 1970:65). More recent research, however, suggests that knowledge of soil temperature must be considerably more precise. Studies by Ridings (1991) and Boyer (1997) in the Taos area indicate that because soil temperature varies between sites as well as vertically and horizontally across the same site, considerable control over both sample provenience and the placement of temperature cells are required to prevent erroneous results. While obsidian hydration dating can be used to examine the reuse of artifacts from earlier sites, and is suitable when a great deal of chronological control is unnecessary, for the most part it was too inexact for this study.

Similarly, radiocarbon dating is also fraught with potential inaccuracies. In particular, this technique can suggest much earlier dates than other temporally sensitive materials at the same site. This is a consequence of the use of old wood for construction or fuel. The latter use, in particular, can yield highly erroneous dates. From his work at Black Mesa, Smiley (1985) concluded that error creeps into the dating of woody materials in several ways, including preservation conditions and the cross-section effect. The latter reflects the tendency of sections of tree wood to contain numerous rings, each reflecting a different period of growth and, consequently, a differential ^{14}C content (Smiley 1985:385). A large error in age estimation can occur in arid or high-altitude situations where tree-ring density may be high and dead wood can preserve for long periods. Disparities as large as 1,000+ years were found at Black Mesa. There was an 80 percent chance that dates were overestimated by more than 200 years, and a 20 percent chance that the error was over 500 years (Smiley 1985:385-386). A much greater disparity was found when fuel wood rather than construction wood was used for dating (Smiley 1985:372).

Samples considered to be low quality include those consisting of sections of construction or fuel woods that have no bark or outer growth rings, and scattered charcoal samples from contexts like hearths (Smiley 1985:71-72). Charcoal from annuals (particularly cultigens), sections of construction wood containing outer growth rings, and twigs or small branches are more desirable for dating (Smiley 1985:71-72). Unfortunately, we recovered only low quality samples from our sites, and can expect discrepancies between different types of temporally sensitive materials. These discrepancies are not particularly important when phases incorporating long time periods are involved. However, when phases are of short duration, the potential inaccuracy of low quality radiocarbon samples renders these dates suspect.

Thus, dates for components were determined using several methods. Radiocarbon dates were used to indicate the presence of preceramic or protohistoric components. However, these dates can only be considered relative and may be several hundred years too early. Components were considered preceramic when radiocarbon dates suggested use before A.D. 200. Similarly, components were considered protohistoric when radiocarbon dates in the fifteenth century and later were obtained. Mogollon components were assigned to phases using associated ceramic assemblages. While this did not provide the degree of precision that was most desirable, it did allow us to examine trends in material use, reduction technology, and projectile point style through time.

A RESEARCH FRAMEWORK FOR EXAMINING VARIATION IN CHIPPED STONE TECHNOLOGY AND MATERIAL USE THROUGH TIME

James L. Moore

INTRODUCTION: GENERAL RESEARCH EXPECTATIONS

Chipped stone assemblages are useful for examining many questions concerning prehistoric settlement and subsistence systems. In addition to topics like how and when a site was used and what types of activities occurred there, chipped stone assemblages can also be used to examine more complex problems. The changing structure of residential mobility in the Mogollon Highlands is of particular interest to this examination. Recent models and studies have shown that chipped stone assemblages can be particularly useful in examining problems of this nature, though they are not as sensitive to fluctuations in local and regional styles as are artifacts like pottery. However, chipped stone assemblages can only provide part of the solution to the puzzle. In the absence of other data like site structure, types of residences used, evidence of storage, longevity of occupation, etc., conclusions based on the structure of a chipped stone assemblage can only be considered tentative. This chapter provides a framework for examining mobility through the analysis of chipped stone assemblages from 25 sites in the Luna-Reserve area. When our conclusions are integrated with other studies, a more accurate picture of temporal changes in mobility for that area should be obtained.

Oakes (1990; Oakes and Wiseman 1993; Oakes and Zamora 1993) developed an overall research orientation for the sites discussed in this document. As she states:

> The research design may be set forth in a single premise; in the Mogollon Highlands, if there is a continuum from full mobility in the Archaic period, to becoming fully sedentary by the Pueblo period, with the change influenced by increasing dependence on agriculture, then that shift should be evident in the archaeological record. In other words, we propose a general model that suggests a positive relationship between dependence on cultigens and decreasing residential mobility. The logic of this argument is that as cultigen dependency increases, the bulk of harvested food increases, cultigens are stored, and because storage entails investment in facilities and the reuse of sites, residential mobility declines [Oakes 1990:86].

As noted in the research design for a later phase of investigation:

> This is a traditional model for explaining change in site structure through time. However, we do not believe the model is as simple as it sounds, and we definitely think that events in the Mogollon Highlands during the Pueblo period (A.D. 1000) did not follow this model. The model merely provides us with a premise from which we can test the relationship between subsistence and settlement strategies in the Mogollon Highlands [Oakes and Zamora 1993:25].

Sites occupied by Archaic hunter-gatherers are expected to exhibit a fully mobile adaptational pattern, with site structure reflecting short-term and presumably repeated occupations by relatively small groups. Thus, expectations were for expediently constructed dwellings, hearths, and storage features (Oakes 1990:91-92). It was assumed that artifact assemblages would be consistent with this expectation.

Pithouse period sites are generally thought to represent sedentary occupations. However, length of site occupation is considered variable, ranging from seasonal to annual or longer (Oakes 1990:44). Thus, more labor was invested in constructing dwellings, hearths, and storage facilities.

Sites occupied during the Pueblo period include supposedly permanent structures, storage facilities, middens, and dispersed fieldhouses (Oakes 1990:45). It is possible that movement out of pithouses into above-ground structures reflects a shift to greater agricultural dependence (Hunter-Anderson 1986:49). Thus, mobility was probably greatly constrained during this period because of substantial labor investment in residences and agriculture (Oakes 1990:45).

Our task is to examine the structure of chipped stone assemblages for the sites excavated by this project and determine whether they reflect the expected trends in mobility or are indicative of contrasting tendencies. In addition, we must also provide more traditional information on site use, activities, and dating. We also examine the array of projectile points recovered from these sites to determine whether they are sensitive to temporal trends and can provide ancillary information on site dating.

Mobility Patterns and Technological Organization

For many years the prehistoric occupants of the Southwest were lumped into two basic types, people who moved around through much (or all) of the year, and people who remained in one place for most (or all) of the year. The former were Archaic hunter-gatherers, and the latter were sedentary farmers of the Ceramic period. However, over the past few decades, studies have changed our perception of the basic lifestyles of both groups. The mobility organization of Archaic hunter-gatherers and "sedentary" farmers simply is not as cut and dried as it once seemed.

Hunter-Gatherers

Binford (1980) describes two idealized hunter-gatherer mobility patterns—foragers and collectors. The difference between these organizational systems is rather simple; foragers move people to resources while collectors move resources to people (Binford 1980:17). As Binford (1979:270) notes (brackets mine):

> With foraging strategies persons range out into the environment searching for resources and return to a residential location each night; with logistically organized strategies [collectors], parties organized specifically for procurement of certain target resources move out of residential locations to temporary camps for their own maintenance while exploiting the resources of a certain location, and range out from these camps in the execution of their procurement strategies.

While foragers tend to consume resources as they are collected, storage is an important aspect of the collector strategy, whether for long or short periods. Thus, collected resources can be transported to the residential site for consumption or storage, or they can be cached at or near the logistical camp for later consumption.

Binford (1980:19) warns that foraging and collecting strategies should not be viewed as opposing strategies; rather they are ". . . organizational alternatives which may be employed in varying mixes in different settings." Thus, a group can fluctuate from a foraging strategy to a collecting strategy seasonally. An example of this type of behavior is the Mesilla phase in the Jornada Mogollon region. Though there was some use of cultigens and pottery during that period, the basic settlement and subsistence organization was still very Archaic in nature. Hard (1983) feels that the late Mesilla population followed a pattern of residence in warm season foraging camps and cold season collecting camps, accompanied by differential resource use depending on moisture conditions. A foraging pattern was probably used during the rainy season (late summer) when rainfall and collection of runoff in temporary ponds allowed people to exploit desert basins. As these water sources disappeared in the basins, people appear to have returned to their winter camps and pursued a collecting strategy through most of the rest of the year. Hard (1983) feels that foraging and collecting camps occupied by the same population should have a different character. It is also possible that there was variation in chipped stone tool use and perhaps reduction technology.

Farmers

Until the mid to late 1970s, most research on Southwestern farmers focused on their more substantial residential sites. Thus, while fieldhouses and scatters of ceramic and lithic artifacts that often represent logistical sites were recognized, they were rarely studied in detail. This led to a perception that prehistoric farmers were essentially sedentary, dwelling in villages nearly all the time. The sheer mass of Ceramic period limited activity sites recorded and excavated over the past few decades has begun changing this perception. While it remains true that residential villages were the main focus of occupation for most Ceramic period farmers, they appear to have been much more mobile than was originally thought.

Preucel (1990:3-4) characterizes the Anasazi agricultural system as a network of permanently and seasonally occupied nodes. Villages and hamlets represent permanent nodes from which people circulated while fulfilling their economic, cultural, and social needs. While much of the population may have been resident at other locations during part of the year, these segments of the settlement system are considered permanent because they represent the nodes from which circulation originated. Farming communities and fieldhouses are the types of seasonally occupied nodes that are currently identified (Preucel 1990:3-4). The former are small communities occupied during the growing season by more than one extended family; historically, many farming communities have become permanently occupied hamlets. The latter are small residences used during the growing season by single families, and exhibit tremendous variability in form.

This model is interesting because it provides for the use of multiple residences on a yearly basis rather than presuming that all activities originated at the village. It is likely that logistical task groups were sent out from villages as well as farming sites to procure wild resources like piñon nuts, grass seeds, and deer, or raw materials for the manufacture of tools and other implements. At times these groups may have been absent for several days or weeks, and probably created camps similar to those used by Archaic collectors.

Thus, residential mobility was also a characteristic of the so-called sedentary farming population. The main difference was one of scale. Hunter-gatherers were almost always on the move, whether shifting the location of a residential site while foraging or establishing new logistical camps while collecting. Farmers, on the other hand, moved their residences far less often. Even when residing at a temporary farming site they probably continued to return to their villages to fulfill ritual and social obligations. Logistical camps were a different matter, and were probably established when and where a need was perceived. Other than a few heavy tools that might be cached in or near a camp, hunter-gatherers were constantly moving their tools and other possessions. An exception to this might be the residential camps of collectors. If the residential camp location was selected in advance of need or the same location was used for several consecutive years, certain equipment might be cached there or nearby. The Nunamuit are a good example of this type of behavior; they possessed two different arrays of equipment for winter and summer, and cached each at the end of their season of use (Binford 1979). In situations where the availability of subsistence goods was not as easily predicted as it was for the Nunamuit, caching of this nature should be less important.

Farmers maintained primary residences where possessions and tools that were not needed at seasonally occupied farming sites or logistical camps could be left. When a farming site was used in consecutive years, tools and other materials required for cultivation and subsistence could simply be stored there. Thus, farmers did not need to transport as many possessions and could feasibly maintain not only a larger but also a more diverse and specialized tool kit. Hunter-gatherers, and foragers in particular, needed to be more generalized because they were continually moving from one place to another. While it was possible to cache heavy tools near locations they anticipated reusing at a later time, there was no central residential node where unnecessary or superfluous goods could be stored until needed and then easily retrieved.

Technological Organization and Residence Patterns

People who are almost continuously on the move should have a technological organization that is distinguishable from that of people who move less frequently. At a coarse-grained level we should be able to discern differences in the production and use of chipped stone tools between hunter-gatherers and farmers. At a finer-grained level we may be able to distinguish between camps used by foragers and collectors, the latter including both hunter-gatherers and farmers.

Two basic organizational strategies that are applicable to this study have been identified. Curated strategies entail the manufacture of tools in anticipation of need, while expedient strategies involve the manufacture of tools in response to need. Both strategies are probably used by all societies, so it is unlikely that there have been groups that only used equipment that was prepared in advance, or that was only manufactured when needed. However, it is probable that highly mobile groups approached anticipated and situational needs differently than did groups that were more residentially sedentary. There also may have been subtle differences in how such needs were fulfilled when hunter-gatherers were in foraging versus collecting modes. Fortunately, recent research has provided some information on how mobility can affect chipped stone technology.

Many researchers have isolated differences between chipped stone assemblages used by mobile and sedentary groups (Chapman 1977; Hicks 1986; Irwin-Williams 1973; Kerley and Hogan 1983; Laumbach 1980a; Moore 1993; Rozen 1981). In particular, Kelly (1988) suggests that mobile and sedentary societies approached the manufacture and use of bifacial tools in different ways, and his model is useful for examining mobility structure. While Kelly's model is directed at hunter-gatherer biface manufacture and use, it also provides an interesting framework for examining the role of bifacial tools in more sedentary societies.

Strategy Versus Technique

Before proceeding further it is necessary to define what is meant by strategy and technique, since both are related to how a material is reduced. While strategy is mostly a mental process, technique is physical. The strategy used to reduce a specific stone nodule was dependent on several factors, including material availability, nodule size, and mobility. When desirable materials were rare or difficult to obtain, they could be reduced in a way that maximized return even when the overall strategy was expedient in nature. Conversely, when suitable materials were locally abundant, they could be expediently reduced, even by mobile groups. Nodule size was sometimes an important factor in reduction strategy. Expedient reduction may have been the only option when materials occurred as small nodules, because it may have been impossible to reduce them more efficiently. Mobility must also be taken into account. Mobile peoples required tool kits that were generalized and easily transported. In the Southwest, this need was often fulfilled by large general-purpose chipped stone tools.

Reduction technique refers to the physical methods used to remove debitage from a core or tool. Two techniques were used in the Southwest: percussion and pressure. Percussion flaking involved the striking of a core or tool with a hammer to remove flakes. Both hard and soft hammers were used, and flakes produced by these tools can often be distinguished from one another. Pressure flaking involved the use of a tool to press flakes off the edge of an artifact. In general, hard hammers were used for core reduction while soft hammers and pressure flaking were used to make tools. However, use of these techniques often overlapped: hard hammers were sometimes used for initial tool manufacture, and soft hammers to reduce cores. To further complicate matters, some formal tools were entirely made by percussion. Removal of flakes from a core or tool can be facilitated by modifying platforms to prevent crushing or shattering. The edge of a platform is often very sharp and fragile; modification by abrasion increases that angle and strengthens the edge so it can better withstand the force applied to it. Platform modification was most common during tool manufacture, though core platforms were sometimes also modified. Thus, platform modification is generally related to reduction strategy.

Our analysis was primarily aimed at producing data that could be used to elucidate reduction strategies. Several characteristics of debitage, cores, and formal tools can provide insight into the reduction strategy used at a site. Debitage is an important indicator of reduction strategy because it was rarely curated and often constitutes the only remaining evidence of reduction when formal tools and cores were removed at the time of abandonment. Thus, our analysis was geared toward examining debitage and determining whether it was removal from cores or bifaces. When it occurs, the types and condition of cores and formal tools are also important evidence of reduction strategy. However, these artifact classes were recovered in much smaller quantities than were debitage, so they are of less utility in examining questions of reduction strategy and mobility.

Patterns of Biface Use

Biface Types

Kelly (1988:731) defines three types of bifaces: (1) those used as cores as well as tools; (2) long use-life tools that can be resharpened; and (3) bifaces manufactured to replace parts of existing composite tools. Each type of biface can be curated, but for different reasons and in different ways. Use of bifaces as cores is conditioned by the type and distribution of raw materials. When suitable raw materials are abundant and tools are used in the same location as the materials from which they are made were procured, an expedient technology can be expected, with little use of bifaces as cores (Kelly 1988:719). These biface-cores can also be reduced into more specific tools when needed. Thus, biface-cores can serve as sources for debitage used as informal tools, they can be used as unspecialized tools, and they can be used as blanks for other tools.

The use of bifaces as tools with long use-lives can also be conditioned by the availability of raw materials:

> Under conditions of extreme raw-material scarcity and low residential mobility, and when a particular bifacial tool is necessary to activities being conducted at or from the residential location, we can expect some bifaces to be used as cores, but, moreover, we can expect to see extensive, repeated rejuvenation of bifacial tools [Kelly 1988:720].

Bifaces with long use-lives can also be manufactured when they are expected to be used under a variety of conditions (Kelly 1988:721). Tools designed for use on logistical forays, like projectile points, need to be bifacial since they must often be used in a variety of tasks (Kelly 1988:721). Thus, the design of such tools may be less related to raw material availability than is the case with those used at residential sites. In other words, the bifacial nature of projectile points and related tools is caused by a need for flexibility and longevity, and may be totally unrelated to the availability of high-quality materials.

Bifaces produced to replace components in composite tools are indicators of the importance of the haft rather than the stone portion of the tool. Kelly (1988:721) notes that a class of tools produced underthese conditions may often contain unifacial examples, where in other times or regions the basic design is bifacial. While Kelly (1988:721) suggests that the presence of these types of tools may be indicative of a primarily logistical acquisition of foods necessitating a reliable technology, he also notes that they were more likely maintained or repaired at residential sites. This fits with Nunamiut descriptions of personal equipment maintenance prior to leaving residential camps on logistical forays (Binford 1979:263).

Mobility, Materials, and Reduction Strategies

Curated strategies in the Southwest often entailed the production of bifaces that could serve as both unspecialized tools and cores, while expedient strategies were based on the removal of flakes from cores for use as informal tools (Kelly 1985, 1988). Technology is often related to lifestyle. Curated strategies are usually associated with a high degree of residential mobility, while expedient strategies are typically associated with sedentism. Exceptions to this include highly mobile groups living in areas that contain abundant and widely distributed raw materials or suitable substitutes for stone tools (Parry and Kelly 1987). Southwestern biface reduction strategies were similar to the blade technologies of Mesoamerica and western Europe in that they focused on efficient reduction with little waste. However, as shown by examination of an Archaic workshop near San Ildefonso (Moore n.d.a), quite a bit of material waste often occurred during the manufacture of large bifaces, though the finished tools are considerably more efficient. This is because flakes for use as informal tools could be easily removed with a minimum of waste, producing a large amount of useable edge per biface. Biface-cores could also be efficiently reworked into other tool forms when the need arose. Thus, prehistoric flintknappers were able to reduce the volume of raw material needed for tool production, which helped lower the amount of weight transported between camps. Neither material waste nor transport cost were important considerations in expedient strategies; flakes were simply struck from cores when needed. Thus, analysis of the reduction strategy used at a site allows us to estimate whether its occupants were residentially mobile, sedentary, or somewhere in between.

An important corollary to this concerns exceptions to the use of curated strategies by mobile societies. From survey data gathered west of El Paso in southern New Mexico, Camilli (1988) proposes that distinctions between curated and expedient strategies might not be clear cut in that area:

> Evidence exists . . . for at least two strategies of tool production and use at places containing lithic assemblages associated with projectile points: one incorporating carried tools and cores, and the other using expediently produced flakes manufactured from local materials. Rather than an emphasis on biface production during the Archaic and on flake production during later periods, expedient flake production may have been a technological option of occupations that were widely separated in time [Camilli 1988:158].

This conclusion is based on evidence for the importation and use of partly decorticated cores on Archaic and Formative period sites. While naturally occurring materials were used, they tend to be uncommon in the desert basins of southwest New Mexico. High-quality chert and obsidian nodules occur but are usually small and unsuitable for the manufacture of large tools. Another source of raw material was debris at sites, and later occupants of the region seem to have recycled materials discarded by earlier peoples.

A study of archaeological components at the Santa Teresa Port-of-Entry Facility west of El Paso (Moore 1997) showed that both Archaic and Formative period occupations relied on an expedient reduction strategy, though there was some evidence for the use of curated tools during the Archaic. This appears to have been due to the small size of high-quality nodules, which made it difficult if not impossible to manufacture many large bifaces. Even so, assemblages from different periods differed enough that variation in the scale of mobility through time could be defined.

Examination of material sources is also critical to a discussion of mobility. Sites occupied by groups that ranged over large areas often contain a wider variety of materials from both local and distant sources. Conversely, more sedentary peoples tend to concentrate on material sources within easy walking distance of their residences. Of course, there are exceptions to this. While a mobile group might possess tools made from distant materials, they will generally only occur at a site if lost or discarded. Thus, local materials may predominate. In addition, sedentary peoples may obtain high-quality materials through trade or exchange, so their presence at a site is not necessarily indicative of mobility.

In this study, materials are classified as local or exotic depending on how distant their sources are from a site. In general, materials are considered local if a source is no more than 10 to 15 km from a site. This distance is based on ethnographic studies that suggest a 20- to 30-km round trip is the maximum distance that hunter-gatherers can comfortably walk in a day (Kelly 1995:133). While more distant regions were undoubtedly also used, this zone represents the area that was most heavily exploited on a day-by-day basis around residential sites.

Changing Patterns of Mobility Through Time

Archaic

Conventional wisdom once held that Southwestern Archaic peoples were initially foragers who then switched to collectors as the population grew and ranges became restricted. The stress on a collector-oriented strategy became even heavier when limited agriculture was added to the mix. Sedentism grew out of this, being marked by the acquisition of pottery-making and year-round residence in villages. However, this picture has been altered by recent research.

According to Irwin-Williams's (1973) model of Archaic adaptations in northern New Mexico, Early (Jay and Bajada) and Middle (San Jose) Archaic sites represent a forager adaptation. However, the larger and more intensively occupied sites of the San Jose phase suggest that the shift to a collector lifestyle may have begun during that period, and was certainly in place by the Late Archaic (Armijo and En Medio phases). Wait (1983) suggests that a collector strategy may have existed throughout the Archaic in his study area in the San Juan Basin, with "central sites" situated in ecotonal situations and shifting according to seasonal variation in resource availability.

Vierra and Doleman (1994) argue that the Archaic peoples of northern New Mexico were organized as foragers in the summer and as collectors in the winter. Unfortunately, time was not taken into account in their analysis, so it is uncertain whether they feel this pattern began at a specific point in the Archaic or occurred throughout. Some researchers (such as Judge 1979b) equate much of the Early Archaic with the terminal Paleoindian period, suggesting that at least the Jay population also represented a focused big-game hunting economy. However, recent research suggests that the northern Southwestern Archaic population followed a broad-spectrum hunting and gathering economy from the outset (Vierra 1994; Wiens 1994). Whether the Early and perhaps Middle Archaic populations were foragers, collectors, or a combination of both is yet to be determined.

A similar developmental pattern has been suggested for the Basin-and-Range Province of southwest New Mexico. Moore (1997) provides a synthesis of models and data for that region, and proposes that a seasonal forager-collector pattern existed there since at least the late Middle Archaic. Before that time the subsistence system was probably dominated by a foraging pattern, though small collector camps may have existed from time to time.

This discussion points out the lack of hard data concerning Archaic organizational patterns. It is evident that a seasonal forager-collector strategy was in use by at least the Late Archaic, and perhaps during much of the Middle Archaic as well. Unfortunately, thoroughly excavated and reported sites from the Early and early Middle Archaic periods are rare. While it is possible that these people were foragers, it is also feasible that they fluctuated seasonally between forager and collector patterns, as did later Archaic peoples.

There does appear to be a distinct shift in occupational pattern and perhaps subsistence system at the Middle-Late Archaic interface. Irwin-Williams (1973) posits the development of a strongly seasonal pattern of population aggregation and dispersion by this time in the Arroyo Cuervo District, which is comparable to the concept of a seasonal forager-collector strategy. Shackley (1996a) suggests a similar break between Middle and Late Archaic in the southern Southwest. He notes that the earlier period was characterized by high residential mobility and low use of storage facilities (Shackley 1996a:11). In contrast, he feels that the Late Archaic represents a period of decreasing residential mobility due to storage, logistical organization, and increasing use of cultigens (Shackley 1996a:11).

Transition to Sedentism

Recently, an attempt has been made to combine and redefine the Late Archaic and Early Ceramic periods as the Early Formative period (Roth 1996a). Roth notes that:

> . . . the simple dichotomy between Late Archaic foragers and Early Ceramic period farmers does not appear to be valid for large portions, if not all, of the southern Southwest. Many differences in mobility and sedentism are observed across this region, tied primarily to the environmental setting within which each group acted [Roth 1996b:3].

Stone and Bostwick (1996:17) note that:

> New evidence has . . . revealed that the transition to farming and settled life occurred at different times and in different ways within geographic regions of the Arizona desert.

Roth (1996c:47) indicates that Late Archaic groups in the Tucson Basin were becoming sedentary during this period, possibly in response to increased dependence on agriculture. Their primary residences were in farming-based villages containing pithouses, storage facilities, and middens. However, these groups were not entirely sedentary, since there is also evidence that they exploited the upper bajada zone using seasonally occupied logistical camps.

In contrast, Gilman et al. (1996) suggest that the timing of the transition to sedentism and agricultural dependence was different in the San Simon drainage of southeast Arizona. They found no evidence for Late Archaic sedentary farming villages, and argue that the introduction of pottery was accompanied by no significant change in settlement or subsistence systems. Rather, ". . . the changes to agricultural dependence and residential sedentism were long and gradual processes that were probably not complete until about A.D. 1000 or 1100" (Gilman et al. 1996:73).

Similarly, Mauldin (1996) suggests that residential sites in the Tularosa Basin of southern New Mexico remained small, temporary, and focused on hunting and gathering until ca. A.D. 600. Moore (1997) reached similar conclusions concerning the Mesilla Basin, suggesting the continuance of an essentially Archaic lifestyle long after the introduction of pottery.

Analogous variation is also visible in the Anasazi region. Throughout most of northwest New Mexico, Basketmaker II sites tend to reflect a hunter-gatherer adaptation with some use of horticulture. In contrast, research in southwest Colorado and southeast Utah suggests that the Basketmaker II adaptation in that part of the region was highly sedentary, with a heavy reliance on domesticated plant foods (Fuller 1988, 1989; Matson 1991; Matson et al. 1983; Matson and Chisholm 1986). Fuller (1989:27) supports this idea with evidence from Black Mesa (Arizona), Cedar Mesa (Utah), Durango (Colorado), and Navajo Reservoir (New Mexico). This suggests that sedentary villages existed in part of the northern Southwest by A.D. 1, while other parts of the region continued to be occupied by people who were essentially hunter-gatherers.

The co-occurrence of pottery and a mobile lifestyle have often been considered contradictory in the Southwest. However, studies from elsewhere indicate that hunter-gatherers can also be pottery makers and users. A hunter-gatherer lifestyle prevailed throughout the prehistory of the western Great Basin, with pottery occurring after A.D. 1100 (Elston 1986:145, 148). Pottery was introduced into the eastern Great Basin by A.D. 400 to 500, accompanied by small amounts of corn (Aikens and Madsen 1986:160). However, the immediate impact of these introductions was apparently small, because the same basic lifestyle prevailed for at least several hundred more years (Aikens and Madsen 1986). While the Southern Paiute have made and used pottery since A.D. 1000 or 1200, their subsistence was based on hunting and gathering until the nineteenth century (Kelly and Fowler 1986). Pottery was a late introduction to the Owens Valley Paiute, appearing in the mid-seventeenth century and disappearing about 200 years later (Liljeblad and Fowler 1986:421). Throughout this period, subsistence was based on the exploitation of a wide variety of wild plants and animals. Somewhat further afield, studies of Seacow River Bushmen sites in South Africa have revealed a well-developed ceramic industry coexisting with a highly mobile hunter-gatherer lifestyle along the lines of the Kalahari San (Sampson 1988:39).

Thus, the presence of pottery is not an immediate indicator of sedentism. Neither is its absence absolute proof of a hunter-gatherer lifestyle. Hence, it is possible that the Archaic sites in our study represent sedentary farming villages rather than hunter-gatherer camps. It is also possible that our Pithouse period sites are the remains of a hunter-gatherer occupation, with the transition to full sedentism not occurring until the Pueblo period. While neither possibility is highly likely, they cannot be ruled out by the presence or absence of pottery alone.

Discussion

As this deliberation suggests, standard notions of what constitute mobility and sedentism do not always hold true. In particular, Late Archaic and Early Ceramic period sites can be quite problematic. Aceramic sites might be the remains of nearly sedentary farming villages, while ceramic sites can be indicative of a hunter-gatherer lifestyle. Only by examining the full range of materials and features recovered at a site can we come to grips with this problem. As discussed earlier, one of the ways in which this can be accomplished is a detailed examination of the chipped stone assemblage. In particular, the reduction strategy followed, when carefully tempered by data on local material availability, can be useful in elucidating mobility patterns. Whether or not pottery is present, mobile hunter-gatherers and sedentary farmers are expected to have used different reduction strategies.

Expectations: Mobile Versus Sedentary Chipped Stone Technology

Kelly's Model of Biface Use and Occurrence

Kelly's (1988:721-723) model of biface manufacture and use predicts an association between site type and the structure of a chipped stone assemblage. As noted earlier, this model pertains mainly to hunter-gatherer sites, but its implications can also be adapted to farming sites. The production and use of bifaces as cores should differ in forager and collector settings. Kelly (1988:719) suggests that foragers tend to use few bifacial tools where suitable raw materials are abundant, producing evidence for an expedient reduction strategy lacking biface-cores. However, foragers should use biface-cores when venturing into regions in which suitable raw materials are not commonly available (Kelly 1988:719).

Collectors may use biface-cores during logistical trips, especially if those trips are long: ". . . the longer the logistical foray, the greater the likelihood that a variety of tasks requiring stone tools will have to be performed, particularly if the group must remain out overnight" (Kelly 1988:720). This is because they cannot always predict the conditions that will be met during such a trip, or the equipment that will be required. In such a situation, hunter-gatherers must be prepared for a variety of needs and cannot take the availability of suitable raw materials for granted. Thus, while foragers should only produce and use biface-cores when venturing into areas lacking suitable raw materials, collectors may use biface-cores in areas that contain suitable materials.

When bifaces are used as cores in a forager setting, residential sites should exhibit several characteristics. First, there should be ". . . a positive correlation between measures of the frequency of bifacial-flaking debris, utilized biface flakes, or biface fragments and measures of the total amount of lithic debris" (Kelly 1988:721). In other words, bifacial debris should be common in the chipped stone assemblage, and biface flakes should comprise a large portion of the informal tool assemblage. Cores, especially unprepared specimens, should not be common, and there should be evidence for gearing up at quarries. Residential sites should contain a low percentage of flakes with large amounts of dorsal cortex, and there should be evidence for the use of high-quality materials, possibly from distant sources.

Two basic site categories are expected in situations where collectors produced biface-cores at residential sites for use on logistical forays. Evidence for biface manufacture and maintenance should be common at residential sites and rare or absent at logistical camps. However, evidence for the use of those same bifaces as sources for informal tools should be uncommon at residential sites, and expediently used core flakes should predominate in the informal tool category. The opposite pattern should be visible at logistical camps, which should exhibit a large percentage of informally used biface flakes and few expedient flake tools.

When bifaces functioned as long use-life tools, unifacial examples should be rare, and those that occur may be evidence of expedient tool production. There should also be a pattern of biface manufacture, rejuvenation, and sharpening at residential sites. While the two latter activities can also occur at logistical sites, those sites should contain no evidence for the manufacture of other than expedient tools. Similarly, there may be evidence for the manufacture or maintenance of hafts at residential sites, which should be lacking at logistical camps. Long use-life bifaces should be resharpened or recycled more frequently than other tool types or the same tool type from other regions or time periods.

Finally, bifacial reduction debris should be concentrated in residential sites when bifaces were a consequence of the shaping process. In particular, very small biface flakes should be found at these sites. There should also be a positive correlation between the occurrence of biface fragments and biface flakes. However, few biface flakes should have been used as tools, unifacial examples of bifacial tools should be relatively common, and residential sites should contain evidence for the maintenance of hafted tools.

At this point a short digression is in order. Kelly's (1988) model separates long use-life bifaces from those that are a consequence of the shaping process. However, he does not consider that many tools may reflect both qualities. The fact that certain high-quality lithic materials used in composite tools are rare or from exotic sources does not suggest that they were more important than the haft they were fitted into. While it may be more wasteful of material, it is probably easier to fit a stone tool to a haft than it is to manufacture a new haft or alter the old one to fit a new tool. Thus, it is more likely that the hafting element of a projectile point or knife will be altered to fit into a foreshaft or handle than the wooden element will be altered to fit the stone tool. Stone blades in composite tools usually represent disposable parts; continual reshaping of the wooden element would render it useless long before it might be expected to wear out.

A more appropriate division might be between generalized and specialized bifacial tools. Generalized tools are those that are manufactured to cover a wide range of needs and situations. Many hafted bifaces fit into this category, including large projectile points and knives. When attached to removable foreshafts the former can also be used as cutting tools, and both are parts of reliable tool kits that can be used in a variety of situations. Most unhafted bifaces also fit into this category. Large biface-cores can be used as cutting and chopping tools and as blanks for the manufacture of more specialized forms when needed. Thus, they are also part of a reliable tool kit. In fact, a more proper term for this class of tool may be generalized biface, since biface-core implies that their most important function is as a source of informal tools. Small projectile points are examples of specialized tools because they are meant to have only one function. While they could feasibly be used in a variety of cutting tasks, the small length of available edge makes them very inefficient for tasks other than the one they were designed for. Drills are another example of tools falling into this category, since they can only be efficiently used for boring. It is likely that most specialized bifacial tools are small and hafted.

Thus, we feel that long use-life bifaces are generalized in function, most are large, and they can be both hafted and unhafted. Bifaces that are a consequence of the shaping process are more specialized in nature, most are small, and nearly all are hafted. These added distinctions are used in the remainder of this analysis.

Expectations: Forager Sites

Two situations will produce forager sites of a very different complexion. When suitable raw materials are common there should be little evidence for the use of cores as bifaces; generalized bifaces will be rare and most informal tools should be of expedient manufacture. Mostly specialized formal tools should occur, since in this situation hafts assume a more important role than stone tools. This is because of the relative difficulties in producing different parts of a composite tool. In most instances production of the chipped stone portion is much less time-consuming than is manufacture of the wooden part. When suitable raw materials are available it is easy to simply remove a worn-out or broken stone tool and fashion a replacement that will fit into its haft. Thus, under these material conditions, a predominantly expedient reduction strategy is expected. An exception to this occurs when future movement will be into areas that lack sources of suitable materials. In this case, generalized bifaces may be manufactured at residential sites situated in areas of good quality and abundant materials.

When suitable raw materials are rare or lacking in an area, a curated reduction strategy should be evident, and generalized bifaces will occur on forager sites. Biface debris should be common in the assemblage, and biface flakes should comprise a large portion of the informal tool assemblage. Simple cores and expediently produced informal flake tools may be comparatively uncommon, or of low-quality materials. Evidence for generalized biface manufacture should not occur at residential sites; it should instead occur at residences or quarries where gearing-up activities took place. Thus, there may be no local evidence for generalized biface manufacture. High-quality materials, possibly from distant locations, should predominate in the biface flake assemblage.

We would also expect the presence of generalized bifaces at these forager sites, and projectile points and perhaps knives should be part of the reliable tool kit when suitable materials are rare or of uneven distribution. These tools should be predominantly bifacial, with few expediently produced replacements. The materials from which they are manufactured should be available only from exotic sources, or they should be comparatively rare locally. Specialized bifaces may occur, but should be less common than generalized forms and the materials they are manufactured from will be locally available.

In both cases the array of tools should reflect a wide range of general subsistence, manufacturing, and maintenance activities. Thus, we might expect to find tools related to plant food processing, hunting, woodworking, etc. When suitable raw materials are rare or lacking in an area, only broken and worn-out tools should be recovered and will be made of materials quarried some distance from the site. When suitable materials are locally plentiful, tools that do not appear to be broken or worn out should also be present in the assemblage, and should be made from local materials.

Expectations: Collector Sites

Collector sites should exhibit evidence of a curated reduction strategy focused on the production and use of large generalized bifaces. Thus, biface flakes and fragments of bifaces broken during manufacture should be common on residential sites where suitable materials are available. Both artifact classes should reflect the early and middle manufacturing stages, though indications of late-stage biface manufacture might also be present. However, evidence for the use of biface flakes as informal tools should be uncommon, and most informal tools should be expediently struck core flakes. Both local and nonlocal materials may occur. The latter should be represented by debitage from generalized biface manufacture and tools discarded when broken or worn out; the former by debitage (both bifacially and expediently reduced), cores, and informal and specialized tools. A wide range of subsistence, maintenance, and manufacturing tools should be present, depending upon the length of occupation. All categories should increase in number as the size of the assemblage increases, reflecting longer stays.

An opposing pattern should occur at logistical camps. These sites should contain no evidence of generalized biface manufacture. Thus, while biface flakes might be present, many should reflect use as informal tools, and none should be indicative of the early or middle stages of manufacture. Few fragments of bifaces should occur, and any that do should reflect late stage manufacture. Simple cores, evidence of early stage reduction, and expediently used core flakes should be rare. Though most tools should be focused toward extraction of a particular resource, some evidence for regular maintenance activities might occur. There should be no signs of manufacturing, unless the production of a certain artifact is the focus of logistical activities at the site.

Expectations: Sedentary Farming Sites

Sites created by farmers are not expected to exhibit evidence of a curated reduction strategy. The only exception to this might be logistical sites, and this possibility is considered highly unlikely. This is because, while farmers often retain a certain degree of mobility, it is at a different scale than is the case for foragers and collectors. Movement may be more carefully scheduled so that it does not interfere with farming tasks, and certain areas might be returned to on a regular basis, allowing necessary equipment to be cached.

Residential sites should contain informal tools consisting entirely of expediently struck debitage. Both categories of formal chipped stone tools should be represented, but specialized tools should predominate. Large generalized bifacial tools can occur, but it is unlikely that they were used as biface-cores. A wide range of food procurement and processing, manufacturing, and maintenance activities should be evident in the array of chipped stone tools.

Logistical sites should fall into two categories: farming sites and those focused on extraction of wild resources. Three types of farming sites can be defined: fieldhouses, farmsteads, and field locations. Fieldhouses and farmsteads are at opposite ends of a behavioral range. Where one end of the continuum (fieldhouses) may represent ephemeral structures used for shelter during the work day or for overnight stays of limited duration by task groups, the other (farmsteads) suggest residence by an entire family for a season or more during farming. While both should exhibit an expedient reduction strategy, there will be differences in the range of tools used and discarded at these locations. Fieldhouses should contain a limited range of tools, primarily reflecting an agricultural function. Some evidence of maintenance might occur, but should not be common. Assemblages associated with farmsteads should resemble those of the main residential site, though assemblage size should be considerably smaller. Field locations can be adjacent to structural sites or they can be located a distance from any associated structural site. Few chipped stone artifacts generally occur on this type of site, and those that are present are either specifically related to agriculture or have a very general function.

Logistical sites used for the extraction of wild resources are relatively rare in most areas. This may be due to archaeological visibility, or to differences in subsistence systems between regions. In many ways these sites should resemble logistical camps used by hunter-gatherers. Lack of evidence for the manufacture of generalized bifaces at residential sites suggests that an expedient reduction strategy should be evidenced at these sites as well. Thus, it is likely that the need for reliable tools was met in some other fashion. It is possible that farming task groups simply carried more equipment with them when moving to a logistical camp. It is also possible that when certain areas were exploited annually, much of the necessary equipment was simply cached rather than returned to the residential site. Unfortunately, this is a question that has received little theoretical consideration, and is beyond the scope of this discussion. Tools on logistical sites used by farmers should, like those used by hunter-gatherers, be focused toward extraction of a particular resource, though some evidence for regular maintenance activities might occur. There should be no signs of manufacturing, unless the production of a certain artifact is the focus of logistical activities.

Expectations: Changes in Reduction Strategies Through Time

As discussed earlier, it is possible that Early and Middle Archaic hunter-gatherers were structured as foragers, though by the late Middle Archaic it appears that most populations were following a mixed foraging-collecting strategy. By the Late Archaic, hunter-gatherer populations across the Southwest were fluctuating seasonally between foraging and collecting strategies. By the end of the Late Archaic there is evidence for sedentary farming villages in some areas, mainly along well-watered lowland rivers and streams. Though logistical sites continued to be part of the seasonal round, foraging camps may have mostly disappeared. A possible exception would be during dry years when agriculture was difficult or impossible and the return to a hunter-gatherer existence was necessitated.

Farming villages probably did not occur in the Mogollon Highlands at this early date. Instead, it is more likely that the population continued to live as hunter-gatherers. How late this adaptation lasted is undetermined, though in the nearby San Simon area it appears to have continued until nearly the Pueblo period (Gilman et al. 1996).

Considering the wide availability of lithic materials through the study area (some of which are high-quality), foraging sites should evidence a basically expedient reduction strategy according to the model presented earlier. A curated reduction strategy should be evident on sites occupied by collectors. If Early and early Middle Archaic hunter-gatherers were primarily foragers, there should be little evidence for the manufacture and use of generalized bifaces on sites dating to those periods. These tools should only become important during the late Middle and Late Archaic, and should mostly have been phased out when agriculture became the main subsistence focus.

Only collecting sites should exhibit a focus on the manufacture and use of generalized bifaces, unless foragers were gearing up for a move to an area in which high-quality materials were rare or nonexistent. Using our model we should be able to differentiate between sites produced by these organizational patterns, though the task may be quite difficult.

If agriculture became the main subsistence focus during the Late Archaic and our sites merely reflect logistical camps related to farming villages in the lowlands, the importance of a curated reduction strategy should begin to decline at this time. Since conditions and material availability should be known before movement to the logistical sites occurred, a primarily expedient reduction strategy might be expected. Similarly, if a focus on hunting and gathering remained the basis of the settlement and subsistence system into the Ceramic period, little difference should be seen between Late Archaic and Early Pithouse period chipped stone assemblages. We might expect reliance on a curated strategy to continue, despite the appearance of pottery. The switch to reliance on expedient reduction should only occur when hunting and gathering was relegated to a secondary importance, and agriculture dominated the subsistence system. This was certainly the case by the Pueblo period, and probably by the Late Pithouse period as well.

PROJECTILE POINTS

A topic that has not yet been directly addressed is analysis of the projectile points. In some ways this study is not closely related to the model developed in this chapter, but in others it is. As discussed in greater detail later, these tools are often used to assign temporal and cultural affinity, though there are problems with this usage. Projectile points have some temporal sensitivity, though they are not as sensitive as other artifact classes, especially pottery. However, since the Mogollon region lacks a detailed projectile point typology, at least for the Ceramic period, this application is currently limited. One of the main functions of the projectile point analysis, then, is to examine the assemblage for evidence of temporal trends in style, size, and material use. These data will then be compared with other published reports from the Mogollon region, and will hopefully allow us to propose a tentative typology.

Trends in projectile point design and material use have implications for the larger study. If, as we have asserted, large dart points are a generalized bifacial tool form while small projectile points are more specialized in function, significant differences in tool design and material use should be visible between these classes. Projectile points as generalized tools should be tough and durable to prolong their use-lives and prevent easy breakage by any one task. Projectile points as specialized tools can be more fragile and prone to breakage—they do not have to be used in other tasks. Foragers and collectors should require more generalized hunting tools, while the array of tools used by farmers should be more specialized. These differences could be a consequence of changes in mobility structure, but the possibility that they are instead related to variation in hunting technology must also be explored.

Hunting Techniques

In general, a dart cast concentrates considerably more force and has much more knock-down power than do arrows. Arrows do their damage differently—they cause organ damage and bleed an animal until it weakens and can be finished off. It is possible that these types of weapons represent not just a difference in hunting equipment, but in hunting techniques as well. The knock-down power of darts would allow many instantaneous kills, whether as a direct consequence of the dart's impact or by stunning the animal so it could not immediately escape. Unless an arrow hits a vital organ, most kills using that weapon system are not instantaneous, and require tracking to dispatch the animal. While tracking would sometimes also be required when using darts, the focus of that system was more toward immediate kills or disabling impact, so tracking a wounded animal would be of secondary importance.

Points that remain in wounds continue to cause tissue damage after impact and can prolong bleeding until an animal collapses, as well as provide a blood spoor for tracking. A shaft that remains attached to the point can be pulled out, either purposely or accidentally, allowing the wound to close. This should be of no great consequence if the initial impact caused significant damage. However, if the wound was superficial, bleeding can slow or stop, the animal may not continue to weaken, and the blood trail can disappear. Thus, it was probably desirable to have projectiles remain in wounds. This could be accomplished in two ways—use of a composite dart with detachable foreshaft that would remain in the wound after the mainshaft fell off, and use of points designed to fracture upon impact.

The main difference is that one class of point is meant to remain in the wound and continue causing damage until the animal can be tracked and dispatched, while the other is designed to remain in the wound in case the animal is not immediately dispatched. In the former case, tracking is a planned part of the hunting strategy, while in the latter it is an option used when the strike goes awry. Subtle differences in strategy, perhaps, but differences that should be traceable in the design of weaponry used for hunting.

Mobility Strategies and Hunting Tools

Changes in mobility accompany changes in subsistence strategy. Foraging hunters have to be prepared for a variety of prey and circumstances. Thus, their hunting tools must be generalized. Collectors may use a different strategy, and focus hunting on specific game at different times. This should result in a greater variety of hunting tools that are perhaps also more specialized.

As agriculture becomes more important and a society more residentially sedentary, hunting gear ought to become increasingly specialized toward that one task. If our arguments are correct, these trends should be visible in the projectile point assemblage. Generalized hunting strategies should use points that are large and made from more durable materials than are those prepared for use in specialized strategies. The latter should be designed to fracture or remain in wounds, while the former should not. Hopefully, these changes will be equated with variation in reduction strategies and material acquisition patterns.

CONCLUSIONS

Using these predicted patterns we can examine the array of components identified at our sites and determine how they fit. In turn, this should provide information on changing patterns of mobility and the structure of subsistence systems through time. Unfortunately, only one Middle Archaic and no Early Archaic components were found. Still, we should be able to test most of our expectations against the data and determine how accurate our predictions were.

The model presented in this chapter should also allow us to examine components identified as protohistoric in age. Whether these components represent occupations by Athabaskan hunter-gatherers or are evidence for logistical use of the Mogollon Highlands by historic Pueblo groups can perhaps be addressed. Differences from expected patterns for mobile versus sedentary assemblages must be passed through a screen of data from contemporary Athabaskan sites to determine whether mobility during that period can be measured in the same way as it is for earlier populations.

By examining reduction strategy, material acquisition patterns, and tool-use patterns for these sites, we should be able to assess the type of mobility represented as well as the role of each component in its settlement system.

CHIPPED STONE ANALYTICAL METHODS

James L. Moore

All chipped stone artifacts were examined using a standardized analysis format developed by the Office of Archaeological Studies (OAS Staff 1994). These methods were developed to increase comparability among projects completed across the state. Hopefully, this will allow analysts to investigate specific problems with a much larger data base representing sites distributed through both time and space. The OAS chipped stone analysis format includes a series of mandatory attributes that describe material, artifact type and condition, cortex, striking platforms, and dimensions. In addition, several optional attributes have been developed that are useful for examining specific questions. This analysis included both mandatory and optional attributes.

The primary areas the analysis format was designed to explore include material selection, reduction technology, and tool use. These topics provide information about ties to other regions, mobility patterns, and site function. While material selection studies cannot reveal *how* materials were obtained, they can usually provide some indication of *where* they were procured. By examining the type of cortex present on artifacts it is possible to determine whether a material was obtained from the primary source or from secondary deposits. By studying the reduction strategy employed at a site it is possible to assess the level of residential mobility. Where a high degree of residential mobility is usually accompanied by a curated strategy, sedentary peoples more commonly used an expedient strategy. The types of tools present on a site can be used to help assign a function, particularly on artifact scatters lacking features. Tools can also be used to help assess the range of activities that occurred at a locale.

Projectile points were examined separately in this study. Since over 300 points were recovered, a more rigorous analysis was undertaken to determine whether we could accurately differentiate between types. An experimental format was developed to allow us to pursue this goal, and included many of the attributes examined in the general chipped stone analysis as well as an array of attributes specific to projectile points. Because of the experimental nature of this format, it is likely that some attributes will prove more useful than others. By weeding out the less useful attributes, we hope to create an analytical framework to examine and classify projectile points from New Mexico.

Each chipped stone artifact was examined using a binocular microscope to aid in defining morphology and material type, examine platforms, and determine whether it was used as a tool. The level of magnification varied between 15x and 80x, with higher magnification used for wear pattern analysis and identification of platform modifications. Utilized and modified edge angles were measured with a goniometer; other dimensions were measured with a sliding caliper. Analytical results were entered into a computerized data base using the *Statistical Package for the Social Sciences (SPSS) Data Entry* program.

GENERAL CHIPPED STONE ANALYTICAL METHODS

Four classes of chipped stone artifacts were recognized: flakes, angular debris, cores, and formal tools. Flakes are debitage exhibiting one or more of the following characteristics: definable dorsal and ventral surfaces, a bulb of percussion, and a striking platform. Angular debris are debitage that lack these characteristics. Cores are nodules from which debitage was struck, and on which three or more negative flake scars originating from one or more platforms were visible. Formal tools were artifacts that were intentionally altered to produce specific shapes or edge angles. Alterations took the form of unifacial or bifacial retouch, and artifacts were considered intentionally shaped when retouch scars obscured their original shape or significantly altered the angle of at least one edge. Informal tools were also recovered and were defined by the presence of marginal attrition caused by use. They lack evidence for purposeful alteration to produce specific shapes or edge angles. Evidence of informal use was divided into two general categories—wear and retouch. Retouch scars were 2 mm or more in length, while wear scars were less than 2 mm long.

Attributes

Attributes recorded on all artifacts included material type and quality, artifact morphology and function, amount of surface covered by cortex, portion, evidence of thermal alteration, edge damage, and dimensions. Platform information was recorded for flakes only.

Material Type. This attribute was coded by gross category unless specific sources were identified. Codes were arranged so that major material groups fell into specific sequences of numbers, progressing from general material groups to specific named materials with known sources. The latter were given individual codes.

Material Texture and Quality. Texture was a subjective measure of grain size *within* rather than *across* material types. Within most materials texture was scaled from fine to coarse, with fine materials exhibiting the smallest grain sizes and coarse the largest. Obsidian was classified as glassy by default, and this category was applied to no other material. Quality recorded the presence of flaws that could affect flakeability, including crystalline inclusions, fossils, visible cracks, and voids. Inclusions that would not affect flakeability, such as specks of different colored material or dendrites, were not considered flaws. These attributes were recorded together.

Artifact Morphology and Function. Two attributes were used to provide information about artifact form and use. The first was morphology, which categorized artifacts by general form. The second was function, which categorized artifacts by inferred use.

Cortex. Cortex is the chemically or mechanically weathered outer rind on nodules; it is often brittle and chalky and does not flake with the ease or predictability of unweathered material. For each artifact, the amount of cortical coverage was estimated and recorded in 10 percent increments.

Cortex Type. The type of cortex present on an artifact can be a clue to its origin. A waterworn cortical surface indicates that it was transported by water, and that its source was probably a gravel or cobble bed. A nonwaterworn cortical surface suggests that an artifact was obtained where it outcrops naturally. When cortex type could not be defined, it was categorized as indeterminate.

Portion. All artifacts were coded as whole or fragmentary; when broken, the portion was recorded if it could be identified.

Flake Platform. This attribute recorded the shape and any alterations to the striking platform on whole flakes and proximal fragments.

Thermal Alteration. Lithic materials were sometimes modified by heating at high temperatures for several hours. This process can cause a realignment of the crystalline structure, and sometimes heals minor flaws like microcracks. Heat treatment is most often performed on cryptocrystalline materials like chert, and can be difficult to detect unless mistakes are made. When present, the type and location of evidence for thermal alteration was recorded to determine whether an artifact was purposely altered.

Waxiness. The degree of waxiness was recorded as an adjunct to information on thermal alteration. Some materials develop a waxy luster when heated to improve flakeability; in particular, cherts, flints, chalcedonies, and some silicified woods can develop this characteristic. Unfortunately, some materials are naturally waxy, so this is not always a good measure of thermal alteration. However, when a specific material is known to lack a waxy luster in its natural state and develop one when heated, this attribute can be used to help determine whether thermal alteration occurred.

Wear Patterns. Use of a piece of debitage or core as an informal tool can result in edge damage, producing patterns of scars suggestive of the way in which it was used. Thus, edge damage, both cultural and noncultural, was recorded and described when present. A separate series of codes was used to describe formal tool edges, allowing measurements for both categories of tools to be separated.

Edge Angles. The angles of all modified informal and formal tool edges were measured; edges lacking cultural damage were not measured.

Dimensions. Length, width, and thickness were measured for all artifacts. On angular debris and cores, length was the largest measurement, width was the longest dimension perpendicular to the length, and thickness was perpendicular to the width and was the smallest measurement. On flakes and formal tools, length was the distance between the platform (proximal end) and termination (distal end), width was the distance between edges paralleling the length, and thickness was the distance between dorsal and ventral surfaces.

Core Numbers. Core numbers were assigned to artifacts during analysis if they met certain criteria. In order to be assigned a core number, a material had to be distinct and relatively rare in an assemblage. In other analyses, this attribute has proven useful in tracking the reduction of certain materials, cores, or tools, allowing a more accurate examination of site structure (Moore 1997, n.d.a). Unfortunately, this attribute was not recorded during all phases of this analysis, so it is available for only a sample of sites. In addition, few materials were amenable to this type of analysis.

Discussion

Examination of changes in mobility patterns through time is an important focus of this analysis. While models like that developed by Kelly (1985, 1988) focus on the use of different types of bifaces, debitage are usually by far the most common artifacts recovered from sites. Bifaces tended to be carried off unless lost, broken, or worn out, so direct evidence of a curated technology is often absent.

In order to facilitate our examination of mobility, flakes were divided into removals from cores and bifaces using a polythetic set of variables (Fig. 3.1). A polythetic framework is one in which fulfilling a majority of conditions is both necessary and sufficient for inclusion in a class (Beckner 1959). The polythetic set contains an array of conditions, and rather than requiring an artifact to meet all of them, only a set percentage in any combination need be fulfilled. This

WHOLE FLAKES

1. Platform:
   a. has more than one facet
   b. is modified (retouched and abraded)
2. Platform is lipped.
3. Platform angle is less than 45 degrees.
4. Dorsal scar orientation is:
   a. parallel
   b. multidirectional
   c. opposing
5. Dorsal topography is regular.
6. Edge outline is even, or flake has a waisted appearance.
7. Flake is less than 5 mm thick.
8. Flake has a relatively even thickness from proximal to distal end.
9. Bulb of percussion is weak (diffuse).
10. There is a pronounced ventral curvature.

BROKEN FLAKES OR FLAKES WITH COLLAPSED PLATFORMS

1. Dorsal scar orientation is:
   a. parallel
   b. multidirectional
   c. opposing
2. Dorsal topography is regular.
3. Edge outline is even.
4. Flake is less than 5 mm thick.
5. Flake has a relatively even thickness from proximal to distal end.
6. Bulb of percussion is weak.
7. There is a pronounced ventral curvature.

ARTIFACT IS A MANUFACTURING FLAKE WHEN:

If whole it fulfills 7 of 10 attributes.
If broken or platform is collapsed it fulfills 5 of 7 attributes.

Figure 3.1. Polythetic set for distinguishing manufacturing flakes from core flakes.

array of conditions models an idealized biface flake and includes data on platform morphology, shape, and earlier removals. The polythetic set used here was adapted from Acklen (1983). In keeping with that model, when a flake met 70 percent of the listed conditions it was considered a removal from a biface. Those that did not were classified as core flakes. This percentage is high enough to isolate flakes produced during the later stages of biface production from those removed from cores, while at the same time it is low enough to permit flakes removed from a biface that do not fulfill the entire set of conditions to be properly identified. While not all flakes removed from bifaces could be distinguished, those that were can be considered definite evidence of biface reduction. Instead of rigid definitions, the polythetic set provides a flexible means of categorizing flakes and accounts for some of the variability seen during experiments.

Distinguishing between biface and core flakes in an assemblage is an important step in defining basic reduction technology. A predominance of biface flakes, particularly those removed from large generalized bifaces, suggests a high degree of mobility. Conversely, a predominance of core flakes and only a few biface flakes suggests limited formal tool manufacture by a sedentary population. Thus, by separating these classes of debitage we should be able to more accurately assess the level of mobility demonstrated by the occupying group.

The Projectile Point Analysis

Projectile points are formal tools whose primary use was as parts of composite weapons. These tools form the piercing tip of spears, darts, and arrows, and were either attached directly to the shaft or to a separate foreshaft that was then socketed into a mainshaft. Projectile points are comprised of two parts, blade and stem. Blades are distal portions because they are situated away from the point of attachment to the main body of the weapon; they are piercing elements and contract to a point. The stem (or base) is the hafting element, and is the part that is attached to the mainshaft or foreshaft. This part of the point is considered the proximal end, and is generally altered in some way to facilitate hafting. In early points this often takes the form of basal grinding, while later points are usually notched to provide a more secure attachment.

Several attributes examined by the projectile point analysis corresponded to those studied in the general chipped stone analysis to provide comparability. Thus, material type and quality, artifact morphology and function, portion, edge alteration and angles, evidence of thermal alteration, and dimensions were recorded for all projectile points. When possible, codes used for the general chipped stone analysis were also used in the projectile point analysis. Upon completion of this study, a conversion program was written for SPSS to create data lines that were added to the general chipped stone files to produce a complete inventory for each site.

Artifact-Specific Attributes

A series of attributes were used to examine each point and provide data that, hopefully, will allow us to attain the goals of this study. They include break pattern, preform morphology, reduction technique, regularity of scarring, extent of scarring, cross section, blade shape, barbs, overall blade length, hafting element shape, tang, hafting element measurements, overall measurements, notch type, notch condition, notch shape, and notch measurements.

Break Pattern. This attribute was recorded for all fragmentary points to examine how and when they were broken. In particular, we looked for evidence of fracturing during manufacture or use. Breakage patterns defined and illustrated by Johnson (1979, 1981) were used as examples.

Preform Morphology. This attribute was a measure of the extent to which the original form of an artifact was altered during tool manufacture, and allowed us to separate points that retained some or much of their original debitage form from those that were completely altered by flaking.

Reduction Technique. Percussion flake scars tend to be large and often irregular in shape, while pressure flake scars are usually small and ribbon-like, with high length to width ratios. Both techniques were often used in the manufacture of a single artifact. This attribute was a subjective measure of the reduction technique(s) used to produce a point, and allowed estimation of the approximate proportions of percussion and pressure flaking used.

Regularity of Scarring. This attribute was used to measure the pattern and regularity of scarring on both surfaces of a projectile point.

Extent of Scarring. This was a subjective measure of the amount of preform surface removed by flaking. Both surfaces were considered when estimating the amount of flaking that occurred.

Cross Section. This attribute recorded the shape of a point along a plane perpendicular to the midline.

Blade Shape. This was the plan view shape of the business end of a projectile point. For lanceolate points, shape referred to the whole artifact. When a point contained both blade and stem, the shape of the stem (base) was ignored, and only the shape of the blade was recorded.

Barbs. Barbs are extensions at the proximal end of a blade edge that often function to stop a point from working its way out of a wound. For this reason barbs are almost always pointed, and points are usually wider across the barbs than across the base. Barbs occur at the shoulders of stemmed points and form the upper edge of notches in notched points. This attribute recorded whether barbs were perpendicular or oblique to the midline of a point.

Overall Blade Length. This dimension measured the distance from the juncture of blade and stem (if present) to the distal end (tip) along the midline.

Hafting Element Shape. This attribute recorded the plan view shape of the proximal end (stem or base) of a point.

Tang. Tangs are extensions at the proximal end of the hafting element. Notched points are generally wider at the tang than at the neck, which is the point at which they are attached to a shaft. Thus, tangs prevent the point from being pulled out of the shaft. In some instances they act similarly to barbs, preventing the point from being withdrawn from a wound. This attribute recorded tang shape.

Hafting Element Measurements. Three measurements were taken for each hafting element (stem or base): width at the point of attachment to the blade (neck), length (distance from its juncture with the blade to the proximal end), and maximum thickness.

Overall Measurements. These attributes recorded the overall maximum length, width, and thickness of each projectile point.

Notch Type. This attribute recorded the location and orientation of hafting notches.

Notch Condition. This category recorded the physical condition of notch elements (tangs and barbs); i.e., whether or not they were damaged.

Notch Shape. This category recorded general hafting notch shape.

Notch Measurements. Two measurements were recorded for hafting notches—length and width. Length was the distance from the end of the barb to the inner edge of the notch, and width was the distance from tang to barb. When two notches were present, measurements were averaged.

Edge-Specific Attributes

Several attributes were recorded for each extant edge of a point including edge element, edge shape, serration, residue, resharpening, edge length, utilization, and edge angle.

Edge Element. This attribute coded whether a blade or basal edge was being recorded.

Edge Shape. This category referred to the shape of an edge, not to the shape of the corresponding blade or stem.

Serrations. The presence or absence of serrations along blade edges was recorded by this attribute.

Residues. The presence or absence of residues along blade edges was recorded by this attribute.

Resharpening. This category recorded evidence of resharpening along blade edges.

Edge Length. This attribute was the length of the edge being analyzed, and extended from barb or shoulder to the tip. The length of a basal edge was the maximum width of the point at the hafting element, except when a contracting stem was present.

Utilization. Evidence of scar patterns attributable to use or platform preparation during manufacture was recorded by this attribute.

Edge Angle. The angle formed by the intersection of upper and lower point surfaces at an edge margin.

Discussion

A preliminary examination of the data produced by this analysis suggests that some of the attributes recorded were of less utility than others. For instance, there were very few definite examples of resharpening, utilization, or residue adherence in the assemblage. When present, these characteristics might be better handled as comments rather than specifically coded attributes. Similarly, blade edges on the same artifact tended to have similar measurements except when the blade was broken. Rather than coding edges separately, it may be preferable to average edge lengths (as was done with notch dimensions) and create codes that would allow inclusion on a single data line. Then again, examination of attributes such as edge angle can be enhanced by coding edges separately, so this procedure has both benefits and drawbacks.

Artifact functions were coded using general values during the initial analysis, except in the case of Archaic forms, which tended to have specific names assigned to them. As detailed in a later chapter, this procedure yielded less than useful results. Thus, except for undiagnostic fragments, the assemblage was reassessed and new codes were assigned that are specific to this analysis. In this way, we were better able to track variations between sites and across time. While Archaic points still received the traditional names, Ceramic period points were assigned descriptive designations.

PROJECTILE POINTS

James L. Moore

This discussion covers several topics concerning projectile points in general, as well as the assemblage from our sites. It is often helpful to know the perspective of a researcher in order to assess their conclusions, because that outlook usually guides the way in which material is presented as well as which data introduced are relevant. Thus, this chapter begins with a discussion of such topics as projectile point typologies, points as chronological markers, and their use in defining cultural affinity. Once our beliefs and biases concerning these topics are presented we move to a discussion of the projectile point styles used in this study. Finally, we approach the data themselves, and see what they tell us about our sites and the people who used them.

Typology, Cultural Affinity, and Chronology

An interesting phenomenon was observed as this topic was researched. A plethora of projectile point types have been named and described for the nearby Plains and Great Basin provinces. Most of the styles described for those regions have dates assigned to them (though they are often inexact), usually beginning with Paleoindian hunters and extending into the protohistoric and early historic periods. Some types are even considered to be indicative of specific cultural groups. In the Southwest, this category of artifact has been treated in a different fashion. While many Paleoindian and Archaic types have been named and described, as soon as pottery appears projectile points fall out of favor and are no longer considered accurate diagnostic tools. This view has merit, since point styles tended to have much longer life spans than most ceramic types and are thus of less utility as temporal indicators. However, this attitude has caused most researchers to virtually ignore this artifact class for the Ceramic period.

Interestingly, it is mainly early researchers like Joe Ben Wheat, Emil Haury, and Paul S. Martin and his many associates who attempted to describe, illustrate, and define the projectile points of the Mogollon region. This has resulted in a veritable lack of type and temporal distinctions for the Ceramic period. Some researchers note general trends visible in their data, but there have been few attempts to separate Ceramic period points into a coherent assemblage of styles and explore their temporal or cultural connotations. In essence, the splitters moved into the realm of ceramics in the Southwest, while projectile points tended to be lumped into more general categories.

While this situation is not necessarily bad, it means that changes in projectile point style during the Ceramic period have been treated in a cursory and perhaps oversimplified manner. For example, early arrow points in the Eastern Anasazi region are considered to follow the same general stylistic pattern as Late Archaic dart points, except they are smaller. Thus, small triangular corner-notched points are usually thought to date to the Basketmaker III and perhaps Pueblo I periods, when they were replaced by side-notched forms. However, analysis of the chipped stone assemblage from a seventeenth-century farmstead near Pecos Pueblo showed that small corner-notched points were the most common type used and manufactured at that site (Moore n.d.b). This is contrary to conventional wisdom, and suggests that the situation is far more complex than is often assumed.

While it is unlikely that we will solve this problem through a single study, it is important to recognize its existence. If simple trends like notching style are not as clear-cut as they often seem, then other trends are probably also of both temporal and cultural relevance. Thus, while the projectile points in our assemblage are assigned to specific types using morphological characteristics, variation within those types will also be examined, when sample size permits, to determine whether changes in certain attributes (both metric and morphological) are temporally or culturally relevant.

Typological Considerations

Few modern Southwestern archaeologists consider projectile points in a systematic and comparative manner unless they derive from prepottery sites or levels. This is understandable, since points rarely provide the same degree of chronological control possible with pottery, which is more immediately responsive to changes in regional styles or organizational systems. Projectile point "types" are simply labels assigned to artifacts that possess certain attributes that have been deemed important by archaeologists (not necessarily by their makers), and can be both useful and dangerous tools.

Type classifications are useful because they represent an archaeological shorthand for description. Unfortunately, they also carry connotations of date and cultural affinity. When used for the region in which they were defined, types can be valuable tools. When applied outside those regions they can cause confusion and misinterpretation. For example, the Pinto point was one of the first Archaic types to be named in the West. It was initially described by Amsden (1935) in a monograph on the Pinto Basin site by Campbell and Campbell (1935). Similar points from the Great Basin and Southwest were initially labeled Pinto points, and some sort of cultural connection was assumed. While more localized typological labels are now used in some regions, in others they are not. Thus, some reports from southeast Arizona and southwest New Mexico refer to Pinto points, while others refer to identical styles as San José points. The defining factor appears to be the region in which the archaeologist who is applying the label received their training. However, each of these labels carries different temporal and cultural connotations, and it is always possible that neither is directly applicable to the area being studied.

This problem is demonstrated by Holmer (1986) for the Great Basin. Bifurcate-stemmed points from that region have often been compared to the Pinto series, but tend to fall into two distinct temporal groups—6300 to 4200 B.C. and 3000 to 1300 B.C. (Holmer 1986:97). Discriminant analysis indicated that the sample of points used for his study could be morphologically divided into two distinct assemblages that essentially replicated the temporal groups, though there was some overlap and 5 percent of the assemblage was incorrectly classified (Holmer 1986:97-98). Not only is there a time differential between these categories, they also vary spatially:

> . . . there are essentially two overlapping areas where the early and late sequences of bifurcate-stemmed points occur. For most of the study area, the pattern is simple: east equals early and west equals late. For the northeastern portion, however, points dating to both periods occur [Holmer 1986:99].

By incorrectly assigning a type label to a bifurcate-stemmed point from the Great Basin it is possible to assume a date that is off by over a thousand years. When the same type designations are used outside the Great Basin, it is likely that even greater errors will be made.

Another example from the same region concerns contracting-stem points. Excavation data suggest that this style was introduced into the Great Basin from the southeast, and its adoption was not immediate throughout the region; the greater the distance from the southeast edge of the basin, the more recent is the introduction of this style (Holmer 1986:112-113). Thus, contracting-stem points from the southeast Great Basin may be considerably older than similar points from further north.

If type designations are used outside the region they were designed for, the likelihood that error and misinterpretation will occur must be considered. Significant temporal differences can even occur within a region. Thus, one cannot assume that similar points from northwest and southwest New Mexico have the same time span or cultural affinity unless it can be demonstrated using complementary data.

Unfortunately, typological designations from other regions have begun to be applied to the Southwest. In particular, type names defined for the Great Basin have been given to similar styles in New Mexico. One example involves large side-notched Archaic dart points. In the past, researchers tended to show a Southwestern bias when these points were found, and they were usually labeled Chiricahua points (for example, Moore 1980), even when they varied significantly from published descriptions of that type. More recently, it has been suggested that many of these points actually represent Great Basin types such as Sudden or San Rafael Side-Notched (Elyea and Hogan 1983:401). Since they occur on sites that appear to date to the proper time period for those styles, it is possible that they are related forms or indicate close interaction with Great Basin groups. If the latter can be demonstrated using other categories of data, this application may be warranted. However, those data are currently lacking, and few examples of this type have been absolutely dated. Thus, it is currently impossible to determine whether they represent similar styles used at the same or different times as those in the Great Basin and are evidence of interaction or independent development. When type names from elsewhere are assigned without qualification, connotations of temporal or cultural affinity may be inadvertently made.

Similarly, type names for late prehistoric and protohistoric points from the Great Basin are being assigned to specimens from New Mexico. Desert Side-Notched and Cottonwood Triangular are type names from that region, and have been assigned to points found on early Navajo sites in northwest New Mexico (Brown et al. 1991; Brown et al. 1993; Kearns 1996). Holmer (1986:107) notes that side-notched points from the Great Basin were generally assigned to the Desert Side-Notched type until it was realized that significant variation, both temporal and spatial, existed. Early examples occurred on sites dated between A.D. 800 and 1200 in the southeast part of the basin, and were associated with Fremont pottery. The later variety occurred on sites dating between A.D. 1200 and 1700 throughout the basin, and were associated with Numic ceramics. Only the later variety is still classified as Desert Side-Notched. Cottonwood Triangular points occasionally occur on Fremont sites, but are most common on Numic sites dating after A.D. 1300 (Holmer 1986:108).

Thomas and Bierworth (1983:179) combine the Desert Side-Notched and Cottonwood Triangular types into the Desert series, which they date between ca. A.D. 1300 and 1850. As Kearns (1996:131-133) notes, while these types are often assumed to have been made by Shoshoneans, similar points are found throughout the west. Citing Buckles (1988:222), he contends that they are more appropriately considered markers of the late prehistoric, protohistoric, and early historic periods (Kearns 1996:131). Indeed, they are the most common types on early Navajo sites (Kearns 1996:133), and according to Hester's (1977:10) description, points similar to Cottonwood Triangular are the most common form from Mission period sites in Texas. Unfortunately, assigning these names to points outside the Great Basin suggests some sort of connection, whether temporal, cultural, or diffusional. While such an association is certainly possible, it remains undemonstrated.

A more alarming example of this trend is the analysis of materials from the OLE electric transmission line in the Jemez Mountains (Brown et al. 1993). Rather than importing a few type names into the Southwest, they use entire projectile point series from the Great Basin. As they note:

> The Elko series is not commonly recognized in New Mexico, although it includes many or most notched dart points found in contiguous states to the north and northwest [Brown et al. 1993:405].

They then proceed to differentiate large corner-notched dart points into En Medio and Elko series points based on notch width; those with notches less than 5 mm wide were placed in the Elko series, while those with wider notches were classified as En Medio points. Unfortunately, they fail to discuss how this differentiation was derived. They do note that the narrower notched points resulted from ". . . a finer pressure flaking technology" (Brown et al. 1993:405), thus implying that points assigned to the Oshara series were somehow inferior to those assigned to the Elko series. They continue in this vein, assigning small arrow points with deep corner notches to the Rosegate series, and those with shallower notches to the Oshara series. Again, they subtly imply that points assigned to the Great Basin series were superior in manufacture than those assigned to the local series. The same procedure is followed with small side-notched points, though in this case a disclaimer is appended:

> An important distinction in the OLE analysis was the separation of such points with a straight or convex base from those with a concave base and a longer stem. The latter was assigned to the Desert series. . . . Although Desert Side-notched points occur frequently in Anasazi sites, only those without the distinctive basal concavity or notching characteristic of the Desert series were placed in the Puebloan category. This distinction is strictly typological; though it does have chronological implications, we do not mean to imply any difference in cultural affiliation [Brown et al. 1993:407].

However, the simple use of the term "Desert series" has the same cultural and chronological implications as did the use of Elko and Rosegate series for other forms, even though they note that their use is strictly typological.

Interestingly, they criticize other researchers for doing precisely what they are attempting to do. As noted earlier, large side-notched dart points were once commonly assigned to the Cochise series, and were often classified as Chiricahua points. They note that while this style of point sometimes occurs on Cochise sites, they are rare at the type locations. They consider such an assignment ". . . both loose typologically and misleading, since assumptions commonly are made regarding cultural affinity with the Cochise tradition" (Brown et al. 1993:405). Yet, this is *exactly* what they have done in transferring three point series from the Great Basin to northern New Mexico.

What this discourse is attempting to say is that one should be very careful when using a type or series defined for one area in another. When this is done, any assumptions that are made should be carefully enumerated. This is what Kearns (1996) does when associating the Desert Side-Notched and Cottonwood Triangular types with similar or identical forms from Navajo sites in northwest New Mexico. He discusses how these types are more widely distributed than was thought at the time they were defined, and extends the applicability of the type designation in space. But even so, difficulties can still arise. Projectile points resembling the Cottonwood Triangular form occur throughout the Mogollon sequence in southwest New Mexico, and points similar to the Desert Side-Notched form are found from the Late Pithouse through Late Pueblo periods in the same region. Thus, if the Great Basin names are used, it must either be totally without temporal or cultural connotations, or their applicability must be carefully limited to certain temporal and cultural conditions. Ideally, new names should be assigned to prevent unwarranted assumptions concerning cultural affinity or date.

Cultural Affinity

As noted above, by assigning a type designation to a point, one is also providing a de facto specification of date and often culture. It is all well and good if this is the purpose of assigning that designation, but problems can arise if it is not. Assigning the Cottonwood Triangular label to a point from a Mogollon pithouse village could suggest a multicomponent situation. While the site should date before A.D. 1000, the use of this type designation can suggest an occupation after A.D. 1300 by a non-Mogollon group. This assertion would not be out of line if there was evidence of an early Athabaskan occupation. However, if such evidence is lacking it can lead to a misinterpretation of the researcher's intent.

Similarly, the use of Archaic dart point names from the Oshara series for the Cochise area, and vice-versa, is often taken as an indication of cultural overlap or contact, even when that is not the intent of the researcher. This is a problem, because we are still in the dark concerning how projectile point styles relate to culture. For example, Berry and Berry (1986) feel that the presence of a variety of projectile point styles in an Archaic site indicates the mixing of materials from different "traditions." As they note:

> The Chiricahua stage is an amalgam of point types from a variety of lithic traditions. Their co-occurrence is attributable to secondary deposition in alluvial contexts, and arbitrary level excavation at complexly stratified cave sites. It is, of course, possible that these different traditions were contemporaneous in the Southwest (we strongly suspect that some were), but chronometric and stratigraphic controls at Archaic sites have been so abysmally neglected that it would be premature to hazard a guess on this matter [Berry and Berry 1986:281].

While much of what they say is true, the general impression is that projectile point styles can be equated with ethnicity. There appears to be no room for the possibility that a variety of point styles were used at the same time by the same group.

This notion is opposed to ideas developed by Holmer (1986:112), who notes that it is tempting to think of projectile point styles as indicative of cultural identity, but that it is also possible they are instead related to function. Changes in point styles in an area through time were not necessarily due to ethnic replacement, as Berry and Berry (1986) seem to suggest. Information flow was probably responsible for many changes:

> The sharing of a point style requires only that groups are mobile and consistently communicate with adjacent groups, whether or not they are of the same ethnic origin. Consistent communication among hunter-gatherer groups could easily result from frequent encounters during subsistence activities, e.g., pursuit of the same resources in the same area. Therefore, the more sharing of resource areas, the more potential for the sharing of the technology that was appropriate to harvest the resources. This accounts for widely dispersed point types during the Archaic and for much more regional variation . . . when Fremont horticultural groups in the eastern intermountain region were apparently living a much more sedentary lifestyle. To summarize, the distribution of projectile point types . . . can be viewed as a product of information flow [Holmer 1986:112].

Thus, the blurring of what are perceived by archaeologists to be ethnic boundaries by projectile point styles might be no more than evidence of information flow. A new style might be used in an adjacent region for a short period of time, then be rejected as unsuitable. Or it might replace the style(s) currently in use. Then again, it could be seen as suitable for use on only certain game animals or in specific circumstances that are socially or ritually prescribed. Certain styles could be the property of ritual organizations who cross-cut several language groups, different styles might be used by young and old men, or by men and women. Then again, perhaps the use of a variety of projectile point styles was for more practical reasons. Holmer (1986:112) suggests that the use of notched versus contracting-stemmed points was related to how they were attached to the shaft. Notched points (including expanding-stemmed forms with no actual notching) were tied to shafts using sinew, while contracting-stemmed forms were attached using pitch. As he notes:

> To change a side-notched point, the sinew . . . would have to be cut and rewrapped, which would take time, effort, and materials. To change a contracting stem point, however, the sinew would not have to be replaced. The pitch would simply have to be heated to melt it slightly, the broken point removed, and the new point inserted. This would require less time and energy than replacing a notched point [Holmer 1986:112].

Thus, a variety of points might be used by members of a single group in response to the availability of suitable materials for hafting. Mixing is inevitable in such a case. One would not immediately replace all notched points when pitch became available once again; points would only be replaced when they became unsuitable for use.

We have no idea how material availability, ideology, tradition, or age and gender differences might have affected the use of particular styles of tools in the prehistoric Southwest. Considering projectile point styles to be indicative of ethnicity is simply not supported by the data at this time. Likewise, the idea that each group of hunter-gatherers used only one style of projectile point is also not supported. This certainly was not the case for the later farming peoples of the Southwest. At Crooked Ridge Village individual pithouses dating to the Circle Prairie and San Francisco phases each contained three to four point styles (Wheat 1954). The Wind Mountain site and RO locus provide similar data; 16 of 19 pithouses that yielded multiple identifiable projectile points contained two to four styles apiece (Woosley and McIntyre 1996:238-241). Multiple points were found on the floors or in floor fill in 5 instances, and more than one style was present in two of those cases. A small farmstead near Pecos that was used for only a few years yielded numerous projectile points, and at least seven styles were identified (Moore n.d.b). Judd (1954:254) recovered three caches of projectile points from burials in Room 330 at Pueblo Bonito. The most interesting of these was Burial 10, which contained the remains of a quiver of arrows that combined both corner- and side-notched points.

From just this brief discussion, it is obvious that multiple styles of projectile points were used at the same time during the Ceramic period. Evidence from the farmstead near Pecos suggests that a wide variety of styles was used by a single family, and the data from Pueblo Bonito suggest that even individuals made use of more than one style of point. Thus, we can neither assume that the use of a specific projectile point style is indicative of ethnicity, nor that any single group of hunter-gatherers or farmers necessarily restricted itself to only one style. Unlike pottery, which can be decorated in a myriad of fashions using a variety of slips, paints, and surface textures, projectile points are more restricted in form. There are just so many ways that a point can be shaped and still remain serviceable. Certainly some styles were purposely manufactured as indicators of group identity or ideology. Elaborate Hohokam points may have been the work of craft specialists, and were almost exclusively used as funerary objects (Gumerman and Haury 1979:83; Haury 1976:296-297). More mundane pursuits appear to have been carried out using less elaborate points that were not made by specialists, and that differed little from points used for similar purposes by groups throughout the Southwest.

Summary

Care must be taken when assigning projectile points to types, particularly those that originate in other areas, whether just over the border or several hundred kilometers away. Type names often carry connotations of chronology and cultural identity that may not hold true from one area to another. Indeed, what is essentially the same type may have a variable temporal distribution, as Holmer (1986) asserts for contracting-stem points in the Great Basin.

While certain styles are often assumed to be indicative of specific cultural identities, in most cases this is not demonstrated by the archaeological record. Point types identical to those defined for the Oshara tradition of northern New Mexico (Irwin-Williams 1973) occur throughout the Cochise area and in the Chihuahuan area of south-central New Mexico (MacNeish and Beckett 1987). They are also common in the Great Basin. Does this mean that a single cultural group occupied that vast area, or is it more likely that communication and interaction were responsible for the spread of these types? The latter seems much more likely. As indicated here and in earlier parts of this discussion, projectile point styles are simply not closely related to ethnicity. They cross-cut cultural boundaries, and are probably related to hunting technology, function, communication, and material availability more than anything else.

As was also discussed earlier, dates for certain projectile point styles can vary from region to region and even within regions. If Holmer's (1986) conclusions concerning the dating of contracting-stem dart points in the Great Basin are correct, at least one instance of the spread of a new hafting system across a large area can be traced. This type, often called Gypsum Cave in the Great Basin and Augustín in the Southwest, may have spread from southeast to northwest across that region. Indeed, in the Southwest the Augustín point is most often associated with Middle Archaic (ca. 3800 to 1800 B.C.) materials, though it may have persisted into the Late Archaic (ca. 1800 B.C. to A.D. 400). Dates for this type in the Great Basin are later, and show a temporal progression from southeast to northwest (Holmer 1986). Thus, it is likely that this style originated in the Southwest (or parts further south) and spread into the Great Basin. Using accepted temporal ranges from the Southwest for the Great Basin would provide dates that are too early, and Great Basin dates would similarly be too late for the Southwest.

Thus, projectile point styles are not good indicators of cultural or temporal relationship between regions, and sometimes not even within a single region. Projectile points will probably never reach the same level of accuracy as temporal and cultural indicators that pottery has attained for the Southwest. However, they may have considerably more potential than is usually recognized. Realizing these limitations, this study will attempt to examine projectile points in a chronological and cultural framework. When type names are applied, it should be remembered that no assumptions concerning chronology or cultural affiliation are being made unless those assumptions are specified. This is where one of our biases occurs. Having received our initial training in northwest New Mexico, we apply type designations from the Oshara series to Archaic points of similar appearance, rather than using the Pinto designations. However, these names are not only used because of similarities between point styles. Rather, we believe there were close ties between the Archaic occupants of northern and southern New Mexico through at least the end of the Middle Archaic period. Thus, rather than being indicative of only one Archaic region, they may be diagnostic of several. If true, extension of the Oshara typology to the south is justified. If wrong, this extension is inappropriate and new type names should be assigned. In other cases, similarities between styles are noted when they occur, but typologies from other regions are not used. Hopefully, this will avoid unnecessary confusion about the temporality and cultural affinity of the population using those styles.

Development of a Typology

A search of the literature found no recent projectile point typologies for the Mogollon region, and no really comprehensive typologies at all. The most useful typologies were produced in the 1950s and 1960s. While some later reports from the region contain profuse illustrations of points (for example, Fitting 1972; M. Nelson 1986), they do not develop a comprehensive typology. One of the most ambitious attempts was produced by Haury (1950), based on his excavations at Ventana Cave. While the later deposits at this site are more properly classified as Hohokam and Papago, there are many parallels with the Mogollon Highlands in the earlier deposits. In general, the typology developed for the Archaic period at Ventana Cave proved useful, and illustrations of protohistoric and early historic Papago points were also both useful and illuminating. Dick's (1965) report on excavations at Bat Cave also proved very useful in developing a typology for Archaic projectile points. Though heavily based on Haury's (1950) typology, Dick provided important corroborative data as well as illustrating and naming new types. The only attempt at constructing a comprehensive typology for the Mogollon occupation of the region was produced by Wheat (1955), based on his investigations in the region as well as those of others.

While other archaeologists provide illustrations and occasionally comparisons of projectile points recovered from their sites with those found by earlier researchers, the reports listed above provide the most detailed discussions of projectile points for the region. It is not the purpose of this analysis to develop a new typology, nor do we wish to invent names for those types that currently do not have typological designations. Rather, we wish to assess the array of points recovered from the sites investigated during this project in light of the findings of earlier researchers. In particular, how do the types of points and their associated dates compare with earlier findings? Unnamed types will receive generic typological designations that can be matched to more complete descriptions.

For the Archaic period we will also compare the array of points recovered with typologies developed for adjacent regions, especially other parts of the Southwest. In particular, we will draw upon typologies developed for the Oshara series (Irwin-Williams 1973; R. Moore 1994), the Chihuahuan series (MacNeish and Beckett 1987, 1994), and the Cochise series (including recent types defined in southeast Arizona).

Procedure

All projectile points were analyzed using the techniques and attributes discussed in the section entitled Analytical Methods. This framework is experimental and contains a number of attributes that were initially considered important, but as analysis proceeded were found to be less valuable than anticipated. Our preliminary type designations were useful in a general sense, but were unsuitable for comparative purposes, except for the few Early and Middle Archaic points recovered. Since most specimens from those periods were of well-defined and established types, the initial typologic designations were adequate. This was not the case for most Late Archaic and Mogollon points. Our general typology was simply not fine-grained enough to distinguish what appeared to be significant variation in that part of the assemblage. In order to correct this deficiency, we first sorted the assemblage intuitively by shape and size. This produced a large number of categories, many of which were initially difficult to justify. Three size categories were distinguished including small, medium, and large. Small points were equated with arrows, large points with darts, and medium points could go either way. Four general characteristics of form were used to distinguish varieties: notching style, base shape, blade form, and amount of flaking. Once the points were sorted intuitively, we had to determine whether or not those categories were real, and how to more accurately define the attributes used to distinguish between them.

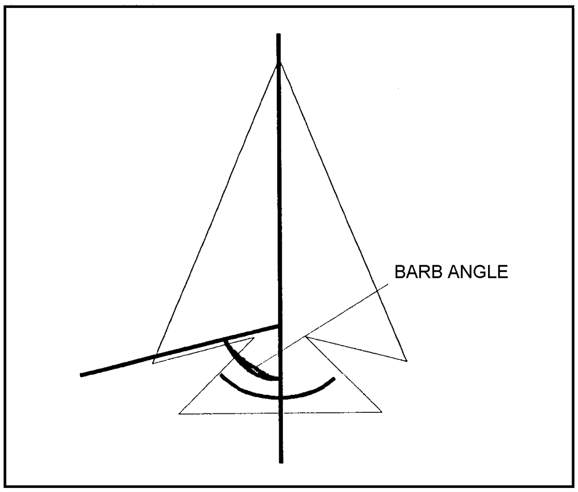

Figure 3.2a. Barb angles.

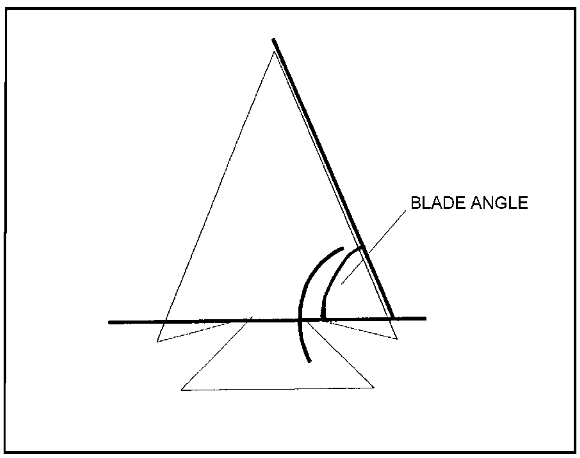

Figure 3.2b. Blade angles.

The intuitive size categories appeared to be real, though whether or not they can be equated with the type of projectile upon which the points were mounted is questionable, and is examined in more detail later. The large number of fragmentary points in the assemblage (mostly those missing varying amounts of their distal ends), precluded using length to distinguish between categories, so width was used to distinguish between size classes. All points categorized as small were less than 15 mm wide; medium were 15 to 25 mm wide, and large were all wider than 25 mm. In only one case did our intuitive sorting place a specimen in the wrong size class. Further analysis will determine whether these classes are valid.

Three basic notching styles were evident including corner, side, and unnotched. These categories were easy to distinguish for the small points, but were often more difficult to differentiate for the medium and large points, because the notches on small points tended to be more precisely knapped than they were on most medium and large points. In many cases, medium and

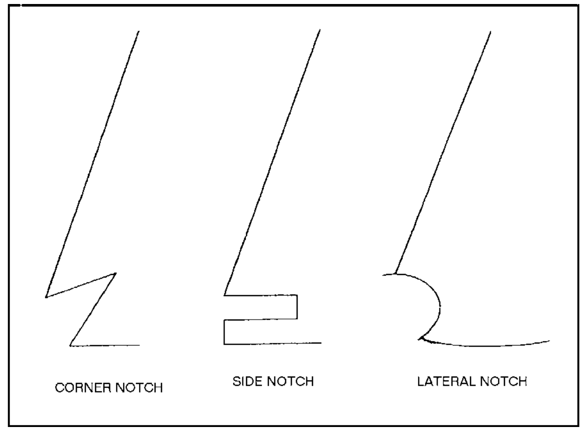

Figure 3.3. Notch types.

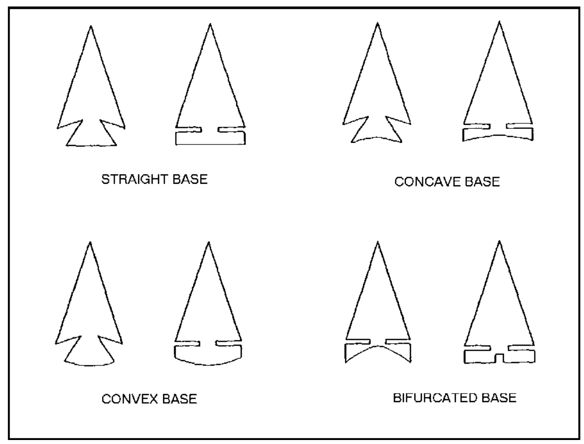

Figure 3.4. Base types.

large points could be more accurately described as corner/side-notched. A simple measurement was devised to solve this problem (Fig. 3.2a). Since side notches on small points tend to be perpendicular to the midline, the angle of the notch should be indicative of notch orientation, and was used to help define this attribute. Corner-notched points have acute barb angles, while side-notched points have barb angles of 90 degrees or more. Points with narrow notch openings and barb angles approaching 90 degrees are classified as side-notched, while those with wide notch openings and obtuse barb angles are laterally notched. Side-notched points also have a comparatively short length of blade between the lower edge of the notch aperture and the intersection of blade and base; the notches on laterally notched points generally extend to the intersection of blade and base (Fig. 3.3). In some cases, depth of notching was also used to distinguish between potential varieties.

Base shape was used to help further differentiate within defined varieties. Four basic base shapes were recognized: straight, concave, convex, and bifurcated. The latter class only occurred in the side-notched category, and included both basal-notched specimens and those in which the top of the basal concavity approached a line formed by connecting the lower edges of both notches (Fig. 3.4). Blade form was also thought to be a potential indicator of type or variety. Since many specimens had broken blades, blade angles were taken as indicators of this attribute. This variable was defined as the angle of the intersection between a line parallel to the blade edge and a line connecting the top of both notches (Fig. 3.2b). In cases where no notches were present, the angle measured was formed by the intersection of blade and basal edges. We had hoped that this variable would allow us to distinguish between points with long parallel-sided blades and those with shorter triangular blades, but a preliminary analysis suggested that it would not. Thus, this variable was not used in the detailed analysis.

Finally, amount of flaking was used to distinguish a separate series of varieties. Points exhibiting only a small amount of flaking were separated from those which evidenced extensive modification of the preform. These varieties were considered to be flake points, and were further divided into notched and unnotched subvarieties.

This largely intuitive categorization of points can be further examined using the numerous attribute data recorded during analysis. Hopefully, this will serve a dual purpose in allowing us to determine whether the intuitive classifications are valid, and to assess the utility of the attributes monitored.

Descriptions of Projectile Point Types

The projectile point assemblage contains 460 specimens, of which 120 are unidentifiable fragments that are not further considered in this section. Seventeen basic styles were defined, many with multiple variants. Traditional names for Archaic styles are used, otherwise labels assigned to styles and variants are general and designed to illustrate assemblage diversity rather than clutter the literature with long descriptive terms. Numbers of specimens in each type and variety are listed in parentheses. Dates assigned to styles are general and preliminary; they are based on information currently available in the literature and some incorrect assignments may have been made. Just how well these styles match the assumed dates is discussed in a later section of this chapter.

Early to Middle Archaic Styles

Jay Point (n = 1). Stemmed dart point with slight shoulders and convex base; blade edges are slightly convex and contract toward the tip; bases are usually heavily ground; stem edges are slightly concave (producing a faint shoulder) and may contract toward the base; flaking is generally by direct percussion (Fig. 3.5a). The single example of this type is atypically well-shouldered.

Bajada Point (n = 1). Stemmed dart point with slight to distinct shoulders and concave base; bases exhibit deliberate thinning and are usually heavily ground; shoulders become increasingly well defined with time, and overall length becomes shorter; blade edges are straight to slightly convex and contract toward the tip; stem edges are straight and parallel or slightly expanding toward the base; blade length is often shortened by resharpening (Fig. 3.5b).

Bajada/San José Point (n = 3). Bases of stemmed points that could fall into either the Bajada or San José categories, but could not be assigned to a specific type (Fig. 3.5c-d).

San José Point (n = 3). Stemmed dart point with slight to distinct shoulders and concave base that is usually heavily ground; stem edges are straight and parallel or slightly expanding toward the base, and somewhat shorter than are those of Bajada points; blade edges are straight to convex, contract toward the tip, and are often serrated; blade length is often shortened by resharpening (Fig. 3.5e-g).

Chiricahua Point (n = 6). Triangular side-notched dart point; blade edges are straight to slightly convex and contract toward the tip; bases are straight or slightly to deeply concave; notching ranges from shallow to moderate in depth and is generally no more than about one-quarter of the length of the point above the base (Fig. 3.5h-l).

Augustín Point (n = 4). Diamond-shaped dart point with sharply contracting stem and convex base; blade edges are straight to slightly convex and contract toward the tip; slight to distinct shoulder (Fig. 3.5m-p).

Pelona Point (n = 3). Teardrop-shaped dart point with contracting stem and convex base; blade edges are straight to slightly convex, contract toward the tip, and are occasionally serrated; sometimes has a slight shoulder (Fig. 3.5q-s).

Late Archaic Styles

San Pedro Lateral-Notched Point (n = 22). Points that are more than 25 mm wide and notched at the intersection of blade and basal edges; barbs are at an obtuse angle relative to the midline of the point (Fig. 3.6). Varieties include specimens with straight bases (n = 9), convex bases (n = 8), and fragments (n = 5). These are the classic San Pedro type.

San Pedro Corner-Notched Point (n = 21). Points that are more than 25 mm wide and notched at the intersection of blade and basal edges; barbs are at an acute angle relative to the midline of the point (Fig. 3.7a-k). Varieties include specimens with straight bases (n = 9), concave bases (n = 1), convex bases (n = 5),

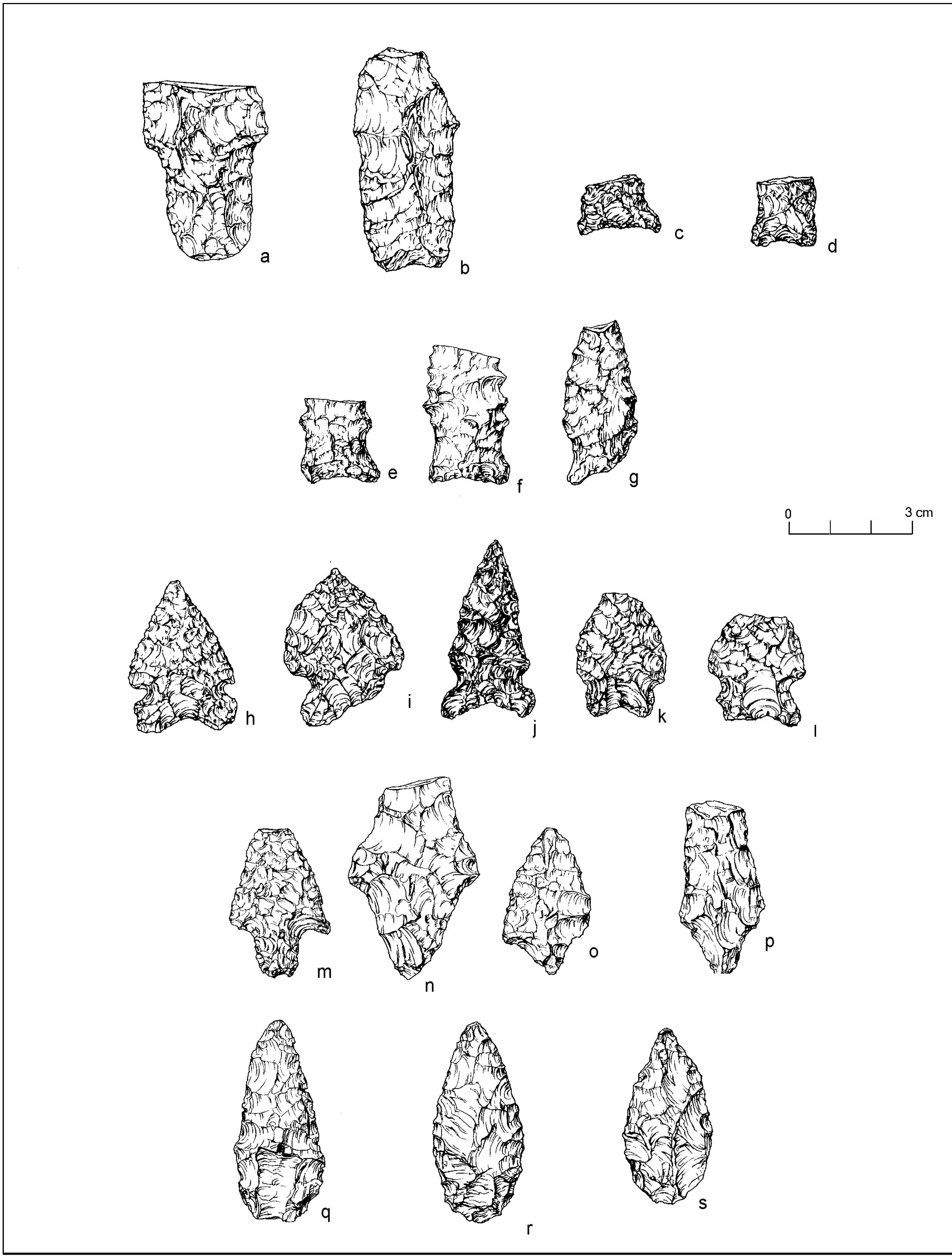

Figure 3.5. Middle and Late Archaic dart points: (a) Jay, (b) Bajada, (c-d) Bajada-San Jose, (e-g) San Jose, (h-l) Chiricahua, (m-p) Augustín, (q-s) Pelona.

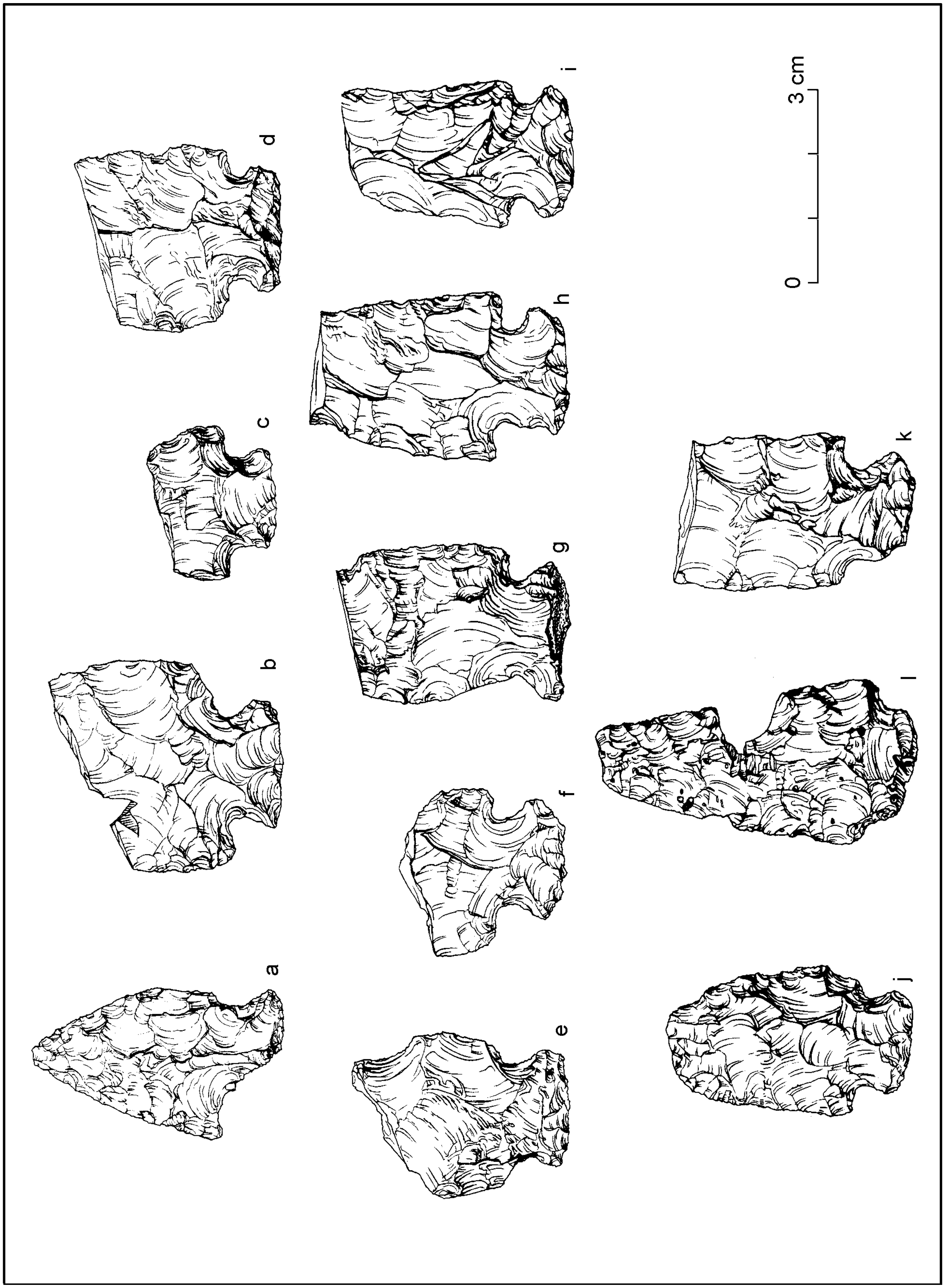

Figure 3.6. Late Archaic dart points: (a-e) San Pedro lateral-notched, straight base, (f-l) San Pedro lateral-notched, convex base.

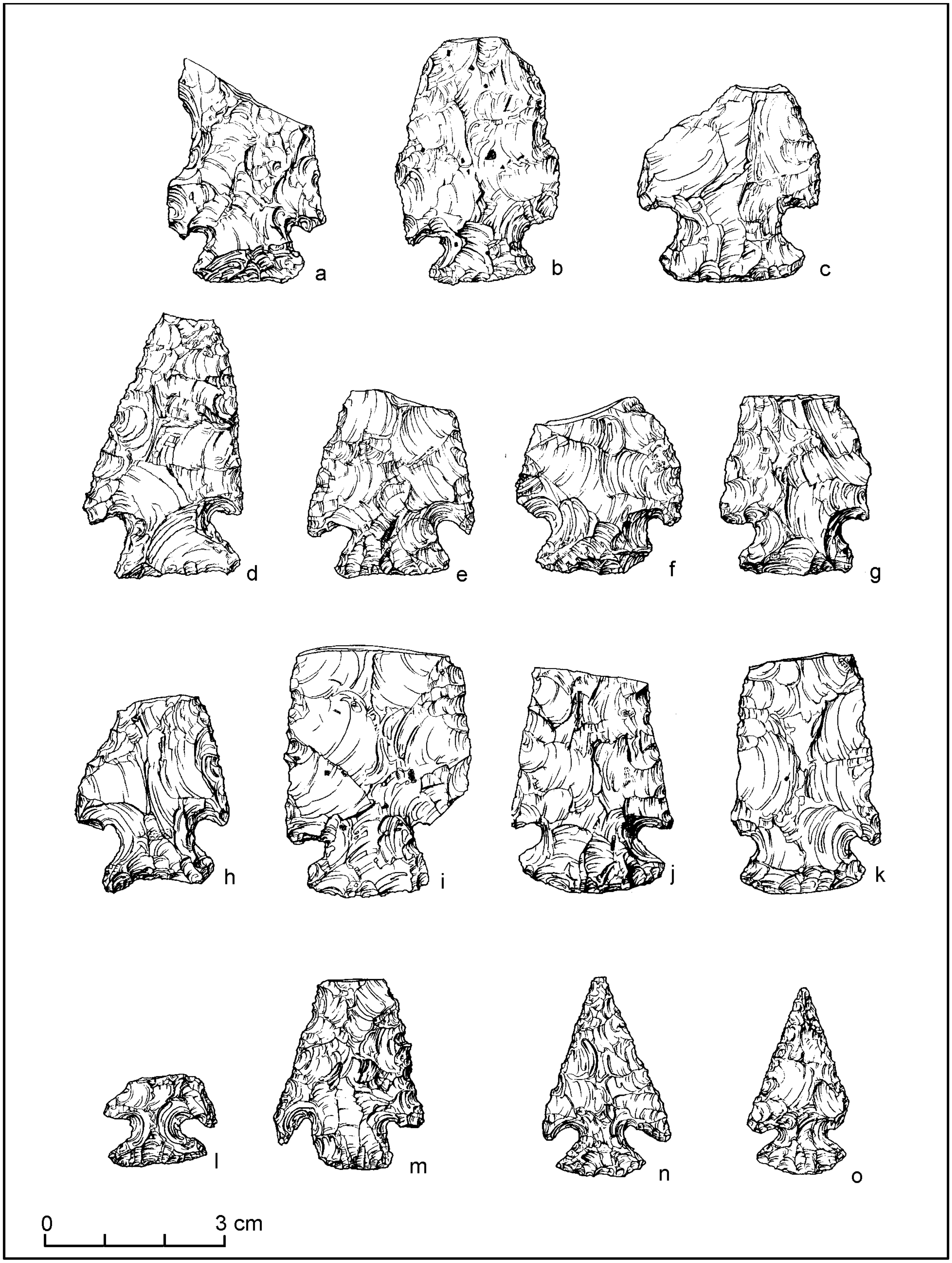

Figure 3.7. Late Archaic dart points: (a-g) San Pedro corner-notched, straight base, (h) San Pedro corner-notched, concave base, (i-k) San Pedro corner-notched, convex base, (l-o) Cienega points?

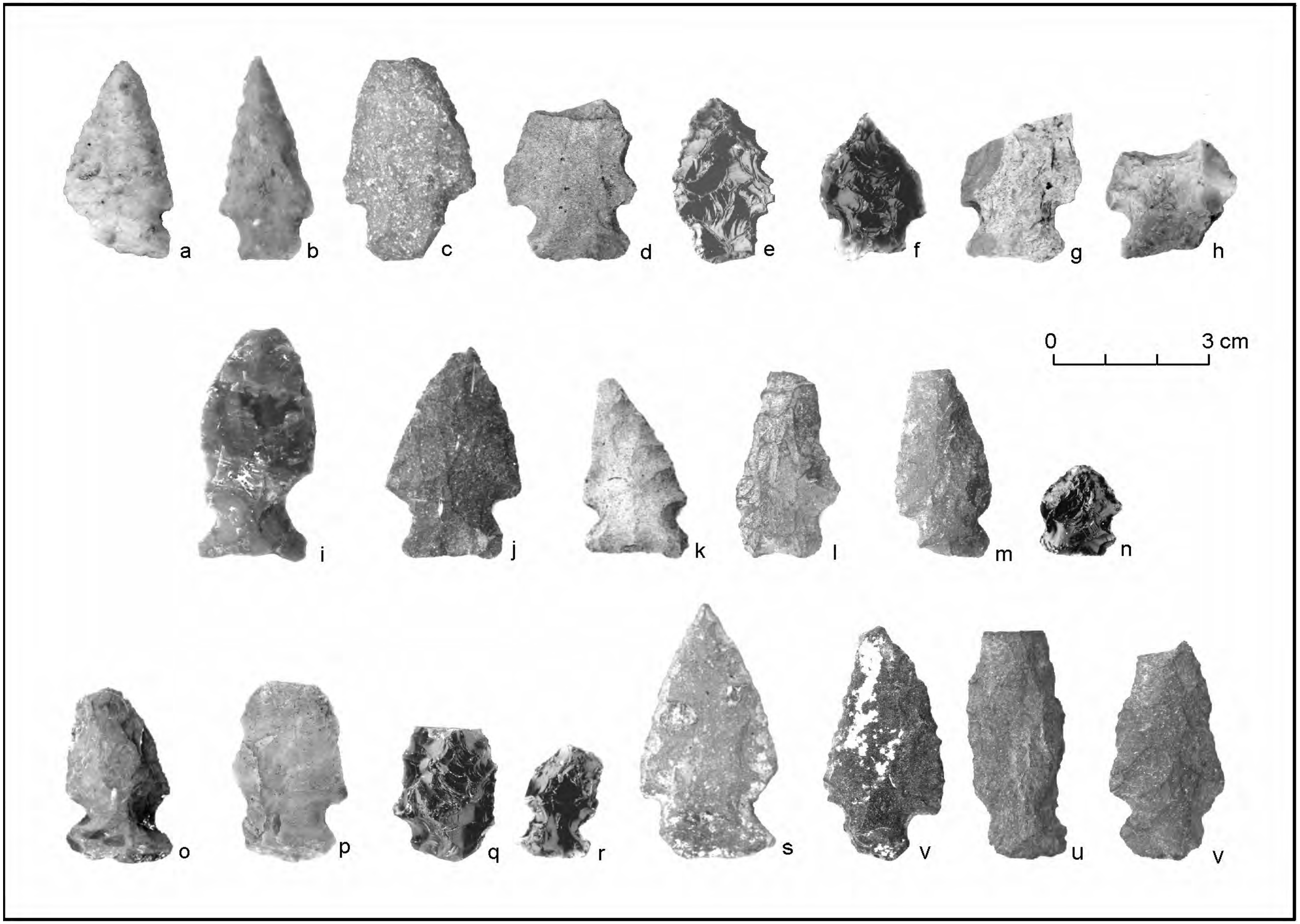

Figure 3.8. Late Archaic and Ceramic period projectile points: (a-h) medium lateral-notched dart points, straight base, (i-j) medium lateral-notched arrow points, straight base, (k-m) medium lateral-notched dart points, concave base, (o-v) medium lateral-notched dart points, convex base.

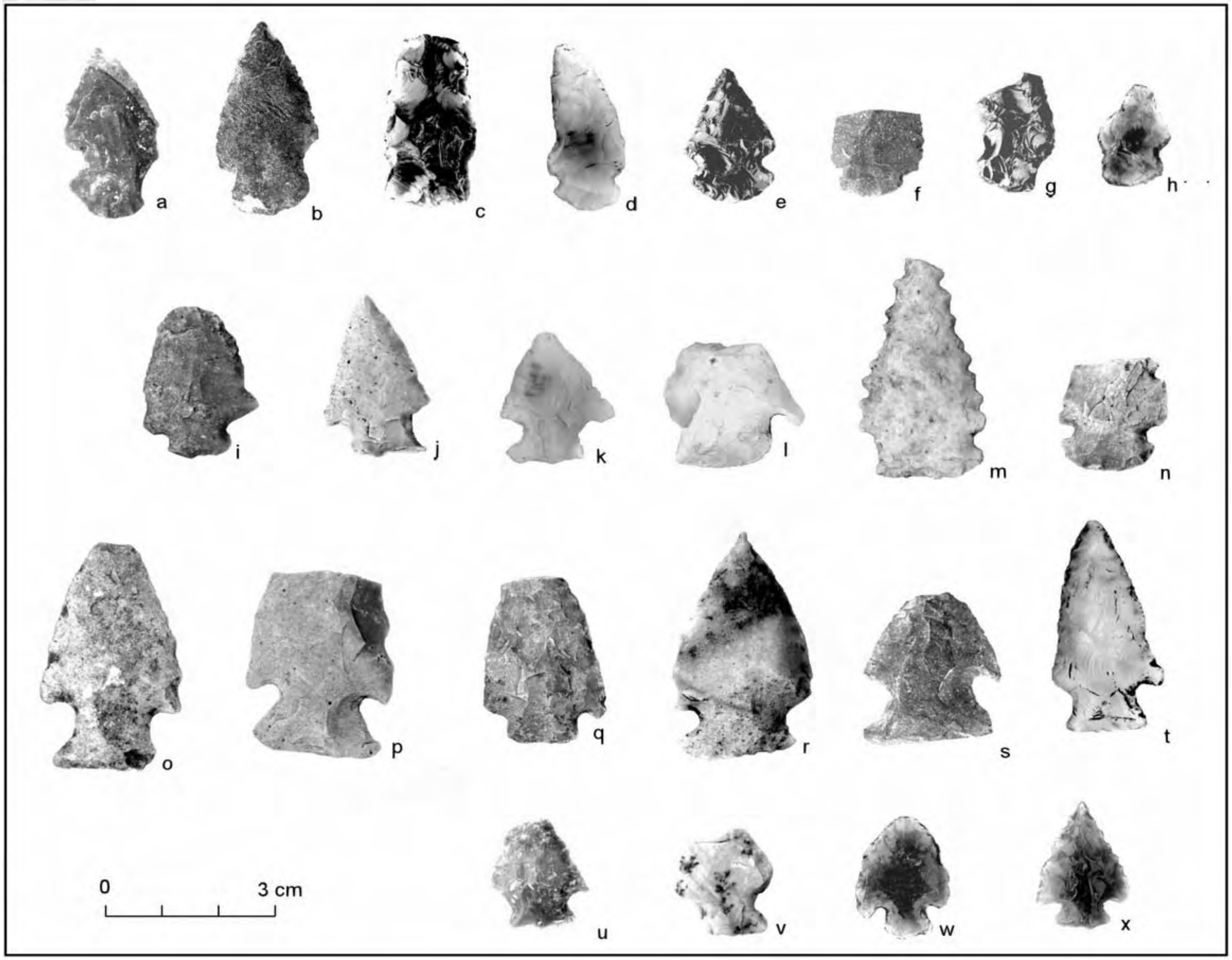

Figure 3.9. Late Archaic and Ceramic period projectile points: (a-h) medium lateral-notched arrow points, convex base, (i) medium lateral-notched dart point, three notches, (j) medium lateral-notched dart point, serrated blade, (k-t) medium corner-notched dart points, straight base, (u-x) medium corner-notched arrow points, straight base.

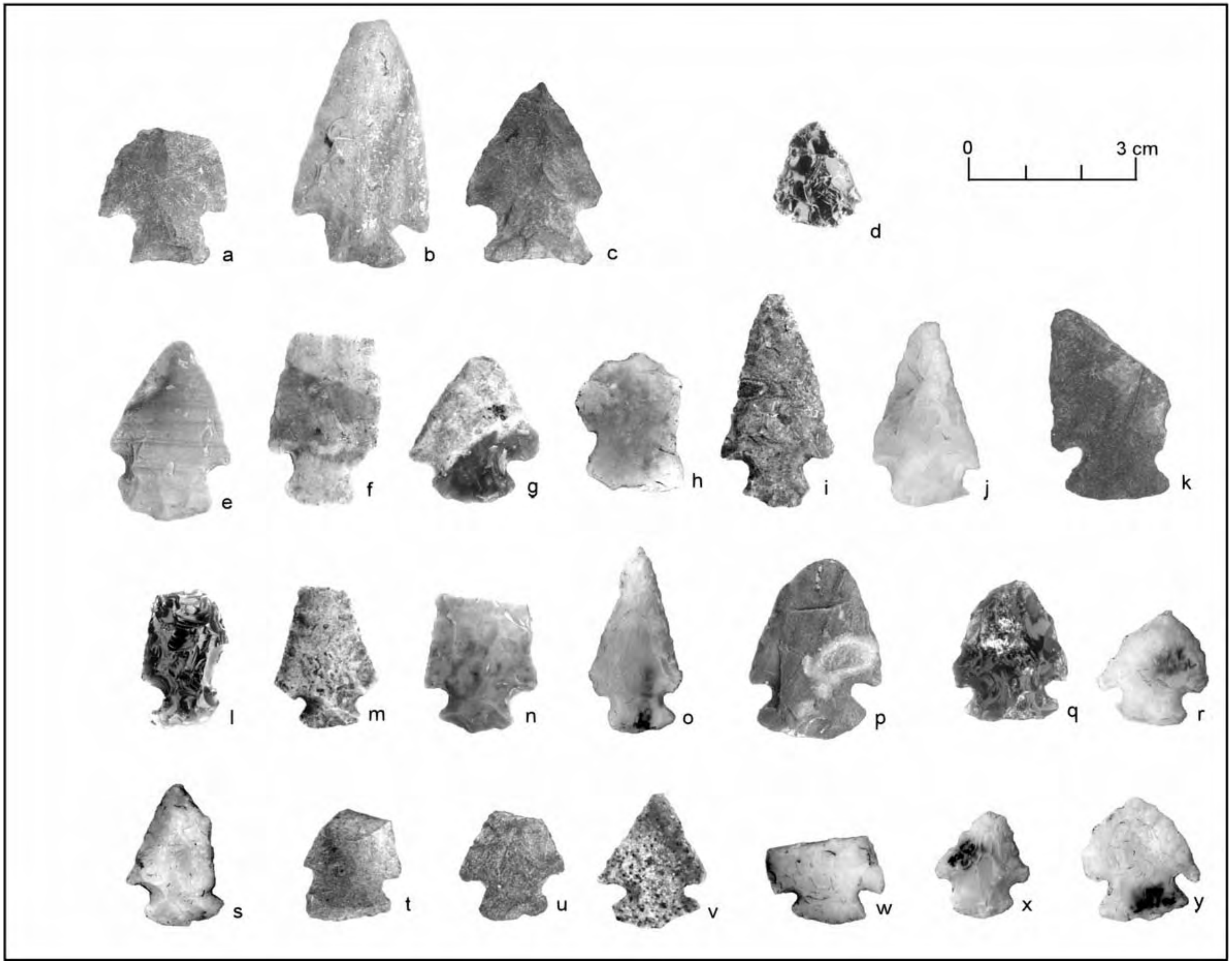

Figure 3.10. Late Archaic and Ceramic period projectile points: (a-c) medium corner-notched dart points, concave base, (d) medium corner-notched arrow point, convex base, (e-y) medium corner-notched dart points, convex base.

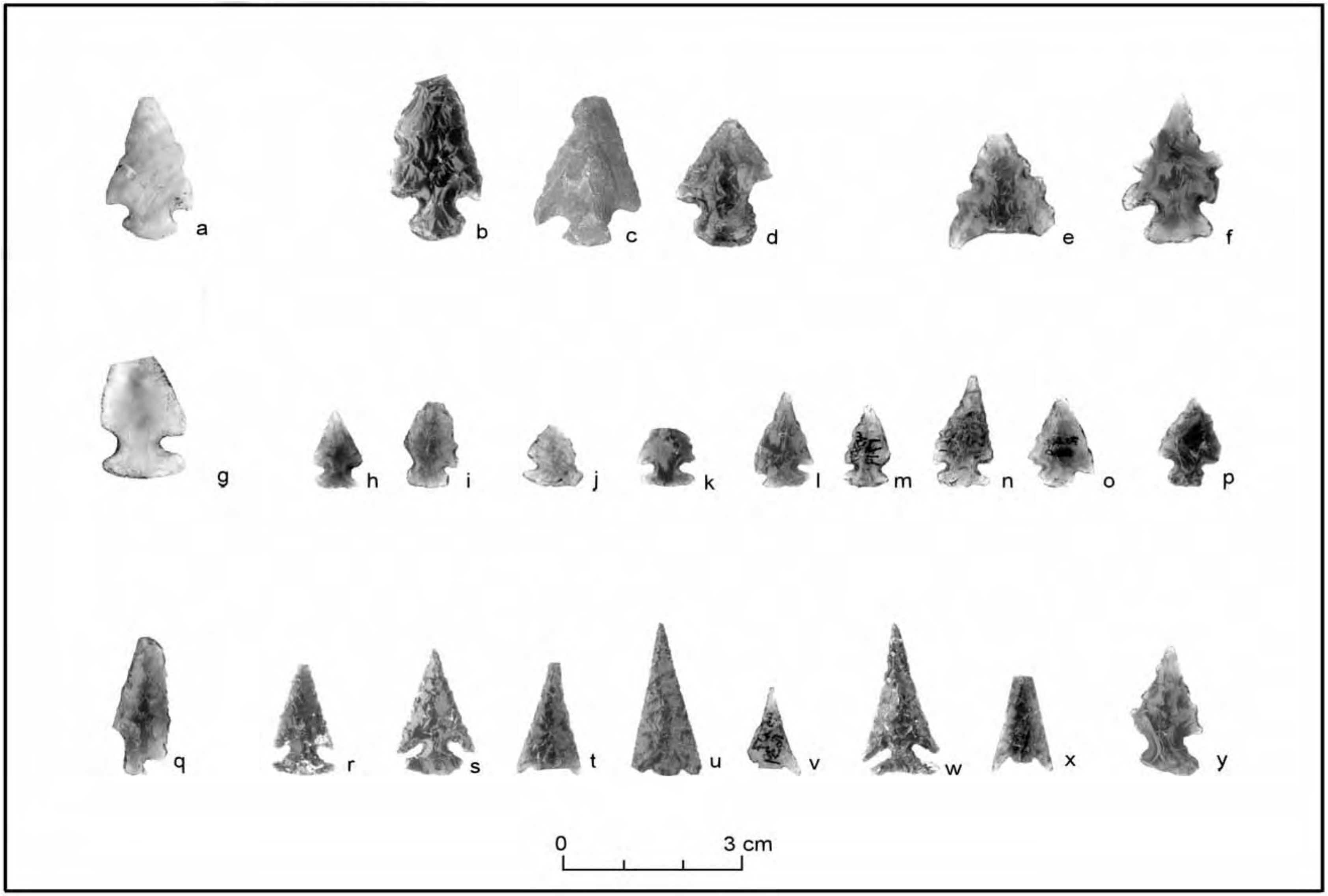

Figure 3.11. Late Archaic and Ceramic period projectile points: (a-b) medium corner-notched dart points, serrated blades, (c-e) medium corner-notched dart points, teardrop-shaped bases, (f) medium corner-notched arrow point, teardrop-shaped base, (g-j) small corner-notched arrow points, straight base, (k-p) small corner-notched arrow points, convex base, (q) small corner-notched arrow point, serrated blade, (r-x) small corner-notched arrow points, deep notches and long blades, (y) small corner-notched arrow point, shallow notches and long blade.

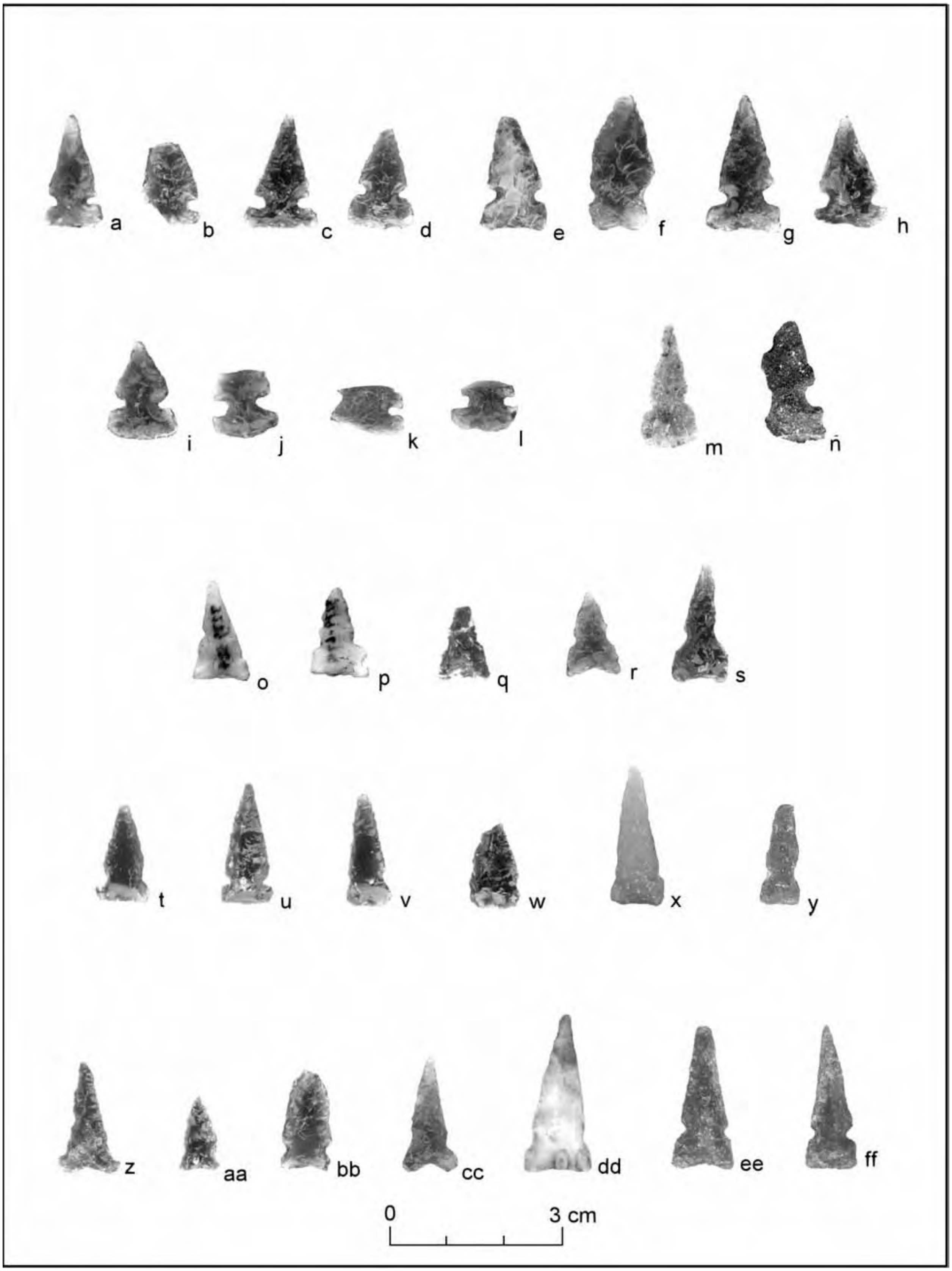

Figure 3.12. Ceramic period small side-notched arrow point: (a-d) straight base, (e-h) concave base, (i-l) convex base, (m-n) long blade, high notches, convex base, (o-s) long blade, high notches, concave base, (t-y) long blade, shallow notches, straight base, (z-ff) long blade, shallow notches, concave base.

and fragments (n = 6). These points are similar in appearance to the En Medio point of the Oshara tradition, and are distinctly corner notched as opposed to the lateral notched, which is generally considered characteristic of San Pedro points.

Cienega Point (n = 4). Points that are between 15 and 25 mm wide and notched at the intersection of blade and basal edges; barbs are at an acute angle relative to the midline of the point; bases are variably shaped (Fig. 3.7l-o). This variety was originally defined in Arizona by Geib and Huckell (1994). Specimens are deeply notched, and workmanship is very fine.

General Late Preceramic to Ceramic Period Styles

Medium Lateral-Notched Point (n = 48). Points that are between 15 and 25 mm wide and notched at the intersection of blade and basal edges; barbs are at a right or obtuse angle relative to the midline of the point (Figs. 3.8, 3.9). Varieties include specimens with straight bases (n = 13), convex bases (n = 18), concave bases (n = 6), three notches (n = 1), serrated blades (n = 1), and fragments (n = 9).

Medium Corner-Notched Point (n = 63). Points that are between 15 and 25 mm wide and notched at the intersection of blade and basal edges; barbs are at an acute angle relative to the midline of the point (Figs. 3.10, 3.11a-f). Varieties include specimens with straight bases (n = 15), convex bases (n = 27), concave bases (n = 3), teardrop-shaped bases (n = 5), serrated blades (n = 2), and fragments (n = 11).

Ceramic Period Styles

Small Corner-Notched Point (n = 19). Points that are less than 15 mm wide and notched at the intersection of blade and basal edges; barbs are at an acute angle relative to the midline of the point (Fig. 3.11g-k). Varieties include specimens with straight bases (n = 5), convex bases (n = 7), serrated blades (n = 1), and fragments (n = 6).

Small Corner-Notched Point with Long Blade (n = 8). Points that are less than 15 mm wide and notched at the intersection of blade and basal edges; barbs are at an acute angle relative to the midline of the point; blades are at least twice as long as they are wide (Fig. 3.11r-y). Varieties include specimens with deep notches and concave base (n = 1), deep notches and convex base (n = 2), deep notches and missing base (n = 4), comparatively shallow notches and straight base (n = 1).

Small Side-Notched Point (n = 21). Points that are less than 15 mm wide and notched along blade edges; barbs are at a right or obtuse angle relative to the midline of the point (Fig. 3.12a-l). Varieties include specimens with straight bases (n = 5), convex bases (n = 5), concave bases (n = 5), and fragments (n = 6).

Small Side-Notched Point with Long Blade and High Notches (n = 7). Points that are less than 15 mm wide and notched along blade edges; barbs are at a right or obtuse angle relative to the midline of the point; blades are at least twice as long as they are wide; notches are comparatively high on the blade (Fig. 3.12m-s). Varieties include specimens with convex bases (n = 2) and concave bases (n = 5).

Small Side-Notched Point with Long Blade (n = 15). Points that are less than 15 mm wide and notched along blade edges; barbs are at a right or obtuse angle relative to the midline of the point; blades are at least twice as long as they are wide (Fig. 3.12t-ff, Fig. 3.13a-b). Varieties include specimens with straight bases (n = 6), convex bases (n = 2), and concave bases (n = 7).

Small Side-Notched Point with Bifurcated Base (n = 7). Points that are less than 15 mm wide and notched along blade edges; barbs are at a right or obtuse angle relative to the midline of the point; bases are deeply concave or notched (Fig. 3.13c-i).

Small Side-Notched Point, Eccentric (n = 20). Points that are less than 15 mm wide and notched along blade edges; barbs are at a right or obtuse angle relative to the midline of the point; blades contain one or more extra notches. Varieties include specimens with one extra notch (n = 15; Fig. 3.13j-u), and with multiple extra notches along one blade edge (n = 5; Fig. 3.13v-y).

Small Lateral-Notched Point (n = 5). Points that are less than 15 mm wide and notched along blade edges; notches are comparatively shallow with barbs at an obtuse angle relative to the midline of the point; blades are comparatively wide; bases are convex (Fig. 3.13z-dd).

Small Unnotched Point (n = 24). Points that are less than 15 mm long and unnotched; they resemble preforms but appear to be finished tools (Fig. 3.14a-u). Varieties include specimens with straight bases (n = 14), convex bases (n = 1), concave bases (n = 8), and indeterminate bases (n = 1).

Medium Unnotched Point (n = 7). Points that are between 15 and 25 mm wide and unnotched; they resemble preforms but appear to be finished tools (Fig. 3.14v-bb). Varieties include specimens with straight bases (n = 2), convex bases (n = 4), and concave bases (n = 1).

Flake Points (n = 17). Debitage that have been minimally flaked for use as projectile points (Fig. 3.15). Varieties include specimens with straight bases and no notches (n = 3), convex bases and no notches (n = 3), corner notches (n = 6), and side notches (n = 5).

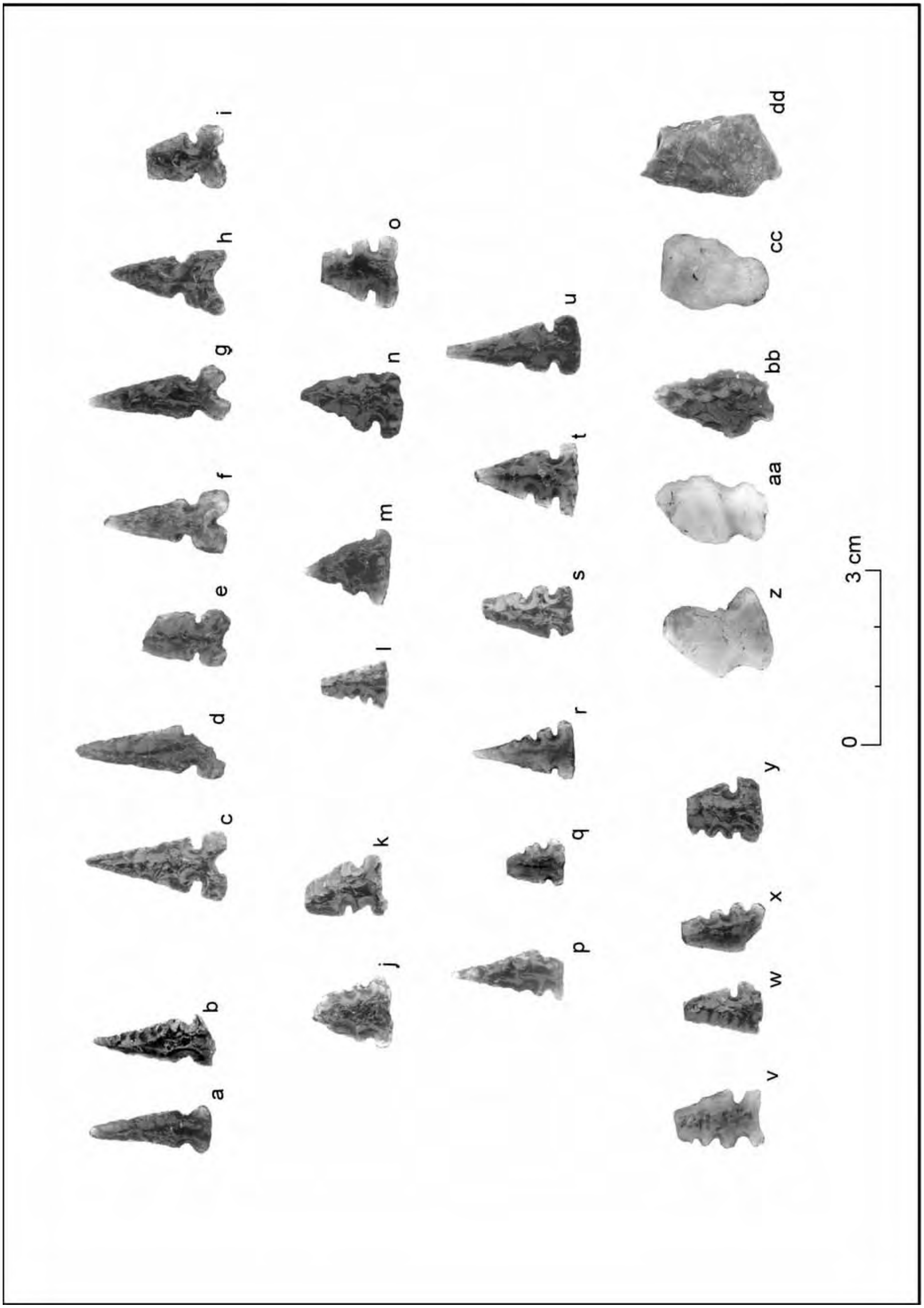

Figure 3.13. Ceramic period small side-notched arrow points: (a-b) long blade, shallow notches, convex base, (c-i) bifurcated base, (j-u) three notches, (v-y) multiple notches along one blade edge, (z-dd) small lateral-notched arrow points.

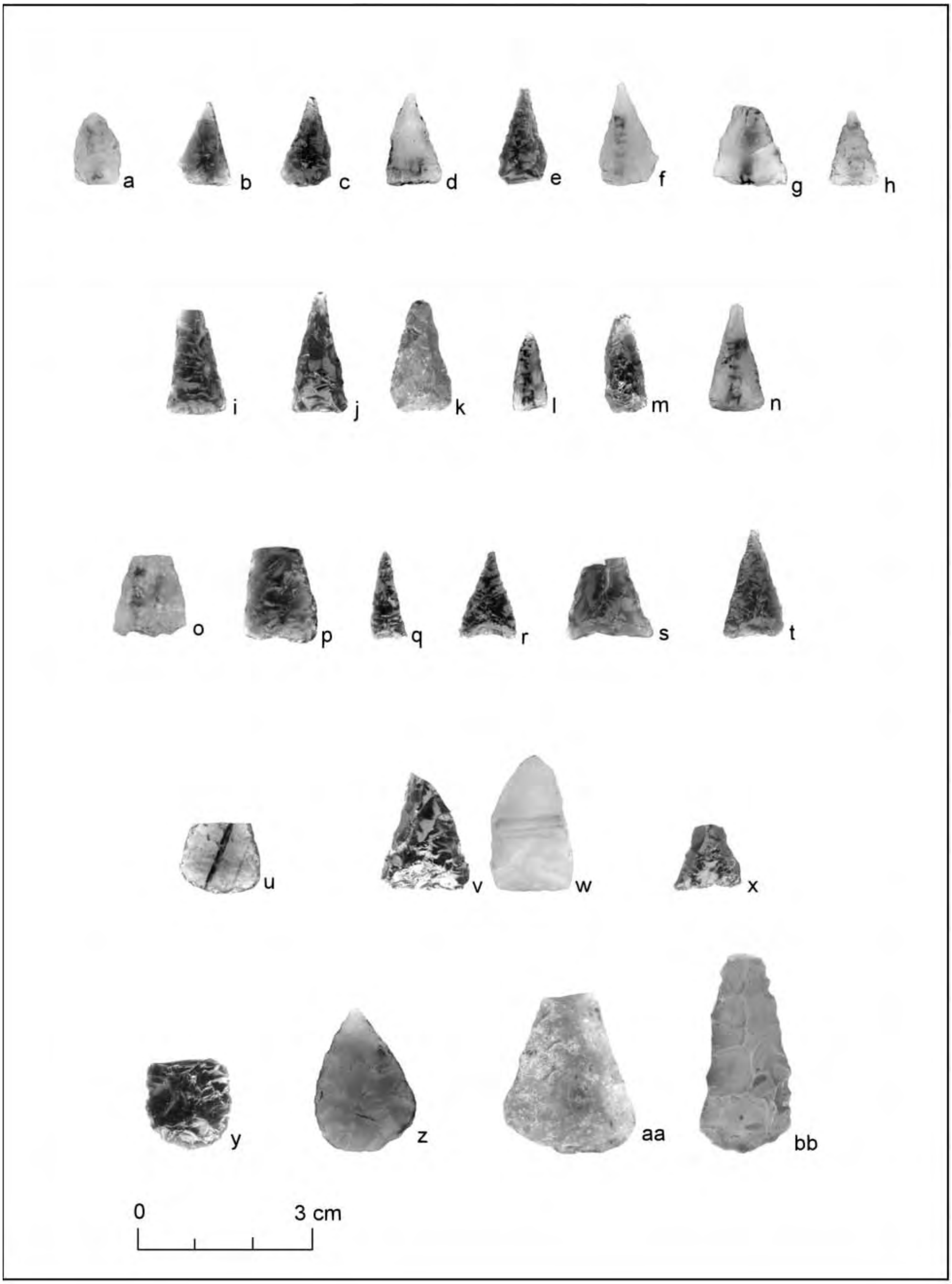

Figure 3.14. Ceramic period small unnotched arrow points: (a-n) straight base, (o-t) concave base, (u) convex base. Medium unnotched points: (v-w) straight base, (x) concave base, (y-bb) convex base.

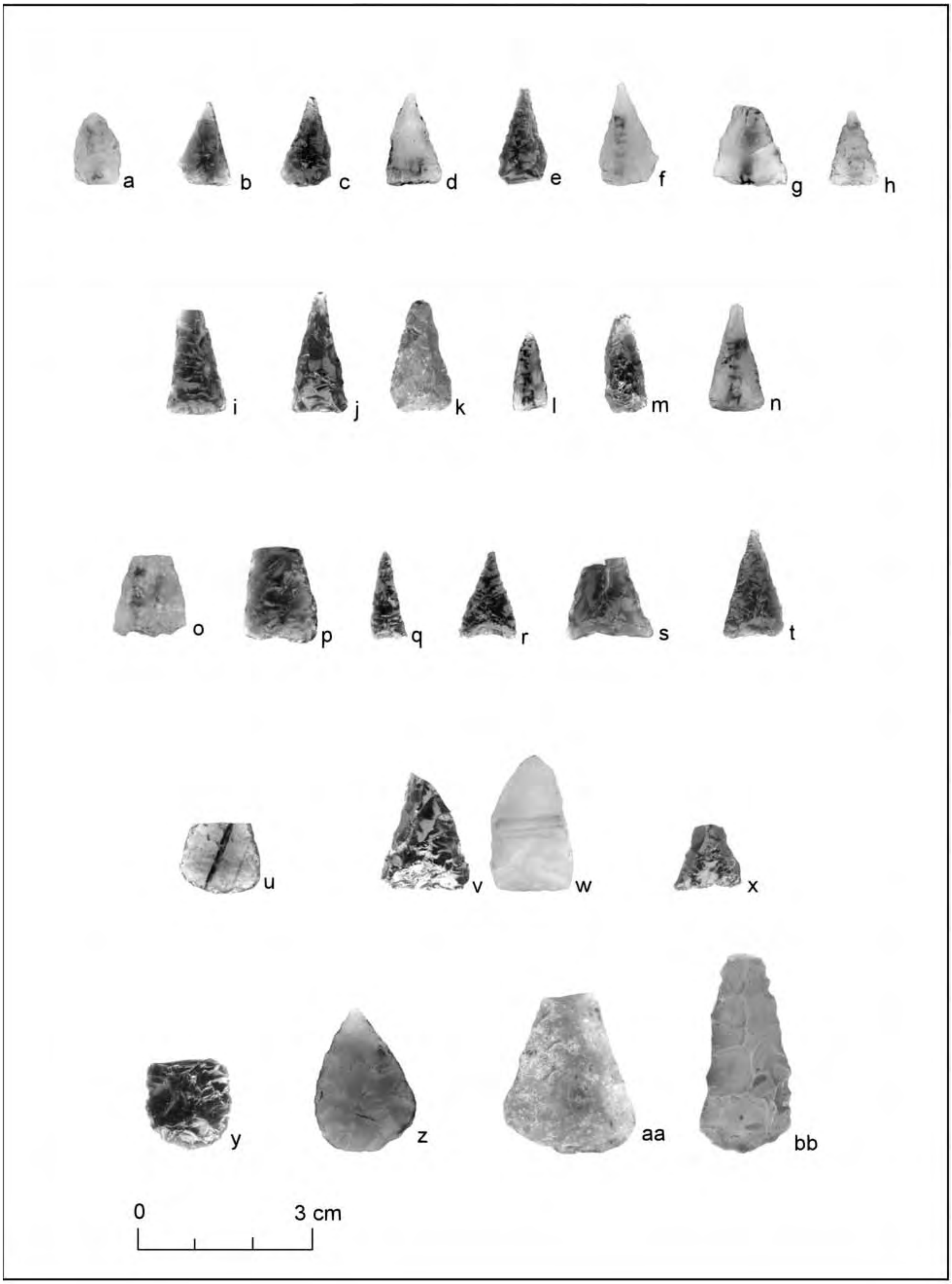

Figure 3.14. Continued. Ceramic period small unnotched arrow points: (a-n) straight base, (o-t) concave base, (u) convex base. Medium unnotched points: (v-w) straight base, (x) concave base, (y-bb) convex base.

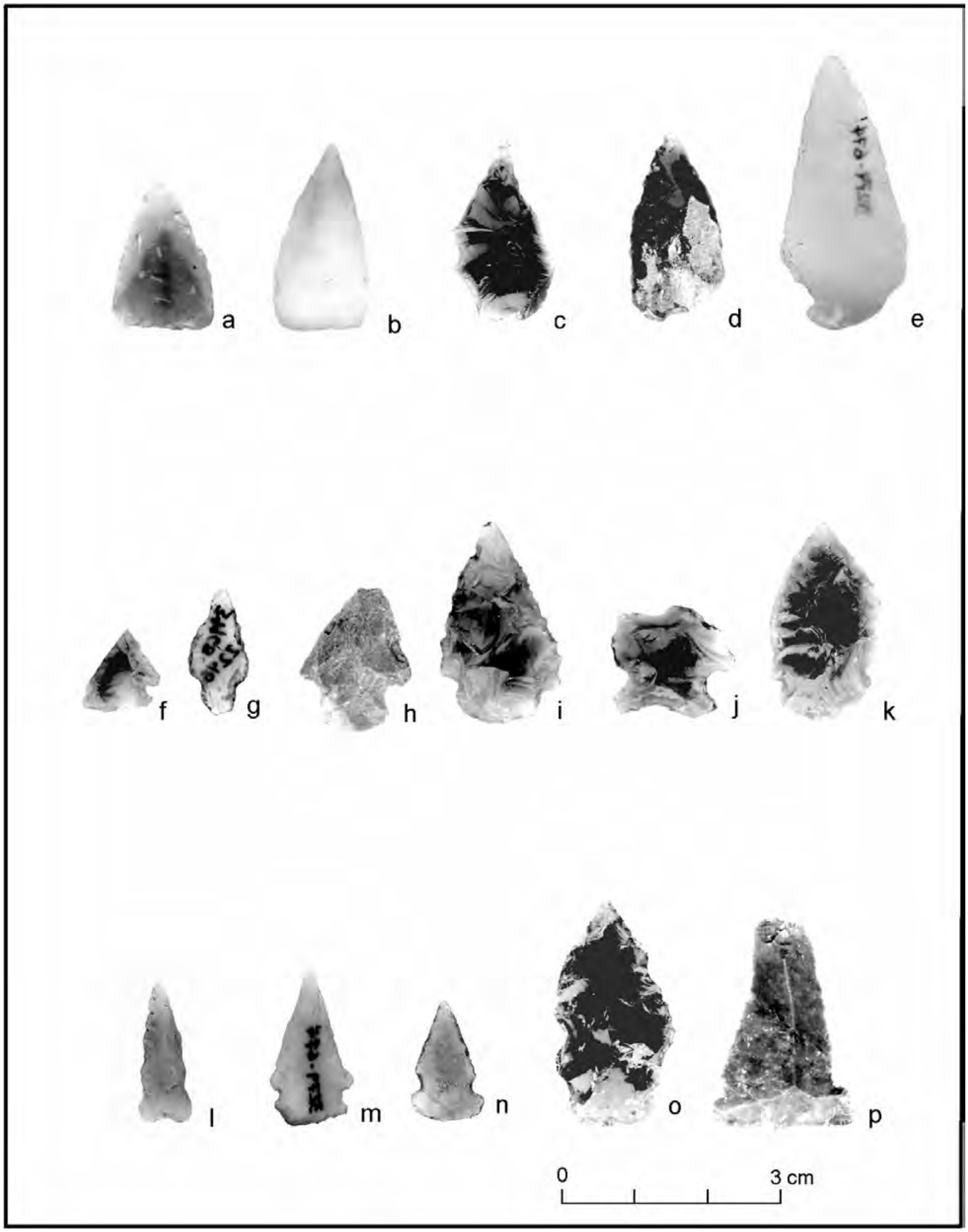

Figure 3.15. Flake points: (a-b) unnotched with straight base, (c-e) unnotched with convex base, (f-k) corner-notched, (l-p) side-notched.

Discussion

As we researched the temporal and cultural affinity of projectile points for the Highland Mogollon region, and as the assemblage was sorted into different stylistic categories, a number of questions that could be further addressed by analysis were generated. All Archaic types are assumed to be dart points. However, it is possible that some San Pedro points (both lateral- and corner-notched) represent knives rather than dart points. If so, what characteristics can be used to separate these tool categories? At least two of the Early and Middle Archaic types are of questionable age. Both the Augustín and Pelona types may also extend into the Late Archaic period. Can our analysis aid in clarifying this question?

The Cienega point is considered an early Formative dart point that appeared at the Preceramic-Ceramic period interface. Our assignment of several points to this type was based on physical characteristics, but all were obtained from sites dating far later than the supposed period of use for the Cienega type. Are these specimens really Cienega points, and if so, are they much later than originally supposed or are they evidence of curation?

Medium lateral- and corner-notched types commonly occur in both Late Archaic and Ceramic period assemblages. In form they are comparable to both San Pedro types, but are smaller. While it would be preferable to assign more specific type designations to these points, we might cause confusion by doing so. Since in form they resemble smaller versions of the San Pedro types it would be logical to assign them to that category. However, since they are also common in Ceramic period components, by assigning them to the San Pedro types we would either be implying that they represent curated tools, or that those types lasted a thousand years beyond the accepted end date. The range of sizes in these types could represent either small dart points or large arrow points. So, where do these points fit, and do they represent a continuation of an early form well into the Ceramic period?

Most Ceramic period points appear to have been used on arrows, though a few are large enough to fall into the small dart point category. Can the latter be distinguished from Archaic dart points, or might there be evidence for a continued use of darts well into the Ceramic period? These questions, along with those raised in the research design, are examined in the remainder of this chapter.

Dart Points Versus Arrow Points: Temporal Changes in Projectile Point Size

This section discusses variation in projectile point size through time. It also applies a formula developed by Thomas (1978) that is useful in helping to distinguish between points used to tip darts versus arrows. Six temporal categories are used: Archaic, Early Pithouse, Late Pithouse, Early Pueblo, Late Pueblo, and protohistoric. Nineteen of 29 components could be assigned to these time periods, 1 was assigned to a general Pithouse period, and 9 contained materials from more than one occupation that were so badly mixed that they could not be separated during analysis. The latter are not directly addressed by this analysis, though the diagnostic points they contain are assessed. A total of 334 projectile points are available for this examination.

Analysis of Dimensional Data

Projectile Point Length. Of the array of points available for analysis, 113 are whole and can provide data on variation in length. Unfortunately, three time periods are represented by only seven examples apiece or less (Table 3.2). Over half of the whole points were obtained from Late Pueblo contexts. This total includes four preforms that were discarded during reduction because of problems, two tools that probably functioned as knives rather than projectiles, and two

Table 3.2. Projectile Point Length Data for Each Time Period; Measurements in Millimeters

Period	Total	Minimum	Maximum	Mean
Archaic	25	18	47	32.4
Early Pithouse	5	16	30	22.8
Late Pithouse	13	15	36	23.7
Early Pueblo	7	15	32	23.1
Late Pueblo	57	13	39	21.7

points that appear to have been curated. The probable knives are from Late Pueblo contexts and are dropped from the remainder of this discussion.

The curated specimens include a Chiricahua point from a Late Pueblo context and an Augustín point from a protohistoric component. These are well known and moderately well dated Archaic types; thus, their temporal assignment is changed and they are included with the Archaic points. This means that there are no whole protohistoric points. With these changes, our assemblage now totals 107. Length may not be the best measure available since it can only be used to examine about one-third of the assemblage.

Table 3.2 illustrates basic length data for each time period. There is a definite drop in mean length between the Archaic and Early Pithouse periods, which undoubtedly is related to introduction of the bow. The results of an analysis of variance (ANOVA) are presented in Table 3.3 and suggest that this difference is significant. While Late Pueblo points are the shortest overall, means for the other Ceramic period divisions may be skewed by small sample sizes. This is confirmed by calculating an ANOVA for the Ceramic period points only, which shows that there is a good probability that these samples represent the same population (Table 3.3).

Table 3.3. Results Of ANOVA Tests on Whole Projectile Point Length by Time Period

Period	F	Significance of f
All periods	17.676	< .0005
Ceramic periods	0.877	.457

One of the problems with this sample is the lack of points falling into the "large" category. None of those specimens were whole, so their lengths cannot be factored into this analysis. A more consistently available measurement is width, which should provide similar results.

Projectile Point Width. Accurate width information is available for 239 points, or 78.1 percent of the specimens that could be assigned to types. Of these, 6 are preforms discarded because difficulties were encountered during manufacture and 2 are probably knives (as discussed in the last section). These specimens were dropped from consideration, leaving a sample of 231 points, or 75.5 percent of the identifiable specimens. Several Archaic points of well known and moderately well dated types were found on later components, and appear to be evidence of curation. They include a Jay and two San José points from Early Pithouse components, Chiricahua points from Late Pithouse (n = 1) and Late Pueblo (n = 2) contexts, and Augustín points from Early Pueblo (n = 1) and protohistoric (n = 2) components. The temporal assignment of these specimens was therefore changed, and they are included with the Archaic points. Since half the identifiable points from protohistoric components are Archaic types, the exact date and cultural affinity of these components is still in doubt, and since the remaining points constitute a very small sample, they are not considered in this particular analysis. Thus, 229 points (74.8 percent of the total) are available for study.

Table 3.4 illustrates basic width data for each time period. There is a definite drop in mean width between the Archaic and Early Pithouse periods, which undoubtedly is related to introduction of the bow. The results of an ANOVA are presented in Table 3.5, and suggest that this difference is significant. While Late Pueblo points are the narrowest overall, means for other Ceramic period divisions may be skewed by small sample sizes. This is confirmed by calculating an ANOVA for the Ceramic period points only, which shows that at the 99 percent confidence level the samples from these periods may represent the same population (Table 3.5). However, this association is weaker than that derived for length. This was explored further by dropping Late Pueblo period points and considering only those from Early Pithouse through Early Pueblo periods. This provided a much stronger

Table 3.4. Projectile Point Width Data for Each Time Period; Measurements In Millimeters

Period	Total	Minimum	Maximum	Mean
Archaic	91	9	38	22.12
Early Pithouse	13	8	28	14.92
Late Pithouse	17	8	20	13.47
Early Pueblo	16	9	24	15.19
Late Pueblo	92	6	28	12.72

association (F=.613, significance=.546). However, by this time only 19.9 percent of available cases are included in the sample so it is uncertain whether this difference reflects variation or smaller sample size.

Table 3.5. Results of ANOVA Tests on Projectile Point Width by Time Period

Period	F	Significance of F
All periods	48.595	< .0005
Ceramic periods	1.894	.134

Again, we find that different projectile point populations are represented when width is analyzed. When Archaic points are dropped the remaining assemblage seems to represent a single population. For this variable, the association seems strongest when only Early Pithouse through Early Pueblo periods are considered. Similar results occur when Late Pueblo points are eliminated from the length analysis (F=.067, significance=.935). Thus, while the Archaic points differ significantly from those of the Ceramic period, there may also be a less significant but real difference between points of the Late Pueblo period and those of the Early Pithouse through Early Pueblo periods.

Projectile Point Thickness. The assemblage used to study width was also used to examine this variable. Similar to the previous two analyses, Archaic points had the largest mean thickness, while Late Pueblo points had the smallest (Table 3.6). Again, the sharpest break occurs between the Archaic and Early Pithouse samples. The results of an ANOVA are presented in Table 3.7 and suggest that different populations are represented, while Late Pueblo period points are the thinnest overall, means for other Ceramic period divisions may be skewed by small sample sizes. However, this is not confirmed by ANOVA (Table 3.7), which continues to suggest that different populations are represented. This was explored further by dropping Late Pueblo points and considering only those from the Early Pithouse through Early Pueblo periods. This provides a very weak association (F=5.004. significance=.008). Again, only 19.7 percent of the available cases are included in this study so it is uncertain whether these results reflect variation or smaller sample size.

Table 3.6. Projectile Point Thickness Data for Each Time Period; Measurements In Millimeters

Period	Total	Minimum	Maximum	Mean
Archaic	91	2	9	5.78
Early Pithouse	13	2	6	4.15
Late Pithouse	17	3	6	3.47
Early Pueblo	16	3	9	4.56
Late Pueblo	92	2	6	3.69

Table 3.7. Results of ANOVA Tests on Projectile Point Thickness by Time Period

Period	F	Significance of F
All periods	206.833	< .0005
Ceramic periods	10.661	<.0005

More Dimensional Comparisons. Notched box plots were created for length, width, and thickness to help determine whether any significant variation could be observed. This category of data plot is discussed by Chambers et al. (1983:21-24, 60-63), and an example is shown in Figure 3.16. The dividing line in the box is the median, the box represents the central 50 percent of the spread, and the tails are remaining data between the 10 and 90 percentiles. Extreme outliers are shown as asterisks. Notched box plots allow comparison of sample medians. As noted by Chambers et al. (1983:62):

> In the language of statistical theory, if the two data sets are independent and identically distributed random samples from two populations with unknown medians but with a normal distributional shape in the central portion, then the notches provide an approximate 95% test of the null hypothesis that the true medians are equal: If the two notches overlap, then we fail to reject the null hypothesis with (approximate) 95% confidence.

Thus, when the notches overlap, there is a 95 percent chance that samples belong to the same population; when they do not it is likely that they belong to separate populations.

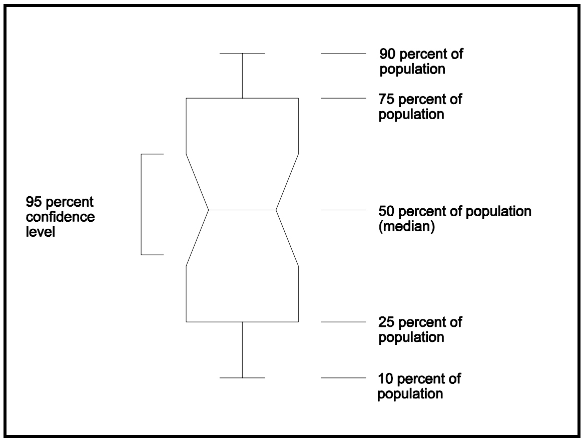

Figure 3.16. Parts of a notched box plot.

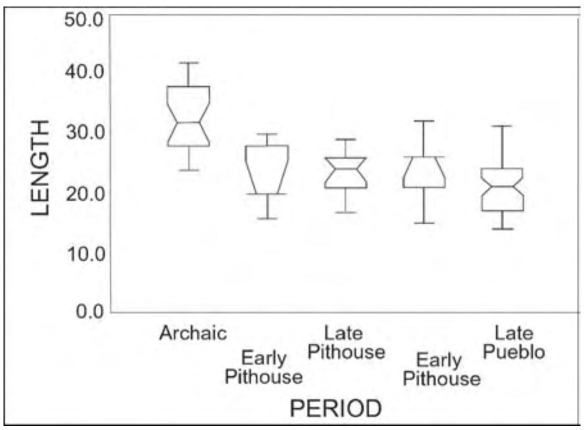

Figure 3.17. Notched box plot of projectile point length by occupational period.

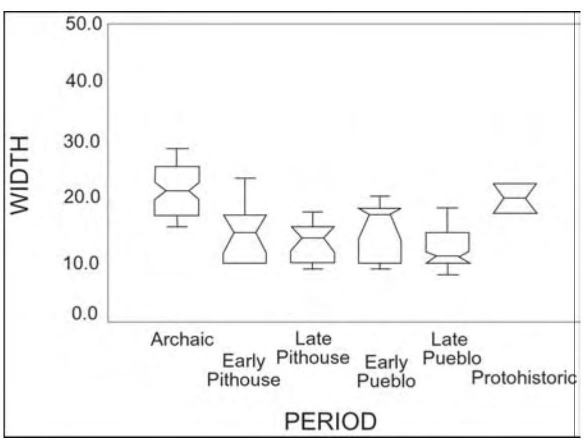

Figure 3.18. Notched box plot of projectile point width by occupational period.

While a notched box plot of point thicknesses was useless in these regards, the other plots are rather instructive. Whole projectile point length is plotted for each period in Figure 3.17, and width is shown in Figure 3.18. As suggested by the ANOVAS, Archaic points are statistically separable from Ceramic period points in both dimensions. There is no overlap between these dimensions for the Archaic and Mogollon points, suggesting that they represent samples from different populations. However, when widths are considered, Archaic and Protohistoric points overlap at the 95 percent confidence level, and can not be statistically separated.

Similarly, when only Mogollon samples are considered, Late Pueblo points cannot be statistically separated from the rest of the assemblage. In terms of width these points appear to differ somewhat from the rest of the Mogollon assemblage, but they are not statistically separable by this dimension. While both the ANOVA and notched box plot analyses suggest that Late Pueblo points may differ from other Mogollon assemblages, this is not statistically demonstrable by dimensional data. However, other information may help confirm or reject this possibility.

Measuring Function

Dart and arrow points are usually subjectively separated by size, with large points assigned to the former category and small points to the latter. However, experiments have shown that large points can be used on arrows and small points on darts (Thomas 1978). Functional assignments based on subjective measures of size are questionable unless they can be tested with empirical data. Thomas (1978) has addressed this issue using a sample of ethnographic and archaeological hafted projectile points numbering 132 arrows and 10 darts. Though the results of this analysis are tentative because of small sample size, its results are instructive. Four variables were examined: length, width, thickness, and neck width. Width was found to be the most important discriminator between dart and arrow points, and length was the least important (Thomas 1978:470).

Discriminant analysis was then employed to produce a set of classification functions, which can be used to categorize projectile points (Thomas 1978:470). Categorization was accomplished by applying two formulas to each point. The formulas are (Thomas 1978:470):

Dart Point Equation

$$C=0.188\ length + 1.205\ width + 0.392\ thickness - 0.223\ neck\ width - 17.552$$

Arrow Point Equation

$$C=0.108\ length + 0.470\ width + 0.864\ thickness + 0.214\ neck\ width - 7.922$$

Both equations were applied to each complete projectile point, and the specimen was placed in the class that provided the higher result. By using these formulas, Thomas (1978:471) was able to correctly reclassify 86 percent of his specimens, which was considered an acceptable level of accuracy. These formulas can be used to categorize whole points in our assemblage and, hopefully, will provide ranges that can then be used to classify broken points.

A total of 92 points from 15 dated site components and 2 mixed components were available for this analysis. The results are shown in Table 3.8. Only 25 percent of the sample were classified as dart points, while 75 percent were classified as arrow points. The dart point assemblage contains one example of an Augustín point from LA 37917. This is a stemmed point, but since its neck width was smaller than its overall width it was correctly classified. For the most part, the results of this analysis are as might be expected. Two Archaic components contained no arrow points, and Mogollon components contained few dart points. However, two Archaic components were dominated by arrow points (LA 70188 and LA 78439), suggesting there might have been more mixing than was initially apparent in the former case, and unexpected contamination in the latter. The presence of some arrow points in Archaic components and dart points in Mogollon components could be due to incorrect classification, since Thomas's (1978) method was only 86 percent correct. Indeed, a Chiricahua point from LA 3279 was incorrectly classified as an arrow point, and has been corrected in Table 3.8.

Width was found to be the most important measure in Thomas's (1978) study. Thus, the range of widths in our analysis may provide a foundation for assigning fragmentary points to dart and arrow categories. Whole dart points had a mean width of 21.167 mm, with a standard deviation of 2.140 mm. Arrow points had a mean width of 12.882 mm and a standard deviation of 3.683 mm. These ranges do not overlap in the first standard deviation: the range for dart point widths is 19.027 to 23.307 mm, and for arrow points it is 9.199 to 16.565 mm. Thus, fragmentary specimens narrower than 17 mm are considered arrow points, and those wider than 19 mm are dart points. Fragments that fall between these categories at 18 mm are arbitrarily classed as dart points. The potential accuracy of these assignments will be examined later. Table 3.9 shows the distribution of whole and fragmentary point types by site component.

Arrow points are still a problem for LA 70188 and LA 78439. Fortunately though, the former assemblage is now reclassified as dart points, while the latter is unchanged. Two arrow points now occur at LA 43766, but dart points are far more common. LA 45508 continues to contain only dart points. Dart points are common in many Mogollon assemblages, but dominate in only three, though they comprise fairly large percentages in four. Only dart points continue to be recognized for the single protohistoric component that contained classifiable projectile points.

Arrow points should not occur in Archaic components, and while dart points can occur in Mogollon components they should be comparatively rare. Part of the reason for this apparent mixing could be the way artifacts were assigned to categories. Thomas's (1978) formula was only 86 percent accurate in classifying the assemblage it was developed from, and some of our mixing could be due to similar

Table 3.8. Whole Points by Projectile Type for Each Site Component; Frequencies and Row Percentages

Period	Component	Dart Point	Arrow Point
Archaic	LA 43766	5 100.0	0 0.0
	LA 45508	3 100.0	0 0.0
	LA 70188	5 41.7	7 58.3
	LA 78439	0 0.0	1 100.0
Early Pithouse	LA 39975	0 0.0	1 100.0
	LA 45510	0 0.0	4 100.0
Late Pithouse	LA 45507	0 0.0	8 100.0
	LA 70196	0 0.0	2 100.0
	LA 70201	0 0.0	1 100.0
Early Pueblo	LA 39969	1 25.0	3 75.0
Late Pueblo	LA 3279	4 14.8	23 85.2
	LA 39968	1 16.7	5 83.3
	LA 70185	2 20.0	8 80.0
Protohistoric	LA 37917	1 100.0	0 0.0
Mixed Components	LA 70188	2 50.0	2 50.0
	LA 75792	0 0.0	2 100.0
	LA 78439	0 0.0	1 100.0

incorrect assignments. Also, classification of the broken points only took the first standard deviation range into account, which contains only 66.7 percent of the variation. When the second standard deviation is taken into consideration, dart and arrow point widths overlap between 16.887 and 20.248 mm. Specimens wider than this are almost certainly properly classified as dart points, and those that are smaller as arrow points. However, specimens falling within this range could feasibly belong to either group.

Table 3.9. Projectile Types for Each Site Component; Frequencies and Row Percentages

Period	Component	Dart	Arrow
Archaic	LA 43766	30 93.8	2 6.3
	LA 45508	5 100.0	0 0.0
	LA 70188	26 68.4	12 31.6
	LA 78439	0 0.0	1 100.0
Early Pithouse	LA 39972	5 100.0	0 0.0
	LA 39975	0 0.0	4 100.0
Late Pithouse	LA 45510	3 27.3	8 72.7
	LA 43786	1 100.0	0 0.0
	LA 45507	1 8.3	11 91.7
	LA 70196	1 14.3	6 85.7
	LA 70201	0 0.0	1 100.0
Early Pueblo	LA 39969	4 40.0	6 60.0
	LA 39972	2 100.0	0 0.0
	LA 75792	1 33.3	2 66.7
Late Pueblo	LA 3279	12 17.1	58 82.9
	LA 39968	2 22.2	7 77.8
	LA 70185	2 11.8	15 88.2
Protohistoric	LA 37917	4 100.0	0 0.0
Mixed	LA 70188	3 60.0	2 40.0
	LA 78439	0 0.0	1 100.0

Table 3.10 illustrates the same data as Table 3.9, with points whose width falls into the questionable range separated. Only 25 specimens (10.8 percent) are in this category, and removing them causes few significant changes. Dart points are less dominant in the LA 70188 Archaic assemblage and in several Mogollon assemblages (LA 45510, LA 39969, LA 39972), disappear from LA 70196, and are less common in the LA 37917 Protohistoric assemblage. Unfortunately, this does not solve the basic problem: are these points misassigned, or are they evidence of assemblage mixing or unexpected behavioral patterns?

Medium-Sized Points

Nearly half of the typed points (46.6 percent) fall into the medium-sized category. Medium-sized points occur in all dated components, and in only three do they comprise less than one-third of the assemblage. Interestingly, two of these cases are Late Pueblo components, and one is a Late Pithouse component. This category was compared using several different measures (Table 3.11), yet no single measure provided a secure means for separating dart from arrow points because they all overlap at both the first and second standard deviations.

Large (> 2.5 cm wide) and small (< 1.5 cm wide) points are not a problem; all of the former are categorized as dart points, and all of the latter as arrow points. Nearly 71 percent of the medium-sized specimens are classified as dart points, and the rest as arrow points. Medium-sized specimens classified as arrow points in Archaic assemblages could be evidence of contamination. Then again, perhaps they simply fall at or near the bottom of the range for acceptable dart points. Conversely, those occurring in Ceramic period assemblages may be evidence for the continued use of darts after introduction of the bow, or they could be at the upper edge of the range of acceptable arrow points. Another way of assigning points to classes is needed, both to check the categorization of the medium-sized points, and to extend the level of assignment to more fragmentary specimens.

Recategorization of the Assemblage

A potential problem with the use of Thomas's (1978) formulas is that they are unable to adjust for resharpening. When dart points are resharpened they are often shortened and made narrower, bringing them closer to the range for arrow points. This can lead to incorrect assignments. Indeed, in reexamining the categorized assemblage, at least nine of the whole specimens and three of the fragmentary points were resharpened. Visual inspection suggested that these specimens should be classified as dart rather than arrow points. These incorrect assignments are not necessarily the fault of Thomas's method; since these points were resharpened they probably should not have been

Table 3.10. Identifiable Points by Projectile Type for Each Site Component with Questionable Specimens Identified; Frequencies and Row Percentages

Period	Component	Dart	Arrow	Questionable
Archaic	LA 43766	27 84.4	2 6.3	3 9.4
	LA 45508	4 80.0	0 0.0	1 20.0
	LA 70188	19 50.0	10 26.3	9 23.7
	LA 78439	0 0.0	1 100.0	0 0.0
Early Pithouse	LA 39972	5 100.0	0 0.0	0 0.0
	LA 39975	0 0.0	4 100.0	0 0.0
Late Pithouse	LA 45510	1 9.1	8 72.7	2 18.2
	LA 43786	1 100.0	0 0.0	0 0.0
	LA 45507	1 8.3	11 91.7	0 0.0
	LA 70196	0 0.0	6 85.7	1 14.3
	LA 70201	0 0.0	1 100.0	0 0.0
Early Pueblo	LA 39969	2 20.0	6 60.0	2 20.0
	LA 39972	1 50.0	0 0.0	1 50.0
Late Pueblo	LA 3279	10 14.3	56 80.0	4 5.7
	LA 39968	2 22.2	7 77.8	0 0.0
	LA 70185	2 11.8	15 88.2	0 0.0
Protohistoric	LA 37917	2 50.0	0 0.0	2 50.0
Mixed	LA 70188	3 60.0	2 40.0	0 0.0
	LA 75792	1 33.3	2 66.7	0 0.0
	LA 78439	0 0.0	1 100.0	0 0.0

Table 3.11. Measures Used to Compare Specimens Classified as Arrow versus Dart Points; Means, First and Second Standard Deviations

Variable	Dart Points			Arrow Points		
	Mean	1st S.d.	2nd S.d.	Mean	1st S.d.	2nd S.d.
Neck Width	12.33	10.55 to 14.11	8.77 to 15.89	9.84	7.98 to 11.7	6.12 to 13.56
Haft Length	8.82	6.53 to 11.11	4.24 to 13.40	7.19	4.42 to 9.96	1.65 to 12.73
Notch Width	6.30	4.77 to 7.83	3.24 to 9.36	4.52	3.19 to 5.85	1.87 to 7.17
Notch Length	4.03	2.90 to 5.16	1.77 to 6.29	2.62	1.70 to 5.54	0.78 to 4.46

Table 3.12. Variable Measures Used in the Assemblage Recategorization; Means, First and Second Standard Deviations

Variable	Dart Points			Arrow Points		
	Mean	1st S.d.	2nd S.d.	Mean	1st S.d.	2nd S.d.
Blade length	25.08	19.65 to 30.52	14.21 to 35.96	16.35	11.83 to 20.87	7.32 to 25.38
Width	21.18	19.03 to 23.31	16.89 to 25.45	16.35	11.83 to 20.87	7.32 to 25.38
Haft width	11.17	8.41 to 13.93	5.65 to 16.69	7.32	4.51 to 10.12	1.70 to 12.93
Haft length	8.33	6.00 to 10.66	3.67 to 12.99	5.85	3.72 to 7.98	1.59 to 10.11
Notch length	3.60	2.94 to 4.98	1.91 to 6.00	2.12	0.91 to 3.32	0 to 4.53
Notch width	5.83	4.08 to 7.57	2.33 to 9.32	3.17	1.96 to 4.38	0.76 to 5.58

included in the sample at all. During the visual examination, we used size and appearance of the base to reassess classification. Except for neck width, Thomas's formulas essentially ignore bases. Yet it is this section of a point that most often escaped resharpening. Bases are also often recovered because they were replaced at residential sites rather than at temporary hunting camps. Thus, a method that examines variables describing point bases in addition to other pertinent data might be useful.

Six variables were selected for use in this study, though in many cases some data are lacking. They include blade length, overall width, neck width, hafting element length, notch width, and notch length. These variables should all vary with size; measurements should be smaller for arrow points, and larger for dart points. Thus, if some are missing, a point might still be classified. Resharpened points were dropped from the array of whole points to which Thomas's formulas were applied, and means and standard deviations were derived for each variable in both the dart and arrow point categories. These figures are shown in Table 3.12. Most variables overlap slightly between categories in the first standard deviation, and there is a complete overlap between the lower range of the second standard deviation for dart points and the upper range for arrow points.

Weights were applied to each variable in which measurements were available. A weight of 1 was used if the value fell within the first standard deviation and higher for darts or the first standard deviation and lower for arrows. A weight of .5 was assigned if it fell within the lower second standard deviation range for darts or the upper second standard deviation range for arrows. The procedure followed was similar to that used by Thomas (1978); each point was scored in dart and arrow categories, and it was assigned to the category that had the higher value. Thus, if a point scored 5.00 as a dart and 2.50 as an arrow it was classified as a dart. Since much of the assemblage consists of broken points, scoring was reviewed to ensure that inappropriate measures were not used. For example, the blade length of a point that was missing much of its distal end might incorrectly increase its arrow score at the expense of its dart score and lead to an incorrect categorization. Thus, this measurement would be dropped from consideration.

Our results were then compared to the categorization of whole points derived using Thomas's formula. We found a 90.4 percent correspondence between analyses, indicating that they classified the vast majority of the assemblage in the same way. Indeed, our measure may be slightly more accurate in that it correctly classified five of nine resharpened points as darts, and two as either dart or arrow. In only two cases did both our method and Thomas's formulas

Table 3.13. Identifiable Points by Projectile Type for Each Site Component, Questionable Specimens Identified; Frequencies and Row Percentages

Period	Component	Dart	Arrow	Either
Archaic	LA 43766	41	1	0
		97.6	2.4	0.0
	LA 45508	6	0	0
		100.0	0.0	0.0
	LA 70188	43	4	1
		89.6	8.3	2.1
	LA 78439	1	0	0
		100.0	0.0	0.0
Early Pithouse	LA 39972	5	0	0
		100.0	0.0	0.0
	LA 39975	1	3	1
		20.0	60.0	20.0
Late Pithouse	LA 43786	1	0	0
		100.0	0.0	0.0
	LA 45507	2	17	0
		10.5	89.5	0.0
	LA 45510	2	12	0
		14.3	85.7	0.0
	LA 70196	3	7	1
		27.3	63.6	9.1
	LA 70201	0	2	0
		0.0	100.0	0.0
Early Pueblo	LA 3563	0	1	0
		0.0	100.0	0.0
	LA 39969	4	8	2
		28.6	57.1	14.3
	LA 39972	1	1	0
		50.0	50.0	0.0
Late Pueblo	LA 3279	16	70	3
		18.0	78.7	3.4
	LA 9721	0	1	0
		0.0	100.0	0.0
	LA 39968	3	8	0
		27.3	72.7	0.0
	LA 70185	4	20	0
		16.7	83.3	0.0
Protohistoric	LA 37917	5	0	0
		100.0	0.0	0.0
Mixed	LA 45508	1	0	0
		100.0	0.0	0.0
	LA 70188	8	7	0
		53.3	46.7	0.0
	LA 70189	0	1	0
		0.0	100.0	0.0
	LA 70191	1	0	0
		100.0	0.0	0.0
	LA 75791	0	1	0
		0.0	100.0	0.0
	LA 75792	3	2	0
		60.0	40.0	0.0
	LA 78439	1	1	0
		50.0	50.0	0.0
	LA 89846	1	0	0
		100.0	0.0	0.0
	LA 89847	0	1	0
		0.0	100.0	0.0

Table 3.14. Projectile Point Types by Time Period; Frequencies and Row Percentages

Time Period	Dart Point	Arrow Point	Either
Archaic	91	5	1
	93.8	5.2	1.0
Early Pithouse	3	3	1
	42.9	42.9	14.3
Late Pithouse	3	38	1
	7.1	90.5	2.4
Early Pueblo	6	12	2
	30.0	60.0	10.0
Late Pueblo	18	99	3
	15.0	82.5	2.5
Protohistoric	3	0	0
	100.0	0.0	0.0

incorrectly classify specimens. It also has the advantage in that it is able to classify fragmentary points (at least tentatively), provided that at least one measurement is complete.

The results of this recategorization are shown in Table 3.13. A total of 329 of the 340 typed specimens was classified; only preforms discarded during manufacture were excluded. Possibly misclassed specimens include arrow points in Archaic components and dart points in Ceramic components. However, it is quite possible that dart points continued in use throughout the Ceramic period. As Table 3.14 shows, this category continues to comprise a fair percentage of the assemblage for each time period. Obviously curated Archaic points have been removed from this table. Even so, only dart points occur in the Protohistoric assemblage from LA 37917, and it remains possible that this component is actually of Archaic date.

There is a considerable drop in the percentage of dart points occurring in assemblages after the Archaic period. Except for the Early Pueblo period, less than 16 percent of each assemblage is comprised of dart points. Yet, they occur so consistently it seems likely that they represent continued use of darts after adoption of the bow. However, for the time being they, along with arrow points in Archaic components, are considered anomalous. This possibility, however, can be tested.

Examining Possibly Misassigned Points

LA 3279, Hough Site. The largest assemblage of typeable points was recovered from this Tularosa phase village, and includes 16 dart points. Among these specimens are 2 laterally notched San Pedro points and 2 Chiricahua points, all of which probably represent artifacts collected from earlier sites. Except for a single unnotched flake point, the remaining specimens identified as dart points or of questionable type are in the medium size range. Measurable noncurated dart points average 21 mm wide, with a range of 16 to 28 mm.

LA 37917, Rocky Hill. Radiocarbon dates suggest this site dates to the Protohistoric period, perhaps representing an Athabaskan occupation. However, all five specimens in this assemblage are classified as dart points. Two are Augustín points, a fairly well known type that dates to the Archaic; the other specimens are medium lateral-notched varieties. None of these types were expected to occur on a protohistoric site. Measurable medium lateral-notched points average 20.5 mm wide, with a range of 18 to 23 mm.

LA 39968, Spurgeon Draw. This is a single component site dating to the Tularosa phase. Most of the points were classified as arrow points, but three were placed in the dart category. One specimen is a San Pedro Corner-Notched point that probably represents an artifact collected from an earlier site. The remaining dart points are medium-sized; measurable specimens average 22 mm wide, with a range of 18 to 25 mm.

LA 36669, Haury's Site. This assemblage dates to the Reserve phase, and contains four specimens classified as dart points. All are medium-sized; measurable specimens average 19 mm wide, with a range of 18 to 21 mm.

LA 39972, SU Tanks. This site was multicomponent, containing materials from both Pinelawn and Reserve phases. According to radiocarbon dates, the Pinelawn component may date to the early centuries A.D. Thus, the presence of five dart and no arrow points is no surprise. The bow did not appear in the Southwest until ca. A.D. 500 (Cordell 1984b:214), and there is no reason to believe that atlatls and darts immediately disappeared following that event. They should have been used throughout this phase, and may not have been completely replaced by bow and arrow until much later. However, four of the points are Archaic types (two San José, one Bajada/San José, one Augustín), and appear to represent curated artifacts. The remaining specimen is a San Pedro Laterally Notched point, which is probably *not* a curated artifact.

The Reserve phase component contains an Augustín point, which was probably collected from an earlier site. Thus, while it may have been used during this occupation, it was almost certainly not made at this late date. No other dart points were assigned to this occupation.

LA 43766, Old Peralta. Radiocarbon samples suggest that this site dates to the Late Archaic, with two preceramic occupation levels noted during excavation. However, a thin veneer of later materials, mostly sherds, is thought to derive from a nearby Reserve phase fieldhouse. The single arrow point identified is a small corner-notched point recovered from a 2-cm-deep surface strip level, and is undoubtedly associated with the Reserve materials washing onto the site. Thus, no arrow points were found in good association with Archaic materials at this site.

LA 43786, Downslope Site. This site was dated to the Three Circle phase; it yielded only one identifiable point, which was classified as a dart point. This specimen is a Chiricahua point, and was undoubtedly collected from an Archaic site. Thus, there is no good evidence for the use of darts at this site.

LA 45507, Luna Village. This is a Three Circle phase site; two dart points were identified in its assemblage. One specimen is a Chiricahua point, a well-known Archaic form that undoubtedly represents an artifact collected from an earlier site. The second is a medium corner-notched point, which is 19 mm wide.

LA 45510, SAK Site. This site is thought to date to the San Francisco phase. The assemblage contains two dart points, one of which is a Jay point, an Archaic form that was most likely collected from an earlier site. The other specimen is a medium corner-notched, which is 24 mm wide.

LA 70185, DZ Site. This site contains a single Late Pueblo component. Four dart points were identified in the assemblage; three are medium corner-notched, and one is a medium-sized flake point. Measurable specimens average 19.25 mm wide, with a range of 17 to 21 mm.

LA 70188, Raven's Roost. This site contains an Archaic component that appears to dominate the assemblage, and Mogollon and protohistoric occupations that have contaminated the upper levels of Archaic deposits. In our initial attempt to separate these assemblages we removed most materials that derived from the upper levels of excavation, and felt that this removed most later contaminants from the Archaic assemblage. However, the Archaic assemblage still contains at least 4 arrow points, no matter what means is used to separate point categories. These artifacts all derive from levels that began 10 cm or less below the surface. Thus, it is likely that they represent contaminants from the later occupation, and that Mogollon or protohistoric materials are still mixed with the Archaic assemblage. The assemblage was resorted to ensure that these materials were removed. While this left slightly less than a third of the assemblage for detailed analysis, it hopefully prevented inclusion of later materials.

LA 70196, Fence Corner Site. This is a San Francisco phase site that yielded three dart points. One specimen is the base of a large dart point, probably a San Pedro lateral-notched. This may represent an artifact collected from an earlier site. The other specimens are medium-sized points, which average 19 mm wide, with a range of 18 to 20 mm.

LA 75792, Thunder Ridge. This site contains a single Early Pueblo component which contains three dart points. One specimen was classified as a Bajada/San José base, and is clearly a curated Archaic specimen. The other specimens are medium corner-notched points, which average 20 mm with a range of 16 to 24 mm.

Summary

Archaic points of named and well-known types were found in up to 10 Ceramic period components. Currently, these specimens are considered curated artifacts, though that may change for the protohistoric component. Ten Ceramic period components also contain dart points that do not appear to represent curated artifacts. All of these specimens are medium-sized, indicating that the problem of medium-sized points has not been solved. However, the categories to which these points are currently assigned are about as accurate as is possible at this time, and it is likely that darts continued in use long after arrival of the bow. This topic will be returned to later.

Now that we have a fairly clear idea of which are dart points and which are arrow points, it is possible to examine stylistic changes through time. Accordingly, each identified type is described in the next section, their temporal ranges are discussed, and they are compared with types recovered during other studies across the region.

EXAMINATION OF PROJECTILE POINT TYPES AND VARIETIES

Early Archaic Styles

Five possible Early Archaic points were recovered from five components, and include one Jay, one Bajada, and three Bajada or San José points. Both the Jay and Bajada points are basalt, while the Bajada/San José points are chert (n = 2) and obsidian (n = 1). The latter are bases that could fit into either of these types; lacking shoulders and blades they cannot be more accurately categorized, but are discussed in this section.

Jay Points. Jay points were initially described for northwest New Mexico. Though some authors have noted a resemblance to Hell Gap points (a terminal Paleoindian type), the workmanship seems less fine, with nearly all manufacture accomplished by soft hammer percussion. Similar specimens in California and the Great Basin have been defined as Lake Mojave points (Amsden 1937), and are illustrated among the nontypical forms from the Pinto site (Campbell and Campbell 1935:48g). Irwin-Williams (1979:36) remarks on the similarity of Jay and Lake Mojave points, suggesting a relationship between the populations using them. Some of Haury's (1950) Ventana-Amargosa I points at Ventana Cave are similar in form to this type. While his specimens are more strongly shouldered than is typical of the type, they originated in what appears to be an Early Archaic stratum, and have convex bases similar to the Jay Point. Closer to our study area, Dick's (1965, fig. 22t) Type 13C from Bat Cave resembles Haury's Ventana-Amargosa I points, and is strongly shouldered with a convex base and a similar shape to the Jay type.

It is possible that a more strongly shouldered variety of the Jay-Lake Mojave type was used during the Early Archaic in southern New Mexico. Hurt and McKnight (1949:180) illustrate several points from the Plains of San Augustín that closely resemble this possible variant, as well as the more classic weak-shouldered variety. Honea (1969) recovered several Jay points at the La Bolsa site near Quemado. Some corroboration is also supplied by studies in the Jornada region to the east and south of our study area, where Jay or "Jay-like" points have been found on sites dating to the Gardner Springs phase, ca. 6000 ± 500 to 4000 ± 300 B.C. (MacNeish 1993; MacNeish and Beckett 1987:10). During a survey in the southern Tularosa Basin, Carmichael (1986:89) identified specimens similar to Dick's (1965) Type 13C and Haury's (1950) Ventana-Amargosa I points as Jay points. Three of four illustrated specimens are strongly shouldered, and one is weak shouldered. Another survey in the southern Tularosa Basin recovered six Jay points (O'Hara 1988a), and studies in the Mesilla Basin west of El Paso found at least three (Camilli et al. 1988:6-69; Hicks 1988:178). Though lacking good associated dates, Jay points were among the types used during the Early Archaic in southwest New Mexico. A strongly shouldered variant may have been used through much of the Mogollon region (both Highland and Jornada), though more classic Jay points also occur.

In northwest New Mexico, this type is dated by Irwin-Williams (1973:5) between 5500 and 4800 B.C. Wiens (1994:65) suggests that more recent radiocarbon dates push the early date back to ca. 6000 B.C. Holmer (1986:95-96) indicates that similar types have been sporadically recovered in the Great Basin from strata dating between 8000 and 7000 B.C. at Danger Cave and ca. 5850 B.C. at Hogup Cave. Thus, the antiquity of this type and its likely variants is established, but absolute dates are rare. The Jay (Jay-like, Lake Mojave) form is undoubtedly among the earliest

Archaic projectile point styles in the Southwest.

The only example of a Jay point recovered by this project was found at a Late Pithouse period site (LA 45510). While this specimen undoubtedly represents a curated artifact, it was quite likely collected from somewhere near the site. Unfortunately, it adds little but this possibility to our knowledge of the Early Archaic in the study area.

Bajada Points. Bajada points were also defined in northwest New Mexico. In shape and date they are similar to points in the Pinto series, which was originally identified in California (Amsden 1935). A direct lineal development from the Jay point is presumed, and the Bajada point is dated between 4800 and 3200 B.C. (Irwin-Williams 1973, 1979). However, R. Moore (1994:460) reports dates as late as 1833 B.C. for this type in northwest New Mexico. These late dates are problematic, since they are later than those assigned to the San José point, which is typically thought to follow the Bajada point in the local sequence.

While this type is generally considered part of the Oshara sequence, it also occurs in the Cochise area. Haury (1950) illustrated no classic Bajada points at Ventana Cave, but a few reworked specimens appear to be examples of either this type or of San José points. A Ventana-Amargosa point shown as figure 60j (Haury 1950:282) may be a short-stemmed variant, but this is uncertain. A more likely candidate is illustrated as figure 60h (Haury 1950:282). Unfortunately, both specimens were recovered from high in the midden stratum, so it is likely that they were either curated or moved upward by bioturbation. However, a third specimen (fig. 55j; Haury 1950:270) resembles a weak-shouldered Bajada point, and was found in the deepest parts of the midden.

Dick (1965) also reports no classic Bajada points from Bat Cave. However, his Type 17 (Dick 1965:29) is similar to at least one example illustrated by Irwin-Williams (1979:37), and it may represent a variant. Formby (1986:112) found several specimens on the Plains of San Augustín and in the southern Mimbres area that appear to fall into this category, and he notes their similarity to one of Harrington's (1957) Pinto subtypes. Possible examples of Bajada points were also found during survey near Quemado (Larralde 1988), and at the La Bolsa site in the same area (Honea 1969). Bajada points also occur in the Jornada region of southwest New Mexico. Along with the Jay point, this type is considered diagnostic of the Gardner Springs phase (MacNeish 1993; MacNeish and Beckett 1987), and several examples were recovered during studies in the southern Tularosa Basin (Carmichael 1986:89; O'Hara 1988a:196; Schutt 1991:426).

One definite and three possible Bajada-San José points were recovered by this project. The definite Bajada point came from LA 70188, and cannot be assigned to a specific occupation because it was recovered from the surface of this multicomponent site. It is impossible to determine whether this specimen represents a separate Early Archaic occupation or was curated by later inhabitants. Only one Bajada-San José point was recovered from an unmixed Archaic context; one was from an Early Pueblo site (LA 75792), and one was recovered from an Early Pithouse site (LA 39972). The specimen found in an Archaic context was from Pit 2 at LA 70188. This feature was associated with several other pits and a pithouse which date near the end of the Late Archaic period. Also found in the pit were a San Pedro Corner-Notched, three medium corner-notched, and two medium lateral-notched points. These are all Late Archaic forms, and are consistent with the date assigned to the cluster of cultural features. Thus, the Bajada-San José base was probably collected from an earlier site and discarded in this feature during the Late Archaic.

Discussion. The Early Archaic period is not well known in the Southwest, and this is particularly true of the Mogollon region. The Archaic of this area, comprised of southwest New Mexico, southeast Arizona, and northern Chihuahua, was defined as the Cochise tradition from a series of sites in alluvial deposits (Sayles 1983; Sayles and Antevs 1941). The Cochise chronology is criticized by some (Berry and Berry 1986; Huckell 1988) and has been revised by others (Whalen 1971). It is poorly understood and not well dated. The Sulphur Spring phase is only known from the original group of six sites, while the Cazador phase was added in a revision of the sequence (Sayles 1983) and was originally assumed to follow the Sulphur Spring phase. Whalen (1971) questioned this assumption and concluded that Cazador represents the hunting aspect of Sulphur Spring (which contained no projectile points as originally defined). Irwin-Williams (1979:37-38) has questioned Whalen's conclusion, asserting that there are problems in the stratigraphic association of materials from both phases. She rejects the Cazador as either a separate phase or as an aspect of Sulphur Spring.

Huckell (1996:11) notes that subsequent work by Waters (1986) has ". . . demonstrated that Cazador represents instead a mixture of artifacts from the same deposits formerly classified as Sulphur Spring, and, at other sites, materials of younger ages redeposited at the Double Adobe type site." Though these deposits were redated by Waters (1986) and remain within the Early Archaic range (ca. 8500 to 8000 B.P.), Huckell (1996:11) indicates that there are still no good examples of associated points.

In their reexamination of data from the seminal Cochise sites in southeast Arizona, Berry and Berry (1986) reject the very existence of the Sulphur Spring and Cazador phases. They also question the validity of the Chiricahua phase, mainly due to the co-occurrence of several distinct point types. The latter assertion is questionable, because it assumes that in every instance in which more than one Archaic point type is present there has been geological mixing. However, their criticisms of the Sulphur Spring and Cazador phases are well reasoned and quite provoking. If they are correct, we know much less about the Early Archaic in the Cochise area than we thought.

Irwin-Williams (1994) provides interesting comments of relevance to this discussion, as well as to a perspective discussed in the introduction to this chapter. In considering MacNeish and Beckett's (1994) Chihuahua tradition, she criticizes their use of ". . . named point types from one area in cross-dating, or simply using them to describe the cultural developments in another area at some distance" (Irwin-Williams 1994:622). We have also criticized this type of usage, though we have ourselves violated the spirit of this criticism, within limits. Irwin-Williams (1994) also notes that, having examined MacNeish and Beckett's illustrations, the points they label "Jay" do not look like those she is familiar with.

Huckell (1996:12) describes the Early Archaic situation in the Southwest as "murky," and suggests that a great deal of research is needed. He notes:

> At this time we are uncertain which projectile point style or styles are diagnostic of this period in southeastern Arizona. However, both Pinto points and long, tapering stemmed points reminiscent of Jay points have been recovered from surface sites in this subregion. . . . These types have been argued to be diagnostic of the Early Archaic in the northern Southwest. . . . [Huckell 1996:11].

Our use of these type names does not imply direct contact between the groups using them. They are simply archaeological shorthand. The dates we have presented illustrate the antiquity of the Jay and Bajada types, but cannot be taken as good dates for their occurrence in the Cochise area. It might be best if these types were given local names, but that is not the purpose of this discussion and will be left to others. What we are trying to show is that points occur in the Cochise area that are recognized as belonging to the Early Archaic across the Southwest. Such points are rarely considered in most discussions of this period, while flawed and nonreplicable data are more consistently used. Obviously, it is time for a drastic revision of the Early Archaic in the Cochise area.

Unfortunately, the Early Archaic points recovered by this project are either of questionable type or represent curated tools. While it is likely that the curated specimens were collected in or near the study area, they cannot be accurately dated by any means that are currently available. They simply suggest that an Early Archaic population was present in the area.

Middle Archaic Styles

A total of 16 Middle Archaic points was recovered from 9 components. Types included in this category are Bajada-San José, San José, Chiricahua, Augustín, and Pelona. The Bajada-San José type has already been discussed. A fairly large percentage (31.3) of the definite Middle Archaic specimens are made from chertic materials, another 31.3 percent are basalt, 25.0 percent are obsidian, and 6.3 percent apiece are andesite and rhyolite. Interestingly, only one stemmed point (a Bajada-San José) is made from obsidian; most specimens made from that material are Chiricahua points (n = 3), and the other Chiricahuas are made from chertic materials (n = 2).

Only 25 percent of these points were recovered from unmixed Archaic components, and two others are from a component of questionable date and cultural affiliation at LA 37917. They include two Pelonas from LA 43766, one San José from LA 45508, two Augustíns from LA 37917, and a Chiricahua from LA 70188 (in addition to a Bajada-San José base). The nine remaining Middle Archaic specimens were found in Ceramic period or mixed deposits. The latter includes a Chiricahua and a Pelona from mixed Archaic and Ceramic period deposits at LA 70188, which can probably be comfortably included with the Archaic materials.

Chiricahua Points. A wide variety of styles is usually subsumed under this type, and someday it may be possible to separate them into varieties or different types. The reason for this range may be attributable to time depth, cultural variation, style variation, or all of these factors. Specimens categorized as Chiricahuas run the gamut from long to short bladed, with shallow to deeply bifurcated bases and narrow to wide side notches. Some closely resemble types defined in the northern Southwest (such as the Armijo), while most are quite distinct.

It is interesting to note that some examples illustrated in early reports from southern Arizona and New Mexico (Dick 1965; Haury 1950; Sayles and Antevs 1941) are similar to Pinto or San José points. For example, short-bladed Chiricahuas with wide, shallow lateral notches and concave rather than bifurcated bases resemble short-stemmed Pinto-San José points. The Pinto-San José type often has a slightly expanding stem that flares at the tang. If the stem was shortened on these specimens, they would appear to have wide, shallow lateral notches. Carried further, true notches could easily develop as a stylistic elaboration. While this idea is tentative, it does provide some testable implications, which are unfortunately beyond the scope of this analysis. If this hypothesis is correct, early Chiricahuas should have wide, shallow lateral notches, while later examples should have narrow, deeper notches.

Chiricahua points were recovered at the type sites for the phase (Sayles 1983; Sayles and Antevs 1941) and occur throughout southeast Arizona and southwest New Mexico. In fact, Roth and Huckell (1992:355) feel that their distribution might be restricted to this region. They were placed in the Chiricahua-Amargosa II horizon at Ventana Cave where they co-occurred with Pinto-San José forms and Augustín points (Haury 1950). At Bat Cave, Chiricahua points co-occurred with Pelona, Augustín, and Bat Cave points, and were found in levels containing San Pedro points (Dick 1965). The latter association was probably a result of mixing by bioturbation. This type has been found in the Mesilla Basin (Camilli et al. 1988; Hicks 1988), the Tularosa Basin (Carmichael 1986; O'Hara 1988a), near Datil (Hayden et al. 1998), in the Quemado area (Larralde 1988), south of Silver City (Moore 1988), and on the Plains of San Augustín (as illustrated by Formby [1986] and Hurt and McKnight [1949]). In general, Chiricahua points are widespread across the Cochise region.

Only general dates are assigned to Chiricahua points in the literature because there are few associated absolute dates. Based on geologic data, the phase with which this type is associated was originally dated between 8000 and 6500 B.P. Bronitsky and Merritt (1986:101-102) note that this date was revised in the 1950s to 6000 to 2400 B.P., overlapping with the San Pedro phase. Using radiocarbon samples, Whalen (1971:67) dates the Chiricahua phase between 5500 and 3500 B.P. Recently, Roth and Huckell (1992:355) have dated the Chiricahua point to a more restricted span of 4500 to 3500 B.P., again based on radiocarbon dates.

Unfortunately, our data can add little to this. Four of six Chiricahua points were found at Ceramic period sites, suggesting they were curated tools. Two specimens were recovered from LA 70188, one from an unmixed Archaic context and the other from mixed Archaic and Ceramic period deposits. While likely that both were discarded during Archaic occupations, this cannot be demonstrated for the latter specimen, which could also be a curated tool deposited during later use of the site. Thus, only one Chiricahua point can potentially add to our knowledge of the temporal range of this type.

That specimen was recovered from a use surface at LA 70188 and could not be directly dated because it was not found in a dateable feature. However, a pit structure and several extramural pits were also associated with the use surface, and yielded an array of radiocarbon dates that suggest it was occupied near the end of the Late Archaic. Of 33 dart points found in this part of the site (in both mixed and unmixed deposits), 30 percent are San Pedro points and 66.7 percent are medium-sized dart points that can probably be classified as small San Pedros. This array of points is consistent with the Late Archaic date, suggesting that the Chiricahua point either represents a curated tool, or that use of this type lasted much later than has been thought. The former option is considered more likely.

Augustín Point. This style was originally defined as the Gypsum Cave point in the Great Basin (Harrington 1933). Gypsum Cave points were initially thought to date to the late Pleistocene because of a supposed association with the remains of extinct fauna. While that association is now known to be incorrect, the use of this term still carries connotations of great antiquity (Holmer 1986:106). One solution to this problem was adopted by Thomas (1981), who simply renamed the type Gatecliff Contracting Stem. However, many early reports like Haury's (1950) work at Ventana Cave associate these contracting-stemmed points with the Gypsum Cave label, as do some recent reports (such as Formby 1986). Dick (1965:32) named this type the San Augustín point at Bat Cave (now shortened to Augustín). He discussed their resemblance to the Gypsum Cave points reported by Harrington (1933), and considered them a possible survival of the "earlier Gypsum Cave tradition" (Dick 1965:32). However, this was before new dates were assigned to specimens in the Great Basin.

Augustín points and related types are widely distributed throughout the Southwest and the southern Great Basin. As noted earlier, specimens were recovered at Ventana Cave and Bat Cave (Dick 1965; Haury 1950). Formby (1986) illustrates numerous examples of this type from the Plains of San Augustín (near Bat Cave) and the southern Mimbres area. Hurt and McKnight (1949) also found this type on the Plains of San Augustín. Examples of this style were recovered during excavations near Datil (Hayden et al. 1998), and a few were found during survey along the upper Gila River (Gossett 1985:108). Windmiller (1973:141) illustrates Augustín points from the Fairchild site in southeast Arizona, and a single specimen was found in the Willcox Basin, also in southeast Arizona (Waters and Woosley 1990:169). In the Jornada Mogollon region, examples of this type have been found in the southern Tularosa Basin (Carmichael 1986:89; O'Hara 1988a:196; Schutt 1991:426) and the Mesilla Basin (Camilli et al. 1988:6-69; Hicks 1988:154).

Interestingly, Irwin-Williams (1973) illustrates an apparent Augustín point with En Medio phase materials from north-central New Mexico. Other specimens from northern New Mexico are illustrated for the Middle Rio Grande Valley (Campbell and Ellis 1952:215; Marshall and Walt 1984), the Grants area (Agogino and Hester 1956:10), and the northern San Juan Basin (Hadlock 1962:181). Augustín points have also been found in west-central Arizona (Wendorf and Thomas 1951:110), northeast Arizona (P. Reed 1992:66), and southeast

Utah (Hunt and Tanner 1960:115; Mohr and Sample 1959:113).

Unfortunately, though this type is widely spread and rather abundant in the archaeological record, few examples have been absolutely dated. Archaeologists generally tend to assign Augustín points to the Middle Archaic. Most examples of this type were found in association with Chiricahua materials at Bat Cave (Dick 1965:103), but some also occurred in the buff sand layer below the Chiricahua level, as well as in San Pedro levels. The specimens in the buff sand stratum could be intrusive from higher levels, but since a redating of that stratum by Wills (1985) suggests a date of 6000 B.P., a Middle Archaic association is still indicated. Haury's (1950) findings at Ventana Cave also suggest a Chiricahua association for this type. In south-central New Mexico, Augustín points are among those considered diagnostic of the Fresnal phase, dates for which are consistent with the late Middle and early Late Archaic (MacNeish 1993; MacNeish and Beckett 1987). Roth and Huckell (1992:355) also suggest a Middle Archaic affiliation for this type, but indicate that debate over date and typological placement continues.

Interestingly, Thomas (1988) suggests a date of 3000 to 1300 B.C. for this type in the central Great Basin. Contracting stem points appeared first in the southeast part of the Great Basin, and their date of introduction grows later as one moves north and west (Holmer 1986). This suggests that contracting stem points may have originated in the Southwest and diffused into the Great Basin. Dates for this type are consistent in the Great Basin, always falling between 2500 B.C. and A.D. 500 (Holmer 1986:105). Thus, it is quite possible that they persisted far later there than in the Southwest.

Unfortunately, the Augustín points recovered during this project shed no light on these problems. Two specimens were found on Ceramic period sites and appear to represent curated tools. Two other specimens were found at LA 37917, which is dated to the protohistoric period by radiocarbon samples. All of the points recovered from this site were found on the surface, and it is impossible to determine whether they are related, represent multiple occupations, or were curated. Curation is most likely if the radiocarbon dates are correct. However, if other analyses are able to determine that more than one occupation is indicated, Archaic use is also possible.

Pelona Point. Several varieties of this type could probably be defined, considering the wide array of points assigned to this type in the literature. Most commonly the Pelona point is leaf-shaped, though some specimens are closer to diamond-shaped. Many illustrated specimens have serrated blades, while others do not. While this type is often recovered, little relevant information is available.

Pelona points have a wide distribution, though perhaps not as wide as that of the Augustín. Three varieties were defined at Bat Cave (Dick 1965:30), but in examining the illustrations it appears that only subtypes 12A and 12B actually belong to the type. Hurt and McKnight (1949:180) show what appears to be at least one example of this type from the Plains of San Augustín. Formby (1986) illustrates probable Pelona points from several locations including the Plains of San Augustín, the southern Mimbres area, and north-central Arizona. Probable examples were recovered from Reserve area caves (Martin et al. 1954:123) and from east-central Arizona and west-central New Mexico (Danson 1957). Several specimens were identified at an Early Pithouse site containing a possible Archaic component south of Silver City (Moore 1988). A few examples appear to have been recovered from the Fairchild site in southeast Arizona (Windmiller 1973). This type is also fairly well distributed through the Jornada region, occurring in the southern Tularosa Basin (Carmichael 1986:89; O'Hara 1988b:310—illustrated as a Lerma), the Mesilla Basin (Hicks 1988:161), and elsewhere in the area (MacNeish and Beckett 1994).

In general, Pelona points are assigned to the Middle Archaic, though few appear to have been recovered in association with absolute dates. Both Dick (1965) and Haury (1950) associate this type with Chiricahua levels at Bat Cave and Ventana Cave. MacNeish (1993) dates this type to the Keystone and Fresnal phases in south-central New Mexico, which encompass the Middle and early Late Archaic periods. Carmichael (1986:85) also assigns this type to the Middle Archaic.

Our study recovered three Pelona points from two sites. A single specimen was found in mixed Archaic and Ceramic period deposits at LA 70188, so it is not possible to determine which occupation it was associated with. Two Pelona points were recovered from LA 43766. The area in which they were found contained two superimposed occupational surfaces with layers of gravel and silt between them. Each surface had projectile points in association, and several points were found in the intervening strata. The lower surface and silt stratum were dated between ca. 1260 and 1000 B.C. (one-sigma range), and the upper surface between ca. 1096 and 884 B.C. (one-sigma range). Both dates are within the Late Archaic period, and most of the points found in association are consistent with this date. The single point found on the lower surface was a San Pedro Corner-Notched. The upper surface contained a San Pedro Lateral-Notched and two medium lateral-notched points. Specimens from the intervening strata include five San Pedro points (corner- and lateral-notched), four medium corner- and lateral-notched points, and two Pelona points. Evidence from a stratified Archaic site near San Ildefonso suggests that materials found between occupational strata like those at Old Peralta are mostly attributable to upward movement (Moore n.d.a). Thus, the Pelona points may have been associated with the early occupation. Even if this is not the case, their presence between two dated surfaces suggests they were used between the dates obtained for the surfaces. Thus, in this case we are able to contribute a bit to regional chronology. Evidence from LA 43766 suggests that Pelona points persisted into the Late Archaic period at least as late as ca. 1000 B.C., and were not restricted to the Middle Archaic.

San José Points. This general style is widespread. In California and the Great Basin it is considered the classic Pinto form, while in northern New Mexico it has been named the San José. Irwin-Williams intentionally avoided terms applied to this and other types elsewhere in the West, opting instead to ". . . use a locally defined and dated nomenclature . . ." (Irwin-Williams 1994:612). She suggests that the length of this type decreases through time, stems become increasingly expanded, and serration more common (Irwin-Williams 1973:8). R. Moore (1994:472) divides the type into early and late varieties; most specimens falling into the early subcategory have ground bases, while most in the late subcategory do not.

Varieties of this type occur in California (Amsden 1935, 1937), the Great Basin (Holmer 1986), in southeast New Mexico (Leslie 1978), and across northern New Mexico. They are also rather common in the Mogollon region, and are considered diagnostic of the Middle Archaic in southeast Arizona (Roth and Huckell 1992:354-355). Several examples are illustrated from Ventana Cave, where they were assigned to the Chiricahua-Amargosa II horizon (Haury 1950:278, 285). Waters and Woosley (1990:171) found specimens in the Willcox Basin of southeast Arizona, and at least one example has been found in the Tucson Basin (Ciolek-Torrello 1995:550). While Dick (1965) does not seem to have recovered this type at Bat Cave, numerous specimens have been found on the nearby Plains of San Augustín (Formby 1986; Hurt and McKnight 1949). Formby (1986) also collected many examples from the southern Mimbres area and west-central Arizona. Danson (1957) recovered at least one probable San José point from east-central Arizona or west-central New Mexico. Examples of this type were found in Reserve area caves (Martin et al. 1954:117), and they occur in the Quemado area (Larralde 1988:6-26). In the Jornada Mogollon region, this type has been identified in the southern Tularosa Basin (Carmichael 1986:91; O'Hara 1988a:196), and is considered diagnostic of the Fresnal phase (MacNeish and Beckett 1987, 1994).

Three definite San José points were recovered, as well as three bases that fit into both Bajada and San José categories, which were discussed earlier. Two of the definite examples were found at an Early Pithouse site (LA 39972), and represent curated tools. The only definite San José point from an unmixed Archaic context was recovered from LA 45508, where all other specimens are medium-sized dart points. The San José point was found in general fill, two medium-sized dart points were found on the surface, and three medium-sized dart points came from a probable Late Archaic pit structure. It is not possible to determine whether the San José point was curated, represents a distinct occupational period, or late use of the form, but the former is most likely.

Discussion. Three of the four point styles discussed in this section are well known and have moderately good dates. Roth and Huckell (1992:354) associate Chiricahua, Augustín-Gypsum Cave, and Pinto-San José points with the Middle Archaic in southeast Arizona, and the same grouping can be extended to southwest New Mexico. An additional type, the Pelona, is fairly well known and distributed through much of the same area. However, use of the Pelona appears to span both the Middle and Late Archaic periods, though no accurate beginning or ending dates are currently available for the type. If conclusions concerning the origin of our specimens are correct, an interesting and potentially dangerous situation is revealed. Not only did Ceramic period peoples collect and reuse many of these points, some also appear to have been reused by later Archaic peoples. Late dates for these styles may indicate the presence of curated artifacts rather than continued manufacture.

Again, if our conclusions are correct, there is no evidence for Early or Middle Archaic occupations at our sites. The presence of projectile points from those periods suggest that such occupations occurred in the region, but since we cannot demonstrate that any (with the likely exception of the Pelona points) are related to in situ occupations rather than curation, we cannot make this assertion for any of our sites.

Late Archaic Styles

Three point styles have been defined for the Late Archaic in Arizona. They include the San Pedro (Sayles and Antevs 1941), the Cienega (Geib and Huckell 1994; Huckell 1988), and the Cortaro (Roth and Huckell 1992). While San Pedro points are distributed across a large area and are well known, the other types have only recently been described and their ranges are as yet undefined. To date, Cienega points have mainly been found in southeast Arizona, but appear to extend into east-central Arizona and west-central New Mexico (Roth and Huckell 1992:356). Cortaro points are common in southern Arizona (Huckell 1995:54), and appear to be restricted to that area and southwestern New Mexico (Roth and Huckell 1992).

While our assemblage contains no examples of the Cortaro point, both the San Pedro and Cienega points appear to be represented. In the system used to classify points in this analysis, only those that are wider than 2.5 cm are considered San Pedros. This categorization is arbitrary, but necessary. While smaller dart points recovered from Late Archaic contexts are usually classified as San Pedros, similar specimens seem to have remained in use through the Late Pueblo period. Thus, in this analysis the smaller versions of the San Pedro are classified as medium corner- and lateral-notched. Since those types continue through the sequence, they are considered in the next section.

San Pedro Points. This type was first identified by Sayles and Antevs (1941) in association with Late Archaic remains. As Roth and Huckell (1992:355) indicate:

> The San Pedro point is found throughout southern Arizona, and variants of this type have been found as far south as northern Mexico . . ., north onto the Colorado Plateau . . ., and east into central New Mexico. . . . The San Pedro point is therefore widely distributed over exceptionally diverse ecological settings, from the Sonoran and Chihuahuan deserts to the forests of the Colorado Plateau.

Shackley (1996b) suggests that the range of San Pedro points extended into western and northwestern Arizona, where they may have co-occurred with Great Basin types. San Pedro points were well represented at Ventana Cave, where they were characteristic of the aceramic part of the upper midden, and extended into the lower pottery-bearing deposits (Haury 1950:288-290). They were also common at Bat Cave, with corner-notched specimens being assigned to a different type (Dick 1965). The stratigraphic position of San Pedro points in the Bat Cave deposits was thought to substantiate the persistence of this type into the early Ceramic period (Dick 1965:30).

Though this is the best dated point in the Cochise sequence, its temporal range is still questionable. Initially, both the San Pedro point and phase were dated between 3500 and 2000 B.P. (Sayles 1983:125). Huckell (1988:58) suggests that they date between ca. 3500 to 3000 and 1800 B.P., but indicates that good radiocarbon dates from clear Late Archaic contexts are only available for the period between 2900 and 2400 B.P. This date is revised by Roth and Huckell (1992:356) to 3000 to 1800 B.P. Upham et al. (1986) suggest a date of 1500 B.C. to A.D. 1050, which contrasts with all other dates suggested for the type. However, these dates were derived using the induced obsidian hydration method without environmental controls, and their conclusions are therefore questionable.

Points falling into the large corner- and lateral-notched categories are considered examples of San Pedro points in this analysis. They overwhelmingly occur on Archaic to Early Pithouse period sites, with only four examples (9.3 percent) found in unmixed Ceramic period components. Ten additional specimens (23.3 percent) were found in mixed Archaic and Ceramic period deposits. This type is almost equally split between corner-notched (21, 48.8 percent) and lateral-notched (22, 51.2 percent) varieties. Only the sample from LA 43766 could be examined stratigraphically for temporal variation in type, but the sample was so small that no meaningful tendencies were derived. All that can be said is that both lateral- and corner-notched varieties were in use ca. 1000 B.C., and it is likely that the same populations were using both varieties.

The four specimens recovered from unmixed Ceramic period deposits are probably examples of curated tools or knives that so closely resemble San Pedro points our analysis has thus far been unable to identify them. A discriminate analysis in which San Pedro points found in Archaic and Ceramic period components were compared using width, neck width, edge angle, and blade angle determined that the two categories could be separated (eigenvalue = 2.225, Wilks Lambda = .310), and all examples were correctly placed in their respective categories. However, there are two problems with this analysis. First, only two specimens from the Ceramic period could be examined, so there is a good possibility that sample error is responsible for these results. The second is that, even if these populations are different enough to be statistically separated, our data are insufficient to determine why they are different. The variation could be due to material type, date, or function. Lacking a larger sample, it is impossible to adequately assess these possibilities.

Cienega Point. This type was recently defined in southern Arizona by Huckell (1988), and described by Geib and Huckell (1994). It is distinguishable from San Pedro points by its deep corner notches and narrow triangular or bulbous stem (Geib and Huckell 1994:448; Huckell 1995:52). Cienega points can co-occur with San Pedros, and sometimes dominate assemblages or occur alone. They are relatively common in southern Arizona, but it is uncertain whether their range extends into southwest New Mexico. Cienega points are diagnostic of the terminal Archaic, or Early Formative period, which dates between 1000 B.C. and A.D. 500 (Roth 1996a:1). Initial estimates of the date range for the Cienega point suggest it occurred between 400 B.C. and A.D. 300. Cienega points differ from other types of corner-notched Archaic dart points that continued to be used into the Early Ceramic period. Those other styles tend to ". . . lack the deeply driven, oblique corner notches typical of Cienega points. Instead, late corner-notched points tend to appear similar to the earlier San Pedro points. . . ." (Geib and Huckell 1994:449).

Only four points that fit the physical description of the Cienega were identified in our assemblage. Unfortunately, all were found on sites dating to the Late Pueblo period (two apiece from LA 3279 and LA 39968). However, three of these specimens were classified as dart points, either suggesting that they were collected from earlier sites, or that the Cienega type persisted much later in this area. In Geib and Huckell's (1994) study of this type, they found that Cienega and San Pedro points could be distinguished using metric characteristics of their stems. In minimum and maximum measurements of stem width, these types did not overlap at the second standard deviation, and Cienega points were considerably narrower than San Pedros. The Cienega points in their sample had mean neck widths of 7.45 ± 1.33 mm, and maximum basal widths of 11.50 ± 2.52 mm (Geib and Huckell 1994:52). Comparing our possible Cienega points with these measurements, three of four fit into the first standard deviation range for neck width, and three of four fit into the second standard deviation range for maximum basal width. Different points did not fit these ranges, so we have two specimens that fit both characteristics and two that fit one characteristic apiece.

Unfortunately, there are not enough data to allow us to confidently conclude that our possible Cienega points are identical to those defined in Arizona. Had they been recovered from Late Archaic or Early Pithouse period sites, the comparison would have been strengthened. Even though three specimens were classified as dart points, it is possible that they could have functioned as large arrow points. Indeed, it is feasible that all of these points actually functioned as arrow rather than dart tips. Their tentative classification as Cienega points is insufficiently supported to suggest that they represent curated artifacts, and they must be considered representative of the Late Pueblo period at this time.

Late Preceramic to Ceramic Period Styles

Few of the point styles from the late Preceramic and Ceramic periods have been named, and in some cases the terms applied to them can lead to incorrect assumptions of cultural and temporal affinity. Thus, no names are assigned to these types at this time. While information on the temporal distribution of some types is available, others are rarely illustrated. For this reason, no comparisons with point assemblages from other sites in the Mogollon region are made until the end of this section.

Medium Lateral-Notched Points. This category contains 48 specimens from sites ranging in date from the Late Archaic to the Late Pueblo period, and some examples were also recovered from a protohistoric component (LA 37917). Over 27 percent were recovered from mixed Archaic and Ceramic period deposits, and cannot be accurately assigned to either. Of the remaining specimens, over 55 percent are from Archaic, possible Archaic, and Early Pithouse period components. Interestingly, 30 percent were recovered from Late Pueblo components.

Five varieties of this type were defined; a sixth category includes specimens that are missing part or all of their base and cannot be more accurately classified (18.8 percent). Specimens with convex bases were the most common variety (37.5 percent), followed by straight bases (27.1 percent), and concave bases (12.5 percent). Two types were represented by only one example apiece (2.1 percent each) and included specimens with three notches and serrated blades.

Straight, concave, and convex- based specimens were most common in Archaic components, but occurred into the Late Pueblo period. The three-notched specimen was recovered from an Archaic component, and the specimen with a serrated blade came from mixed Archaic and Ceramic period contexts. Overall, 72.9 percent of this type were classified as dart points, 25.0 percent as arrow points, and 11.1 percent as either (Table 3.15). Except for the three-notched and serrated blade specimens, each variety included both types. However, a third of the convex-based specimens were categorized as arrow points, while dart points were more dominant in the straight- and concave-based varieties. As Table 3.16 shows, dart points continue throughout the sequence. They are the only type present during the Archaic, and are dominant in only one later period.

To determine whether Archaic and Ceramic period dart points are statistically different, a series of T-tests were run for blade length (T=1.36, DF=37), neck width (T=1.38, DF=36), haft length (T=1.35, DF=36), and overall width (T=2.22, DF=41). Differences between medium lateral-notched dart points from all periods were not statistically significant at the 99 percent confidence level, and they appear to represent a single population. This suggests that there either was little change in this type through time, or that examples in Ceramic period assemblages are curated tools. Since there is no direct evidence for the latter and there is a large number of specimens in Late Pueblo components, curation does not appear to be responsible. This type appears to have been used from the Late Archaic through the rest of the prehistoric occupation of this region.

Table 3.15. Projectile Types for Medium Lateral-Notched Point Varieties; Frequencies and Row Percentages

Variety	Dart Points	Arrow Points	Either
Straight base	10 76.9	3 23.1	0 0.0
Concave base	5 83.3	1 16.7	0 0.0
Convex base	12 66.7	6 33.3	0 0.0
3-notches	1 100.0	0 0.0	0 0.0
Serrated blade	1 100.0	0 0.0	0 0.0
Fragments	6 66.7	2 22.2	1 11.1

Table 3.16. Projectile Types for Medium Lateral-Notched Points by Period; Frequencies and Row Percentages

Period	Dart Points	Arrow Points	Either
Archaic	22 100.0	0 0.0	0 0.0
Early Pithouse	0 0.0	2 100.0	0 0.0
Late Pithouse	1 50.0	1 50.0	0 0.0
Early Pueblo	3 60.0	1 20.0	1 20.0
Late Pueblo	2 22.2	7 77.8	0 0.0
Protohistoric	3 100.0	0 0.0	0 0.0
Mixed Archaic and Ceramic period	4 80.0	1 20.0	0 0.0

Medium Corner-Notched Point. This type contains the largest number of specimens of any of those defined; 63 specimens were found on sites ranging in date from the Late Archaic through Late Pueblo periods. Only 9.5 percent were recovered from mixed Archaic and Ceramic period deposits, and cannot be accurately assigned to either component. Of the remaining specimens, over half (54 percent) are from Archaic and Early Pithouse components, and 23.8 percent are from Late Pueblo contexts.

Five varieties were defined; a sixth category includes specimens that are missing part or all of their base and cannot be accurately classified (17.5 percent). Specimens with convex bases were the most common variety (42.9 percent), followed by straight bases (23.8 percent), teardrop-shaped bases (7.9 percent), concave bases (4.8 percent), and serrated blades (3.2 percent).

Table 3.17. Projectile Types for Medium Corner-Notched Point Varieties; Frequencies and Row Percentages

Variety	Dart Points	Arrow Points	Either
Straight base	10 66.7	4 26.7	1 9.1
Concave base	3 100.0	0 0.0	0 0.0
Convex base	21 77.8	4 14.8	2 7.4
Serrated blade	1 50.0	0 0.0	1 50.0
Teardrop-shaped base	2 40.0	3 60.0	0 0.0
Fragments	6 66.7	2 22.2	1 11.1

Straight-, concave-, and convex-based specimens were most common in Archaic components. While straight- and convex-based specimens occurred into the Late Pueblo period, concave-based specimens were only found in Archaic contexts. The serrated blade variety was found in Archaic and Late Pueblo components, but none were found in the intervening periods. The teardrop-shaped base variety occurred only in Archaic and Pueblo assemblages. Overall, 73.0 percent of the medium corner-notched type are classified as dart points, 19.0 percent as arrow points, and 7.9 percent as either (Table 3.17). Except for concave-based points, each variety includes both types. Dart points dominate the fragmentary and convex-based varieties, while arrow points are particularly common in the straight-based and teardrop-shaped base varieties.

As Table 3.18 shows, dart points were used throughout the sequence. They are the only type present during the Archaic, and dominate in three later periods. To determine whether Archaic and Ceramic period dart points are statistically different, a series of T-tests were run for blade length (T=-.92, DF=28), neck width (T=1.04, DF=27), haft length (T=-.86, DF=26), and overall width (T=2.48, DF=29). Differences between Archaic and Ceramic period dart points are not statistically significant at the 99 percent confidence level, and they appear to represent a single population. This suggests that there was either little change in this type through time, or that examples in Ceramic period assemblages were curated. Since there is no direct evidence for the latter and there is a large

Table 3.18. Projectile Types for Medium Corner-Notched Points by Period; Frequencies and Row Percentages

Period	Dart Points	Arrow Points	Either
Archaic	17 100.0	0 0.0	0 0.0
Early Pithouse	1 33.3	1 33.3	1 33.3
Late Pithouse	2 66.7	1 33.3	0 0.0
Early Pueblo	3 66.7	2 40.0	0 0.0
Late Pueblo	10 66.7	2 13.3	3 20.0
Mixed Archaic and Ceramic period	14 63.6	7 31.9	1 4.5

number of specimens in Late Pueblo components, curation does not appear to be responsible. In general, this type was used from the Late Archaic through the rest of the prehistoric occupation of this region. However, the concave-based variety is restricted to the Archaic period in our population.

Small Corner-Notched Point. This type contains 19 specimens on sites ranging in date from the Late Archaic through Late Pueblo periods. However, the single Archaic example is from LA 43766 and, as discussed earlier, was recovered from the upper 2 cm of fill and appears to have been washed onto the site from a nearby Reserve phase fieldhouse. That specimen is reassigned to the Early Pueblo period. Only one specimen (5.3 percent) was recovered from mixed Archaic and Ceramic period deposits; while this point cannot be accurately assigned to either component, it is most likely associated with the later occupation. In our limited sample, small corner-notched points appeared during the Early Pithouse period, were most common in the Late Pithouse period, and persisted into the Late Pueblo period. All are classified as arrow points.

Three varieties were defined; a fourth category includes specimens that are missing part or all of their base and cannot be accurately classified (31.6 percent). Specimens with convex bases are the most common variety (36.8 percent), followed by straight bases (26.3 percent), and serrated blades (5.3 percent). Only one specimen with a serrated blade was recovered, and was found in a Late Pueblo assemblage. No other types are restricted to a single period of occupation.

Small Corner-Notched Point with Long Blade. This type contains eight specimens from Late Pithouse and Late Pueblo period components; no specimens were recovered from mixed deposits. Three varieties were defined; a fourth category includes specimens that are missing part or all of their base and cannot be accurately classified (50.0 percent). Specimens with convex bases are the most common variety (25.0 percent), followed by concave and straight bases (12.5 percent each).

This type is characterized by long, narrow blades. Three varieties (including fragments) possess deep corner notches with straight or concave blade edges, while the fourth has relatively shallow corner notches and convex blade edges. While these varieties are grouped together by some characteristics, others suggest that two groups are clearly represented. Indeed, all of the deeply notched specimens were recovered from a Late Pithouse period occupation at LA 45507, while the more shallowly notched specimen came from Late Pueblo deposits at LA 3279.

The seven specimens from Luna Village (LA 45507) are almost identical in manufacturing style and form, varying only in such characteristics as size and base shape. All are made from obsidian; two were recovered from an extramural hearth (Feature 15), four from general fill in Pithouse 12, and one from general fill in Pithouse 13. These proveniences are near one another, and the most distant point specimens were found 12 m apart. Pithouse 12 and Feature 15 are probably associated; thus, six of seven points are from a structure and associated surface feature. Pithouse 13 is only about 5 m west of Pithouse 12, suggesting that the single point found in that structure could have washed in from surface refuse deposits if it was not acquired by a resident of that structure. The similarity of the workmanship in these points and the close proximity in which they were recovered suggests that they are the work of a single flintknapper.

It appears that this variety should be split into two categories. One includes specimens with long blades and deep corner notches that appear to represent the work of a single artisan, and the second includes the long-bladed point with shallow corner notches from LA 3279. With these specimens added to the array of other small corner-notched points, nearly 70 percent of those from unmixed deposits were recovered from Late Pithouse period components. The use of small corner-notched points appears to have been most prevalent during that period, but this type persists through the Late Pueblo period.

Small Side-Notched Point. This type contains 21 specimens from sites ranging in date from the Late Pithouse through Late Pueblo periods; all are classified as arrow points. Only one specimen (4.8 percent) was recovered from mixed deposits. Three varieties were defined; a fourth category includes specimens that are missing part or all of their base and cannot be accurately classified (28.6 percent). Other varieties include specimens with convex bases, straight bases, and concave bases (23.8 percent each). This type does not appear until the Late Pithouse period in our sample and was used until the end of the prehistoric occupation. No varieties are restricted to any one period of occupation.

Small Side-Notched Point, Long Blade. This type contains 22 specimens from sites ranging in date from the Late Pithouse through Late Pueblo period, and is characterized by a comparatively long blade; all are classified as arrow points. Only one specimen (4.5 percent) was recovered from mixed deposits. Five varieties were defined using base, blade, and notch characteristics. Two varieties have long blades, notches placed high on blade edges, and convex (9.1 percent) or concave (22.7 percent) bases. The remaining varieties have long blades, shallow side notches, and straight (27.3 percent), concave (31.8 percent), or convex (9.1 percent) bases.

The temporal distribution of this type is very interesting. With the exception of one specimen from a Late Pithouse period component (LA 70201), all examples from unmixed deposits date to the Late Pueblo period. That specimen has a long blade with shallow side notches and a straight base. Thus, this type is a relatively good indicator of a Late Pueblo component in our sample and is mostly restricted to that period.

Small Side-Notched Point, Bifurcated Base. This type contains seven specimens from sites dating to the Early and Late Pueblo periods; all are classified as arrow points. This type has long blades and deeply bifurcated bases and occurred on four sites from two periods, suggesting that they are a distinct type rather than the product of a single flintknapper, as was determined for small corner-notched points with long blades and deep corner notches. However, they appear to bee restricted to the general Pueblo period.

Small Side-Notched Point, Eccentric. Twenty points were assigned to this category, and are distinguished by the presence of multiple notches along one blade edge; all are classified as arrow points. Points with a second side notch on one blade edge (three notches) dominated this category (75 percent), while a second variety with more than two notches along one blade edge (multiple notches) was less common (25 percent).

The three-notched variety occurred at four sites with occupations ranging from the Late Pithouse through Late Pueblo periods. In contrast, the multiple notched variety only occurred at one Late Pueblo site (LA 3279). The multiply notched points were variable enough in overall shape and workmanship to suggest manufacture by more than one flintknapper.

Small Lateral-Notched Point. This category was a catch-all for small points possessing wide, shallow lateral notches; all are classified as arrow points. Of the five specimens in this category, only one (20 percent) was recovered from mixed deposits. With the exception of one point from an Early Pithouse period component, this type is restricted to Late Pueblo sites. However, since this is a catch-all category, it lacks diagnostic power.

Small Unnotched Point. This category contains 24 specimens from sites ranging in date from the Early Pithouse through Late Pueblo periods; all are classified as arrow points. Only two specimens (8.3 percent) were recovered from mixed deposits. Three varieties were defined; a fourth category includes specimens that are missing part of their base and cannot be accurately classified (4.2 percent). Varieties include specimens with straight (58.3 percent), concave (33.3 percent), and convex (4.2 percent) bases.

These points can be a problem because they are often defined as preforms rather than finished points. In this analysis, specimens were only categorized as preforms if they were rejected during reduction because of breakage, step fracturing, or some other reason that would preclude successful completion. The points included in this type appear to be finished tools rather than rejected preforms.

The temporal distribution of these points is very interesting. With the exception of one specimen they are restricted to the Pueblo period, and primarily occur during the Late Pueblo period. The early point was found in a Late Pithouse component, and is the only example of a convex base. It was reexamined to determine whether it represents a preform or a finished tool. This specimen is fragmentary; the distal end is missing. The break is a nondiagnostic snap fracture that could have occurred during as well as after manufacture. However, all remaining edges are heavily abraded, apparently to prepare platforms for further flaking. This sort of abrasion is not characteristic of other points in this type, or of most finished points in general. It is likely that the convex-based specimen was broken during manufacture and should be considered a preform rather than a finished tool. Thus, small unnotched points with concave or straight bases appear to be diagnostic of the Pueblo period in our sample.

Medium Unnotched Point. This category contains seven specimens from Early and Late Pueblo period components; one (14.3 percent) was categorized as a dart point, and one (14.3 percent) could be classified in either category. Only one specimen (14.3 percent) was recovered from mixed deposits. Three varieties were defined and included specimens with convex (57.1 percent), straight (28.6 percent), and concave (14.3 percent) bases.

This type is also often classified as preforms rather than finished points. Since four specimens (57.1 percent) exhibit impact fractures (including the only specimen classified as a dart point), they were obviously broken in use and certainly represent finished tools. Two of the remaining three specimens also appear to be complete tools, showing none of the

Table 3.19. Distribution of Medium Corner-Notched and Lateral-Notched Points through Time; Frequencies and Column Percentages

Period	Corner-notched	Lateral-notched	Total	Total Assemblage	Percentage of Period Assemblage
Archaic	17 37.8	17 48.6	34 42.5	9,184 21.6	0.37
Early Pithouse	2 4.4	1 2.9	3 3.8	2,103 4.9	0.14
Late Pithouse	4 8.9	3 8.6	7 8.8	4,377 10.3	0.16
Early Pueblo	3 6.7	5 14.3	8 10.0	6,528 15.3	0.12
Late Pueblo	19 42.2	9 25.7	28 35.0	20,386 47.9	0.14
Total Percent	45 56.3	35 43.8	80 100.0	45,570 67.4	

characteristics of discarded preforms. The third specimen, however, exhibits an outrepassé scar, which began at the proximal end and removed the distal end, or tip. Instead of a finished tool, this point probably represents a preform discarded during manufacture because of breakage.

Flake Points. This category contains 17 points with a variety of shapes, sizes, and notching techniques. Tools were placed in this category if they exhibited minimal or marginal modification to produce a shape approximating that of another point type, and ranged in date from Late Archaic through Late Pueblo. Only two specimens (11.8 percent) were recovered from mixed deposits. Four (23.5 percent) are classified as dart points, 12 (70.6 percent) as arrow points, and 1 (5.9 percent) could be classified in either category. Four varieties were defined by base and notch characteristics including unnotched with straight base (17.6 percent), unnotched with convex base (17.6 percent), corner-notched (35.3 percent), and side-notched (29.4 percent).

The only examples of this type from the Archaic and Early Pithouse periods (1 apiece) are dart points. The 2 remaining dart points are from Late Pueblo contexts, while the specimen that fits both categories is from a Late Pithouse component. Both corner- and side-notched flake arrow points occur in Late Pithouse through Late Pueblo components, while unnotched specimens occur only in Late Pithouse and Late Pueblo contexts.

This type is temporally sensitive in some ways, since the different varieties tend to follow the same trends as the more formally manufactured assemblage. However, as an individual type it has little diagnostic use. Since these varieties appear to have been expediently manufactured, they may not hold to the stylistic norm. Instead, they may be notched or unnotched according to the shape of the flake being modified, or whatever seems easiest. Manufacture probably ceased when their minimum requirements were fulfilled.

Discussion

One of the few comprehensive studies of Mogollon projectile point styles was conducted by Wheat (1955). Surprisingly, while this study is long out of date it provides quite a bit of good information. Unfortunately, most studies in this region have either recovered few projectile points or fail to illustrate any but a representative sample, so it is difficult to compare the full range of variability demonstrated in our assemblage, and it may be necessary to combine several types to provide a detailed discussion.

Two general types of projectile points originated in the Late Archaic and appear to have persisted through the Late Pueblo period. These are the medium corner- and lateral-notched types. Unfortunately, they were very long-lived types and it was not possible to define temporal differences in our sample. Indeed, no significant differences were found when points of both types from Late Archaic and Ceramic period contexts were compared.

Wheat (1955:128) illustrates the medium corner-notched variety as Type 5a, and suggests that they were the most common type in the Early and Late Pithouse periods. Though they continued in use after that time, he feels that their popularity declined and that they are not as common in Pueblo period sites (Wheat 1955:127). Medium corner-notched points with teardrop-shaped bases are illustrated as Type 15 by Wheat (1955:128). While they are not as common as other varieties, they seem to occur from at least the Early Pithouse through Early Pueblo periods. The medium lateral-notched type is illustrated as Types 7 and 8 (Wheat 1955:128), and is common in Early and Late Pithouse period contexts (Wheat 1955:130). After this time he feels the type began disappearing from the northern Mogollon area (Wheat 1955:130).

Danson (1957:95) indicates that the medium corner-notched type is common on sites dating to the Pithouse periods, but also occurs on Pueblo period sites. Both types were found at Early Pithouse sites such as Crooked Ridge Village (Wheat 1954) and the SU site (Martin et al. 1940), and at Early to Late or Late Pithouse sites such as Turkey Foot Ridge (Martin and Rinaldo 1950a), the Bluff site (Haury and Sayles 1947), Mogollon Village (Haury 1936b), and Bear Ruin (Haury 1941). They have also been found in Late Pithouse to Pueblo period contexts at Gallita Springs (Kayser 1975), in Early to Late Pueblo rooms (corner- and lateral-notched) and a Late Pithouse structure (lateral-notched) at the Saige McFarland site (Lekson 1990), and in Late Pueblo deposits at Gila Cliff Dwellings (Teague 1986). Gifford (1980) reports these types from Red Bow Cliff Dwelling, which is dated between A.D. 1325 and 1400. During investigations of caves in the Mogollon region, Martin et al. (1952) recovered these types from pre-pottery to Tularosa Phase deposits, and considered them poor temporal markers (Martin et al. 1954). M. Nelson (1986) also comes to this conclusion, and indicates that this form persists into the Cliff phase in the Mimbres area.

Our analysis found that these types may have initially been made during the Late Archaic, and probably represent smaller forms of the San Pedro Lateral- and Corner-Notched types. Examination of reports from the region suggests that, while it is possible that they were most common in the Pithouse periods, these types appear to have been used throughout the sequence. Our data are in basic agreement with these trends. Table 3.19 illustrates the distribution of these types by period, the total assemblage attributed to each period, and the percentage of the total assemblages comprised by these types. Medium-sized points represent a fairly steady percentage of assemblages through time. It is unlikely that this would be the case if most of these points represented curated tools. Thus, either darts continued to be used as part of the hunting tool kit through the Late Pueblo period, or there was a continuing need for very large arrow points in addition to the smaller varieties.

Small corner-notched arrow points were apparently introduced late in the Early Pithouse period. In form, they resemble the medium corner-notched variety, and were classified as Type 5b by Wheat (1955:127, 130). Both Wheat (1955) and Dick (1965) suggest that use of this type appears to have been common through the Late Pueblo period. It probably represents the earliest type of arrow point in the region, and is similar to early arrow points in the Anasazi region as well as the ubiquitous Scallorn point of the Midwest and East. Since this type is virtually the same as the large variety, it may be difficult to distinguish between small dart points and large arrow points. Thus, medium corner-notched arrow points may actually represent the upper size range for this type. Since these points were easily manufactured from small flakes, they appear to have remained popular after their introduction along with the bow around A.D. 500 (Cordell 1984b).

Wheat (1955:127, 130) places this type in the Early and Late Pithouse periods. Dick (1965) suggests that it occurred from the Early Pithouse through Early Pueblo periods, and Woosley and McIntyre (1996) date its occurrence to essentially the same period at Wind Mountain. Numerous examples were recovered from pre-pottery through Late Pueblo period deposits at Tularosa Cave, but they are thought to have been most abundant between the pre-pottery and early Late Pithouse periods (Martin et al. 1952). In the Forestdale Valley they have been found in Early Pithouse through Early Pueblo period sites (Haury 1985c). M. Nelson (1986) indicates that these points occur from the Early Pithouse period through the Cliff phase in the Mimbres area. Early Pithouse period occurrences have been documented at Crooked Ridge Village (Wheat 1954), Cave Creek and the San Simon Valley (Sayles 1945), Winn Canyon (Fitting 1973), and the Bluff site (Haury and Sayles 1947). They occur in both Early and Late Pithouse contexts at Crooked Ridge Village (Wheat 1954), and in Late Pithouse contexts at Mogollon Village (Haury 1936b; Gilman et al. 1991) and Bear Ruin (Haury 1941). This type was most frequently found in Early and Late Pueblo deposits in Reserve area caves (Martin et al. 1954), and was found in similar contexts at the Saige-McFarland site (Lekson 1990). Early Pueblo Period occurrences include Reserve phase sites in the Pine Lawn Valley (Martin and Rinaldo 1950b) and Mimbres phase sites (Fitting 1972; Nesbitt 1931). Late Pueblo occurrences include Tularosa phase sites in western New Mexico (Martin et al. 1957) and Gila Cliff Dwelling (Teague 1986).

It is difficult to determine whether small corner-notched points with long blades represent a distinct type or are simply variants of the more general small corner-notched type. As discussed earlier, most examples of this type were recovered from a single site, and may represent the work of one single artisan. These deeply notched points are not well represented in the literature, though Sayles (1945, plate 42) illustrates an undated example recovered during his investigations in southeast Arizona. An example similar to the long-bladed but more shallowly notched variety is illustrated by Martin et al. (1940:65) from the Pithouse period at the SU site. Because of the limited distribution of this type, it is currently considered a variant of the small corner-notched type.

Small side-notched points are a somewhat later addition to the array of styles. Wheat (1955:128) classified this style as Type 13, and considered it to be a refinement of his Type 8, though he notes they may occur later than that style. This type appears to be absent from Early Pithouse period contexts. While it occurs in the Late Pithouse period, it is much more common in the Pueblo periods. Type 14 (small side-notched points with three notches) is a variant of this style, and is noted as occurring rarely in Early Pueblo period contexts (Wheat 1955).

During his survey, Danson (1957:95) found this type on sites dating after A.D. 900, essentially the Late Pithouse through Pueblo periods. This type has been found in Late Pithouse period contexts in the Mimbres area, where they occur through the Cliff phase (M. Nelson 1986), and at Tla Kii Ruin (Haury 1985b). Most other occurrences noted are from Pueblo period sites including Mattocks Ruin (Nesbitt 1931), Starkweather Ruin (Nesbitt 1938), the Saige-McFarland site (Lekson 1990), Tla Kii Ruin (Haury 1985b), Early Pueblo sites in the Pine Lawn Valley (Martin and Rinaldo 1950b), Late Pueblo sites in western New Mexico (Martin et al. 1957), and in the Salado sites of Foote Canyon Pueblo (Rinaldo 1959) and Red Bow Cliff Dwelling (Gifford 1980). The only possible reference to earlier occurrences is at Tularosa Cave, where this type is reported from pre-pottery through Late Pithouse deposits (Martin et al. 1952). However, this early occurrence is probably due to mixing of deposits, both through bioturbation and excavation technique, and calls into question other point type distributions from that site, especially since the small side-notched type was principally derived from Pueblo period deposits in other nearby caves (Martin et al. 1954).

While small side-notched points with long blades, bifurcated bases, and extra notches along one edge have been considered individual types in this analysis, they are separated out by few other researchers. As noted above, small side-notched points with three notches were considered a separate, though rare type by Wheat (1955). He does not illustrate the long-bladed or bifurcated-based types. Possible examples of the long bladed type are illustrated by Haury (1936b) from Mogollon Village and Nesbitt (1938) from Starkweather Ruin, both Late Pithouse period sites. This type also appears to have been recovered by Nesbitt (1931) from the Pueblo period Mattocks Ruin, and Martin et al. (1957) from Late Pueblo sites in the Apache Creek area. The bifurcated base type is illustrated by Nesbitt (1938) from Late Pithouse contexts at Starkweather Ruin, and by Lekson (1990) from Early to Late Pueblo contexts at the Saige-McFarland site. The three-notched type has been found by Martin and Rinaldo (1950a) at Turkey Foot Ridge and Nesbitt (1938) at Starkweather Ruin, both of which date to the Late Pithouse period. Rinaldo (1959) found this type at Foote Canyon Pueblo (Cliff phase), and Martin et al. (1954) illustrate undated examples from Reserve area caves.

Interestingly, while no examples of the multiple-notched variety were found in reports from the Mogollon area, a similar specimen was recovered from Pueblo Bonito in Chaco Canyon. Pepper (1920:110) illustrates a hafted point from Room 32 that has three notches along one edge and one along the other. Interestingly, neither of the extra notches appear to have been used to haft the point, suggesting that they had a different function. Judd (1954, plate 74) illustrates a point with at least one extra side notch, also from Pueblo Bonito. This specimen was recovered from a quiver of arrows found in a burial in Room 330, and is the only specimen with three notches among the 28 points shown. These elaborations appear to have been widespread, and it is likely that they served a nonutilitarian purpose.

Wheat (1955:128-129) may classify small lateral-notched points as his Types 10 and 16, which he notes occurred from Early Pithouse through at least Early Pueblo times. Similar points were recovered from Early to Late Pueblo deposits at the Saige-McFarland site (Lekson 1990), Late Pithouse contexts at Starkweather Ruin (Nesbitt 1938), and Early Pithouse deposits at Winn Canyon (Fitting 1973). This type does not appear to be common, and may actually be a small version of the medium lateral-notched type. As such, they do not appear to be temporally diagnostic.

Small unnotched points are rather common in our assemblage. Wheat (1955:128-129) classified this style as his Types 1 through 3, and dates them to the Early and Late Pithouse periods. Danson (1957:95) indicates that they are common on sites dating to the Pithouse periods, but also occur on Pueblo period sites. The convex-based variety has been found at Early Pithouse sites including Crooked Ridge Village (Wheat 1954) and the SU site (Martin et al. 1940). They occurred in Early to Late or Late Pithouse contexts at the Bluff site (Haury and Sayles 1947), Mogollon Village (Haury 1936b), Turkey Foot Ridge site (Martin and Rinaldo 1950a), and Bear Ruin (Haury 1941). They have also been found in Late Pithouse to Pueblo period contexts at Gallita Springs (Kayser 1975), in Early to Late Pueblo rooms at the Saige-McFarland site (Lekson 1990), and in Late Pueblo deposits at Gila Cliff Dwelling (Teague 1986). Gifford (1980) reports this type from Red Bow Cliff Dwelling, which is dated between A.D. 1325 and 1400. During investigations of caves in the Mogollon region, Martin et al. (1952) recovered this type from pre-pottery to Tularosa phase deposits, and considered them a poor temporal marker (Martin et al. 1954). M. Nelson (1986) also comes to this conclusion, and indicates that this form persists into the Cliff phase in the Mimbres area. Similar points were found at Ventana Cave (Haury 1950:266); while it is difficult to determine the exact provenience of these specimens, they appear to be most common in the pottery-bearing levels. Haury (1950:268) suggests that larger specimens may be of Late Archaic age, but he appears to have no good evidence for this possibility. Thus, while this type may be most common during the Early and Late Pithouse periods, it appears to occur throughout the sequence.

The straight- and concave-based varieties are also often discussed or illustrated. The straight-base variety has been found in Early Pithouse contexts at the Bluff site (Haury and Sayles 1947), Crooked Ridge Village (Wheat 1954), and Winn Canyon (Fitting 1973). Specimens of this type from the SU site (Martin et al. 1940) are probably also from Early Pithouse structures. Both straight and concave base specimens were found in Late Pithouse contexts at Bear Ruin (Haury 1941), and concave-based specimens were found in Late Pithouse deposits at the Turkey Foot Ridge site (Martin and Rinaldo 1950a). Haury (1985c) found points of this type in Late Pithouse sites in the Forestdale Valley, and illustrates a possible example from Late Pithouse deposits at Mogollon Village (Haury 1936b). This type also occurs at Pueblo period sites and was found in Mimbres phase rooms at Mattocks Ruin (Nesbitt 1931), in Reserve phase villages in the Pine Lawn Valley (Martin and Rinaldo 1950b), at Tularosa phase sites in western New Mexico (Martin et al. 1957), and in Salado deposits at Foote Canyon Pueblo (Rinaldo 1959). Lekson (1990) found a specimen of the straight-based variety in Pueblo period deposits at the Saige-McFarland site, and Gifford (1980) reports both straight and concave-based varieties from Red Bow Cliff Dwelling (ca. A.D. 1325 to 1400). M. Nelson (1986) indicates that this type was found in Early Pithouse to Cliff phase contexts in the Mimbres region.

These varieties are similar to types found at Ventana Cave and in southeast Arizona, which are ascribed to Papago use (Haury 1950:274). They are also similar to illustrations of Cottonwood Triangular, a protohistoric and early historic type. Later specimens are mostly of the concave-based variety, suggesting that it persisted into the early historic period. Thus, these varieties occur throughout the sequence and possibly into the early historic period.

Flake points also appear to be a rather common, though rarely illustrated, type. Wheat (1955:128-129) classifies them as his Type 4, and feels they were probably much more common than the archaeological record indicates (Wheat 1955:132). He notes examples from the Early and Late Pithouse periods. Haury (1950:264) recovered numerous specimens of this type from Ventana Cave. Even though most are attributable to Hohokam rather than Mogollon use, his findings are of interest to this discussion. Most points in this category exhibit little or no alteration, and had it not been for a quiver of arrows containing hafted examples they would probably not have been noticed (Haury 1950:264). Flake points occurred in many of the defined categories from Ventana Cave, but were sufficiently shaped to allow them to be classified (Haury 1950:264).

Several varieties were defined in our analysis including unnotched, corner notched, and side notched; both dart and arrow points are represented. Other examples in the literature are rather rare, probably because this type is difficult to identify unless notched, and when notches are present they are probably placed in other categories. Haury (1985b) encountered other examples of this type at Tla Kii Ruin in Late Pithouse through Early Pueblo contexts. Fitting (1972) illustrates a few marginally flaked specimens from a survey in the Mimbres area, at least one of which is from a Pueblo period site. Wheat (1954:144) illustrates examples of the unnotched and side-notched varieties from Late Pithouse structures at Crooked Ridge. Examples were also found in Late Pithouse deposits at Mogollon Village (Gilman et al. 1991), and in a Pueblo period room at the Saige-McFarland site (Lekson 1990). As a type, flake points do not appear to be good diagnostic indicators. However, notched varieties may be viewed as crude examples of those types rather than flake points, and as such may have some potential as diagnostic indicators.

Temporal Trends in Projectile Point Styles

Many of our types and varieties contain few examples and could be obscuring overall temporal trends. For that reason, point types were reorganized into 13 groups (Table 3.20). Only specimens that could be assigned to a specific time period, were identified by type, and could be classified as dart or arrow tips are included in this table. Specimens that predate the Late Archaic period or were obviously collected from earlier sites were excluded. The number of specimens per group for each component is shown in Table 3.21. LA 37917 is included with the Archaic sites because all of the points from this site seem to date to the Late Archaic period, whether the rest of the assemblage does or not. Also, it is likely that the single Group 4

Table 3.20.Projectile Point Types Contained within Each Group

Group	Included Projectile Point Types
1	Pelona dart points
2	San Pedro Corner-notched dart points San Pedro Lateral-notched dart points
3	Medium Corner-notched dart points Medium Lateral-notched dart points Flake dart points, medium-sized and notched
4	Medium Corner-notched arrow points Medium Lateral-notched arrow points Flake arrow points, medium-sized and notched
5	Small Corner-notched arrow points Flake arrow points, small and corner-notched
6	Small Side-notched arrow points Flake arrow points, small and side-notched
7	Small Side-notched arrow points, long-bladed
8	Small Side-notched arrow points, bifurcated bases
9	Small Side-notched arrow points, 3 notches
10	Small Side-notched arrow points, multiple notches
11	Unnotched medium-sized dart points Flake dart points, medium-sized and unnotched
12	Unnotched arrow points, small-sized Unnotched arrow points, medium-sized Flake arrow points, small-sized and unnotched
13	Small Lateral-notched points

specimen (small corner-notched arrow point) in the LA 43766 assemblage is a contaminant from an adjacent Reserve phase site, and that point is assigned to the Early Pueblo period in subsequent tables.

Typed points from dated components total 247. However, 9 components (50.0 percent) contain less than 10 specimens apiece, and 2 components contain 50 percent of the typed points. Thus, there is consider able variation between point assemblage sizes, making it difficult to accurately appraise temporal distribution by component. Instead, variation in point groups is examined by time period, combining assemblages from dated components.

This distribution is shown in Table 3.22. Pelona points are restricted to the Late Archaic period, and San Pedro points (both corner and side notched) were mostly recovered from Late Archaic components, though a few were found at later sites. While it is possible that this group was used until the introduction of the bow in the Early Pithouse period, this cannot be demonstrated with our data. Later occurrences of this group comprise very small percentages of period assemblages (2.4 percent for the Late Pithouse and 2.5 percent for the Late Pueblo periods), and are most likely curated tools. Unfortunately, this cannot be proven, since these points are not amenable to direct dating.

The medium dart point group appears to have been introduced in the Late Archaic period and persisted through the rest of the sequence. Similarly, the medium arrow group first appeared in the Early Pithouse period, and is found in every subsequent period. The Late Pithouse period saw the introduction of the small corner and side-notched groups, which also persisted until the end of the sequence. The small side-notched arrow points and the three-notched small and unnotched arrow point groups also appeared during the Late Pithouse period and were used through the Late Pueblo period. Three groups occur only in Late Pueblo contexts: small side-notched arrow points with long blades, small side-notched arrow points with multiple notches, and unnotched dart points.

As noted earlier, the small lateral-notched arrow point group was a catch-all. One specimen was recovered from an Early Pithouse site, while the others came from Late Pueblo components. There is no consistent resemblance between these points to suggest that they represent a coherent style. One specimen is made from obsidian and may have originally been corner notched, but resharpening has so altered the edges that no barbs remain and the point has assumed a lateral-notched appearance. A chert specimen was almost certainly meant to have this configuration. The three remaining points in this category were manufactured from Luna blue agate. While one appears to have been meant to have this configuration, the other two specimens are crude and their shapes may be a result of material flaws and hardness. The Early Pithouse period specimen was thermally altered, and this created a flaw that was encountered during reduction, removing the area that would have formed a barb on one side of the point. The other side could not be sufficiently thinned to permit a notch to be cut, and the point is so narrow that notching could probably not have been successfully accomplished anyway. However, this did not lead to abandonment of the tool; the presence of an impact fracture at the distal end implies that it was successfully hafted and used, even though it was probably not finished to the satisfaction of the knapper.

Thus, the small lateral-notched category is not diagnostic in temporal or stylistic terms. Fortunately, other types are. It is interesting to note that, with the exception of the Pelona and possibly San Pedro groups, once a projectile point group was introduced it was used until the end of the sequence. This suggests that the projectile point assemblage resembles the ceramic assemblage in that it was cumulative (see Wilson, Volume 4). Three groups were used during the Late Archaic, and by the Late Pueblo period at least 11 were in use. However, several of the latter are variations on the small side-notched arrow point group. Thus, rather than representing completely different groups they represent elaborations of existing groups. For this reason, they are combined in Table 3.24, which shows the proportional makeup of point groups for each time period. Small lateral-notched points are eliminated because they do not represent a coherent style.

Even though our collection of Early Pithouse period points is small, it appears that arrow points assumed an importance equal to that of dart points after the bow was introduced. Five dart points were recovered from LA 39972, at least four of which appear to have been collected from earlier sites for reuse. In contrast, three of four specimens from LA 39975 are arrow points, both small and medium sized (the former is not shown in Table 3.23 because it is lateral notched). This may indicate that LA 39972 was occupied very early in the period before the introduction of the bow, while LA 39975 was occupied near the end of the phase after the bow came into use.

Small corner-notched arrow points first appear during the Late Pithouse period in our sample, as do small side-notched arrow points. Regionally, however, small corner-notched arrow points first appeared during the Early Pithouse period and are probably missing from our sites because of the small sample size. Thus, percentages seen in the Late Pithouse period probably reflect the continuing popularity of small corner-notched points and the growing popularity of the new group. The temporal distribution of small side-notched arrow points in our assemblage mirrors regional trends, and this type does not appear before the Late Pithouse period. By the Early Pueblo period, small side-notched points are the most common style and small corner-notched arrow points comprise a much smaller percentage of the assemblage. However, medium-sized dart and arrow points are much more common than in either the preceding or succeeding periods. The potential significance of this trend is tested later.

Unnotched arrow points also first appear during the Late Pithouse period in our sample. However, when considered regionally, this style has been found in Early Pithouse period contexts by several researchers. Again, sample error probably accounts for their absence from our Early Pithouse sites. This group comprises only small percentages of period assemblages until the Late Pueblo period, when they become the second most common group, and unnotched dart points are also used. The most common group during that period is the small side-notched arrow point, which comprises nearly half of the assemblage.

Arrow Point Size Considered

It is possible that small corner-notched arrow points are missing from our sample of Early Pithouse period sites because of the way in which they were categorized. Our medium-sized arrow points average 16.2 mm in width, and 14 of 18 were only 1 or 2 mm wider than the maximum width allowed for small points. Are 2 size groupings of arrow points actually present, or is this a fiction introduced by our categorization methods? If different size groups do occur, this could mean that the presence of only medium-sized specimens in our sample from the Early Pithouse period indicates that the width variation of arrow points decreased through time as the bow became more popular.

Arrow points were considered in five groups: medium-sized, small corner-notched, small side-notched, small unnotched, and medium unnotched. A one-way ANOVA for these groups yielded an F ratio of 42.0552 with a significance of less than .00005, indicating that there is a statistically significant difference in widths between arrow point groups. When medium-sized points are removed from consideration and a new one-way ANOVA run, the statistical significance in widths between groups disappears (F=1.5786, significance=.2107). Thus, medium-sized arrow points (both notched and unnotched groups) are significantly different in width from small-sized arrow points (corner-notched, side-notched, and unnotched).

This could mean that the medium-sized arrow points merely represent small dart points. In order to explore this possibility, a one-way ANOVA was run on three groups: medium-sized dart points, medium-sized arrow points, and small arrow points. This yielded an F Ratio of 315.8923 with a significance of less than .00005, demonstrating a statistically significant difference in width between these groups. With small arrow points removed from consideration, there is still a statistically significant difference in width between medium-sized dart and arrow points (F=31.8753, significance= < .00005). Thus, based on point width, these categories appear to reflect real divisions.

In order to test the idea that arrow point width changed through time, a one-way ANOVA was run on samples from the Early Pithouse through Late Pueblo periods. This yielded an F ratio of 1.9192 with a significance of .1291, indicating that at the 99 percent confidence level there is not a statistically significant difference in width between periods.

These analyses suggest two conclusions. First, the widths of medium-sized dart, medium-sized arrow, and small-sized arrow points are significantly different. Currently, these differences are thought to be related to function, but data that would allow us to demonstrate this possibility are lacking. Second, there does not appear to be a significant decrease in point width through time after the bow was introduced. Arrow points are arrow points from the beginning of the sequence until the end.

Table 3.21. Number of Projectile Points by Site Component and Time Period

Period	Component	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	Group 13	Total
Late Archaic	LA 37917			3											3
	LA 43766	2	24	15		1									42
	LA 45508			5											5
	LA 70188		4	10											14
	LA 78439			1											1
Early Pithouse	LA 39972		1												1
	LA 39975			1	2									1	4
Late Pithouse	LA 45510			1	2	1	7			2					13
	LA 45507			1	2	14	1								18
	LA 70196		1	2	1	4							2		10
Early Pueblo	LA 3563					1									1
	LA 39969			4	2		2		2	1			1		12
	LA 39972				1										1
	LA 75792						1		1						2
Late Pueblo	LA 3279		2	10	8	5	5	13	2	11	5	2	20	1	82
	LA 9721													1	1
	LA 39968		1	2		1	2	3					2		11
	LA 70185			3	3	1	5	4	2	1		1	3	1	26

Table 3.22. Distribution of Projectile Point Groups by Time Period; Frequencies.

Group	Late Archaic	Early Pithouse	Late Pithouse	Early Pueblo	Late Pueblo	Total
1. Pelona Dart Points	2					2
2. San Pedro Dart Points	28	1	1		3	33
3. Medium Dart Points	34	1	4	4	15	58
4. Medium Arrow Points		2	5	3	11	21
5. Small Corner-notched Arrow Points			20	1	7	28
6. Small Side-notched Arrow Points			8	3	12	23
7. Small Side-notched Arrow Points, Long Blades					20	20
8. Small Side-notched Arrow Points, Bifurcated Bases				3	4	7
9. Small Side-notched Arrow Point, 3 Notches			2	1	12	15
10. Small Side-notched Arrow Point, Multiple Notches					5	5
11. Unnotched Dart Points					3	3
12. Unnotched Arrow Points			2	1	25	28
13. Small Lateral-notched Arrow Points		1			3	4
Total	64	5	42	16	120	247
Percent	25.9	2.0	17.0	6.5	48.6	100.0

Table 3.23. Percent of Each Time Period Comprised of Various Projectile Point Groups

Group	Late Archaic	Early Pithouse	Late Pithouse	Early Pueblo	Late Pueblo
Pelona dart point	3.1				
San Pedro dart point	43.8	25.0	2.4		2.6
Medium dart point	53.1	25.0	9.5	25.6	12.8
Medium arrow point		50.0	11.9	18.8	9.4
Small Corner-notched arrow point			47.6	6.3	6.0
Small Side-notched arrow point			23.8	43.8	45.3
Unnotched dart point					2.6
Unnothced arrow point			4.8	6.3	21.4
TOTAL PERCENT	26.3	1.7	17.3	6.6	48.2

Differences in the Temporal Distribution of Functional Types

Some differences in the distribution of functional types through time were noted earlier. In particular, the possibility that larger percentages of medium-sized dart and arrow points in the Early Pueblo period might be significant. In order to test this possibility, a chi-square was run on the distribution of these types through time. The Late Archaic and Early Pithouse periods are not considered because the bow was unknown in the former and introduced after the midpoint of the latter. This analysis produced a chi-square value of 4.79516, with 4 degrees of freedom and a significance of .30897. Thus, there is not a statistically significant difference in the distributions of these types between periods.

A Brief Comparison of Style Trends with an Anasazi Assemblage

Recently, a study of projectile points from Chaco Canyon has become available (Lekson 1997b). While this study represents a summary of an earlier unpublished report, it also incorporates data not previously available and provides enough information to allow us to make a preliminary comparison of chronological changes in projectile points between Chaco and our study area.

As Lekson notes, ". . . there is little in the stone tool inventory that should raise the eyebrows of any Anasazi archeologist. The points, knives, and drills of Chaco Canyon are, in themselves, unremarkable examples of Anasazi lithic technology" (Lekson 1997b:691). In general, the projectile point typology developed for the Chaco Canyon sample is comparable to others from the Eastern Pueblo area. However, a caution is in order:

> It is interesting to note that studies at Salmon Ruin (Moore 1981; Shelley 1980) demonstrated that arrow points within the same general types and time periods fall into *regional groups* (e.g., Salmon, Chaco, Mesa Verde, etc.), based on discriminant functions that include metric attributes. Even though it is not possible to decode the discriminant functions . . . , these analyses suggest that there are significant differences of dimension...between contemporaneous regional point populations; regional "styles" which would be lost under the three type system [Lekson 1997b:675].

The three type system referred to in this quote was the original typological scheme used in the Pueblo area that divides points into stemmed, corner-notched, and side-notched varieties (Lekson 1997b:662). Simplification of analytical techniques applied to projectile points can obscure important regional diversity, even within general culture areas. This suggests that the Chaco assemblage cannot be considered representative of the entire Pueblo area, though general trends may be replicated across the region. Unfortunately, our comparisons must remain fairly general since neither typological nor analytical schemes are consistent between the two studies. However, it is possible to derive some interesting trends from this comparison.

Lekson (1997b) focused his study on points from Ceramic period sites, further limiting his sample population to specimens considered representative of arrow points, defined as hafted tools with a minimum stem width of 10 mm (Lekson 1997b:662). Though he does not specify where the minimum measurement was taken, it probably represents the neck width. Since this method correctly classified nearly all of the Luna arrow points as such, our assemblages should be relatively comparable. The only points that were incorrectly classified were flake points, which exhibit a minimal amount of retouch and represent expedient tools.

Six basic arrow point forms were defined in the Chaco assemblage, and temporal ranges were assigned to each (Lekson 1997b:665). The earliest type is a small triangular stemmed form on which basal edges are relatively parallel (Type A). This form originated in the early Basketmaker III period and may have persisted into early Pueblo II times, a temporal range of ca. A.D. 500 through 1020. By widening the base, a true corner-notched form was developed and occurred from ca. A.D. 600 through 820 (Type B). Lekson (1997b:665) feels that this change in basal shape represents a major discontinuity in the sequence since intermediate forms were not found. However, he does not consider that this type may simple represent a smaller version of the En Medio (Basketmaker II) style, which has been in use for at least 1,000 years preceding the Basketmaker III period.

Corner-notched styles persisted through the Pueblo I period, though the exact type is not specified. By ca. A.D. 920 to 1020 a new variety of corner-notched point with deeper and narrower notches became common (Type C). The earliest side-notched form also appeared during this period (Type D), representing an elaboration of the deeply notched corner-notched form in which the notches became slightly more perpendicular to the long axis. By A.D. 1120 to 1220 a true side-notched point with a straight base was manufactured (Type E). The latest type represented in the assemblage is a concave based side-notched form (Type F), though no date for its inception is provided (Lekson 1997b:665).

Interestingly, unnotched forms in the Chaco assemblage were classed as knives, though Lekson (1997b:680) feels that smaller specimens represent projectile point blanks or preforms. Only a third of the specimens assigned to the knife category were judged to be finished tools (Lekson 1997b:680). In addition, while few arrow points exhibited evidence of initial percussion flaking, fully two-thirds of the "knives" did (Lekson 1997b:680). Any evidence of initial percussion work on the points was thought to have been eradicated by the pressure flaking used to finish them.

Unfortunately, no analysis of fracture type was attempted on broken points, so several of Lekson's ideas cannot be tested. This includes the function of the so-called small knives or preforms. If some of these tools were found to exhibit impact fractures as do examples in the Luna assemblage, we would have evidence for a similar use of unnotched points. Indeed, 40 percent of the medium unnotched and 50 percent of the small unnotched points from Luna exhibit impact fractures, a sure indication that these varieties represent finished tools in that assemblage. Fully half of the small unnotched points with impact fractures and all of those in the medium-sized category evidenced the use of percussion flaking in their manufacture. Lekson (1997b) assumes that because small bifaces are unnotched and exhibit evidence of percussion flaking in initial shaping they represent unfinished tools. In light of our data, this assumption may be erroneous.

Another difference between these analyses is the assignment of notched bifaces with neck widths greater than 10 mm to the knife category in the Chaco analysis. Some of the forms assigned to this category may in fact represent curated points from earlier periods or could be an indication of the persistence of dart points into the Ceramic period in the Pueblo area. From the available data, neither of these possibilities can be tested. However, this does point out a possibly erroneous assumption made during our analysis. Thus far we have assumed that large notched bifaces from the Ceramic period represent a continued use of darts in the Mogollon Highlands. Similarly, we assume that knives will lack notches. However, both of these assumptions may be incorrect. Larger notched bifaces may simply represent arrow points that fall outside the populations used to create the models that assign points to types. Conversely, they could simply be small hafted knives. The data gathered during our analysis are simply insufficient to allow us to address this problem in detail.

Setting these potential problems aside, we find that there are both similarities and differences between the developmental schemes devised for the Luna and Chaco Canyon areas. The Luna assemblage lacks any points comparable to Lekson's Type A. Wheat (1955:131-132) indicates that small stemmed arrow points occur in early Mogollon assemblages, perhaps persisting into the Pueblo period. However, they do not seem to have been common, and were certainly not as popular as they were in the Chaco assemblage. Instead, small corner-notched points seem to be the most common type in Early Pithouse period assemblages that postdate the appearance of the bow. Corner-notched arrow points of various forms persist in the Chaco assemblage until at least the end of the Pueblo II period (A.D. 1120). A few corner-notched specimens similar to Lekson's Type B were found in the Luna assemblage. However, all examples of this type were recovered from the same site and seem to reflect the work of a single craftsman. Thus, there is no evidence for the prevalence of this form in our data. Side-notched types began to be used by A.D. 1020 to 1120 at Chaco, and dominated after A.D. 1120. Convex-based forms were a somewhat later development, though an inception date for this type is not specified for the Chaco assemblage. This type (including bifurcated bases) occurs in Early Pueblo period assemblages at Luna, a bit earlier than at Chaco.

Side-notched forms seem to occur at an earlier date in the Luna samples. While small corner-notched specimens comprise nearly half of the points from the Late Pithouse period (ca. A.D. 800 to 1000), small side-notched points comprise nearly a quarter of that assemblage. Thus, there is a substantial presence of side-notched arrow points in our assemblage before A.D. 1000, and this form became dominant by the Early Pueblo period. This is at odds with Lekson's (1997b:665) assertion, following Brugge (1981:283), that this style seems to have diffused from north to south through the Anasazi region and eventually down into Mexico. Since side-notching appears to have been adopted at an earlier date in the Highland Mogollon region, it is unlikely that the diffusion of this hafting style through the Southwest was as simple and straightforward as he suggests.

Interestingly, Lekson also discusses a series of atypical points recovered from an eighteenth-century Navajo site at Chaco. The six illustrated examples (Lekson 1997b:678) resemble forms that are often assumed to be protohistoric Athabaskan points and are similar to the Desert Side-Notched type of the Great Basin. Similarities to this small collection allowed Lekson (1997b:679) to suggest that a point from Pueblo Bonito was also of Navajo manufacture, and represents a reuse of open rooms at that site.

In addition to these specimens is a group of four nearly identical points found at a Navajo site, possibly representing part of the contents of a medicine bundle (Lekson 1997b:679). These points are similar to those manufactured during the Late Pueblo occupation of the canyon except that they have bifurcated bases, considered an unusual treatment in Chaco. As described: "They are nearly identical in shape and flaking, are all of the same white chert and give every appearance of having been made by one knapper" (Lekson 1997b:679).

It is considered highly unlikely that these specimens represent curated artifacts. Instead, Lekson suggests they were carefully manufactured for ceremonial purposes by a Navajo. If this supposition is correct, some Athabaskan points of finer manufacture than the norm may be indistinguishable from prehistoric points made in the same area.

If we are interpreting Lekson's discussion correctly, the Chaco assemblage does not demonstrate the same perseverance of numerous forms through time that we see at Luna. Certain hafting styles appear earlier in the Luna area, though there does not seem to have been a great lag in time before they also appeared at Chaco. Of course, this does not mean that the impetus for these hafting techniques diffused into the Chaco region from the Mogollon area. They could as easily have developed independently in the Pueblo region or been adopted from elsewhere. The important point is that these regions differ in developmental sequence as well as the array of points used at any one time. Considerably more research would be necessary to determine whether this reflects important differences in point technology trends between the Mogollon and Pueblo provinces, or simply indicates a more subtle regional variation. However, it may be significant that the Luna projectile point assemblage is cumulative in nature, and that this may not be characteristic of the Pueblo assemblage from Chaco Canyon. Perseverance of forms versus replacement of forms may constitute one of the major differences between these culture areas.

Materials Used in Projectile Point Production

The final topic left for discussion concerns the types of materials used in projectile point manufacture. This is illustrated for each projectile point group in Table 3.24. Nine different materials were used for projectile point manufacture; silicified palm wood was represented by a single example, and is combined with other chertic materials in Table 3.24. The material identified as chalcedony is probably the same as Luna blue agate, but lacked the more diagnostic attributes of that type and was categorized differently.

It is interesting that none of the large dart points (stemmed dart points and San Pedro dart points) were made from Luna blue agate. This is a very hard material that often does not fracture predictably, and so may have been unsuitable for the manufacture of large retouched tools or lacked the requisite durability. Basalt was most commonly used for large dart points, probably because of its durable nature. Comparatively few arrow points were made from basalt, undoubtedly because the grades of this material that were available were not as amenable to pressure flaking as were less grainy materials.

Chertic materials were the second most common group, and were used for all types of dart points as well as some of the larger arrow points. The most abundant material used in the manufacture of projectile points was obsidian, which comprises nearly 40 percent of the total. Luna blue agate is the third most common material, though over half the points made from this material were fragmentary and unidentifiable to type.

Some interesting trends are visible in Table 3.25, which shows material types by point type classes with indeterminate fragments eliminated. Andesite, rhyolite, and aphanitic rhyolite were only used to manufacture dart points. Basalt was used for a few medium- and small-sized arrow points, but nearly 90 percent of the specimens made from this material are dart points. Chertic materials were used similarly, with about 87

Table 3.24. Material Type Makeup of Each Projectile Point Group; Frequencies and Row Percentage

Point Group	Chertic	Chalcedony	Luna Blue Agate	Obisidian	Basalt	Andesite	Rhyolite	Aphanitic Rhyolite	Totals
Indetermiate	72 36.7	0 0.0	43 21.9	48 24.5	28 14.3	0 0.0	3 1.5	2 1.0	196 42.6
Stemmed dart point	5 23.8	2 9.5	0 0.0	5 23.8	7 33.3	1 4.8	1 4.8	0 0.0	21 4.6
San Pedro dart point	12 36.4	0 0.0	0 0.0	1 3.0	16 48.5	1 3.0	2 6.1	1 3.0	33 7.2
Medium-sized dart point	22 37.9	1 1.7	10 17.2	10 17.2	11 19.0	1 1.7	3 5.2	0 0.0	58 12.6
Medium-sized arrow point	1 4.8	0 0.0	4 19.0	13 61.9	3 14.3	0 0.0	0 0.0	0 0.0	21 4.6
Small Corner-notched arrow point	0 0.0	0 0.0	2 7.1	26 92.9	0 0.0	0 0.0	0 0.0	0 0.0	28 6.1
Small Side-notched arrow point	4 5.9	0 0.0	6 8.8	57 83.8	1 1.5	0 0.0	0 0.0	0 0.0	68 14.8
Unnotched dart point	1 33.3	0 0.0	2 66.7	0 0.0	0 0.0	0 0.0	0 0.0	0 0.0	3 0.7
Unnotched arrow point	0 0.0	0 0.0	7 25.0	21 75.0	0 0.0	0 0.0	0 0.0	0 0.0	28 6.1
Small Lateral notched arrow point	1 25.0	1 25.0	1 25.0	1 25.0	0 0.0	0 0.0	0 0.0	0 0.0	4 0.9
Total Percent	118 25.7	4 0.9	75 16.3	182 39.6	66 14.3	3 0.7	9 2.0	3 0.7	460 100.0

Table 3.25. Materials by Projectile Point Classes; Frequencies and Column Percentages

Material Type	Dart Point	Medium-sized Arrow Point	Small-sized Arrow Point	Total
Chertic	40	1	5	46
	34.8	4.8	3.9	17.4
Chalcedony	3	0	1	4
	2.6	0.0	0.8	1.5
Luna Blue	12	4	16	32
Agate	10.4	19.0	12.5	12.1
Obsidian	16	13	105	134
	13.9	61.9	82.0	50.8
Basalt	34	3	1	38
	29.6	14.3	0.8	14.4
Andesite	3	0	0	3
	2.6	0.0	0.0	1.1
Rhyolite	6	0	0	6
	5.2	0.0	0.0	2.3
Aphanitic	1	0	0	1
Rhyolite	0.9	0.0	0.0	0.4
Total	115	21	128	264
Percent	43.6	8.0	48.5	100.0

Table 3.26. Comparison of Projectile Point Assemblage Material Makeup by Area; Frequencies and Column Percentages

Material Type	Luna Area	Reserve Area	Total
Chert	20	98	117
	9.6	39.0	25.4
Chalcedony	0	4	4
	0.0	1.6	0.9
Luna Blue	55	20	75
Agate	26.3	8.0	16.3
Obsidian	123	59	182
	58.9	23.5	39.6
Basalt	9	57	66
	4.3	22.7	14.3
Andesite	0	3	3
	0.0	1.2	0.7
Rhyolite	2	7	9
	1.0	2.8	2.0
Aphanitic	0	3	3
Rhyolite	0.0	1.2	0.7
Total	209	251	460
Percent	45.4	54.6	100.0

Table 3.27. Material Types by Area for Each Time Period; Frequencies and Column Percentages

Material Type	Late Archaic		Early Pithouse		Late Pithouse		Early Pueblo	Late Pueblo	
	Luna Area	Reserve Area	Luna Area	Reserve Area	Luna Area	Reserve Area	Reserve Area	Luna Area	Reserve Area
Chert	3	41	1	4	0	2	3	15	5
	16.7	47.7	5.0	33.3	0.0	9.1	14.3	10.3	33.3
Chalcedony	0	1	0	1	0	1	1	0	0
	0.0	1.2	0.0	8.3	0.0	4.5	4.8	0.0	0.0
Luna Blue	6	0	0	1	2	2	1	45	1
Agate	33.3	0.0	0.0	8.3	9.5	9.1	4.8	31.0	6.7
Obsidian	5	4	17	3	19	15	14	80	9
	27.8	4.7	85.0	25.0	90.5	68.2	66.7	55.2	60.0
Basalt	2	31	2	3	0	2	2	5	0
	11.1	36.0	10.0	25.0	0.0	9.1	9.5	3.4	0.0
Andesite	0	3	0	0	0	0	0	0	0
	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rhyolite	2	5	0	0	0	0	0	0	0
	11.1	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aphanitic	0	1	0	0	0	0	0	0	0
Rhyolite	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

percent of these specimens falling into the dart category. Luna blue agate (and chalcedony) comprise relatively minor percentages of each class, but is most common in the medium-sized arrow point category. Obsidian was, by far, the material most commonly selected for the manufacture of medium- and small-sized arrow points. That this material was less commonly used for dart points may be indicative of two possibilities. First, since obsidian is not very durable it was not suitable for darts in most situations. Second, this might reflect the size of available obsidian nodules, which may have been too small to produce flakes of the requisite size for dart point manufacture.

The sites examined by this project cluster in two different areas. Luna sites include LA 3279, LA 45507, LA 45508, LA 45510, LA 70185, LA 89846 and LA 89847. Reserve sites include LA 3563, LA 9721, LA 37917, LA 37919, LA 39968, LA 39969, LA 39972, LA 39975, LA 43766, LA 43786, LA 70188, LA 70191, LA 70196, LA 70201, LA 75791, LA 75792, and LA 78439. As Table 3.26 shows, material type distributions are structured differently in these areas. Considerably more Luna blue agate and obsidian were used in the Luna area, while chertic materials and basalt were much more common in the Reserve area. However, much of the difference between these areas could be due to the presence of large site assemblages from different time periods. For instance, LA 3279 was in the Luna area, and this multiroom Tularosa phase pueblo contained over a quarter of the total chipped stone assemblage. The two largest Archaic sites, LA 43766 and LA 70188, were both in the Reserve area, and together contained over one-third of the chipped stone assemblage (mixed components included). Thus, the material makeup of these areas should also be viewed from the perspective of time.

Table 3.27 shows how the material type makeup of the two areas is structured through the prehistoric period. The points from LA 37917 are considered Archaic in this table, and the arrow point from LA 43766 is assigned to the Reserve phase. The differences between these areas are very interesting. Chert and basalt dominate the projectile point assemblage for the Reserve area in the Late Archaic period, while Luna blue agate and obsidian are most common for the Luna area. Obsidian dominates the Luna area in the Early and Late Pithouse periods. The most common materials used in the Reserve area are chert, basalt, and obsidian during the Early Pithouse period, and obsidian in the Late Pithouse. No Early Pueblo sites were excavated in the Luna area, but obsidian continues to dominate in the Reserve area. By the Late Pueblo period there were some changes. While obsidian use remained at about the same level in the Reserve area, chert was also very important. Obsidian declined in importance in the Luna area, with most of the slack taken up by Luna blue agate.

Obviously, some of these differences are attributable to the resource structure of the two areas. This is considered in detail in a later chapter. There also seem to be important temporal differences, particularly in regards to the heavy use of Luna blue agate for projectile point manufacture during the Late Pueblo period in the Luna area. While obsidian remained an important resource for the manufacture of these tools, it is possible that access to the source(s) became somewhat restricted at this time.

Summary and Conclusions

As stated in the introduction to this chapter, several subjects have been addressed in an attempt to examine the use of projectile points through time in the Luna-Reserve area. In the introduction we addressed several concerns including the use of point typologies, projectile point styles as an indicator of cultural affinity, and how they are used in chronologies. We concluded that the transfer of a projectile point typology or the names for specific styles from one area to another was only acceptable under certain circumstances. In particular, using similarities in point styles to infer cultural or temporal relationships is a very chancy proposition, and should only occur when other forms of evidence pointing to these similarities are also available. The simple fact that a point from one area is similar to a style from another is not enough evidence upon which to base temporal or affinal relationships.

Several point types were very widespread during the Early and Middle Archaic, occurring from at least the Great Basin to the edge of the Plains and probably beyond. They include the Lake Mojave-Jay, Pinto-San José, and Gypsum Cave-Augustín styles, among others. Considering the large number of language groups encountered across this vast area when Europeans first began to explore the Southwest and the variation in dates between regions for some of these styles, it is not likely that they represent a single unified series with strict chronological and affinal boundaries. Rather, they seem to represent a series of styles that are similar in appearance, occur among numerous different groups (linguistic and otherwise), and vary in temporal range. These styles may have diffused across a large-scale but low-level communication system. Some might have disappeared from the areas in which they originated as they were beginning to appear at the other end of the communication system. Others might have been retained in some areas long after new styles were adopted in others.

Thus, our use of names from the Oshara area and Great Basin for many Archaic styles was a simple shorthand to describe form. This presents an acute problem—do archaeologists need to define new typologies for every small area, or is there a way to get around this difficulty? Perhaps this can be made possible by dropping temporal and cultural inferences from projectile point typologies and simply considering them to be descriptive shorthand. However, this still leaves us with the problem of defining temporal and cultural parameters within areas occupied by related peoples.

A good case in point was raised earlier. Point types like Cottonwood Triangular and Desert Side-Notched have been imported into New Mexico for use in the protohistoric period, and their original definitions have been altered to allow this. While in some ways this is a useful procedure and helps prevent assumptions concerning culture and date, it introduces yet another problem. Points that fall into the range of variation for both of these styles were used during the prehistoric period in the Mogollon area, in some cases occurring on sites that are several hundred years older than such definitions would suggest. Thus, in the Southwest at least, these types lose their power of definition. Their presence on sites is *not* indicative of a late prehistoric or protohistoric date, and the use of such terms can lead to misinterpretation. However, what can be done when the same style of point occurs in different time periods and on sites occupied by very different cultural groups?

The solution used in this analysis was to apply very generic and descriptive terms to point styles that have not received region-specific names, essentially any points manufactured and used after the Late Archaic period. Types that could not be distinguished at this level of analysis but were used in several periods were also given generic labels. This helped avoid the problems that would occur when a type used from the Late Archaic through Late Pueblo periods was given a name that essentially tied it to the Archaic. While the generic terms are often a mouthful and certainly do not have the appeal of names like Bajada and Augustín, they help us avoid uncertain or completely erroneous assumptions of chronologic or cultural relationships.

No high-powered statistical methods were used to define the typology used here. Rather, points were assigned to size classes based on their maximum width. Several attributes were then used to sort them within size classes including notch type (defined by the angle of the barb), basal edge shape, and the presence of any characteristics that made them different. Even with the moderately large assemblage of points available, such attributes as basal shape were rarely useful in examining chronological trends because there simply were not enough specimens from enough sites and time periods available. Still, we feel that this method was useful and allowed us to examine the distribution of styles through time in detail.

During this analysis we have made several assumptions that may or may not be correct. For instance, we have assumed that the Archaic stemmed point traditions were actually restricted to the Archaic period, and that examples of these types found on later sites represent curated artifacts. In one instance we have also assumed that the occurrence of strictly dart points (among them a relatively well-known and dated type) suggests that the points from an otherwise protohistoric component represent curated Late Archaic tools or indicate that the assemblage is actually much earlier than the radiocarbon dates suggest. These questions are addressed with other data in a later chapter to determine whether either can be supported.

Two methods of determining whether points were used to tip darts or arrows were used. Thomas (1978) developed a formula to do this using ethnographic and archaeological specimens, which was applied to our assemblage. Using a series of variables that only partly overlapped Thomas's, we developed a method that would allow us to extend this type of categorization to fragmentary points. While there was a very high percentage of agreement between these methods, neither is foolproof. Thus, our conclusions regarding the use of points remain tentative as far as individual specimens go. When assemblage tendencies are considered, however, they are most likely real. The most important findings of this analysis are:

1. Though the bow was introduced late in the Early Pithouse period, darts seem to have continued in use throughout the prehistoric sequence, though dart points comprise a minor part of projectile point assemblages after the Early Pithouse period.

2. After the Late Archaic period the projectile point assemblage becomes cumulative in nature. While new styles come into use, old ones are not abandoned. Instead, they simply become less common. Not only are up to 11 basic projectile point styles in use by the Late Pueblo period, they all also occur in the largest assemblage from this period (LA 3279). Thus, there is no good evidence for the use of different projectile point styles by individual social groups. Rather, a range of styles was used by individual social groups in each period, perhaps reflecting functional differentiation (though this remains tentative).

3. While obsidian, an exotic material, becomes favored for the manufacture of projectile points by the Early Pithouse period, there are significant differences in materials used between the Luna and Reserve areas. This is probably a function of local geology, with some materials being more common in one area than the other.

Projectile points are often less useful than other temporally sensitive artifacts in assigning dates to a site. However, as this analysis has shown, several trends are visible through time and, in concert with other assemblage characteristics, can help to provide accurate temporal information. Other questions still need to be addressed with larger, more regional data bases. In particular, what is the meaning behind certain eccentric forms such as points with multiple notches along one edge. Do they represent signatures for individual craftsmen, or could they be related to membership in certain social or ritual groups? Research in this area might provide richer dividends than do temporal studies.

CHIPPED STONE REDUCTION: MATERIAL SELECTION

Lloyd A. Moiola

LOCAL GEOLOGY

The study area is in the Luna and Reserve Graben on the Mogollon Slope of the Colorado Plateau, which includes portions of the San Francisco, Saliz, and Tularosa Mountains (Chamberlin et al. 1994). Local geology is predominantly defined by volcanic formations that include Quaternary alluvium and basalt flows, the Gila Conglomerate, and Tertiary volcanic conglomerates and sediments of the Datil Formation (Dane and Bachman 1965). The Gila Conglomerate is interspersed with basalt flows but primarily consists of volcanic conglomerate, sandstone, rhyolitic tuffs, silt, and alluvial gravels. Rhyolite flows, latite, volcanic conglomerate, andesite, basaltic andesite, and volcanic sediments are all found within the Datil Formation (Weber and Willard 1958).

OAS archaeologists conducted a general reconnaissance of the project area in 1995 and 1997 and collected raw material samples. Several lithic material types suitable for the manufacture of chipped stone items were collected from primary sources (directly from outcrops or as float below outcrops), and from secondary sources such as gravel deposits in local drainages and the Gila Conglomerate. Most collected materials came from secondary sources that contain alluvial cobbles and gravels eroded from the Gila Conglomerate and outcrops of the Datil Formation.

Although the sites are located in a lithic-rich environment, there were notable differences in quantities and availability of different raw materials between the Reserve and Luna sides of the San Francisco Mountains. The Reserve area in general was much more amenable to raw material acquisition in terms of access and availability (i.e., more drainages and rock exposures). The variety and abundance of raw materials was also much more prolific in the drainages near Reserve.

Two materials that dominate the chipped stone assemblages, chert and Luna blue agate, occur in greater frequencies on opposite sides of the study area. Although some cherts were collected near Luna, chert cobbles were much more common in drainages near Reserve. The predominant lithic resource in the Luna area is Luna blue agate, which outcrops at or near all of our sites in that area. Rhyolite, andesite, and unidentified igneous materials occur in great quantities near Reserve and Luna, however various grades of rhyolite were much more common near Reserve.

DESCRIPTIONS OF SAMPLES

Raw materials were collected from nineteen sample locales, both within and outside of the project area. Figure 3.19 shows the location of each area sampled.

Sample Area 1

Sample Area 1 was located on a south-facing hillslope above LA 3279. Bedrock was mostly igneous, though the slope was traversed by an exposure of Gila Conglomerate. Luna blue agate was relatively common across the landscape. Nine samples were obtained from this location.

Sample 1. Gray chert with white fossiliferous inclusions, fine grained with some waxy luster; cortex is waterworn. Source: Gila Conglomerate. Original Source: unknown.

Sample 2. Brown chert with black inclusions, medium grained with a reddish waterworn cortex. Grades into a fine-grained red-brown chert. Source: Gila Conglomerate. Original Source: unknown.

Sample 3a. Brown chert with black inclusions, fine grained with a reddish brown waterworn cortex. Source: Gila Conglomerate. Original Source: unknown.

Sample 3b. Yellow-brown chert with black inclusions, a few white, clear, and red inclusions also noted. Grades from fine to medium grained, and from yellow-brown to brown in color. Cortex is reddish brown and waterworn. Source: Gila Conglomerate. Original Source: unknown.

Sample 3c. Brown chert with black inclusions, fine to coarse grained with a reddish brown waterworn cortex. Contains some voids, particularly in coarse-grained areas. Source: Gila Conglomerate. Original Source: unknown.

Sample 4. Gray banded rhyolite, aphanitic to medium grained, with nonwaterworn cortex. Contains light gray to dark gray bands and some dark phenocrysts. Source: probably from local igneous deposits, found as float on slope.

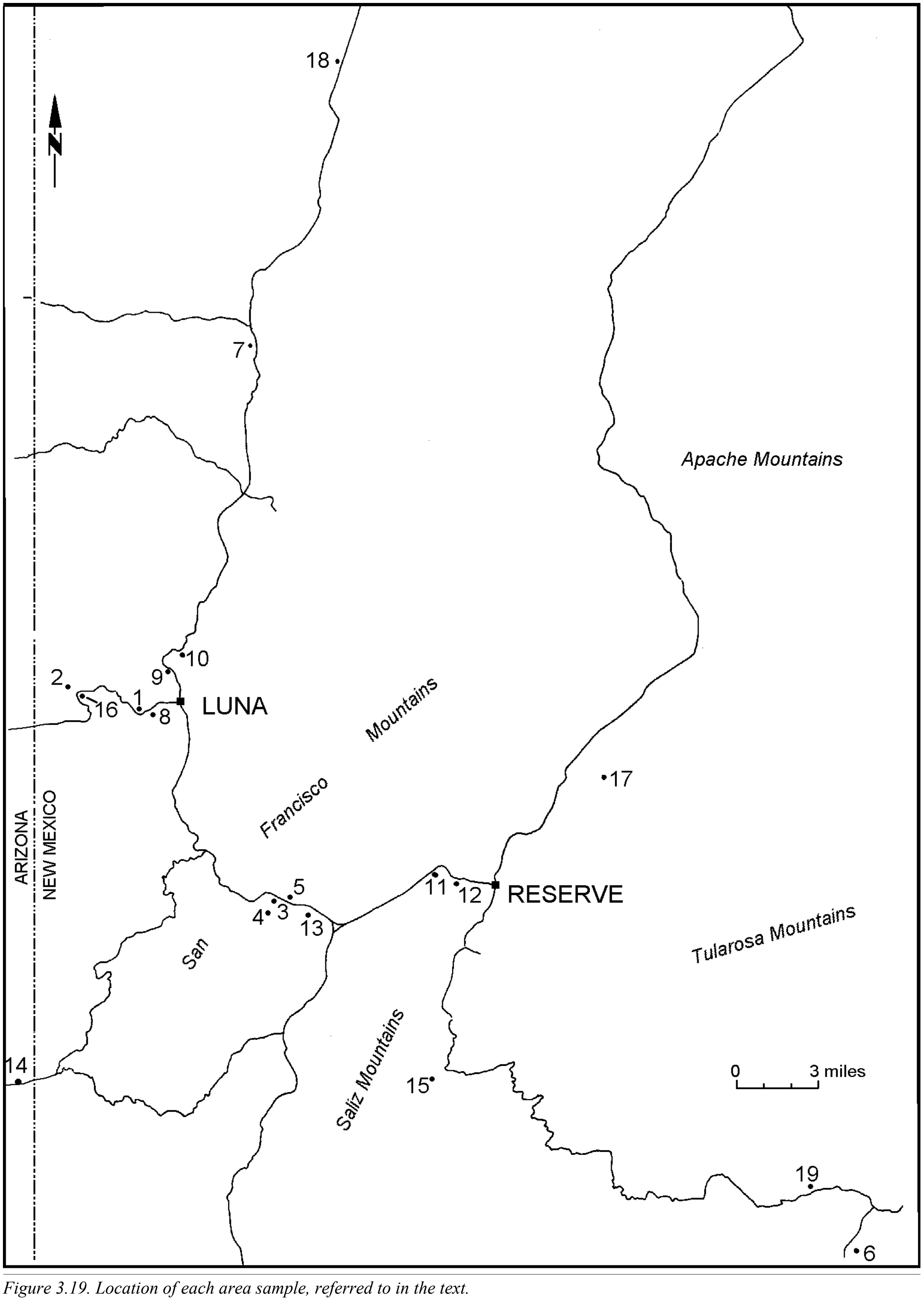

Figure 3.19. Location of each area sample, referred to in the text.

Sample 5. Purple chert with a few black inclusions and white streaks, fine grained and occasionally waxy luster, brown nonwaterworn cortex. Source: probably from a local outcrop, and possibly formed along with Luna blue agate, but this is uncertain. Occurs as float on a slope, and is very similar in appearance to Sample 10, which outcropped near Stone Creek.

Sample 6. Gray rhyolite, medium grained. Numerous dark and light phenocrysts, probably olivine or hornblende and feldspar; nonwaterworn cortex. Source: probably from local igneous deposits, found as float on slope.

Sample 7. Gray aphanitic rhyolite containing occasional dark and light phenocrysts. Fine grained, with a conchoidal fracture and nonwaterworn cortex. Source: probably from local igneous deposits, found as float on slope.

Sample Area 2

Sample Area 2 was along a small intermittent drainage that flows into Stone Creek, a tributary of the San Francisco River on the north side of NM 180. Both igneous and sedimentary deposits were present, and Luna blue agate is common in this area. Three samples were collected at this location.

Sample 8. Green silicified ashflow tuff, banded but grades into a solid olive green with purple-black inclusions; medium grained with nonwaterworn cortex. Source: local outcrop.

Sample 9. Green banded ashflow tuff, fine to medium grained. Source: local outcrop, grading into a silicified ashflow tuff.

Sample 10. Purple and white chert with purple masses and streaks. Fine grained and contains some voids. Source: local outcrop. Purple sections of material resemble Sample 5, which was found as float on the slope above LA 3279.

Sample Area 3

Sample Area 3 was on the northeast facing slope of Leggett Peak. Bedrock was mostly igneous, though some exposures of Gila Conglomerate were noted. Samples were taken both above and below that formation. Luna blue agate was very common on the slopes. Five samples were collected at this location.

Sample 11. Red chert with some whitish spots and swirls, fine grained with occasional voids and a waxy luster; seems to grade into Luna blue agate and was probably formed by the same process. Source: local outcrop, though specimens were found as float on slope.

Sample 12. Yellow-brown chert with large white and matte black inclusions; fine to medium grained, grades into a white to clear chalcedony. May have formed along with Luna blue agate. Source: local outcrop, though specimens were found as float on slope.

Sample 13. Pink and white banded chert with occasional bands of clear crystals; fine grained, occasionally with a waxy luster. May have formed along with Luna blue. Source: local outcrop, though specimens were found as float on slope.

Sample 14. Light yellow-brown chert, grading into small areas of yellow-white; fine grained with occasional voids and bands of clear crystals. May have formed along with Luna blue agate. Source: local outcrop, though specimens were found as float on slope.

Sample 15. Light and dark gray chert with some banding, clear crystal inclusions, and some brown inclusions; fine grained grading into a medium-grained gray-brown chert. Source: probably from a local outcrop, since cortex is nonwaterworn. However, it only occurred on the slope below an outcrop of Gila Conglomerate, so it could be from that source as well.

Sample Area 4

Sample Area 4 was within the Wet Leggett Creek drainage at the base of the slope that contained Sample Area 3. Four samples were obtained from this location.

Sample 16. Light and dark gray chert with some banding; fine grained grading into bands of medium-grained material. Source: probably the same as Sample 15. Cortex is waterworn, either from transport in Wet Leggett Creek or as part of the Gila Conglomerate.

Sample 17. Andesite, fine grained with waterworn cortex. Source: probably Gila Conglomerate. Original Source: Unknown.

Sample 18. Pinkish gray quartzite, medium grained with waterworn cortex. Source: probably Gila Conglomerate. Original Source: unknown.

Sample 19. Dark gray chert with some light gray bands and fossil inclusions; fine grained with waxy luster, heavily waterworn cortex. Source: probably Gila Conglomerate. Original Source: unknown.

Sample Area 5

Sample Area 5 was on the south facing slope of Prairie Peak in the vicinity of the Raven's Roost site. Bedrock in this area is predominantly igneous, but there are also large exposures of Gila Conglomerate. Seven samples were obtained at this location.

Sample 20. White chert with coarse brown inclusions; medium grained with a heavily waterworn cortex. Source: probably Gila Conglomerate. Original Source: unknown.

Sample 21. Limestone with clear crystal inclusions and bands. Source: Gila Conglomerate. Original Source: unknown.

Sample 22. Yellow-brown chert with white crystalline, black, and brown inclusions. Grades from fine to medium grained and has a heavily waterworn cortex. Source: probably Gila Conglomerate. Original Source: unknown.

Sample 23. Andesite, medium grained with heavily waterworn cortex. Source: Gila Conglomerate. Original Source: unknown.

Sample 24. Gray chert containing some red swirls and occasional clear crystalline inclusions; fine to medium grained, heavily waterworn cortex. Source: Gila Conglomerate. Original source: unknown.

Sample 25. Gray chert with some bands of light gray, yellow brown, and purple; occasional clear crystalline bands and inclusions; fine grained with a heavily waterworn cortex. Source: Gila Conglomerate. Original Source: unknown.

Sample 26. Gray-brown chert with coarse brown inclusions, similar to Sample 20, which grades into a light gray chert lacking inclusions. It also contains occasional clear crystalline inclusions, is coarse grained, and has a heavily waterworn cortex; very badly flawed with small voids. Source: Gila Conglomerate. Original Source: unknown.

Sample Area 6

Ewe Canyon obsidian source. Obsidian occurs predominantly as small nodules of less than 5 cm in diameter, though occasional specimens are larger. Found in gravels of Ewe Creek as well as on adjacent slopes.

Sample 27. Ewe Canyon obsidian. Thought to be very similar, if not identical, to material from Gwynn Canyon. Source: Ewe Canyon.

Sample Area 7

Material was collected from two localities: one near Bill Knight Spring and the other near Bill Knight Gap, both along NM 19.

Sample 28. Fine-grained pink and red to purple rhyolite; rhyolite tuff to aphanitic rhyolite. Source: local outcrops.

Sample Area 8

Sample Area 8 was a gravel bed lining the bottom of the San Francisco River from the vicinity of LA 3279 into Luna. Three samples were collected from this location.

Sample 29. Brown chert containing numerous coarse brown inclusions around small voids; fine grained grading into coarse grained, heavily waterworn cortex. The voids and inclusions are similar to those seen in Samples 20 and 26. Source: San Francisco River gravels. Original source, unknown, but probably eroded from the Gila Conglomerate.

Sample 30. Mottled red, purple, and gray chert with a waxy luster in places and a heavily waterworn cortex. Source: San Francisco River gravels. Original Source: unknown, but possibly eroded from the Gila Conglomerate.

Sample 31. Mottled gray and brown chert with coarse brown inclusions; waxy luster and heavily waterworn cortex. Source: San Francisco River gravels. Original Source: unknown, possibly eroded from the Gila Conglomerate.

Sample Area 9

Sample Area 9 was a gravel bed lining the bottom of Dillman Creek along NM 19. The gravels also contain basalt, limestone, quite a bit of rhyolite, and Luna blue agate. Four samples were obtained from this location.

Sample 32. Gray chert containing some white crystalline inclusions and fossils; heavily waterworn cortex. Source: Dillman Creek gravels. Original Source: eroded from the Gila Conglomerate.

Sample 33. Red rhyolite, medium grained with numerous black and white phenocrysts (probably feldspar and hornblende). Source: Dillman Creek gravels. Source: probably from local outcrops.

Sample 34. Gray rhyolite with occasional small black phenocrysts. Source: Dillman Creek Gravels. Original Source: probably from local outcrops.

Sample 35. Gray banded rhyolite with some white and small black phenocrysts. Source: Dillman Creek Gravels. Original Source: probably from local outcrops.

Sample Area 10

Sample Area 10 was a gravel bed lining the bottom of Trout Creek. Other materials noted include basalt, rhyolite, Luna blue agate, and exposures of Gila Conglomerate. The latter is probably the source for local cherts. Three samples were collected from this location.

Sample 36. Pink rhyolite, coarse grained containing numerous white and small black phenocrysts. Source: Trout Creek gravels. Original Source: probably local outcrops.

Sample 37. Andesite, coarse grained with some vesicles and occasional white phenocrysts. Source: Trout Creek gravels. Original Source: probably from local outcrops.

Sample 38. Brown and gray chert, fine grained with occasional white inclusions and banding; heavily waterworn cortex. Source: Trout Creek gravels. Original Source: probably eroded from the Gila Conglomerate.

Sample Area 11

Sample Area 11 was the gravel bed of Starkweather Creek near LA 43766. Materials were plentiful and varied, and included much limestone and rhyolite in addition to the samples taken. Nine samples were obtained from this location.

Sample 14. One sample was visually identical to this material, which is a light yellow-brown chert grading into small areas of yellow-white; fine grained with occasional voids and bands of clear crystals. May have formed along with Luna blue. Source: stream gravels. Original source: Local outcrops?

Sample 39. Fine- to medium-grained pink to red rhyolite with waterworn cortex. Source: stream gravels. Original source: probably local outcrops.

Sample 40. Fine-grained granite, dark pink with numerous quartz and feldspar crystals; waterworn cortex. Source: stream gravels. Original source: Unknown.

Sample 41. Cream to light gray chert; fine grained with occasional small flaws and waterworn cortex. Source: stream gravels. Original source: unknown, probably the Gila Conglomerate.

Sample 42. Yellow limestone, fine-grained with occasional small fossils and heavily waterworn cortex. Source: stream gravels. Original source: unknown, probably the Gila Conglomerate.

Sample 43. Purple and white chert, fine to medium grained; very flawed containing areas of coarse material with some crystals; heavily waterworn cortex. Source: stream gravels. Original source: unknown, probably the Gila Conglomerate.

Sample 44. Light brown quartzite; medium grained with a heavily waterworn cortex. Source: stream gravels. Original source: unknown, probably the Gila Conglomerate.

Sample 45. Dark greenish gray andesite. Very fine grained, almost aphanitic with occasional red and yellow-brown streaks. Cortex is very waterworn, and the material resembles chert until it is broken. Source: stream gravels. Original source: probably from local outcrops, but could also derive from the Gila Conglomerate.

Sample 46. Grayish black andesite; aphanitic, but very flawed with yellowish stains along flaw lines. Cortex is very waterworn and resembles that of limestone until broken. Source: stream gravels. Original source: probably from local outcrops, but could also derive from the Gila Conglomerate.

Sample Area 12

Sample Area 12 was the gravel bed of Starkweather Creek near the Reserve Ranger Station. Materials were plentiful and varied, and included much limestone and rhyolite in addition to the samples taken. Six samples were obtained from this location.

Sample 13. Pink and white banded chert with occasional bands of clear crystals; fine grained, occasionally with a waxy luster; waterworn cortex. Source: stream gravels. Original source: local outcrop, specimens found as float on slope; may have formed along with Luna blue agate.

Sample 22. Yellow-brown chert with white crystalline, black, and brown inclusions. Grades from fine to medium grained, and has a heavily waterworn cortex. Source: stream gravels. Original Source: probably from the Gila Conglomerate.

Sample 23. Andesite, medium grained with a heavily waterworn cortex. Source: stream gravels. Original Source: Gila Conglomerate?

Sample 32. Gray chert containing some white crystalline inclusions and fossils; heavily waterworn cortex. Source: stream gravels. Original Source: eroded from the Gila Conglomerate.

Sample 47. Tan chert with white and yellow inclusions. Medium grained with considerable expanses of white and clear quartz crystals; heavily waterworn cortex. Source: stream gravels. Original source: unknown, probably from the Gila Conglomerate.

Sample 48. Rhyolite; very coarse grained with a conchoidal fracture; reddish in color with dark gray to black masses and bands; very grainy, with a considerable amount of pink feldspar visible; waterworn cortex. Source: stream gravels. Original source: probably from local outcrops.

Sample Area 13

Sample Area 13 was the stream bed of Wet Leggett Creek near LA 37919. Three samples were obtained from this location.

Sample 23. Andesite, medium grained with a heavily waterworn cortex. Source: stream gravels. Original source: probably local outcrops.

Sample 49. Gray flow-banded rhyolite with a slight reddish cast. Fine-grained, but does not break conchoidally; contains numerous large black and white phenocrysts, which are probably hornblende and quartz. Cortex is heavily waterworn. Source: stream gravels. Original source: probably local outcrops.

Sample 50. Andesite, medium grained containing many small dark crystals. Cortex is heavily waterworn and has weathered to a reddish gray color; some specimens have a gray cortex. Source: stream gravels.

Original source: probably from local outcrops.

Sample Area 14

Sample Area 14 includes various locations along the Blue River in southeast Arizona. Three samples were obtained from this location.

Sample 51. Gray rhyolite; medium grained with occasional large quartz phenocrysts and a heavily waterworn cortex. Source: stream gravels. Original source: probably from local outcrops.

Sample 52. Pinkish gray rhyolite; medium grained with numerous black phenocrysts; some yellowish areas were noted. Source: stream gravels. Original source: probably from local outcrops.

Sample 53. Glassy basalt containing numerous white spherical inclusions and hornblende phenocrysts; heavily waterworn cortex. Source: stream gravels. Original source: probably from local outcrops.

Sample Area 15

Sample Area 15 was in Willow Canyon along Forest Road 141 above the San Francisco Canyon. One sample was obtained from this location.

Sample 54. Basalt; fine grained, with some large, clear phenocrysts. Source: local outcrop.

Sample Area 16

Sample Area 16 was next to the San Francisco River bridge along U.S. 180 west of Luna. One sample was obtained from this location.

Sample 55. Basalt or basaltic andesite; relatively fine grained with some dark phenocrysts; waterworn cortex. Source: stream gravels. Original source: probably from local outcrops.

Sample Area 17

Sample Area 17 was along the Tularosa River in the Tularosa Box near Apache Creek. One sample was obtained from this location.

Sample 56. Basalt, medium grained with small voids and white and brown phenocrysts; waterworn cortex. Source: stream gravels. Original source: probably from local outcrops.

Sample Area 18

Sample Area 18 was along Forest Road 19 south of U.S. 60 in an area of lacustrine deposits. Red Hill obsidian nodules occur in this area. Three samples were obtained from this location.

Sample 57. Pink flow-banded aphanitic rhyolite; very fine grained with a conchoidal fracture. Occasional very small dark phenocrysts occur in some bands; waterworn cortex. Source: lacustrine deposits. Original source: probably local outcrops.

Sample 58. Silicified rhyolitic tuff, light gray or white with numerous small phenocrysts; medium grained. Source: lacustrine deposits. Original source: probably from local outcrops.

Sample 59. Red Hill obsidian found as small nodules generally less than 5 cm in diameter. Source: Lacustrine deposits. Original source: local outcrops.

Sample Area 19

Sample Area 19 was along Forest Road 141 within the Gwynn Canyon area. One sample was obtained at this location.

Sample 60. Gwynn Canyon obsidian occurring as small nodules less than 5 cm in diameter eroding from rhyolitic deposits in Gwynn Canyon and nearby drainages. Source: local outcrops.

Discussion

Most of the sampled materials were previously identified in many of the chipped stone assemblages. Twenty-two separate material types were identified and recorded during chipped stone analysis. Table 3.28 shows the combined totals for all 25 sites by material type. Fine-grained, cryptocrystalline materials like chert and Luna blue agate make up 69.1 percent of the raw material assemblages. Chalcedony originates from andesite and basalt flows of the Datil Formation, as does Luna blue agate; however, its separation from Luna blue agate was dependant upon the individual analyst. Although chalcedony represents only 1 percent of the material assemblage, it is most likely a misidentified grade of Luna blue agate.

Luna blue agate, or Apache Creek agate as it is sometimes called (Warren 1972), formed in andesite and basaltic andesite flows of the Datil Formation. It outcrops as nodules or geodes in the San Francisco and Gallo mountains (Chamberlin et al. 1994; Warren 1972) and occurs throughout the study area on hillsides and in drainages near Luna, Reserve, and Apache Creek. The interior matrix consists of a waxy, fine-grained cryptocrystalline variety of quartz that, in most cases, grades into a massive quartz crystal center. Luna blue agate is usually banded and ranges in color from clear, opaque, white to various shades of blue and orange. All of our sites are located in close proximity to primary or secondary sources of this material.

Table 3.28. Frequencies and Percentages of Raw Material Types

Material Type	Count	Percent
Chert	21,756	34.5
Chalcedony	648	1.0
Luna blue agate	21,820	34.6
Silicified wood	35	0.1
Obsidian	1,859	2.9
Igneous	104	0.2
Basalt	4,768	7.6
Andesite	2,755	4.4
Silicified andesite	179	0.3
Rhyolite	6,437	10.2
Silicified rhyolitic tuff	133	0.2
Rhyolitic chert	812	1.3
Sedimentary	80	0.1
Limestone	18	0.03
Sandstone	17	0.03
Mudstone	1	0.002
Siltstone	111	0.2
Metamorphic	47	0.1
Quartzite	1,013	1.6
Quartzitic sandstone	498	0.8
Schist	1	0.002
Massive quartz	39	0.1
Total	63,131	100.0

Local cherts are comprised of two classes: those outcropping from primary sources (such as tabular deposits in outcrops), and those occurring as waterworn cobbles in gravel beds in local drainages. Samples 5 and 10 through 15 were tabular in form and were collected from float below outcrops. Samples 10 through 14 came from exposures of igneous deposits stratigraphically above the Gila Conglomerate, and contain inclusions of agate that suggest they may have formed along with Luna blue or grade into that material. The remaining cherts were collected from local drainages as waterworn cobbles that have eroded from the Gila Conglomerate.

Cherts and Luna blue agate are prevalent and easily accessible across the study area. Little effort would have been needed to procure these materials, which may explain why they were predominantly chosen for the manufacture of chipped stone items in site assemblages. This is particularly true of Luna blue agate.

Obsidian makes up 3 percent of the assemblage and is the only nonlocal (exotic) material used at our sites. Nonlocal materials were defined as materials that were only available from sources at least 20 km from a site. All known obsidian sources are located further than a day's travel from our sites; therefore, procurement of obsidian may have occurred either through exchange or during logistical forays.

Ewe and Gwynn canyons are the sources of obsidian nearest the Reserve sites, while Red Hill is the only obsidian source near Luna. Small nodules (generally less than 5 cm in diameter) were collected from slopes of rhyolitic tuff above Negrito Creek in both Ewe and Gwynn canyons and from lacustrine deposits along Forest Service Road 19 south of U.S. 60. Site residents near Reserve would have had to hike through rough mountain terrain (32+ km round trip) in order to gather materials directly from Ewe or Gwynn canyons. Negrito Creek is a tributary of, and joins the San Francisco River just below the town of Reserve; it is also the major drainage for the Gwynn Canyon area. Although we did not find obsidian in Negrito Creek, it is possible that nodules were transported down this stream, making them more easily accessible to peoples near Reserve. Red Hill obsidian is even more distant (80+ km round trip) and would have required several days of travel for site residents near Luna to procure it.

After completion of the chipped stone analysis, a selective sample of obsidian artifacts (n = 180) was submitted for x-ray fluorescence analysis. Results of the analysis showed that most of the obsidian originated south of the project area from deposits of Quaternary alluvium at Mule Creek (74.4 percent) and Cow Canyon (10.6 percent). Other sources used include Red Hill (7.2 percent), Gwynn Canyon (6.7 percent), and Cerro Toledo (Jemez Mountains; 1.1 percent). See Appendixes 3.1-3.4 for a more detailed discussion.

Basalt, andesite, rhyolite, and unidentified igneous materials make up 24 percent of the assemblages. These materials range in quality from fine grained to coarse grained and outcrop in volcanic flows of the Datil Formation or occur in exposures of Gila Conglomerate. Various grades of rhyolite are the most common igneous materials in the chipped stone assemblages, followed by basalt and andesite. Large cobbles of all these materials can be found in secondary deposits throughout the study area. Basalt also occurs in local drainages; however, the only fine-grained basalt that was located came from outcrops in Willow Canyon (Area 15).

Sedimentary and metamorphic materials represent only a small percentage (2.9 percent) of the combined assemblage. These materials occur as cobbles in exposures of the Gila Conglomerate and as alluvial gravels in secondary deposits.

Discussion

Most of the materials collected during sampling studies came from secondary deposits (drainages) in the Reserve and Luna areas. As stated earlier, the Reserve area was more prolific in the amount of available raw materials. Drainages near Reserve contain all material types listed in Table 3.29 except for obsidian. More varieties and a greater abundance of chert, rhyolite, and other igneous materials were found in the drainages near Reserve than in the Luna area. While these materials can be found in the Luna area, the predominant material resource in that area is Luna blue agate, which outcrops near all of the sites. Reserve area residents would have had to obtain this material from secondary sources.

Obsidian was the only nonlocal material identified in these assemblages. Red Hill, Gwynn Canyon, and Ewe Canyon are the sources nearest our study area; however, procurement of obsidian from these locations would have required round trips from the Reserve or Luna areas of 32 to 80+ km. X-ray fluorescence analysis showed that most of the obsidian (74.4 percent) found in these assemblages originated south of our study area near Mule Creek. Therefore, people from Luna and Reserve would have had to procure obsidian through exchange or by logistical forays.

Material Selection

Studies of raw material distributions and variation can provide insight into the relationship between chipped stone technologies and patterns of mobility or exchange. Several factors that may determine procurement strategies include material availability, accessibility, and the use for which a particular material may be suitable (Binford 1980; Kelly 1988, 1992). Our study area is located in a lithic-rich environment, providing site residents many choices in their selection of raw materials. Depending on reduction technology or the type of tool needed for certain tasks, the prevalence of raw materials within the study area would have allowed site occupants to use locally available materials rather than those that may have been preferable (for example: Luna blue agate instead of chert or obsidian).

Analysis identified a total of 63,131 chipped stone artifacts that resulted from the reduction of 22 separate raw material types. In an effort to simplify material selection and use, material types were condensed into more general categories. Silicified wood was grouped with cherts and chalcedony with Luna blue agate. The igneous category includes unidentified igneous materials as well as andesite and silicified andesite. Rhyolite includes rhyolitic chert and silicified rhyolitic tuff. Unidentified sedimentary rocks as well as sandstone, limestone, siltstone, and mudstone were grouped under the sedimentary category. Metamorphic rocks, which could not be identified, as well as quartzite, quartzitic sandstone, and schist, were all labeled metamorphic.

One of the objectives of this analysis was to look for evidence of material selection, variability, and use differences through time. Many of the sites show evidence of multiple occupations over long periods. In order to differentiate these time periods, site assemblages were separated by component, when possible. Components that could not be separated are classified as mixed (see *Introduction to the Chipped Stone Analysis*).

Table 3.29 shows the distribution of materials by site and component for each of the 25 assemblages. When looking at combined totals for each period, there are notable differences in material selection through time. Sedimentary rocks were rarely selected in any component. Metamorphic materials were somewhat more common, especially in the Early and Late Pueblo assemblages. While all components seem to contain high percentages of chert or Luna blue agate, cherts were more frequently selected for reduction during the Late Archaic period, and Luna blue agate was used more often during the Late Pueblo period. Obsidians were predominantly selected for use during the Late Pithouse, Late Pueblo, and Protohistoric periods, as well as in one Late Archaic component (LA 78439). The use of basalt appears to decrease through time and primarily occurs in Late Archaic components. Various grades of rhyolite are the most common materials available in the study area, and use of this material occurs in fairly high percentages, especially from the Early Pithouse through the Early Pueblo periods. Igneous materials were predominantly selected during the Early Pueblo period. Both classes of materials can be found in great quantities in the drainages near Reserve, and were used more frequently on the components in that area.

Table 3.29. Material Category by Component; Frequencies and Row Percentages

Period	Component	Material Type							
		Chert	Luna Blue Agate	Obsidian	Igneous	Basalt	Rhyolite	Sedimentary	Metamorphic
Late Archaic	LA 43766	1004	10	0	39	923	13	1	11
		50.2	0.5	0.0	1.9	46.1	0.6	0.0	0.5
	LA 45508	933	1319	87	9	58	88	7	5
		37.2	52.6	3.5	0.4	2.3	3.5	0.3	0.2
	LA 70188	2988	1053	62	45	376	490	4	90
		58.5	20.6	1.2	0.9	7.4	9.6	0.1	1.8
	LA 78439	159	138	114	22	15	67	6	17
		29.6	25.7	21.2	4.1	2.8	12.5	1.1	3.2
	Total	5084	2520	263	15	1372	658	18	123
		50.1	24.8	2.6	1.1	13.5	6.5	0.2	1.2
Early Pithouse	LA 39972	328	32	20	64	53	16	2	8
		62.7	6.1	3.8	12.2	10.1	3.1	0.4	1.5
	LA 39975	415	557	30	89	23	346	30	90
		26.3	35.3	1.9	5.6	1.5	21.9	1.9	5.7
	Total	743	589	50	153	76	362	32	98
		35.3	28.0	2.4	7.3	3.6	17.2	1.5	4.7
Late Pithouse	LA 43786	4	17	0	5	2	58	0	7
		4.3	18.3	0.0	5.4	2.2	62.4	0.0	7.5
	LA 45507	749	1128	128	34	10	89	2	59
		34.1	51.3	5.8	1.5	0.5	4.0	0.1	2.7
	LA 45510	315	482	75	44	10	302	3	2
		25.5	39.1	6.1	3.6	0.8	24.5	0.2	0.2
	LA 70196	99	106	168	50	6	391	1	31
		11.6	12.4	19.7	5.9	0.7	45.9	0.1	3.6
	Total	1167	1733	371	133	28	840	6	99
		26.7	39.6	8.5	3.0	0.6	19.2	0.1	2.3

Period	Component	Material Type							
		Chert	Luna Blue Agate	Obsidian	Igneous	Basalt	Rhyolite	Sedimentary	Metamorphic
Pithouse	LA 70201	35 6.4	29 5.3	12 2.2	6 1.1	3 0.6	453 83.3	0 0.0	6 1.1
	Total	35 6.4	29 5.3	12 2.2	6 1.1	3 0.6	453 83.3	0 0.0	6 1.1
Early Pueblo	LA 3563	106 6.4	140 8.4	25 1.5	76 4.6	16 1.0	1236 74.3	6 0.4	58 3.5
	LA 39969	1191 39.0	460 15.1	71 2.3	783 25.7	188 6.2	154 5.0	14 0.5	189 6.2
	LA 39972	259 36.2	116 16.2	15 2.1	230 32.1	30 4.2	45 6.3	7 1.0	14 2.0
	LA 75792	46 4.2	64 5.8	21 1.9	19 1.7	10 0.9	923 84.0	0 0.0	16 1.5
	Total	1602 24.6	780 12.0	132 2.0	1108 17.0	244 3.7	2358 36.0	27 0.4	277 4.3
Late Pueblo	LA 3279	1333 9.7	10741 77.8	446 3.2	389 2.8	83 0.6	504 3.6	41 0.3	273 2.0
	LA 9721	1 3.2	6 23.1	1 3.8	0 0.0	0 0.0	18 69.2	0 0.0	0 0.0
	LA 39968	1956 45.4	966 22.4	66 1.5	757 17.6	63 1.5	261 6.1	40 0.9	197 4.6
	LA 70185	503 22.4	958 42.7	78 3.5	200 8.9	109 4.9	289 12.9	0 0.0	107 4.8
	Total	3793 18.6	12671 62.2	591 2.9	1346 6.6	255 1.3	1072 5.3	81 0.4	577 2.8
Protohistoric	LA 37917	167 25.1	208 31.2	95 14.3	32 4.8	38 5.7	116 17.4	0 0.0	10 1.5
	LA 37919	361 51.8	111 15.9	49 7.0	46 6.6	39 5.6	73 10.5	0 0.0	18 2.6
	Total	528 38.7	319 23.4	144 10.6	78 5.7	77 5.6	189 13.9	0 0.0	28 2.1
Mixed	LA 43766	2188 50.6	38 0.9	11 0.3	107 2.5	1910 44.2	35 0.8	11 0.3	20 0.5

Period	Component	Material Type							
		Chert	Luna Blue Agate	Obsidian	Igneous	Basalt	Rhyolite	Sedimentary	Metamorphic
	LA 70188	5976	2659	160	99	751	1022	30	270
		54.5	24.2	1.5	0.9	6.8	9.3	0.3	2.5
	LA 70189	103	125	9	31	4	24	5	21
		32.0	38.8	2.8	9.6	1.2	7.5	1.6	6.5
	LA 70191	73	32	40	8	4	17	0	9
		39.9	17.5	21.9	4.4	2.2	9.3	0.0	4.9
	LA 75791	42	27	9	5	5	44	1	12
		29.0	18.6	6.2	3.4	3.4	30.3	0.7	8.3
	LA 78439	58	63	34	18	20	42	0	7
		24.0	26.0	14.0	7.4	8.3	17.4	0.0	2.9
	LA 89846	328	611	11	1	15	107	16	7
		29.9	55.7	1.0	0.1	1.4	9.8	1.5	0.6
	LA 89847	71	272	22	2	4	226	0	5
		17.7	67.7	5.5	0.5	1.0	6.5	0.0	1.2
	TOTAL	8839	3827	296	271	2713	1317	63	351
		50.0	21.7	1.7	1.5	15.4	7.5	0.4	2.0

Table 3.30. Material Category in the Luna Components; Frequencies and Row Percentages.

Period	Component	Material Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Archaic	LA 45508	933	37.2	1319	52.6	87	3.5	9	.4	58	2.3	88	3.5	7	.3	5	.2
	Total	933	37.2	1319	52.6	87	3.5	9	.4	58	2.3	88	3.5	7	.3	5	.2
Late Pithouse	LA 45507	749	34.1	1128	51.3	128	5.8	34	1.5	10	.5	89	4.0	2	.1	59	2.7
	LA 45510	315	25.5	482	39.1	75	6.1	44	3.6	10	.8	302	24.5	3	.2	2	.2
	Total	1064	31.0	1610	46.9	203	5.9	78	2.3	20	.6	391	11.4	5	.1	61	1.8
Late Pueblo	LA 3279	1333	9.7	10741	77.8	446	3.2	389	2.8	83	.6	504	3.6	41	.3	273	2.0
	LA 70185	503	22.4	958	42.7	78	3.5	200	8.9	109	4.9	289	12.9			107	4.8
	Total	1836	11.4	11699	72.9	524	3.3	589	3.7	192	1.2	793	4.9	41	.3	380	2.4
Mixed	LA 89846	328	29.9	611	55.7	11	1.0	1	.1	15	1.4	107	9.8	16	1.5	7	.6
	LA 89847	71	17.7	272	67.7	22	5.5	2	.5	4	1.0	26	6.5			5	1.2
	Total	399	26.6	883	58.9	33	2.2	3	.2	19	1.3	133	8.9	16	1.1	12	.8

Table 3.31. Material Category in the Reserve Components; Frequencies and Row Percentages

Period	Component	Materal Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Archaic	LA 43766	1004	50.2	10	.5			39	1.9	923	46.1	13	.6	1	.0	11	.5
	LA 70188	2988	58.5	1053	20.6	62	1.2	45	.9	376	7.4	490	9.6	4	.1	90	1.8
	LA 78439	159	29.6	138	25.7	114	21.2	22	4.1	15	2.8	67	12.5	6	1.1	17	3.2
	Total	4151	54.3	1201	15.7	176	2.3	106	1.4	1314	17.2	570	7.5	11	.1	118	1.5
Early Pithouse	LA 39972	328	62.7	32	6.1	20	3.8	64	12.2	53	10.1	16	3.1	2	.4	8	1.5
	LA 39975	415	26.3	557	35.3	30	1.9	89	5.6	23	1.5	346	21.9	30	1.9	90	5.7
	Total	743	35.3	589	28.0	50	2.4	153	7.3	76	3.6	362	17.2	32	1.5	98	4.7

Period	Component	Materal Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Pithouse	LA 43786	4	4.3	17	18.3			5	5.4	2	2.2	58	62.4			7	7.5
	LA 70196	99	11.6	106	12.4	168	19.7	50	5.9	6	.7	391	45.9	1	.1	31	3.6
	Total	103	10.9	123	13.0	168	17.8	55	5.8	8	.8	449	47.5	1	.1	38	4.0
Pithouse	LA 70201	35	6.4	29	5.3	12	2.2	6	1.1	3	.6	453	83.3			6	1.1
	Total	35	6.4	29	5.3	12	2.2	6	1.1	3	.6	453	83.3			6	1.1
Early Pueblo	LA 3563	106	6.4	140	8.4	25	1.5	76	4.6	16	1.0	1236	74.3	6	.4	58	3.5
	LA 39969	1191	39.0	460	15.1	71	2.3	783	25.7	188	6.2	154	5.0	14	.5	189	6.2
	LA 39972	259	36.2	116	16.2	15	2.1	230	32.1	30	4.2	45	6.3	7	1.0	14	2.0
	LA 75792	46	4.2	64	5.8	21	1.9	19	1.7	10	.9	923	84.0			16	1.5
	Total	1602	24.6	780	12.0	132	2.0	1108	17.0	244	3.7	23.58	36.0	27	.4	277	4.3
Late Pueblo	LA 9721	1	3.8	6	23.1	1	3.8					18	69.2				
	LA 39968	1956	45.4	966	22.4	66	1.5	757	17.6	63	1.5	261	6.1	40	.9	197	4.6
	Total	1957	45.2	972	22.4	67	1.5	757	17.5	63	1.5	279	6.4	40	.9	197	4.5
Protohist-oric	LA 37917	167	25.1	208	31.2	95	14.3	32	4.8	38	5.7	116	17.4			10	1.5
	LA 37919	361	51.8	111	15.9	49	7.0	46	6.6	39	5.6	73	10.5			18	2.6
	Total	528	38.7	319	23.4	144	10.6	78	5.7	77	5.6	189	13.9			28	2.1
Mixed	LA 43766	2188	50.6	38	.9	11	.3	107	2.5	1910	44.2	35	.8	11	.3	20	.5
	LA 70188	5976	54.5	2659	24.2	160	1.5	99	.9	751	6.8	1022	9.3	30	.3	270	2.5
	LA 70189	103	32.0	125	38.8	9	2.8	31	9.6	4	1.2	24	7.5	5	1.6	21	6.5
	LA 70191	73	39.9	32	17.5	40	21.9	8	4.4	4	2.2	17	9.3			9	4.9
	LA 75791	42	29.0	27	18.6	9	6.2	5	3.4	5	3.4	44	30.3	1	.7	12	8.3
	LA 78439	58	24.0	63	26.0	34	14.0	18	7.4	20	8.3	42	17.4			7	2.9
	Total	8486	49.1	3008	17.4	284	1.6	287	1.7	2704	15.6	2107	12.2	47	.3	355	2.1

Table 3.32. Debitage by Material Categories in the Luna Components; Frequencies and Row Percentages.

Component	Morphology	Material Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
LA 3279	angular debris	416	6.7	5471	88.1	70	1.1	103	1.7	10	.2	92	1.5	6	.1	42	.7
	core flake	836	12.3	4764	70.3	269	4.0	247	3.6	58	.9	365	5.4	32	.5	208	3.1
	biface flake	6	3.7	138	84.1	19	11.6	1	.6								
	Total	1258	9.6	10373	78.9	358	2.7	351	2.7	68	.5	457	3.5	38	.3	250	1.9
LA 45507	angular debris	158	33.5	276	58.5	9	1.9	4	.8	2	.4	10	2.1	1	.2	12	2.5
	core flake	532	36.0	742	50.3	62	4.2	23	1.6	8	.5	66	4.5	1	.1	42	2.8
	biface flake	45	30.0	63	42.0	38	25.3					4	2.7				
	Total	735	35.0	1081	51.5	109	5.2	27	1.3	10	.5	80	3.8	2	.1	54	2.6
LA 45508	angular debris	123	26.2	322	68.7	7	1.5			3	.6	9	1.9	2	.4	3	.6
	core flake	462	35.7	695	53.7	32	2.5	8	.6	26	2.0	64	4.9	5	.4	2	.2
	biface flake	324	49.0	263	39.8	37	5.6			26	3.9	11	1.7				
	Total	909	37.5	1280	52.8	76	3.1	8	.3	55	2.3	84	3.5	7	.3	5	.2
LA 45510	angular debris	82	20.2	155	38.2	6	1.5	7	1.7			156	38.4				
	core flake	213	30.0	284	40.1	27	3.8	37	5.2	3	.4	140	19.7	3	.4	2	.3
	biface flake	14	20.3	33	47.8	15	21.7			4	5.8	3	4.3				
	Total	309	26.1	472	39.9	48	4.1	44	3.7	7	.6	299	25.3	3	.3	2	.2
LA 70185	angular debris	88	23.0	196	51.3	12	3.1	24	6.3	8	2.1	33	8.6			21	5.5
	core flake	326	21.0	652	42.0	27	1.7	152	9.8	86	5.5	230	14.8			79	5.1
	biface flake	75	34.1	89	40.5	10	4.5	16	7.3	11	5.0	14	6.4			5	2.3
	Total	489	22.7	937	43.5	49	2.3	192	8.9	105	4.9	277	12.9			105	4.9
LA 89846	angular debris	172	33.1	299	57.5	1	.2	1	.2	5	1.0	34	6.5	5	1.0	3	.6
	core flake	148	26.9	302	54.9	7	1.3			9	1.6	70	12.7	10	1.8	4	.7
	biface flake	1	14.3	5	71.4					1	14.3						
	Total	321	29.8	606	56.3	8	.7	1	.1	15	1.4	104	9.7	15	1.4	7	.6
LA 89847	angular debris	31	15.8	155	79.1	3	1.5					6	3.1			1	.5

Component	Morphology	Material Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
	core flake	35	18.0	111	57.2	18	9.3	2	1.0	4	2.1	20	10.3			4	2.1
LA 89847	biface flake	2	25.0	5	62.5	1	12.5										
	Total	68	17.1	271	68.1	22	5.5	2	.5	4	1.0	26	6.5			5	1.3

Table 3.33. Debitage by Material Categories in the Reserve Components; Frequencies and Row Percentages.

Component	Morphology	Material Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
LA 3563	angular debris	9	9.6	19	20.2	2	2.1	3	3.2	2	2.1	56	59.6	1	1.1	2	2.1
	core flake	81	5.7	112	7.9	16	1.1	66	4.7	12	.8	1073	75.8	5	.4	50	3.5
	biface flake	10	14.5	2	2.9	4	5.8	2	2.9			50	72.5			1	1.4
	Total	100	6.3	133	8.4	22	1.4	71	4.5	14	.9	1179	74.7	6	.4	53	3.4
LA 9721	angular debris			1	50.0							1	50.0				
	core flake	1	4.8	5	23.8							15	71.4				
	Total	1	4.3	6	26.1							16	69.6				
LA 37917	angular debris	40	31.3	65	50.8	5	3.9	4	3.1	1	.8	13	10.2				
	core flake	117	23.8	136	27.6	74	15.0	26	5.3	31	6.3	98	19.9			10	2.0
	biface flake	2	11.1			14	77.8					2	11.1				
	Total	159	24.9	201	31.5	93	14.6	30	4.7	32	5.0	113	17.7			10	1.6
LA 37919	angular debris	45	40.2	47	42.0	5	4.5	1	.9	3	2.7	10	8.9			1	.9
	core flake	301	54.7	62	11.3	37	6.7	43	7.8	33	6.0	57	10.4			17	3.1
	biface flake	12	46.2			6	23.1			3	11.5	5	19.2				
	Total	358	52.0	109	15.8	48	7.0	44	6.4	39	5.7	72	10.5			18	2.6
LA 39968	angular debris	648	43.3	531	35.4	18	1.2	179	11.9	12	.8	72	4.8	6	.4	32	2.1
	core flake	1197	47.2	400	15.8	25	1.0	521	20.6	35	1.4	176	6.9	33	1.3	148	5.8
	biface flake	15	48.4	3	9.7	5	16.1	2	6.5	4	12.9					2	6.5
	Total	1860	45.8	934	23.0	48	1.2	702	17.3	51	1.3	248	6.1	39	1.0	182	4.5

Component	Morphology	Material Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
LA 39969	angular debris	302	34.8	220	25.3	14	1.6	208	23.9	32	3.7	35	4.0	2	.2	56	6.4
	core flake	834	41.3	224	11.1	44	2.2	540	26.8	137	6.8	108	5.4	10	.5	121	6.0
	biface flake	4	33.3	5	41.7	3	25.0										
	Total	1140	39.3	449	15.5	61	2.1	748	25.8	169	5.8	143	4.9	12	.4	177	6.1
LA 39972	angular debris	206	50.2	88	21.5	7	1.7	70	17.1	17	4.1	14	3.4	3	.7	5	1.2
	core flake	347	46.5	56	7.5	24	3.2	208	27.8	46	6.2	43	5.8	6	.8	17	2.3
LA 39972	biface flake	11	39.3	1	3.6	2	7.1	1	3.6	13	46.4						
	Total	564	47.6	145	12.2	33	2.8	279	23.5	76	6.4	57	4.8	9	.8	22	1.9
LA 39975	angular debris	50	22.0	130	57.3	4	1.8	4	1.8	4	1.8	28	12.3	3	1.3	4	1.8
	core flake	322	26.8	376	31.3	16	1.3	79	6.6	13	1.1	292	24.3	23	1.9	82	6.8
	biface flake	21	33.9	18	29.0	6	9.7	2	3.2	1	1.6	14	22.6				
	Total	393	26.3	524	35.1	26	1.7	85	5.7	18	1.2	334	22.4	26	1.7	86	5.8
LA 43766	angular debris	603	57.4	11	1.0			42	4.0	378	36.0	7	.7	2	.2	8	.8
	core flake	1956	57.0	23	.7	7	.2	95	2.8	1288	37.6	29	.8	10	.3	21	.6
	biface flake	547	32.3	13	.8	2	.1	2	.1	1121	66.3	5	.3			2	.1
	Total	3106	50.3	47	.8	9	.1	139	2.3	2787	45.2	41	.7	12	.2	31	.5
LA 43786	angular debris			2	28.6			1	14.3			2	28.6			2	28.6
	core flake	3	3.7	14	17.1			4	4.9	1	1.2	55	67.1			5	6.1
	biface flake	1	100.0														
	Total	4	4.4	16	17.8			5	5.6	1	1.1	57	63.3			7	7.8
LA 70188	angular debris	1050	36.0	1450	49.7	7	.2	26	.9	162	5.6	143	4.9	13	.4	65	2.2
	core flake	4866	56.6	1774	20.6	109	1.3	89	1.0	582	6.8	906	10.5	18	.2	250	2.9
	biface flake	2856	68.3	406	9.7	83	2.0	16	.4	350	8.4	438	10.5	2	.0	31	.7
	Total	8772	55.9	3630	23.1	199	1.3	131	.8	1094	7.0	1487	9.5	33	.2	346	2.2
LA 70189	angular debris	20	29.9	38	56.7	2	3.0	2	3.0			4	6.0			1	1.5
	core flake	78	34.4	79	34.8	4	1.8	22	9.7	4	1.8	16	7.0	4	1.8	20	8.8
	biface flake	2	14.3	5	35.7	3	21.4	2	14.3			2	14.3				
	Total	100	32.5	122	39.6	9	2.9	26	8.4	4	1.3	22	7.1	4	1.3	21	6.8

Component	Morphology	Material Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
LA 70191	angular debris	11	42.3	10	38.5			1	3.8	1	3.8	2	7.7			1	3.8
	core flake	48	41.4	20	17.2	20	17.2	6	5.2	2	1.7	12	10.3			8	6.9
	biface flake	12	32.4	1	2.7	19	51.4	1	2.7	1	2.7	3	8.1				
	Total	71	39.7	31	17.3	39	21.8	8	4.5	4	2.2	17	9.5			9	5.0
LA 70196	angular debris	23	29.1	16	20.3	2	2.5	2	2.5			33	41.8			3	3.8
	core flake	65	10.1	84	13.1	64	10.0	45	7.0	3	.5	351	54.8	1	.2	28	4.4
	biface flake	3	3.2			85	90.4	1	1.1			5	5.3				
	Total	91	11.2	100	12.3	151	18.6	48	5.9	3	.4	389	47.8	1	.1	31	3.8
LA 70201	angular debris	3	11.1	6	22.2	1	3.7					17	63.0				
	core flake	29	6.0	22	4.6	3	.6	6	1.2	1	.2	417	86.3			5	1.0
	biface flake	2	16.7			6	50.0					3	25.0			1	8.3
	Total	34	6.5	28	5.4	10	1.9	6	1.1	1	.2	437	83.7			6	1.1
LA 75791	angular debris	2	18.2	4	36.4			2	18.2			2	18.2			1	9.1
	core flake	36	29.8	23	19.0	5	4.1	3	2.5	5	4.1	38	31.4	1	.8	10	8.3
	biface flake	1	16.7			3	50.0					2	33.3				
	Total	39	28.3	27	19.6	8	5.8	5	3.6	5	3.6	42	30.4	1	.7	11	8.0
LA 75792	angular debris	6	4.7	19	14.7	1	.8	4	3.1	1	.8	96	74.4			2	1.6
	core flake	33	3.5	42	4.5	15	1.6	14	1.5	9	1.0	805	86.5			13	1.4
	biface flake	2	15.4	2	15.4	1	7.7					8	61.5				
	Total	41	3.8	63	5.9	17	1.6	18	1.7	10	.9	909	84.7			15	1.4
LA 78439	angular debris	37	32.5	48	42.1	15	13.2	3	2.6	1	.9	9	7.9			1	.9
	core flake	157	27.7	143	25.3	90	15.9	35	6.2	25	4.4	87	15.4	6	1.1	23	4.1
	biface flake	5	9.6	5	9.6	37	71.2					5	9.6				
	Total	199	27.2	196	26.8	142	19.4	38	5.2	26	3.6	101	13.8	6	.8	24	3.3

Although material selection in the mixed assemblages reflects a predominant use of cherts and Luna blue agate, counts are heavily affected by two assemblages (LA 43766 and LA 70188). Mixed assemblages from LA 70188 and LA 43766 contain large amounts of chert and basalt, which are primarily associated with biface manufacture in the Late Archaic components of these sites: unfortunately these artifacts could not be separated from later materials. LA 70191 is a mixed assemblage that shows selective preferences in material use. Obsidian makes up 22 percent of this assemblage; however, this site is primarily comprised of redeposited materials that have eroded downslope from an Early Pithouse site.

Evidence of protohistoric use of the area is complicated at best. Most of the sites with protohistoric dates contain assemblages from multiple occupations that could not be separated. Although LA 37917 contained Late Archaic style projectile points, both it and LA 37919 are the only components considered to date to the protohistoric period in this analysis. The protohistoric components exhibit a heavy reliance on local materials; however, both assemblages show very different frequencies of chert, Luna blue agate, and obsidian. LA 37919 is dominated by cherts, and in this aspect it is similar to the Late Archaic components.

In order to determine whether differences in material selection through time were due to material availability or based on technological considerations, the components were separated into two physiographic regions. Tables 3.30 and 3.31 show material use by temporal period and component for the Luna and Reserve sides of the San Francisco Mountains. When the sites are broken down into separate regions, differences in material selection become more distinct and location (accessibility) stands out among the sites. Before a discussion of differences between these regions can take place, it must be noted that two of the twenty-five sites contain half of the total chipped stone assemblage (LA 70188 on the Reserve side and LA 3279 near Luna).

Three raw material types that stand out as examples of location (accessibility) in determining procurement are cherts, Luna blue agate, and basalt. Chert cobbles are much more common in drainages near Reserve, which may explain why this material was used more often than other types found in the same locations. Although Luna blue agate is available throughout the study area, it occurs in greater quantities near the Luna sites. Selection of Luna blue agate may primarily have been a matter of convenience on the Luna side of the project area, since all of those sites are located near major outcrops of this material. Site residents on the Reserve side of the mountains would have had to seek out secondary sources for Luna blue agate. This material is available in drainages near Reserve, but it is not as abundant as it is near Luna. Also, cherts are much more common in drainages of the Reserve area.

Basalt was mainly selected for use in the Reserve components, especially during the Late Archaic period at LA 43766 and LA 70188. Primary outcrops of this material occur along the Tularosa and San Francisco rivers (northeast and southwest of Reserve), making it a more viable resource to residents of the Reserve area. Extensive travel (more than a day) over rough terrain would have been required of Luna area residents to procure these basalts. Chipped stone assemblages of the Late Archaic components in each area may be more reflective of resource availability than technological constraints. The Luna Archaic assemblage is dominated by Luna blue agate, while the Reserve Archaic assemblages are dominated by cherts, and in one case, cherts and basalt.

Tables 3.32 and 3.33 show percentages of debitage by material type for both the Luna and Reserve sites. Flakes and angular debris from cherts and Luna blue agate occur in high percentages in most of the assemblages; however, Luna blue agate was primarily selected for chipped stone reduction on the Luna side of the mountains. Chert was selected over Luna blue in more that half of the assemblages on the Reserve side, and this was not true of any of the Luna sites. Igneous materials, rhyolite, and basalt are represented by higher percentages of debitage in the Reserve assemblages. High frequencies of use for these materials in the Luna area seem to mainly occur in a Late Pithouse component (LA 45510) and the Late Pueblo assemblages of LA 3279 and LA 70185. Although the use of igneous (excluding basalt) and rhyolitic materials for chipped stone reduction mostly occurred during the Early Pithouse through Late Pueblo periods in the Reserve area and the Late Pithouse through Late Pueblo periods in the Luna area, these materials were predominantly selected for use during the Early Pueblo period in the Reserve area (Table 3.29).

An emphasis on expedient core reduction and informal tool use is usually reflected in the chipped stone assemblages of sites in which agriculture was the primary means of subsistence. Most basalt, rhyolite, and igneous materials are well suited to expedient core reduction, the production of durable-edged tools, and as ground stone tools. A reliance on agriculture along with a chipped stone technology geared toward the production of expedient tools might explain the increase in the use of igneous and rhyolitic materials during the Early Pueblo period in the Reserve assemblage.

Chert and Luna blue agate biface flakes occur throughout the sequence in both the Luna and Reserve assemblages; however, basalt was predominantly selected for biface reduction in the Late Archaic components of LA 43766 and LA 70188 (Reserve area), and obsidian was used extensively for biface manufacture in a Late Pithouse component (LA 70196). Although a preference for the use of chert, Luna blue agate, and basalt for biface manufacture in the Late Archaic period components (LA 45508, LA 43766, and LA 70188) is reflected in Tables 3.34 and 3.35, these tables also reveal a differential use of obsidian for biface manufacture between the two areas. Obsidian was used much more frequently for the manufacture of bifaces in the Luna area.

Most of the obsidian bifaces were found in Luna area assemblages, and many came from a Late Pueblo component (LA 3279). According to Moore (*Projectile Points,* this volume), obsidian accounts for 50.8 percent of the projectile point assemblage, primarily in the form of small arrow points, over half (58.9 percent) of which are from the Luna sites. Material quality and size may have been the determining factor in the selection of obsidian for arrow points. It is interesting to note that while many bifaces were made of obsidian, very few biface flakes of this material were recovered (LA 70188 and LA 70196 are the only assemblages from which a significant number of obsidian biface flakes were recovered; Tables 3.32 and 3.33). During excavation, only ¼-inch screens were used to recover artifacts, except at LA 70188 where ⅛-inch screen was used. Most of the obsidian nodules collected during material sampling are in the 5-cm-diameter range. Only small bifaces could have been produced from obsidian nodules of this size, and most biface flakes from them would have passed through the screens. Larger points were predominantly made from cherts, basalt, and Luna blue agate. While these materials are abundant they are difficult to work; Luna blue agate is hard and tends to shatter, while cherts and basalts are more difficult to pressure flake. Obsidians fracture more predictably and are better suited to pressure flaking, making them more amenable to small biface-arrow point production. Obsidians tended to be selected for biface production from the Late Pithouse through Late Pueblo periods in both assemblages (Luna and Reserve). This coincides with a shift from the use of atlatl darts to the bow.

Cortex and Material Source

The location from which raw materials were procured does not always indicate the geological source of those materials. Stones are often moved great distances away from their primary source by water transport or other erosional processes. Raw material distributions are also affected by cultural processes including patterns of exchange and logistical strategies. Studies of the type of cortex remaining on an artifact can be indicative of where raw materials were acquired.

Cortex is the weathered outer rind on a nodule. Our analysis identified three types of cortex on chipped stone artifacts: waterworn, nonwaterworn, and indeterminate. Waterworn cortex indicates that a material was transported away from its original source by water. Evidence of water transportation can be seen in the form of mechanical weathering such as overlapping conchoidal scars on the cortical surface and rounding. Artifacts with this type of cortex were primarily procured from secondary sources such as gravel deposits. However, waterworn cortex as a source indicator is complicated in our study area. Many chert cobbles and other raw materials found in exposures of Gila Conglomerate have waterworn cortex because they are remnants of ancient stream deposits. This makes it difficult to distinguish between materials that site residents procured from modern and ancient stream deposits. It is also difficult to distinguish the type of cortex remaining on artifacts made of Luna blue agate, since the natural outer rind of these nodules often looks waterworn.

Nonwaterworn cortex is a natural cortex that has not been affected by alluvial processes. This type of cortex shows evidence of chemical weathering in the form of a rough or unbattered texture. Artifacts with a nonwaterworn cortex were made from materials that were procured from their original source or within close proximity to that source. Indeterminate cortex means that cortex is present, but the type could not be identified.

Tables 3.36 and 3.37 show chipped stone assemblages for the Reserve and Luna areas by cortex and material type. Both assemblages contain similar percentages of materials acquired from drainages and outcrops. It is interesting that cortex on Luna blue agate was predominantly waterworn in the Luna assemblage and nonwaterworn in the Reserve assemblage, because during material source studies we found that most of the Luna blue agate near Reserve was available in local drainages. Although there are outcrops of Luna blue agate at or near all of the Luna sites, the San Francisco River is nearby and many large cobbles of this material can be found in the river gravels. This may explain the substantial numbers of Luna blue agate artifacts with waterworn cortex in the Luna assemblage.

Table 3.34. Bifaces by Material Category for the Luna Components; Frequencies and Row Percentages

Component	Morphology	Material Category													
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
LA 3279	biface, undifferentiated	5	13.9	22	61.1	9	25.0								
	biface-early stage	9	10.8	61	73.5	11	13.3			2	2.4				
	biface-middle stage	5	7.9	36	57.1	17	27.0			4	6.3			1	1.6
	biface-late stage	9	9.9	36	39.6	42	46.2	1	1.1	3	3.3				
	Total	28	10.3	155	56.8	79	28.9	1	.4	9	3.3			1	.4
LA 45507	biface-early stage	1	50.0			1	50.0								
	biface-middle stage					5	100.0								
	biface-late stage			2	14.3	12	85.7								
	Total	1	4.8	2	9.5	18	85.7								
LA 45508	biface, undifferentiated	7	50.0	6	42.9	1	7.1								
	biface-early stage	5	62.5	2	25.0	1	12.5								
	biface-middle stage	4	36.4	5	45.5	2	18.2								
	biface-late stage	2	18.2	3	27.3	3	27.3			1	9.1	2	18.2		
	Total	18	40.9	16	36.4	7	15.9			1	2.3	2	4.5		
LA 45510	biface, undifferentiated			1	16.7	5	83.3								
	biface-early stage			1	25.0	3	75.0								
	biface-middle stage					7	100.0								
	biface-late stage	1	7.1			11	78.6			2	14.3				
	Total	1	3.2	2	6.5	26	83.9			2	6.5				
LA 70185	biface, undifferentiated					1	50.0	1	50.0						
	biface-early stage	1	14.3			6	85.7								
	biface-middle stage	2	10.0	1	5.0	17	85.0								
	biface-late stage	3	25.0	4	33.3	5	41.7								
	Total	6	14.6	5	12.2	29	70.7	1	2.4						
LA 89846	biface, undifferentiated	2	50.0	2	50.0										
LA 89846	biface-early stage	1	100.0												
	biface-middle stage	1	50.0			1	50.0								

Component	Morphology	Material Category													
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
	biface-late stage	1	25.0	1	25.0	2	50.0								
	Total	5	45.5	3	27.3	3	27.3								
LA 89847	biface-early stage	1	100.0												
	biface-middle stage			1	100.0										
	Total	1	50.0	1	50.0										

Table 3.35. Bifaces by Material Category for the Reserve Components; Frequencies and Row Percentages

Component	Morphology	Material Category													
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
LA 3563	biface-early stage	1	50.0									1	50.0		
	biface-middle stage					1	50.0					1	50.0		
	biface-late stage			1	25.0	2	50.0					1	25.0		
	Total	1	12.5	1	12.5	3	37.5					3	37.5		
LA 37917	biface, undifferentiated					1	50.0			1	50.0				
	biface-early stage									1	100.0				
	biface-middle stage	1	100.0												
	biface-late stage	3	37.5			1	12.5			3	37.5	1	12.5		
	Total	4	33.3			2	16.7			5	41.7	1	8.3		
LA 37919	biface-middle stage					1	50.0					1	50.0		
	biface-late stage	1	100.0												
	Total	1	33.3			1	33.3					1	33.3		
LA 39968	biface, undifferentiated	2	50.0			2	50.0								
	biface-early stage			2	25.0	3	37.5	1	12.5	2	25.0				

Component	Morphology	Material Category													
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
	biface-middle stage	1	11.1			6	66.7			1	11.1	1	11.1		
	biface-late stage	4	44.4			5	55.6								
	Total	7	23.3	2	6.7	16	53.3	1	3.3	3	10.0	1	3.3		
LA 39969	biface, undifferentiated	1	100.0												
	biface-early stage			2	50.0	2	50.0								
	biface-middle stage	4	44.4	1	11.1	4	44.4								
	biface-late stage	2	28.6	1	14.3	3	42.9			1	14.3				
	Total	7	33.3	4	19.0	9	42.9			1	4.8				
	biface-early stage	2	50.0							1	25.0	1	25.0		
LA 39972	biface-middle stage	1	16.7			1	16.7			4	66.7				
	biface-late stage	3	50.0	1	16.7	1	16.7			1	16.7				
LA 39972	Total	6	37.5	1	6.3	2	12.5			6	37.5	1	6.3		
LA 39975	biface, undifferentiated	2	66.7			1	33.3								
	biface-early stage	1	50.0							1	50.0				
	biface-middle stage			1	25.0	2	50.0			1	25.0				
	biface-late stage			1	50.0	1	50.0								
	Total	3	27.3	2	18.2	4	36.4			2	18.2				
LA 43766	biface, undifferentiated	11	78.6							3	21.4				
	biface-early stage	9	52.9							5	29.4	3	17.6		
	biface-middle stage	22	45.8			1	2.1	3	6.3	19	39.6	3	6.3		
	biface-late stage	22	55.0			1	2.5			16	40.0	1	2.5		
	Total	64	53.8			2	1.7	3	2.5	43	36.1	7	5.9		
LA 43786	biface-early stage									1	100.0				
	biface-late stage			1	100.0										
	Total			1	50.0					1	50.0				
LA 70188	biface, undifferentiated	29	64.4	3	6.7	6	13.3			3	6.7	4	8.9		

Component	Morphology	Material Category													
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
	biface-early stage	23	63.9	4	11.1	2	5.6			1	2.8	5	13.9	1	2.8
	biface-middle stage	38	55.9	11	16.2	5	7.4			10	14.7	4	5.9		
	biface-late stage	48	57.1	9	10.7	10	11.9			14	16.7	3	3.6		
	Total	138	59.2	27	11.6	23	9.9			28	12.0	16	6.9	1	.4
LA 70189	biface-late stage			2	100.0										
	Total			2	100.0										
LA 70191	biface, undifferentiated	1	50.0			1	50.0								
	biface-late stage	1	100.0												
	Total	2	66.7			1	33.3								
LA 70196	biface, undifferentiated					2	100.0								
	biface-early stage					3	100.0								
	biface-middle stage	2	25.0	2	25.0	2	25.0			2	25.0				
LA 70196	biface-late stage	2	15.4	1	7.7	10	76.9								
	Total	4	15.4	3	11.5	17	65.4			2	7.7				
LA 70201	biface-middle stage					1	50.0			1	50.0				
	biface-late stage					1	50.0			1	50.0				
	Total					2	50.0			2	50.0				
LA 75791	biface-middle stage	1	50.0			1	50.0								
	Total	1	50.0			1	50.0								
LA 75792	biface-early stage											1	100.0		
	biface-middle stage	1	100.0												

Component	Morphology	Material Category													
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
	biface-late stage	2	40.0			3	60.0								
	Total	3	42.9			3	42.9					1	14.3		
LA 78439	biface, undifferentiated	2	50.0			2	50.0								
	biface-early stage	1	20.0	1	20.0	3	60.0								
	biface-middle stage	2	66.7							1	33.3				
	biface-late stage									3	100.0				
	Total	5	33.3	1	6.7	5	33.3			4	26.7				

An examination of frequencies of cortex by period and component reveals differences in material acquisition patterns through time (Tables 3.38 and 3.39). Procurement of materials from gravel deposits increases through time in the Reserve assemblage. Only during the Late Pueblo period in the Luna area does there appear to be an increase in materials collected from secondary sources. The Late Archaic and Late Pithouse components in each area are different in that during those periods materials were mostly collected from drainages in the Reserve area and from local outcrops in the Luna area. The Protohistoric components are interesting in that most raw materials were collected from primary sources; secondary sources were predominantly used during other periods in the Reserve area.

The previous tables contain the entire chipped stone assemblage, which is primarily comprised of debitage. While cortical debitage may indicate procurement sources, they are a better indicator of reduction stage. Cores may be better suited for establishing the origin of a particular material type. A total of 1,259 cores was collected from our sites. Tables 3.40 and 3.41 show frequencies of cortex types on cores by material. Although both areas contain large percentages of cores collected from secondary deposits, people near Reserve were primarily collecting chert cobbles from local drainages, and people near Luna were collecting cobbles of Luna blue agate from both primary and secondary sources. Waterworn cobbles of igneous, basalt, and rhyolitic materials were more frequently selected for core reduction in the Reserve area than in the Luna area.

Tables 3.42 and 3.43 show frequencies of cores and cortex type by component in the Reserve and Luna assemblages. There is a high frequency of waterworn cores in both assemblages, and materials collected from secondary sources increase substantially through time in the Reserve area. Secondary sources dominate in the Luna area only during the Late Pueblo period.

Table 3.36. Material by Cortex Type in the Luna Assemblages; Frequencies and Row Percentages

Material	Cortex Type						Total	
	Waterworn		Nonwaterworn		Indeterminate			
	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Chert	478	72.2	113	17.1	71	10.7	662	100.0
Luna blue	1131	65.2	430	24.8	173	10.0	1734	100.0
Obsidian	186	60.8	84	27.5	36	11.8	306	100.0
Igneous	157	80.5	11	5.6	27	13.8	195	100.0
Basalt	55	74.3	8	10.8	11	14.9	74	100.0
Rhyolite	207	67.2	63	20.5	38	12.3	308	100.0
Sedimentary	21	84.0	3	12.0	1	4.0	25	100.0
Metamorphic	65	81.3	3	3.8	12	15.0	80	100.0
Total	2300	68.0	715	21.1	369	10.9	3384	100.0

Table 3.37. Material by Cortex Type in the Reserve Assemblages; Frequencies and Row Percentages

Material	Cortex Type						Total	
	Waterworn		Nonwaterworn		Indeterminate			
	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Chert	3593	79.0	534	11.7	422	9.3	4549	100.0
Luna blue	559	35.5	781	49.6	235	14.9	1575	100.0
Obsidian	142	32.5	252	57.7	43	9.8	437	100.0
Igneous	1221	90.1	52	3.8	82	6.1	1355	100.0
Basalt	360	78.4	55	12.0	44	9.6	459	100.0
Rhyolite	1243	55.3	774	34.4	230	10.2	2247	100.0
Sedimentary	55	75.3	15	20.5	3	4.1	73	100.0
Metamorphic	420	78.7	65	12.2	49	9.2	534	100.0
Total	7593	67.6	2528	22.5	1108	9.9	11,229	100.0

Table 3.38. Luna Components by Cortex Type and Period; Frequencies and Row Percentages

Period	Component	Cortex Type					
		Waterworn		Nonwaterworn		Indeterminate	
		Count	Pct	Count	Pct	Count	Pct
Late Archaic	LA 45508	121	33.1	208	56.8	37	10.1
	Total	121	33.1	208	56.8	37	10.1
Late Pithouse	LA 45507	63	34.2	102	55.4	19	10.3
	LA 45510	58	35.6	78	47.9	27	16.6
	Total	121	34.9	180	51.9	46	13.3
Late Pueblo	LA 3279	1743	80.4	236	10.9	190	8.8
	LA 70185	125	53.9	27	11.6	80	34.5
	Total	1868	77.8	263	11.0	270	11.2
Mixed	LA 89846	172	76.1	44	19.5	10	4.4
	LA 89847	18	40.9	20	45.5	6	13.6
	Total	190	70.4	64	23.7	16	5.9

Table 3.39. Reserve Components by Cortex Type and Period; Frequencies and Row Percentages

Period	Component	Cortex Type					
		Waterworn		Nonwaterworn		Indeterminate	
		Count	Pct	Count	Pct	Count	Pct
Late Archaic	LA 43766	320	90.7	7	2.0	26	7.4
	LA 70188	270	48.7	175	31.6	109	19.7
	LA 78439	52	22.7	165	72.1	12	5.2
	Total	642	56.5	347	30.5	147	12.9
Early Pithouse	LA 39972	198	97.5	5	2.5		
	LA 39975	410	51.5	284	35.7	102	12.8
	Total	608	60.9	289	28.9	102	10.2
Late Pithouse	LA 43786	10	21.7	35	76.1	1	2.2
	LA 70196	232	60.9	96	25.2	53	13.9
	Total	242	56.7	131	30.7	54	12.6
Pithouse	LA 70201	240	89.9	5	1.9	22	8.2
	Total	240	89.9	5	1.9	22	8.2
Early Pueblo	LA 3563	382	44.3	394	45.7	86	10.0
	LA 39969	1606	92.9	36	2.1	87	5.0
	LA 39972	393	98.7	5	1.3		
	LA 75792	245	56.8	137	31.8	49	11.4
	Total	2626	76.8	572	16.7	222	6.5
Late Pueblo	LA 9721			12	92.3	1	7.7
	LA 39968	1383	82.3	163	9.7	134	8.0
	Total	1383	81.7	175	10.3	135	8.0
Protohistoric	LA 37917	69	22.8	229	75.8	4	1.3
	LA 37919	66	25.5	185	71.4	8	3.1
	Total	135	24.1	414	73.8	12	2.1
Mixed	LA 43766	793	91.4	8	.9	67	7.7
	LA 70188	746	49.8	428	28.6	324	21.6
	LA 70189	58	50.0	50	43.1	8	6.9
	LA 70191	40	62.5	19	29.7	5	7.8
	LA 75791	45	60.8	22	29.7	7	9.5
	LA 78439	35	33.0	68	64.2	3	2.8
	Total	1717	63.0	595	21.8	414	15.2

Table 3.40. Core Cortex by Material Category in the Luna Components; Frequencies and Row Percentages

Morphology	Cortex Type	Material Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Tested Cobble	Waterworn	7	58.3	5	41.7												
	Nonwaterworn	3	50.0	2	33.3	1	16.7										
	Indeterminate											1	100.0				
	Total	10	52.6	7	36.8	1	5.3					1	5.3				
Undifferentiated	Waterworn	2	25.0	3	37.5			1	12.5			2	25.0				
	Nonwaterworn	3	17.6	8	47.1			1	5.9	1	5.9	3	17.6			1	5.9
	Indeterminate	1	9.1	8	72.7											2	18.2
	Total	6	16.7	19	52.8			2	5.6	1	2.8	5	13.9			3	8.3
Unidirectional	Waterworn			3	33.3			1	11.1			4	44.4			1	11.1
	Nonwaterworn			3	100.0												
	Indeterminate							1	100.0								
	Total			6	46.2			2	15.4			4	30.8			1	7.7
Bidirectional	Waterworn			5	62.5			1	12.5			2	25.0				
	Nonwaterworn			3	50.0	2	33.3					1	16.7				
	Total			8	57.1	2	14.3	1	7.1			3	21.4				
Multidirectional	Waterworn	28	14.0	92	46.0	2	1.0	27	13.5	5	2.5	34	17.0	2	1.0	10	5.0
	Nonwaterworn	4	9.8	30	73.2	1	2.4	2	4.9	1	2.4	3	7.3				
	Indeterminate	3	18.8	8	50.0			1	6.3			3	18.8			1	6.3
	Total	35	13.6	130	50.6	3	1.2	30	11.7	6	2.3	40	15.6	2	.8	11	4.3
Bipolar	Waterworn	1	100.0														
	Total	1	100.0														

Table 3.41. Core Cortex by Material Category in the Reserve Components; Frequencies and Row Percentages

Morphology	Cortex Type	Material Category															
		Chert		Luna Blue		Obsidian		Igneous		Basalt		Rhyolite		Sedimentary		Metamorphic	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Tested Cobble	Waterworn	28	53.8	5	9.6	1	1.9	7	13.5	3	5.8	3	5.8	1	1.9	4	7.7
	Nonwaterworn	6	26.1	14	60.9			1	4.3			2	8.7				
	Indeterminate	1	100.0														
	Total	35	46.1	19	25.0	1	1.3	8	10.5	3	3.9	5	6.6	1	1.3	4	5.3
Undifferentiated	Waterworn	11	57.9					3	15.8	2	10.5	1	5.3			2	10.5
	Nonwaterworn	6	27.3	10	45.5			2	9.1	1	4.5	3	13.6				
	Indeterminate	1	50.0	1	50.0												
	Total	18	41.9	11	25.6			5	11.6	3	7.0	4	9.3			2	4.7
Unidirectional	Waterworn	13	28.3	5	10.9			8	17.4	3	6.5	11	23.9			6	13.0
	Nonwaterworn	6	33.3	5	27.8			3	16.7			3	16.7			1	5.6
	Indeterminate							1	25.0			3	75.0				
	Total	19	27.9	10	14.7			12	17.6	3	4.4	17	25.0			7	10.3
Bidirectional	Waterworn	14	34.1	5	12.2			6	14.6	1	2.4	11	26.8	2	4.9	2	4.9
	Nonwaterworn	1	6.3	5	31.3			2	12.5			7	43.8			1	6.3
	Indeterminate			1	33.3							2	66.7				
	Total	15	25.0	11	18.3			8	13.3	1	1.7	20	33.3	2	3.3	3	5.0
Multidirectional	Waterworn	106	36.3	20	6.8			77	26.4	15	5.1	48	16.4	5	1.7	21	7.2
	Nonwaterworn	21	22.3	37	39.4			1	1.1	4	4.3	25	26.6			6	6.4
	Indeterminate	4	33.3	2	16.7					2	16.7	3	25.0			1	8.3
	Total	131	32.9	59	14.8			78	19.6	21	5.3	76	19.1	5	1.3	28	7.0

Table 3.42. Cortex Type by Core Type for the Luna Components; Frequencies and Row Percentages

Period	Cortex Type	Artifact Morphology											
		Tested Cobble		Undifferentiated		Unidirectional		Bidirectional		Multidirectional		Bipolar	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Archaic	Waterworn	3	60.0					1	20.0	1	20.0		
	Nonwaterworn	1	5.3	2	10.5			5	26.3	11	57.9		
	Indeterminate			1	50.0					1	50.0		
	Total	4	15.4	3	11.5			6	23.1	13	50.0		
Late Pithouse	Waterworn			7	53.8					6	46.2		
	Nonwaterworn	1	5.0	14	70.0					5	25.0		
	Indeterminate			10	90.9					1	9.1		
	Total	1	2.3	31	70.5					12	27.3		
Late Pueblo	Waterworn	9	4.1	1	.5	9	4.1	7	3.2	191	87.6	1	.5
	Nonwaterworn	3	9.4	1	3.1	3	9.4	1	3.1	24	75.0		
	Indeterminate	1	6.3			1	6.3			14	87.5		
	Total	13	4.9	2	.8	13	4.9	8	3.0	229	86.1	1	.4
Mixed	Waterworn									2	100.0		
	Nonwaterworn	1	50.0							1	50.0		
	Total	1	25.0							3	75.0		

Table 3.43. Cortex Type by Core Type for Reserve Components; Frequencies and Row Percentages

Period	Cortex Type	Artifact Morphology									
		Tested Cobble		Undiffernitated		Unidirectional		Bidirectional		Multidirectional	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Archaic	Waterworn	1	7.1	4	28.6	3	21.4			6	42.9
	Nonwaterworn	1	4.0	8	32.0	2	8.0	1	4.0	13	52.0
	Indeterminate									1	100.0
	Total	2	5.0	12	30.0	5	12.5	1	2.5	20	50.0
Early Pithouse	Waterworn	7	14.0	1	2.0	8	16.0	12	24.0	22	44.0
	Nonwaterworn	7	22.6	1	3.2	4	12.9	6	19.4	13	41.9
	Indeterminate					2	100.0				
	Total	14	16.9	2	2.4	14	16.9	18	21.7	35	42.2
Late Pithouse	Waterworn	2	22.2			1	11.1			6	66.7
	Nonwaterworn					1	33.3			2	66.7
	Total	2	16.7			2	16.7			8	66.7
Pithouse	Waterworn	2	11.1			3	16.7	3	16.7	10	55.6
	Total	2	11.1			3	16.7	3	16.7	10	55.6
Early Pueblo	Waterworn	13	8.2	8	5.0	15	9.4	12	2.5	111	69.8
	Nonwaterworn	3	9.7			2	6.5	4	12.9	22	71.0
	Indeterminate	1	11.1			2	22.2	3	33.3	3	33.3
	Total	17	9.2	8	4.3	16	8.6	19	10.3	125	67.6
Late Pueblo	Waterworn	21	16.7	3	2.4	8	6.3	4	3.2	90	71.4
	Nonwaterworn	1	5.6	1	5.6	1	5.6			15	83.3
	Indeterminate			1	12.5					7	87.5
	Total	22	14.5	5	3.3	9	5.9	4	2.6	112	73.7

Period	Cortex Type	Artifact Morphology									
		Tested Cobble		Undiffernțiated		Unidirectional		Bidirectional		Multidirectional	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Protohistoric	Waterworn							1	20.0	4	80.0
	Nonwaterworn	5	41.7	4	33.3	2	16.7	1	8.3		
	Indeterminate			1	100.0						
	Total	5	27.8	5	27.8	2	11.1	2	11.1	4	22.2
Mixed	Waterworn	6	8.7	3	4.3	8	11.6	9	13.0	43	62.3
	Nonwaterworn	6	11.3	8	15.1	6	11.3	4	7.6	29	54.7
	Indeterminate									1	100.0
	Total	12	9.8	11	9.0	14	11.5	13	10.7	72	59.0

Table 3.44. Material Category by Texture for the Reserve Components; Frequencies and Row Percentages

Material Category	Texture								Total	
	Glassy		Fine-Grained		Medium-Grained		Coarse-Grained			
	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Chert			13,931	79.3	3447	19.6	181	1.0	17,559	100.0
Luna blue			6585	94.7	372	5.3			6957	100.0
Obsidian	1012	100.0							1012	100.0
Igneous			1444	57.1	1034	40.9	53	2.1	2531	100.0
Basalt			3483	77.8	983	21.9	13	.3	4479	100.0
Rhyolite			3072	52.6	2109	36.1	663	11.3	5844	100.0
Sedimentary			61	38.6	93	58.9	4	2.5	158	100.0
Metamorphic			515	46.8	534	48.5	52	4.7	1101	100.0
Total	1012	2.6	29091	73.4	8572	21.6	966	2.4	39,641	100.0

Table 3.45. Material Category by Texture for the Luna Components; Frequencies and Row Percentages

Material Category	Texture								Total	
	Glassy		Fine-Grained		Medium-Grained		Coarse-Grained			
	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Chert			3814	90.1	415	9.8	3	.1	4232	100.0
Luna blue			15,463	99.7	48	.3			15,511	100.0
Obsidian	847	100.0							847	100.0
Igneous			372	54.8	292	43.0	15	2.2	679	100.0
Basalt			196	67.8	90	31.1	3	1.0	289	100.0
Rhyolite			679	48.3	699	49.8	27	1.9	1405	100.0
Sedimentary			38	55.1	31	44.9			69	100.0
Metamorphic			252	55.0	193	42.1	13	2.8	458	100.0
Total	847	3.6	20,814	88.6	1768	7.5	61	.3	23,490	100.0

Table 3.46. Material Texture by Debitage Type for Each Period Represented in the Luna Assemblages; Frequencies and Row Percentages

Period	Debitage Type	Texture							
		Glassy		Fine-Grained		Medium-Grained		Coarse-Grained	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Archaic	Angular Debris	7	1.5	445	94.9	17	3.6		
	Core Flake	32	2.5	1181	91.3	70	5.4	11	.9
	Biface Flake	37	5.6	612	92.6	12	1.8		
	Total	76	3.1	2238	92.3	99	4.1	11	.5
Late Pithouse	Angular Debris	15	1.7	735	83.7	122	13.9	6	.7
	Core Flake	89	4.1	1811	82.9	270	12.4	15	.7
	Biface Flake	53	24.2	159	72.6	7	3.2		
	Total	157	4.8	2705	82.4	399	12.2	21	.6
Late Pueblo	Angular Debris	82	1.2	6316	95.8	192	2.9	2	.0
	Core Flake	296	3.6	7176	86.1	839	10.1	20	.2
	Biface Flake	29	7.6	342	89.1	12	3.1	1	.3
	Total	407	2.7	13834	90.4	1043	6.8	23	.2
Mixed	Angular Debris	4	.6	667	93.2	45	6.3		
	Core Flake	25	3.4	633	85.1	85	11.4	1	.1
	Biface Flake	1	6.7	13	86.7	1	6.7		
	Total	30	2.0	1313	89.0	131	8.9	1	.1

Table 3.47. Material Texture by Debitage Type for Each Period Represented in the Reserve Assemblages; Frequencies and Row Percentages

Period	Debitage Type	Texture							
		Glassy		Fine-Grained		Medium-Grained		Coarse-Grained	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Archaic	Angular Debris	12	1.0	974	77.8	245	19.6	21	1.7
	Core Flake	108	2.4	3195	71.9	1090	24.5	50	1.1
	Biface Flake	48	2.7	1521	85.2	215	12.0	2	.1
	Total	168	2.2	5690	76.1	1550	20.7	73	1.0
Early Pithouse	Angular Debris	6	1.4	364	87.7	41	9.9	4	1.0
	Core Flake	33	2.2	956	64.0	408	27.3	96	6.4
	Biface Flake	6	8.1	51	68.9	14	18.9	3	4.1
	Total	45	2.3	1371	69.2	463	23.4	103	5.2

Period	Debitage Type	Texture							
		Glassy		Fine-Grained		Medium-Grained		Coarse-Grained	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Pithouse	Angular Debris	2	2.3	62	72.1	19	22.1	3	3.5
	Core Flake	64	8.9	452	62.5	158	21.9	49	6.8
	Biface Flake	85	89.5	8	8.4	2	2.1		
	Total	151	16.7	522	57.7	179	19.8	52	5.8
Pithouse	Angular Debris	1	3.7	13	48.1	10	37.0	3	11.1
	Core Flake	3	.6	204	42.2	175	36.2	101	20.9
	Biface Flake	6	50.0	4	33.3	2	16.7		
	Total	10	1.9	221	42.3	187	35.8	104	19.9
Early Pueblo	Angular Debris	22	1.7	861	65.5	400	30.4	31	2.4
	Core Flake	82	1.7	2931	60.8	1514	31.4	294	6.1
	Biface Flake	10	9.1	79	71.8	13	11.8	8	7.3
	Total	114	1.8	3871	62.0	1927	30.9	333	5.3
Late Pueblo	Angular Debris	18	1.2	1204	80.3	264	17.6	14	.9
	Core Flake	25	1.0	1799	70.4	690	27.0	42	1.6
	Biface Flake	5	16.1	22	71.0	3	9.7	1	3.2
	Total	48	1.2	3025	74.0	957	23.4	57	1.4
Protohistoric	Angular Debris	10	4.2	153	63.8	72	30.0	5	2.1
	Core Flake	111	10.7	581	55.8	318	30.5	32	3.1
	Biface Flake	20	45.5	20	45.5	4	9.1		
	Total	141	10.6	754	56.9	394	29.7	37	2.8
Mixed	Angular Debris	12	.4	2434	83.0	466	15.9	21	.7
	Core Flake	127	1.5	6542	76.0	1797	15.1	144	1.7
	Biface Flake	99	2.4	3756	89.5	333	7.9	9	.2
	Total	238	1.5	12732	80.1	2596	16.5	174	1.1

Table 3.48. Utilized Debitage by Material Texture for the Luna Components; Frequencies and Row Percentages

Morphology	Texture								Total	
	Glassy		Fine-Grained		Medium-Grained		Coarse-Grained			
	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Angular Debris	5	7.9	57	90.5	1	1.6			63	100.0
Core Flake	67	14.0	375	78.6	33	6.9	2	.4	477	100.0
Biface Flake	15	16.0	75	79.8	4	4.3			94	100.0
Total	87	13.7	507	80.0	38	6.0	2	.3	634	100.0

Table 3.49. Utilized Debitage by Material Texture for the Reserve Components; Frequencies and Row Percentages

Morphology	Texture								Total	
	Glassy		Fine-Grained		Medium-Grained		Coarse-Grained			
	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Angular Debris	9	8.5	83	78.3	13	12.3	1	.9	106	100.0
Core Flake	133	8.7	1081	71.0	264	17.3	44	2.9	1522	100.0
Biface Flake	60	24.1	176	70.7	13	5.2			249	100.0
Total	202	10.8	1340	71.4	290	15.5	45	2.4	1877	100.0

Table 3.50. Utilized Debitage by Material Texture for Periods Represented in the Luna Assemblage; Frequencies and Row Percentages

Period	Morphology	Texture							
		Glassy		Fine-Grained		Medium-Grained		Coarse-Grained	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Archaic	Angular Debris			11	100.0				
	Core Flake	7	7.6	81	88.0	4	4.3		
	Biface Flake	2	5.6	33	91.7	1	2.8		
	Resharpening Flake			1	100.0				
	Total	9	6.4	126	90.0	5	3.6		
Late Pithouse	Angular Debris	2	14.3	11	78.6	1	7.1		
	Core Flake	28	20.0	104	74.3	7	5.0	1	.7
	Biface Flake	10	35.7	17	60.7	1	3.6		
	Total	40	22.0	132	72.5	9	4.9	1	.5
Late Pueblo	Angular Debris	3	9.4	29	90.6				
	Core Flake	28	12.4	178	79.1	18	8.0	1	.4
	Biface Flake	3	10.3	24	82.8	2	6.9		
	Bipolar flake			1	100.0				
	Total	34	11.8	232	80.8	20	7.0	1	.3
Mixed	Angular Debris			3	100.0				
	Core Flake	3	16.7	11	61.1	4	22.2		
	Total	3	14.3	14	66.7	4	19.0		

Table 3.51. Utilized Debitage by Material Texture for Periods Represented in the Reserve Assemblage; Frequencies and Row Percentages

Period	Morphology	Texture							
		Glassy		Fine-Grained		Medium-Grained		Coarse-Grained	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Archaic	Angular Debris	3	33.3	6	66.7				
	Core Flake	30	17.1	115	65.7	28	16.0	2	1.1
	Biface Flake	11	19.3	42	73.7	4	7.0		
	Total	44	18.3	163	67.6	32	13.3	2	.8
Early Pithouse	Angular Debris			7	77.8	1	11.1	1	11.1
	Core Flake	5	3.2	98	63.2	42	27.1	10	6.5
	Biface Flake	3	33.3	5	55.6	1	11.1		
	Total	8	4.6	110	63.6	44	25.4	11	6.4
Late Pithouse	Angular Debris			3	100.0				
	Core Flake	14	17.1	61	74.4	5	6.1	2	2.4
	Biface Flake	11	91.7	1	8.3				
	Total	25	25.8	65	67.0	5	5.2	2	2.1
Pithouse	Angular Debris	1	100.0						
	Core Flake	1	1.6	38	62.3	18	29.5	4	6.6
	Biface Flake	4	66.7	2	33.3				
	Total	6	8.8	40	58.8	18	26.5	4	5.9
Early Pueblo	Indeterminate					1	100.0		
	Angular Debris	3	14.3	11	52.4	7	33.3		
	Core Flake	23	5.3	316	73.0	81	18.7	13	3.0
	Biface Flake	5	35.7	8	57.1	1	7.1		
	Total	31	6.6	335	71.6	89	19.0	13	2.8
Late Pueblo	Angular Debris	1	7.1	13	92.9				
	Core Flake	4	4.9	63	76.8	13	15.9	2	2.4
	Biface Flake			1	100.0				
	Bipolar flake			2	100.0				
	Total	5	5.1	79	79.8	13	13.1	2	2.0
Protohistoric	Angular Debris	1	12.5	7	87.5				
	Core Flake	33	24.4	66	48.9	30	22.2	6	4.4
	Biface Flake	9	69.2	2	15.4	2	15.4		
	Total	43	27.6	75	48.1	32	20.5	6	3.8

Period	Morphology	Texture							
		Glassy		Fine-Grained		Medium-Grained		Coarse-Grained	
		Count	Pct	Count	Pct	Count	Pct	Count	Pct
Mixed	Angular Debris			35	89.7	4	14.3		
	Core Flake	18	4.8	305	81.8	45	12.1	5	1.3
	Biface Flake	16	12.4	108	83.7	5	3.9		
	Bipolar flake					1	100.0		
	Total	34	6.3	448	82.7	55	10.2	5	.9

Table 3.52. Morphology by Material Texture for Formal Tools in the Luna Assemblage; Frequencies and Row Percentages

Morphology	Texture						Total	
	Glassy		Fine-Grained		Medium-Grained			
	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Uniface, undifferentiated			1	100.0			1	100.0
Uniface-late stage	1	33.3	2	66.7			3	100.0
Biface, undifferentiated	16	25.8	46	74.2			62	100.0
Biface-early stage	22	20.8	83	78.3	1	.9	106	100.0
Biface-middle stage	49	45.0	60	55.0			109	100.0
Biface-late stage	75	51.4	69	47.3	2	1.4	146	100.0
Reworked middle stage biface	1	100.0					1	100.0
Reworked late stage biface	1	25.0	3	75.0			4	100.0
TOTAL	165	38.2	264	61.1	3	.7	432	100.0

Table 3.53. Morphology by Material Texture for Formal Tools in the Reserve Assemblage; Frequencies and Row Percentages

Morphology	Texture								Total	
	Glassy		Fine-Grained		Medium-Grained		Coarse-Grained			
	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Uniface, undifferentiated	1	12.5	5	62.5	2	25.0			8	100.0
Uniface-early stage			6	42.9	8	57.1			14	100.0
Uniface-middle stage			2	100.0					2	100.0
Uniface-late stage			1	100.0					1	100.0
Biface, undifferentiated	15	19.5	57	74.0	5	6.5			77	100.0

Morphology	Texture								Total	
	Glassy		Fine-Grained		Medium-Grained		Coarse-Grained			
	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Biface-early stage	13	15.5	62	73.8	8	9.5	1	1.2	84	100.0
Biface-middle stage	25	15.2	129	78.2	11	6.7			165	100.0
Biface-late stage	38	20.2	137	72.9	13	6.9			188	100.0
Reworked tool, undifferentiated					1	100.0			1	100.0
Reworked early stage biface	1	50.0			1	50.0			2	100.0
Reworked middle stage biface	1	33.3	2	66.7					3	100.0
Reworked late stage biface	1	25.0	3	75.0					4	100.0
TOTAL	95	17.3	404	73.6	49	8.9	1	.2	549	100.0

Material Texture

Materials fracture differently depending on mineral composition, grain size, and natural flaws; thus, physical characteristics (texture) of material types determine their suitability for specific tasks (Chapman and Schutt 1977; Elyea and Eschman 1985a). Fine-grained or glassy materials were frequently selected for the production of formal tools because their composition allows predictable fracturing. Cherts, chalcedonies, and obsidians are well suited to the production of formal tools in which a sharp and efficient edge is needed; however, fine-grained basalt and rhyolite are also amenable to the production of a sharp-edged tool. Although fine-grained or glassy materials are often quite brittle, they can be predictably worked and are well suited to the production of both formal and informal tools requiring sharp edges for cutting and scraping activities. Medium and coarse-grained materials (quartzites, rhyolite, etc.) are less well suited to delicate shaping (such as biface production) or tasks requiring sharp edges. More frequently they were used when a durable cutting or scraping edge was required for tasks like chopping, battering, or grinding.

The material quality and texture of each artifact was recorded during analysis and grouped under one of four categories: glassy, fine grained, medium grained, and coarse grained. Obsidian is the only material included in the glassy category. Frequencies of material type by texture for the Reserve and Luna areas are shown in Tables 3.44 and 3.45. Fine-grained materials were used in high percentages in both assemblages. Medium-grained materials were used to some extent in the Luna area; however, medium-grained materials, especially chert, were more commonly used in the Reserve area, as were coarse-grained materials. Luna blue agate is a fine-grained, cryptocrystalline material, and artifacts of this material that fell into the medium-grained category most likely contain visible quartz crystals.

Tables 3.46 and 3.47 illustrate debitage frequency by material texture for components from the Luna and Reserve areas. Fine-grained materials were more often used in the Luna area than in the Reserve area, while medium- and coarse-grained materials occur in much higher frequencies in the Reserve area in all time periods. Because Luna blue agate was easily acquired, it dominates the fine-grained assemblage in the Luna area. Frequent use of glassy materials was sporadic throughout time in both assemblages. However, these materials comprise a greater portion of debitage in the Late Pithouse and protohistoric components in the Reserve assemblage, and during the Late Pithouse period in the Luna assemblage.

The selection of materials for production of formal and informal tools depends on accessibility, fracturing qualities, and the use for which a tool is intended. Tables 3.48 through 3.53 show the combined frequencies of utilized debitage (informal tools) and formal tools by material texture in both areas. Although some medium-grained materials were utilized, glassy and fine-grained materials were predominantly selected for informal tool use at the Luna sites, suggesting that the tasks for which they were used required sharp edges. Materials selected for use at the Reserve sites were mostly fine grained and medium grained. Coarse-grained materials were rarely selected for use in either area. Tables 3.50 and 3.51 show utilized debitage and component by material texture. Fine-grained materials were primarily selected for informal tool use throughout time in each area. Glassy materials were used more frequently in Reserve area components except during the Late Pueblo period. Higher percentages of medium-grained materials were used throughout the temporal sequence in the Reserve area.

While glassy and fine-grained materials were primarily selected for the manufacture of unifacial and bifacial tools in the both areas, medium-grained materials were more commonly used for formal tools in the Reserve area, and glassy materials were more frequently used in the Luna area (Tables 3.52 and 3.53). Many of the glassy bifaces in the Luna assemblages are small projectile points, suggesting that this texture was selected for its workability. Many formal tools in the Reserve area are made from cherts and basalts, materials that are not as abundant in the Luna area.

Thermal Alteration

Thermal alteration is used to improve the fracture qualities of siliceous materials, more specifically cherts. When properly applied, heat can alter the microcrystalline structure of chert and improve its fracturing quality. Water loss from free pores and cracks is incurred during a slow heating process, and microcrystals begin to fuse. This can create a more homogeneous texture as the material slowly cools (Luedtke 1992). Cherts and chalcedonies are often difficult to work in their raw state; however, proper heat treatment can improve their pressure flaking qualities (Crabtree and Butler 1964).

Experimental studies on the effects of heat treatment have centered on temperature variation and material size in an effort to determine temperature ranges that will improve the fracturing qualities of certain siliceous materials. Crabtree and Butler (1964) were the first of a number of researchers to monitor temperature, treatment time, and material size during experimental studies of thermal alteration. Raw materials were subjected to temperatures of 204, 487, and 593 degrees C for 24, 36, and 72 hours. They found that materials were more easily worked after heating; however, experiments also showed that sudden fluctuations in temperature can cause crazing, spalls (potlids), and cracks. Material size is also an important factor; flakes and bifaces are more amenable to correct thermal alteration than are cores or nodules because they can be heated more evenly.

Flenniken and Garrison (1975) performed a series of experiments on thermally altered novaculite (a light colored siliceous rock) from Arkansas. They heated a number of projectile point blanks at temperatures of less than 216 degrees C and more than 216 and 288 degrees C for 48 hours (heating and cooling time). The results of their experiments were similar to Crabtree and Butler's (1964) in that temperature fluctuations caused crazing and potlids, there was a decrease in the force needed to flake thermally treated materials, and there was better control over the manufacturing process. Their results showed that the energy applied to stone during reduction is more evenly dissipated over a longer distance due to the homogeneous texture of the fused microcrystalline material structure. Longer and wider flakes could be removed from material heated above 232 degrees C with fewer step and hinge fractures than similar materials heated below 232 degrees C. Replication studies by Bleed and Meier (1980) on heated and nonheated chert tiles had similar results, and heated materials in their experiment produced more flakes than nonheated materials.

Heat-treated artifacts often exhibit color change, potlids, crazing, and sooting. When properly heated, cherts often darken or become pink or red as iron compounds oxidize. Translucent materials become less so, and nearly all become more glossy (waxy). Within the study area, thermally altered artifacts of Luna blue agate grade in color from glossy white to pink and orange. Internal fractures, crazing, and potlids are often the result of mistakes during the heating process. Cherts and chalcedonies that are fire-cracked from incidental heating show signs of sooting, cracks, potlids, and the material becomes white and brittle (Luedtke 1992).

Thermal alteration data in both the Luna and Reserve areas are shown in Table 3.54. Color change is usually indicative of successful heat treatment, while materials that are crazed or have potlids underwent fluctuations in temperature and were unsuccessfully altered. Sooted materials display the effects of incidental thermal alteration in the form of smoke blackening, spalls on all surfaces, and a friable texture. Materials other than chert and Luna blue agate in these assemblages are not amenable to successful thermal alteration. Examples that are thermally altered are considered evidence of incidental heating.

Cherts were more frequently heat treated in the Reserve assemblage, while Luna blue agate was the predominant material subjected to thermal alteration in the Luna assemblage. Many pieces of this material were crazed, charred, or exhibited potlids. Luna blue agate is extremely tough to break when it is in cobble form. Smashing cobbles of this material against a rock is one way to break it up; however, another potential method would be to fracture cobbles by heat treatment and select useable fragments (Luedtke 1992). If this occurred, it may explain why so much of the Luna blue agate was unsuccessfully heat treated.

Whole flakes with potlids on dorsal surfaces may be the by-products of intentional thermal alteration and were treated as such during analysis. Most occurred in two Late Archaic components (LA 70188 and LA 45508) and one Early Pithouse component (LA 39975). Table 3.55 suggests that artifacts which spalled during heating may have remained useful and were sometimes further reduced as cores or bifaces. This is especially true of thermally altered artifacts in the LA 70188 assemblage.

Table 3.56 shows thermal alteration across time by site. While more specimens of chert and Luna blue agate exhibit evidence of thermal alteration in the Late Archaic and Late Pueblo components, successful heat treatment was most common in the Late Pithouse and Late Pueblo periods. The mixed component of LA 70188 contains a large number of thermally altered artifacts that can most likely be attributed to the Late Archaic occupation. Although the Late Archaic assemblages do not contain a large percentage of artifacts that were successfully heat treated, they contain many large generalized bifaces and dart points made of chert, and thermal alteration would have made them easier to work. Most of the heat-treated material is Luna blue agate, as are all but 29 of the successfully treated artifacts. As stated earlier, this material is difficult to work in its natural form and thermal alteration would have improved its fracturing qualities.

Table 3.54. Thermal Alteration Category by Material Category for Both Study Areas; Frequencies and Row Percentages

Area	Material Category	Thermal Alteration Category					
		Successful		Unsuccessful		Incidental	
		Count	Pct	Count	Pct	Count	Pct
Luna	Chert	5	.8	538	83.4	102	15.8
	Luna Blue	377	13.8	2017	73.9	335	12.3
	Obsidian					3	100.0
	Igneous					14	100.0
	Basalt					7	100.0
	Rhyolite					113	100.0
	Sedimentary					2	100.0
	Metamorphic					7	100.0
	Total	382	10.9	2555	72.6	583	16.6
Reserve	Chert	24	1.5	1527	96.3	34	2.1
	Luna Blue	128	10.2	1118	88.9	11	.9
	Obsidian					5	100.0
	Igneous					9	100.0
	Basalt					11	100.0
	Rhyolite					236	100.0
	Sedimentary					5	100.0
	Metamorphic					13	100.0
	Total	152	4.9	2645	84.7	324	10.4

Table 3.55. Whole Flakes with Dorsal Potlid Fractures by Component; Frequencies and Row Percentages

Location	Component	Morphology	Count	Percent
Luna	LA 3279	Core Flake	6	3.2
	LA 45507	Core Flake	4	2.1
	LA 45508	Core Flake	15	8.0
		Biface Flake	9	4.8
	LA 45510	Core Flake	3	1.6
		Biface Flake	1	.5
	LA 70185	Core Flake	5	2.7
Reserve	LA 3563	Core Flake	2	1.1
		Biface Flake	1	.5
	LA 37917	Core Flake	6	3.2
	LA 37919	Core Flake	7	3.7
	LA 39968	Core Flake	6	3.2
	LA 39969	Core Flake	2	1.1
	LA 39972	Core Flake	4	2.1
		Biface Flake	1	.5
	LA 39975	Core Flake	15	8.0
	LA 43766	Core Flake	4	2.1
		Biface Flake	2	1.1
	LA 70188	Core Flake	61	32.4
		Biface Flake	19	10.1
	LA 70189	Core Flake	1	.5
	LA 70191	Core Flake	1	.5
	LA 70196	Core Flake	4	2.1
	LA 70201	Core Flake	2	1.1
	LA 75791	Core Flake	1	.5
	LA 75792	Core Flake	2	1.1
	LA 78439	Core Flake	4	2.1

Table 3.56. Thermal Alteration Category by Components for All Time Periods; Frequencies and Row Percentages

Period	Component	Thermal Alteration Category					
		Successful		Unsuccessful		Incidental	
		Count	Pct	Count	Pct	Count	Pct
Late Archaic	LA 43766			61	95.3	3	4.7
	LA 45508	26	3.9	559	82.8	90	13.3

Period	Component	Thermal Alteration Category					
		Successful		Unsuccessful		Incidental	
		Count	Pct	Count	Pct	Count	Pct
	LA 70188	10	1.8	523	93.4	27	4.8
	LA 78439			35	92.1	3	7.9
	Total	36	2.7	1178	88.1	123	9.2
Early Pithouse	LA 39972			51	96.2	2	3.8
	LA 39975	2	1.7	96	81.4	20	16.9
	Total	2	1.2	147	86.0	22	12.9
Late Pithouse	LA 43786			4	100.0		
	LA 45507	1	.5	93	45.6	110	53.9
	LA 45510	73	21.3	141	41.1	129	37.6
	LA 70196	3	4.7	24	37.5	37	57.8
	Total	77	12.5	262	42.6	276	44.9
Pithouse	LA 70201	1	5.9	4	23.5	12	70.6
	Total	1	5.9	4	23.5	12	70.6
Early Pueblo	LA 3563	5	5.7	18	20.7	64	73.6
	LA 39969	2	4.5	32	72.7	10	22.7
	LA 39972	1	3.1	28	87.5	3	9.4
	LA 75792			12	41.4	17	58.6
	Total	8	4.2	90	46.9	94	49.0
Late Pueblo	LA 3279	196	10.4	1486	79.2	194	10.3
	LA 9721					1	100.0
	LA 39968	44	19.3	140	61.4	44	19.3
	LA 70185	69	35.2	76	38.8	51	26.0
	Total	309	13.4	1702	74.0	290	12.6
Protohistoric	LA 37917	12	14.5	59	71.1	12	14.5
	LA 37919	2	2.1	83	86.5	11	11.5
	Total	14	7.8	142	79.3	23	12.8
Mixed	LA 43766			107	99.1	1	.9
	LA 70188	59	4.2	1300	92.3	49	3.5
	LA 70189	10	21.3	33	70.2	4	8.5
	LA 70191			12	92.3	1	7.7
	LA 75791			8	80.0	2	20.0
	LA 78439	1	5.9	15	88.2	1	5.9
	LA 89846	10	5.8	156	90.2	7	4.0
	LA 89847	7	13.2	44	83.0	2	3.8
	Total	87	4.8	1675	91.6	67	3.7

Table 3.57. Projectile Points by Material Texture for Time Periods Represented in the Luna Area; Frequencies and Row Percentages

Period	Material Texture					
	Glassy		Fine-Grained		Medium-Grained	
	Count	Pct	Count	Pct	Count	Pct
Late Archaic	5	27.8	12	66.7	1	5.6
Late Pithouse	36	87.8	5	12.2		
Late Pueblo	80	55.2	65	44.8		
Mixed	2	40.0	3	60.0		

Table 3.58. Projectile Points by Material Texture for Time Periods Represented in the Reserve Area; Frequencies and Row Percentages

Period	Material Texture					
	Glassy		Fine-Grained		Medium-Grained	
	Count	Pct	Count	Pct	Count	Pct
Late Archaic	3	6.5	43	93.5		
Early Pithouse	3	25.0	9	75.0		
Late Pithouse	13	68.4	6	31.6		
Pithouse	2	50.0	2	50.0		
Early Pueblo	15	62.5	6	25.0	3	12.5
Late Pueblo	9	60.0	6	40.0		
Protohistoric	1	12.5	7	87.5		
Mixed	13	10.5	104	83.9	7	5.7

Discussion

In general, the data reflect an overwhelming use of cherts and Luna blue agate for chipped stone reduction. Cherts are more abundant in drainages near Reserve and were the dominant materials used in that area in all but the Late Pithouse period. Luna blue agate, which is more common near Luna, dominated on the Luna sites in all time periods.

Distinct temporal affiliations can be seen in the selection and use of two material types in the Reserve assemblages—chert and basalt. Chert was more frequently selected for use in the Late Archaic components of two sites (LA 70188 and LA 43766), and in a protohistoric assemblage (LA 37919). Although cherts were used in all time periods, there seems to be a dramatic decrease in use between the Late Archaic and protohistoric periods (Table 3.29). Basalt was most common in the Reserve assemblages and decreased in use through time. Basalt was heavily used in the Archaic component on LA 43766 for the manufacture of projectile points and bifaces, and to a lesser extent for the manufacture of bifaces and projectile points in the Archaic component at LA 70188. The heaviest use of other igneous materials occurred during the Early Pueblo period, though rhyolite was extensively used from the Early Pithouse through the Early Pueblo period. Both materials can be found in great quantities in drainages near Reserve, and were used much more frequently there than in the Luna area.

Obsidian is the only exotic material identified in these assemblages and was predominately acquired from the Mule Creek-Cow Canyon area. The use of obsidian was sporadic across time periods, but it was commonly used for the manufacture of small bifaces and arrow points from the Early Pithouse through Late Pueblo periods.

Cortical studies revealed several differences in material acquisition patterns through time and between areas. Luna blue agate was more often collected from primary sources in the Reserve area than in the Luna area. This contradicts our material source studies in that we found more outcrops of Luna blue agate near Luna, and most examples in the Reserve area were found in drainages. The only period in which Luna blue agate was predominantly obtained from primary sources in the Reserve area was during the protohistoric period. The Late Archaic and Late Pithouse components exhibit opposing procurement strategies between study areas; materials were mostly collected from drainages in the Reserve area and from local outcrops in the Luna area during these periods.

There was a substantial increase from the Late Archaic through Late Pueblo periods in the Reserve area in the amount of materials collected from secondary sources, both in the overall cortical assemblage and in the cortical core assemblage. In the Luna assemblage, this is only true of the Late Pueblo period.

Material texture is often a determining factor in the selection of materials for a particular use. Fine-grained materials were predominantly used in all assemblages from the Late Archaic through Late Pueblo periods. Differences in material texture primarily occur in the informal and formal tool assemblages. Medium-grained materials were used more frequently in the Reserve assemblages for both formal and expedient tool manufacture. Obsidian was selected for the production of formal tools more frequently in the Luna assemblages, especially during the Late Pithouse and Late Pueblo periods (Tables 3.57 and 3.58).

Most heat-treated artifacts are Luna blue agate in both areas; however, most successfully alteration examples were found in a Late Pithouse component (LA 45510), the Late Pueblo period components, and the mixed component of LA 70188. While heat-treated cherts most commonly occur in the Late Archaic components of the Reserve area, most examples were unsuccessfully altered and exhibit potlids and crazing.

Conclusions

Several differences in material procurement and use were observed during the Late Archaic, Mogollon, and Protohistoric periods. Local materials dominate assemblages from all time periods; however, geographic and geologic differences were determining factors in the use of cherts, igneous materials (rhyolite, basalt, etc.), and Luna blue agate. Luna blue agate dominated the Luna assemblages because it is the most abundant cryptocrystalline material in that area, while chert, rhyolite, basalt, and other igneous materials were most often used in the Reserve assemblages because they occur more frequently in drainages and outcrops in that area.

Material selection and use during the Late Archaic period was geared toward the procurement of local materials for both expedient core reduction and formal tool manufacture. Late Archaic assemblages in the Reserve area show a preference for the use of fine-grained chert and basalt, while the Late Archaic component near Luna (LA 45508) is dominated by Luna blue agate. Both assemblages also contain high percentages of artifacts that were subjected to thermal alteration. Thermal alteration occurs in all periods, but was most common in the Late Archaic and Late Pueblo periods. Although there was little evidence for successful thermal alteration in the Late Archaic assemblages, cherts and Luna blue agate were used for large biface manufacture, and heat treatment would have made them easier to work. Thus, it is likely that many if not most of the unsuccessfully treated specimens are evidence of a conscious attempt to manipulate these materials. In contrast to later occupations in the study area, Late Archaic assemblages are marked by a more frequent use of cherts and basalts, and the use of predominantly fine-grained (with some use of medium-grained) materials for formal tool manufacture.

Obsidian is the only demonstrably nonlocal material in these assemblages, and was frequently used for the manufacture of formal tools during the Late Pithouse through Late Pueblo periods in both areas. Although other materials were also used in formal tool manufacture, obsidian was predominantly used for the manufacture of projectile points from the Late Pithouse through Late Pueblo periods. This may coincide with a shift in technology from the use of the atlatl to the bow and arrow. Obsidian fractures more predictably, is easier to work than local materials, and is well suited to the manufacture of small bifaces and arrow points.

Other differences between Luna and Reserve assemblages during the Mogollon periods occur in material textures selected for informal tool use. Frequencies of utilized debitage made of fine-grained materials were high in both areas; however, glassy-textured informal tools were more common in the Luna assemblage, and medium-grained informal tools were more common in the Reserve assemblage.

Igneous and rhyolitic materials were used in increasing numbers during the Mogollon occupation, but were selected for use more frequently in the Reserve area, especially during the Early Pueblo period. The Mogollon assemblages are similar to the Late Archaic assemblages in that Luna blue agate was more commonly used in the Luna area, and cherts, rhyolites, and igneous materials were more frequently used in the Reserve area. Material acquisition from secondary sources is also more common in Mogollon assemblages than it was in Archaic or protohistoric components.

The protohistoric components are similar to the Late Archaic assemblages in terms of material use. They primarily contain local materials, but greater percentages of obsidian were used than in any other time period. The Late Pithouse assemblage is the only other one that contains a similar overall percentage of obsidian. Most materials used in the Protohistoric components were procured from primary sources. Only one Late Archaic component (LA 78439) exhibited similar percentages of materials from primary sources.

Material selection percentages in the mixed assemblages are dominated by two components—LA 43766 and LA 70188. Most of the mixed assemblages from these sites are most likely related to Archaic occupations. With the exception of LA 70191, all of the mixed assemblages primarily contain local materials. A large percentage of the mixed assemblage from LA 70191 is comprised of obsidian. LA 89846 and LA 89847 both contain high percentages of Luna blue agate like other Luna area assemblages. Most of the mixed assemblages contain a Mogollon component and, with the exception of LA 43766 and LA 70188, exhibit material acquisition patterns similar to the unmixed Mogollon assemblages.

In summary, material selection throughout all time periods is dominated by use of local materials. Sites located near Reserve or Luna contain the materials that were most common in those areas. Exotic materials (obsidians) were more frequently used in Mogollon and protohistoric assemblages. The Reserve assemblages are characterized by the use of a wide variety of materials obtained from secondary sources, while the Luna assemblages are dominated by Luna blue agate.

CHIPPED STONE REDUCTION: DEBITAGE AND CORES

James L. Moore

Examination of reduction strategies at archaeological sites is best accomplished by studying the artifacts created by that process. Southwestern curated reduction strategies concentrated on production of large generalized bifaces that could be used as unspecialized tools, cores, or blanks for the manufacture of specialized tools. Expedient reduction strategies focused on the flaking of cores to produce debitage that could be informally used as tools. Flakes produced by these processes can generally be distinguished by characteristics of shape and platform morphology. Most generalized bifaces tended to be removed from manufacturing locales unless they were broken during production. Thus, the best evidence of reduction strategy that often remains at a site is the debris that accumulated during manufacture.

Tool manufacture tends to produce flakes that are morphologically distinguishable from those removed from cores. In turn, flakes removed by percussion tend to be larger than those removed by pressure. Large bifaces are generally shaped by soft hammer percussion, at least in the early stages of manufacture. Final shaping and edge sharpening can be accomplished by pressure flaking, but this is not always necessary. Small bifaces are usually shaped by pressure flaking in all manufacturing stages. Thus, core reduction and the manufacture of both large and small bifacial tools produce different arrays of debris that are often distinguishable in the archaeological record.

Preliminary screening experiments suggest that most flakes removed by pressure flaking tend to pass through ¼-inch mesh hardware cloth, such as was used during most of these excavations. Small biface flakes are rarely recovered unless smaller mesh screens are used. Thus, most of the biface flakes in our assemblage probably result from the manufacture of large bifaces, and except for tools broken during manufacture or discarded for other reasons, we should find little evidence of small biface manufacture.

This type of artifact recovery has led to some common misconceptions. Archaic peoples are often viewed as superior flintknappers because their assemblages tend to be largely comprised of biface flakes and large complete or broken bifacial tools are often recovered. Later sedentary peoples are often considered to be less competent flintknappers because their assemblages are comprised of expediently struck flakes, large amounts of angular debris, and few biface flakes. Bifacial tools in these assemblages tend to be small and are sometimes very expedient. In actuality, there was probably little difference in the proficiency of flintknappers during these periods. It is simply that the focus of chipped stone reduction was different. Archaic and Mogollon bifacial tools are equally well made, the main difference is in the "quality" of the debitage. Since most Mogollon bifaces were small and produced by pressure flaking, the resultant biface flakes are also small and rarely recovered in ¼-inch mesh screens. Because of this, Mogollon assemblages appear to be "cruder" and less focused on the manufacture of bifacial tools. However, the real difference is in the size of the bifaces that were manufactured. Archaic peoples did plenty of expedient core reduction, but it is partly masked by the presence of numerous large biface flakes.

As discussed in the research design for this analysis, curated tools are produced in anticipation of need, while expedient tools are made in reaction to need. Large generalized bifaces were quite useful to mobile hunter-gatherers because they were easily transported, could be further reduced with little waste or fashioned into formal tools if necessary, and allowed them to carry a supply of high-quality lithic material into regions where they might be lacking. This is not meant to imply that local materials would be ignored unless suitable for large biface manufacture. On the contrary, Archaic peoples usually made considerable use of local materials, even when they were of comparatively low quality. Thus, assemblages in which large generalized bifaces were manufactured should contain high percentages of biface flakes of high-quality materials. Where large generalized bifaces were used as cores or transformed into specialized tools, assemblages should contain mostly expediently struck debitage with a smattering of biface flakes of high-quality, nonlocal materials. Since sedentary peoples did not have to worry as much about the transportability of their raw materials, there was much less use of large generalized bifaces, though they did not completely disappear. Rather, most tasks were accomplished using expediently struck debitage or specialized bifacial tools. Thus, depending on level of mobility, quality and abundance of raw materials, and site function, we would expect different debitage configurations.

Table 3.59. Chipped Stone Assemblage Data for All Components; Frequencies and Row Percentages

Component	Debitage	Core	Cobble Tool	Flaked Tool	Indeterminate	Total
LA 3279	13,172 95.4	361 2.6	1 0.007	276 2.0	0 0.0	13,810 21.9
LA 3563	1,578 94.9	76 4.6	0 0.0	9 0.5	0 0.0	1,663 2.6
LA 9721	23 88.5	2 7.7	0 0.0	1 3.8	0 0.0	26 0.04
LA 37917	638 95.8	14 2.1	0 0.0	14 2.1	0 0.0	666 1.1
LA 37919	689 98.9	4 0.6	0 0.0	4 0.6	0 0.0	697 1.1
LA 39968	4,072 94.6	182 4.2	15 0.3	37 0.9	0 0.0	4,306 6.8
LA 39969	2,903 95.2	109 3.6	9 0.3	27 0.9	2 0.1	3,050 4.8
LA 39972	1,185 95.6	34 2.7	3 0.2	17 1.4	0 0.0	1,239 2.0
LA 39975	1,492 94.4	76 4.8	1 0.1	11 0.7	0 0.0	1,580 2.5
LA 43766	6,174 97.7	21 0.3	0 0.0	126 2.0	0 0.0	6,321 10.0
LA 43786	90 96.8	1 1.1	0 0.0	2 2.2	0 0.0	93 0.1
LA 45507	2,098 95.4	64 2.9	15 0.7	22 1.0	0 0.0	2,199 3.5
LA 45508	2,428 96.9	33 1.3	0 0.0	45 1.8	0 0.0	2,506 4.0
LA 45510	1,188 96.4	13 1.1	0 0.0	32 2.6	0 0.0	1,233 2.0
LA 70185	2,157 96.1	40 1.8	4 0.2	43 1.9	0 0.0	2,244 3.6
LA 70188	15,700 97.7	133 0.8	5 0.03	236 1.5	1 0.006	16,075 25.5
LA 70189	308 95.7	11 3.4	0 0.0	3 0.9	0 0.0	322 0.5
LA 70191	179 97.8	1 0.5	0 0.0	3 1.6	0 0.0	183 0.3
LA 70196	814 95.5	11 1.3	0 0.0	27 3.2	0 0.0	852 1.3
LA 70201	522 96.0	18 3.3	0 0.0	4 0.7	0 0.0	544 0.9
LA 75791	138 95.2	5 3.4	0 0.0	2 1.4	0 0.0	145 0.2
LA 75792	1,073 97.6	18 1.6	0 0.0	8 0.7	0 0.0	1,099 1.7
LA 78439	734 94.1	24 3.1	4 0.5	18 2.3	0 0.0	780 1.2
LA 89846	1,078 98.4	6 0.5	0 0.0	12 1.1	0 0.0	1,096 1.7
LA 89847	398 99.0	2 0.5	0 0.0	2 0.5	0 0.0	402 0.6
Total Percent	60,831 96.4	1,259 2.0	57 0.1	981 1.6	3 0.005	63,131 100.0

A total of 63,131 chipped stone artifacts was recovered from the 25 sites excavated by this project. The basic makeup of each assemblage is summarized in Table 3.59. Assemblages were of variable size, and three (LA 3279, LA 43766, and LA 70188) comprised over half of the total. By far the most common chipped stone artifact class was debitage. Cores were a distant second, followed closely by flaked tools; cobble tools were very uncommon. Only three artifacts were not identified by this analysis.

A total of 20 essentially unmixed and 9 mixed components were identified (see *Introduction to the Chipped Stone Analysis* for details). Most of the following analysis is focused on the unmixed assemblages to define patterns that can be used to examine temporal changes in chipped stone technology for this area. These patterns will also be used to help determine whether the mixed assemblages are mostly representative of single occupations, or are so mixed that further temporal definition is impossible. In some cases, patterning in the unmixed assemblages may help assess the accuracy of temporal assignments for components with questionable dates, such as LA 37917.

Analysis of the Unmixed Debitage Components

Of the 60,831 pieces of debitage recovered by this project, 44,508 (68.2 percent) are from unmixed assemblages. Table 3.60 shows the distribution of debitage types by component. Angular debris are pieces of shatter produced during core reduction and, to a lesser extent, tool manufacture. The core flake category includes flakes that were struck by free-hand percussion as well as the bipolar method. The biface flake category includes flakes removed from bifacial tools during manufacture or modification of existing tools. Hammerstone flakes are a very specialized category, and represent accidental removals from hammerstones during hard hammer percussion. As such, they are not actually a by-product of reduction, and are not considered further.

Variability can be seen in Table 3.60. Most Archaic components contain high percentages of biface flakes and low percentages of angular debris, and most Mogollon components display the opposite distribution—high frequencies of angular debris and few biface flakes. However, there are exceptions to this. Only one Late Archaic component, LA 78439, contains a comparatively small percentage of biface flakes. This could be due to several possibilities including differences in types of materials reduced, functional variation, or more extreme mixing than was originally thought. Two components (LA 70185 and LA 70196) contain higher percentages of biface flakes than are evident in other Mogollon assemblages. These differences could be due to the same range of possibilities affecting LA 78439, or the presence of Archaic components that were not otherwise visible. These questions can be addressed with available data, though it may not be possible to derive any satisfactory conclusions. However, they must be addressed before characterizing assemblages from different time periods to provide a comparison for the mixed assemblages, because we must know if they are atypical or incorrectly assigned.

Potentially Atypical Components

LA 78439: Archaic or Mogollon? Several chi-square analyses were conducted to determine whether the small percentage of biface flakes in the LA 78439 assemblage represents a significant difference. Unfortunately, the distribution of morphological types between the Archaic assemblages is so variable that no dependable results were obtained. When the distribution of debitage categories is examined, analytical results weakly suggest that different populations are represented (chi-square = 155.63, df = 6, significance = <.0005; Cramer's V = .09312). The sample still appears to represent weakly different populations when LA 78439 is removed (chi-square = 60.335, df = 4, significance = <.0005; Cramer's V = .05972). Since we are primarily interested in differences in flake categories, angular debris was dropped from consideration. In addition, since it was difficult to correctly categorize flake fragments with missing platforms, only whole flakes and proximal fragments were included in this examination. Again, when all four Archaic components are considered, analysis weakly suggests that they do not represent the same population (chi-square = 94.740; df = 3, significance = <.0005; Cramer's V = .13082). However, with LA 78439 removed, there are very weak indications that the remaining components represent a single population at the 99 percent level of confidence (chi-square = 19.804, df = 2, significance = .005; Cramer's V = .06185).

Using percentages of various debitage types as a measure of association, there are only weak indications that most of the Archaic components form a single population. Much of this may be due to the types of materials reduced in these components, since materials vary in fracturing characteristics. In particular, Luna blue agate tends to be very hard and brittle, producing much angular debris. Indeed, LA 45508 contains the highest percentage of Luna blue agate in this sample, as

Table 3.60. Debitage Types for Unmixed Components; Frequencies and Row Percentages

Period	Component	Angular Debris	Core Flake	Biface Flake	Hammerstone Flake
Late Archaic	LA 43766	265 13.5	1,130 57.7	562 28.7	0 0.0
	LA 45508	319 21.4	757 50.9	412 27.7	0 0.0
	LA 70188	911 18.2	2,918 58.2	1,185 23.6	0 0.0
	LA 78439	76 14.8	396 76.9	43 8.3	0 0.0
Early Pithouse	LA 39972	188 38.4	290 59.2	12 2.4	0 0.0
	LA 39975	227 15.2	1,203 80.6	62 4.2	0 0.0
Late Pithouse	LA 45510	406 34.2	713 60.0	69 5.8	0 0.0
	LA 43786	7 7.8	82 91.1	1 1.1	0 0.0
	LA 45507	472 22.5	1,476 70.4	150 7.1	0 0.0
	LA 70196	79 9.7	641 78.7	94 11.5	0 0.0
Pithouse	LA 70201	27 5.2	483 92.5	12 2.3	0 0.0
Early Pueblo	LA 3563	94 6.0	1,415 89.7	69 4.4	0 0.0
	LA 39969	869 29.9	2,019 69.5	12 0.4	3 0.1
	LA 39972	222 31.9	457 65.8	6 2.3	0 0.0
	LA 75792	129 12.0	931 86.8	13 1.2	0 0.0
Late Pueblo	LA 3279	6,210 47.1	6,797 51.6	165 1.3	0 0.0
	LA 9721	2 8.7	21 91.3	0 0.0	0 0.0
	LA 39968	1,498 36.8	2,540 62.4	32 0.8	2 0.05
	LA 70185	382 17.7	1,554 72.0	221 10.2	0 0.0
Protohistoric	LA 37917	128 20.1	492 77.1	18 2.8	0 0.0
	LA 37919	112 16.3	551 80.0	26 3.8	0 0.0

Table 3.61. Results of Chi-Square Analyses on Flake Assemblages from Mogollon Components

Sample	Period	Chi-square	Df	Significance	Cramer's v
All Components	Early Pithouse	0.46630	1	.49469	.01725
	Late Pithouse	15.89757	3	.00119	.07020
	Early Pueblo	70.89865	3	<.0005	.11990
	Late Pueblo	461.64867	3	<.0005	.20186
LA 70185 and LA 70196 eliminated	Early Pithouse	.46630	1	.49469	.01725
	Late Pithouse	6.30884	2	.04266	.05033
	Early Pueblo	61.56495	2	<.0005	.12425
	Late Pueblo	12.23256	2	.00221	.03578

Table 3.62. Results of Chi-Square Analyses on Materials and Platform Types from Mogollon Components

Sample	Period	Chi-square	Df	Significance	Cramer's v
Materials	Early Pithouse	454.197	7	< .000005	.47871
	Late Pithouse	1352.150	21	< .000005	.32798
	Early Pueblo	2950.157	24	< .000005	.44653
	Late Pueblo	5965.092	21	< .000005	.31995
Platform types	Early Pithouse	13.335	1	.00015	.11809
	Late Pithouse	343.185	3	< .000005	.38814
	Early Pueblo	74.058	3	<.000005	.15343
	Late Pueblo	103.644	6	< .000005	.09322

well as the highest percentage of angular debris (21.4 percent). While this material comprises 48.3 percent of the overall debitage assemblage for LA 45508, 64.9 percent of the angular debris are Luna blue agate. A chi-square test on material types weakly indicates that the sample of Archaic components was drawn from different populations (chi-square = 3985.73, df = 9, significance = <.0005; Cramer's V = .34877). Standardized residuals suggest that the largest degrees of variance are the result of a low percentage of Luna blue agate and a high percentage of basalt at LA 43766, a high percentage of Luna blue agate at LA 45508, and a high percentage of obsidian at LA 78439.

LA 45508 was the only component in this sample located in the Luna area; all others were in the Reserve area. This may have contributed to the heavy use of Luna blue agate at LA 45508, but is not the only source of differentiation in the material makeup of these components. When only Reserve area Archaic components are considered, there are still significant differences in types of materials reduced (chi-square = 2718.858, df = 6, significance = <.0005; Cramer's V = .45028). Interestingly, only LA 78439 contains a large percentage of obsidian. Since the types of obsidian used in this area do not tend to occur in large nodules (at least currently), it is possible that reduction in this component focused on the manufacture of smaller bifaces. This can be tested by examining biface flake length and evidence for platform modification. An analysis of variance (ANOVA) was calculated for lengths of whole biface flakes. At the 99.9 percent confidence level, the results of this analysis suggest that all four components are members of the same population, though the association is weak (F = 3.687, df = 3, significance = .012). Proportions of modified and unmodified platforms were then compared using a chi-square test, which weakly suggests that these components are not members of the same population (chi-square = 312.668, df = 3, significance = <.0005; Cramer's V = .28110).

Differences in types of materials used in these components appear to have obscured some of the expected similarities. When considered as a group, the Archaic components vary enough in their basic makeup that they do not seem to be members of the same population. Thus, we cannot conclude whether or not the assemblage from LA 78439 is Archaic from these data alone. Several radiocarbon dates were obtained from a roasting pit associated with this component, and dates for the most reliable samples place this occupation around 1950 B.C., near the beginning of the Late Archaic period. Dates for LA 43766 and LA 70188 also place the main occupations of those sites in the Late Archaic period. While there is much variability among the Archaic components in our sample, LA 78439 stands out from the rest because of its small percentage of biface flakes and comparatively large percentage of obsidian. It is likely that these differences are related to site function. If so, then the weak indications from the debitage analysis, which suggest the other Archaic components represent a single population, may be important.

LA 70196 and LA 70185: Mogollon Assemblages? These assemblages contain much higher percentages of biface flakes than other Mogollon components, which could be an indication of incorrect placement or unforeseen mixing. Building on our experience with the Archaic assemblages, chi-square tests were run on proportions of flake types from all Mogollon components for each time period. The same data, then, were tested with LA 70185 and LA 70196 removed. The results are shown in Table 3.61. When all Mogollon components are considered, chi-square tests weakly suggest that the Early Pithouse and Late Pithouse period assemblages represent the same populations. Both the Early Pueblo and Late Pueblo period components seem to represent multiple populations, though again the results are quite weak. With LA 70185 and LA 70196 removed the results are somewhat different. The significance level increases for the Late Pithouse period, and at the 99.9 percent confidence level, analysis weakly suggests that the remaining Late Pueblo components represent the same population. Only the Early Pueblo components remain diverse enough to suggest that more than one population is represented.

There are some indications that location (and consequently material availability) may have something to do with these results. LA 70196 is a Late Pithouse component in the Reserve area. When components from this period are examined by area, chi-square analysis very weakly suggests that Luna area Late Pithouse components represent a single population (chi-square = .10299, df = 1, significance = .74827; Cramer's V = .00654). Similar results were obtained for the Reserve area Late Pithouse sites, though the level of significance is much lower (chi-square = 9.74981, df = 1, significance = .00179; Cramer's V = .10917). When Late Pueblo components are examined, there are weak indications that the Reserve area sample represents a single population (chi-square = .26454, df = 1, significance = .60702; Cramer's V = .01010), while there are still significant differences between those from the Luna area (chi-square = 340.36892, df = 1, significance = <.0005; Cramer's V = .19738). Though most of these results have a high level of significance, they are weak.

Table 3.62 shows the results of chi-square tests on distributions of materials and flake platforms in components dating to these periods. In the latter case, platforms were combined into modified and unmodified categories and missing platforms were eliminated. As this table suggests, there are no overall similarities between components from the same periods for these variables. When LA 70185 and LA 70196 are removed, there are no significant changes in our results; different populations are still represented. This trend continues to hold when Mogollon components are examined by period and area, with only the distribution of platform types from Reserve area Late Pueblo components possibly representing the same population. However, this result is very weak and not highly significant (chi-square = 9.133, df = 1, significance = .00251; Cramer's V = .07598). Thus, whether or not the components that contain higher percentages of biface flakes are included in our samples, there does not appear to be much correspondence between assemblages for these variables.

Like the Archaic assemblages, Mogollon components appear to be quite variable in composition. Much of this may be attributed to material use patterns, though this cannot be demonstrated. Unlike the Archaic components, the two potentially anomalous Mogollon components cannot be separated from the others on the basis of date. The pottery and features encountered at these sites fit solidly into the Late Pithouse (LA 70196) and Late Pueblo (LA 70185) periods. Comparing the LA 70185 and LA 70196 assemblages with Archaic components, both together and individually, revealed no significant relationship. These examinations included chi-square tests on proportions of debitage types, flake types, materials, and modified platforms as well as ANOVA tests on the length of whole biface flakes. In each case, our results suggest that different populations are represented. Thus, these assemblages do not fit well with either the Archaic or other ceramic components. For the time being they will retain their current period assignments, but we will continue looking for variables that might set them apart.

Reduction Stages: Dorsal Cortex Percentages

Reduction can be divided into two basic stages—core reduction and tool manufacture. Flakes are removed for use or further modification during core reduction.

Primary core reduction includes initial core platform preparation and removal of the cortical surface. *Secondary* core reduction is the removal of flakes from core interiors. During reduction, this difference is rarely as obvious as these definitions make it seem. Both processes often occur simultaneously and rarely is all cortex removed before secondary reduction begins. In essence, they represent opposite ends of a continuum, and it is difficult to determine where one stops and the other begins. Nevertheless, the amount of cortex on the dorsal surfaces of flakes can be used to examine reduction stages.

In this analysis, primary core flakes are those with 50 percent or more of their dorsal surfaces covered by cortex, and secondary core flakes are those with less than 50 percent dorsal cortex. This distinction provides information on the condition of cores used at a site. For example, a lack of primary flakes suggests that initial reduction occurred elsewhere, while the presence of few secondary flakes may indicate that cores were carried elsewhere for further reduction. Tool manufacture refers to the purposeful modification of debitage into specific forms. Primary core flakes represent the early stage of reduction, while secondary core flakes and biface flakes represent the later stages.

Cortex is often brittle and chalky and does not flake with the predictability or ease of unweathered material. This can cause problems during tool manufacture, so cortex is usually removed during the early stages of tool production. Large biface manufacture can be rather wasteful, and quite a bit of debitage is often removed before the proper shape is achieved. These flakes must be carefully struck and are generally thinner than those removed from cores. As a large biface is manufactured, numerous interior flakes lacking cortical surfaces are removed, and the proportion of noncortical debitage increases. Fewer and thicker interior flakes tend to be removed during core reduction, so debitage assemblages reflecting a purely expedient strategy should contain lower percentages of noncortical debitage than those in which a purely curated strategy was employed. Most debitage created during reduction should be noncortical in both cases, but the proportion in curated strategies should be much higher.

Table 3.63 contains dorsal cortex information for flakes from unmixed components. Three categories are shown—0 percent, 1 to 49 percent, and 50 to 100 percent. The first two represent secondary core reduction and tool manufacture, and the latter represents primary reduction. Percentages vary considerably by component, though in each case flakes with no dorsal cortex dominate the assemblages, usually by a very large percentage. Since this table is not very informative, components were grouped by time period and the same percentages were recalculated and are shown in Table 3.64. The Archaic group contains all components from that period except LA 78439, which is considered separately. The Archaic group contains a much smaller percentage of primary flakes than any of the others, and a correspondingly higher percentage of noncortical interior flakes. Percentages for the Pithouse and Pueblo groups are similar, but a chi-square test suggests that they represent different populations (chi-square = 76.679, df = 2, significance = <.000005; Cramer's V = .06897). The only groups that statistically seem to represent the same population are LA 78439 and the protohistoric components, and those results are weak (chi-square = 2.782, df = 2, significance = .24887; Cramer's V = .04269).

When the groups are separated into areas in Table 3.65, percentages of primary flakes remain small and percentages of noncortical interior flakes remain high for the Archaic components in both areas. However, the Mogollon assemblages from each area are quite different. Percentages of primary and noncortical interior flakes are considerably smaller for the Luna area than for the Reserve area. While possible that this difference reflects variation in reduction strategies, it is more likely the result of differences in material availability and selection.

Table 3.66 illustrates the distribution of dorsal cortex by material groups for Mogollon components from each area. Overall, percentages of flakes with dorsal cortex are smaller for materials from Luna, but percentages for obsidian are similar for both areas. Obsidian is the only definite exotic material found in these assemblages; it was mostly obtained from the same sources and should have occurred in a similar range of nodule sizes. The fact that percentages of cortical flakes are similar between areas for obsidian suggests that it was reduced in much the same way. This is probably true for the array of other materials as well, and it is possible that these differences result from variation in nodule size. However, consistency in these percentages for the Archaic components suggests that the same factor may not have been a controlling factor for that period. Perhaps the actual reason is a differential availability of materials between these areas, causing cores in the Luna area to be reduced to a greater extent than those from the Reserve area. Sizes of cores and whole flakes may provide further information concerning this question and are considered later.

Interestingly, the distribution of dorsal cortex on flakes from LA 78439 does not resemble that of the other Archaic components, and is more similar to that of the protohistoric components. Neither LA 70185 nor LA 70196 differ enough from other components in their temporal groups and areas to be considered significantly different in terms of this attribute.

Table 3.63. Amount of Dorsal Cortex on Flakes by Component (Unmixed); Frequencies and Row Percentages

Component	0%	1 to 49%	50 to 100%	Total
LA 3279	5,908 84.9	529 7.6	525 7.5	6,962 23.2
LA 3563	851 57.3	399 26.9	234 15.8	1,484 4.9
LA 9721	14 66.7	7 33.3	0 0.0	21 0.1
LA 37917	332 65.1	132 25.9	46 9.0	510 1.7
LA 37919	422 73.1	99 17.2	56 9.7	577 1.9
LA 39968	1,638 63.6	420 16.3	516 20.0	2,574 8.6
LA 39969	957 47.1	614 30.2	463 22.8	2,034 6.8
LA 39972	413 53.3	207 26.7	155 20.0	775 2.6
LA 39975	740 58.5	303 24.0	222 17.5	1,265 4.2
LA 43766	1,419 83.9	148 8.7	125 7.4	1,692 5.6
LA 43786	49 59.0	17 20.5	17 20.5	83 0.3
LA 45507	1,554 95.6	34 2.1	38 2.3	1,626 5.4
LA 45508	1,048 89.6	72 6.2	49 4.2	1,169 3.9
LA 45510	697 89.1	55 7.0	30 3.8	782 2.6
LA 70185	1,644 92.6	70 3.9	61 3.4	1,775 509
LA 70188	3,688 89.9	250 6.1	165 4.0	4,103 13.7
LA 70196	447 60.8	171 23.3	117 15.9	735 2.5
LA 70201	278 56.2	117 23.6	100 20.2	495 1.7
LA 75792	614 65.0	216 22.9	114 12.1	944 3.1
LA 78439	290 66.1	96 21.9	53 12.1	439 1.5

Table 3.64. Distribution of Dorsal Cortex by Temporal Groups; Frequencies and Row Percentages

Temporal Group	0%	1 to 49%	50 to 100%	Total
Archaic	6,155	470	339	6,964
	88.4	6.7	4.9	27.3
LA 78439 (Archaic)	290	96	53<	439
	66.1	21.9	12.1	1.7
Pithouse	3,676	654	463	4,793
	76.7	13.6	9.7	18.8
Pueblo	9,815	1,242	1,215	12,272
	80.0	10.1	9.9	48.0
Protohistoric	754	231	102	1,087
	69.4	21.3	9.4	4.3

Table 3.65. Distribution of Dorsal Cortex by Temporal Group and Location; Frequencies and Row Percentages

Area	Temporal Group	0%	1 to 49%	50 to 100%	Total
Luna	Archaic	1,048	72	49	1,169
		89.6	6.2	4.2	9.5
	Pithouse	2,251	89	68	2,408
		93.5	3.7	2.8	19.6
	Pueblo	7,552	599	586	8,737
		86.4	6.9	6.7	71.0
Reserve	Archaic	5,107	398	290	5,795
		88.1	6.9	5.0	43.0
	LA 78439 (Archaic)	290	96	53	439
		66.1	21.9	12.1	5.6
	Pithouse	1,425	565	395	2,385
		59.7	23.7	16.6	18.0
	Pueblo	2,263	643	629	3,535
		64.0	18.2	17.8	26.7
	Protohistoric	754	231	102	1,087
		69.4	21.3	9.4	8.2

Table 3.66. Distribution of Dorsal Cortex by Material Group on Mogollon Components for Each Area; Frequencies and Row Percentages

Area	Material Group	0%	1 to 49%	50 to 100%	Total
Luna	Chert	1,781 87.0	119 5.8	148 7.2	2,048 18.4
	Luna Blue	6,252 92.2	279 4.1	250 3.7	6,781 60.8
	Obsidian	302 63.8	97 20.5	74 15.6	473 4.2
	Igneous	370 77.6	58 12.2	49 10.3	477 4.3
	Basalt	126 73.7	19 11.1	26 15.2	171 1.5
	Rhyolite	661 80.3	89 10.8	73 8.9	823 7.4
	Sedimentary	22 61.1	8 22.2	6 16.7	36 .3
	Metamorphic	289 86.0	19 5.7	28 8.3	336 3.0
Reserve	Chert	1,653 55.5	693 23.3	635 21.3	2,981 28.7
	Luna Blue	1,034 75.5	211 15.4	125 9.1	1,370 13.2
	Obsidian	184 57.7	81 25.4	54 16.9	319 3.1
	Igneous	716 49.2	394 27.1	346 23.8	1,456 14.0
	Basalt	160 58.2	70 25.5	45 16.4	275 2.6
	Rhyolite	1,999 57.9	868 25.2	584 16.9	3,451 33.2
	Sedimentary	37 47.4	21 26.9	20 25.6	78 .8
	Metamorphic	209 44.2	133 28.1	131 27.7	473 4.6

Two components (LA 37917 and LA 37919) were assigned to the protohistoric period based on radiocarbon dates. However, the LA 37917 assemblage contains several dart points suggesting that an Archaic component might also be present. Considering the distribution of dorsal cortex on flakes, these components represent the same population at the 99.9 percent confidence level, though the association is weak (chi-square = 12.355, df = 2, significance = .00208; Cramer's V = .10661). Both components were in the Reserve area, and the distribution of dorsal cortex falls between percentages for the Archaic components and LA 78439 for that area. Separate populations appear to be represented when the protohistoric components are compared with all Archaic components (chi-square = 249.128, df = 2, significance= <.000005; Cramer's V = .17130), and with all Archaic components except LA 78439 (chi-square = 301.740, df = 2, significance = <.000005; Cramer's V = .19359). Thus, this attribute weakly suggests that the protohistoric components belong to the same population, and that LA 78439 may also belong to that group.

Flake Platforms

Platforms are the remains of core or tool edges that were struck to remove flakes. Various types of platforms can be identified, providing data concerning the condition of the artifact from which a flake was removed as well as reduction technology. Cortical platforms are usually evidence of early stage core reduction, particularly when dorsal cortex is also present. Single facet platforms can occur at any time but are most often associated with core reduction. Multifacet platforms are evidence of previous removals along an edge. They occur on both core and biface flakes and suggest that the parent artifact was subjected to a considerable amount of earlier reduction.

Platforms were often modified by retouch or abrasion to facilitate flake removal. While abrasion can occur on most types of platforms, retouch is itself a distinct type. Thus, abrasion can occur on single facet and multifacet platforms, but retouch cannot. Both modifications result from rubbing an abrader across an edge. A perpendicular movement removes microflakes and retouches an edge, while parallel movement produces abrasion. These processes increase the edge angle, strengthening it and reducing the risk of shattering. Stronger platforms also increase control over the shape and length of flakes removed from a core or tool.

Flake platform types could not be defined in many instances. The most common reason was breakage, with part of the flake missing. Two other processes also obscured platforms during reduction. A platform that is unmodified or poorly prepared will sometimes crush when force is applied. Crushing can also occur when excessive force is used. While the point of impact is often still visible on a crushed platform, its original configuration is impossible to determine. Platforms can also collapse when force is applied. Collapsed platforms detach separately from flakes, leaving a scar on the dorsal or ventral surface. Occasionally a small part of the platform is preserved on one or both sides of the scar. While these remnants are usually too small to allow definition of the original platform type, they show where impact occurred and indicate that while the platform is missing, flake dimensions may be complete. Platforms can also be damaged by use or impact from natural processes. These were recorded as obscured.

Table 3.67 illustrates the distribution of platform types for each component. In general, single facet platforms are the most common type, comprising nearly a quarter of the flake assemblage. Collapsed platforms are the next most common, and make up just over a fifth of the assemblage. Absent platforms are third most common, followed by multifaceted platforms. Cortical platforms comprise less than 9 percent of the assemblage, and other types make up less than 3 percent apiece. Assemblages from the Luna and Reserve areas are compared in Table 3.68. While the distribution of platform types for these areas are somewhat similar, there also appear to be important differences. In terms of percentages, there are nearly two and a half times as many cortical platforms in the Reserve assemblage. While other platform types do not have comparable differences in percentages, they do vary considerably. These differences may have their roots in variation in material availability as well as temporal distribution.

In order to compare the temporal distribution of platforms for each area, the various types are collapsed into three categories in Table 3.69, with absent and obscured platforms dropped from consideration. Cortical platforms are those that are covered with cortex, faceted platforms combine the single and multifacet categories, and modified platforms are those exhibiting abrasion or retouch. The first two categories usually represent removals from cores, while modified platforms generally indicate removal during the manufacture or resharpening of formal tools. Archaic assemblages contain considerably higher percentages of modified platforms than Mogollon assemblages, and there is a general decrease in the percentage of modified platforms in assemblages through time. However, the protohistoric assemblages vary from this pattern, and contain a proportion of modified platforms similar to that of the Archaic assemblages. Since the protohistoric components contain similar proportions of modified platforms (31.6 percent for LA 37917 versus 33.9 percent for LA 37919), no single component is responsible for this percentage.

When this attribute is contrasted for all components by time period (Table 3.70), a steady decline is visible in percentages of modified platforms from the Archaic through Late Pueblo periods, with a sharp increase in protohistoric components. Indeed, Archaic and protohistoric period components appear to represent a single population, though the association is very weak (chi-square = .90578, df = 1, significance = .34124; Cramer's V = .01409). A similar association does not exist between Archaic and Early Pithouse assemblages (chi-square = 40.920, df = 1, significance = <.000005; Cramer's V = .09060), or Pithouse and Pueblo period assemblages (chi-square = 59.385, df = 1, significance = <.000005; Cramer's V = .06838).

Table 3.67. Platform Types By Component; Frequencies And Row Percentages

Component	Cortical	Single Facet	Single Facet and Abraded	Multifacet	Multifacet and Abraded	Retouched	Retouched and Abraded	Abraded	Collasped	Crushed	Absent	Obscured	Total
LA 3279	367	1,752	84	626	128	94	61	23	1,964	139	1,720	3	6,962
	5.3	25.2	1.2	9.0	1.8	1.4	0.9	0.3	28.2	2.0	24.7	0.04	23.2
LA 3563	262	357	76	180	63	10	6	13	286	58	172	1	1,484
	17.7	24.1	5.1	12.1	4.2	0.7	0.4	0.9	19.3	3.9	11.6	0.1	4.9
LA 9721	3	4	1	1	1	1	0	0	9	1	0	0	21
	14.3	19.0	4.8	4.8	4.8	4.8	0.0	0.0	42.9	4.8	0.0	0.0	0.1
LA 37917	73	50	21	76	39	16	5	11	125	18	75	1	510
	14.3	9.8	4.1	14.9	7.6	3.1	1.0	2.2	24.5	3.5	14.7	0.2	1.7
LA 37919	61	54	17	92	56	16	6	11	134	19	110	1	577
	10.6	9.4	2.9	15.9	9.7	2.8	1.0	1.9	23.2	3.3	19.1	0.2	1.9
LA 39968	333	746	35	270	13	24	5	5	678	41	416	5	2,571
	13.0	29.0	1.4	10.5	0.5	0.9	0.2	0.2	26.4	1.6	16.2	0.2	8.6
LA 39969	405	578	42	228	34	6	1	5	371	90	271	3	2,034
	19.9	28.4	2.1	11.2	1.7	0.3	0.05	0.2	18.2	4.4	13.3	0.1	6.8
LA 39972	112	173	32	87	31	5	5	10	216	11	90	3	775
	14.5	22.3	4.1	11.2	4.0	0.6	0.6	1.3	27.9	1.4	11.6	0.4	2.6
LA 39975	250	312	103	132	34	10	3	8	239	31	139	4	1,265
	19.8	24.7	8.1	10.4	2.7	0.8	0.2	0.6	18.9	2.5	11.0	0.3	4.2
LA 43766	53	231	24	217	29	111	86	2	512	9	414	4	1,692
	3.1	13.7	1.4	12.8	1.7	6.6	5.1	0.1	30.3	0.5	24.5	0.2	5.6
LA 43786	19	25	3	13	4	0	1	0	13	0	5	0	83
	22.9	30.1	3.6	15.7	4.8	0.0	1.2	0.0	15.7	0.0	6.0	0.0	0.3
LA 45507	61	531	9	730	10	48	1	1	65	49	119	2	1,626
	3.8	32.7	0.6	44.9	0.6	3.0	0.1	0.1	4.0	3.0	7.3	0.1	5.4
LA 45508	33	54	44	85	76	52	94	29	354	37	308	3	1,169
	2.8	4.6	3.8	7.3	6.5	4.4	8.0	2.5	30.3	3.2	26.4	0.3	3.9
LA 45510	46	54	60	93	42	11	17	11	149	56	237	6	782
	5.9	6.9	7.7	11.9	5.4	1.4	2.2	1.4	19.1	7.2	30.3	0.8	2.6
LA 70185	62	644	18	615	10	34	2	0	147	53	184	6	1,775
	3.5	36.3	1.0	34.6	.6	1.9	0.1	0.0	8.3	3.0	10.4	0.3	5.9
LA 70188	84	918	143	903	149	134	99	44	530	143	945	11	4,103
	2.0	22.4	3.5	22.0	3.6	3.3	2.4	1.1	12.9	3.5	23.0	0.3	13.7
LA 70196	100	239	33	83	19	6	1	7	97	19	128	3	735
	13.6	32.5	4.5	11.3	2.6	0.8	0.1	1.0	13.2	2.6	17.4	0.4	2.5

Component	Cortical	Single Facet	Single Facet and Abraded	Multifacet	Multifacet and Abraded	Retouched	Retouched and Abraded	Abraded	Collasped	Crushed	Absent	Obscured	Total
LA 70201	59	199	12	10	2	0	0	1	96	1	113	2	495
	11.9	40.2	2.4	2.0	0.4	0.0	0.0	0.2	19.4	0.2	22.8	0.4	1.7
LA 75792	97	402	20	59	12	8	2	4	140	12	185	3	944
	10.3	42.6	2.1	6.3	1.3	0.8	0.2	0.4	14.8	1.3	19.6	0.3	3.1
LA 78439	47	64	24	47	38	15	19	9	96	15	64	1	439
	10.7	14.6	5.5	10.7	8.7	3.4	4.3	2.1	21.9	3.4	14.6	0.2	1.5
Total	2,527	7,387	801	4,547	790	601	414	194	6,221	802	5,696	62	30,042
Percent	8.4	24.6	2.7	15.1	2.6	2.0	1.4	0.7	20.7	2.7	19.0	0.2	100.0

Differences are also apparent in the types of modification that occur on platforms. Platform modification is divided into two categories in Table 3.71, abrasion and retouch (with or without abrasion). Temporal groups are shown with Archaic and Late Archaic categories combined because the latter is represented by a single example. This table suggests that retouched platforms are much more common in Archaic assemblages than in the other periods. Simple abrasion occurs much more frequently in Mogollon and protohistoric assemblages, and the latter is more similar in proportion to the Pithouse period than the Archaic. While possible that a single protohistoric assemblage is responsible for this similarity, a chi-square test weakly suggests that the protohistoric assemblages represent a single population in terms of this attribute (chi-square = .12430, df = 1, significance = .72442; Cramer's V = .02506).

As far as this attribute is concerned, the components discussed earlier as potentially atypical (LA 70185, LA 70196, and LA 78439) seem to fit the general patterns for their time periods and locations. Indeed, LA 78439 has the highest percentage of modified platforms of the Archaic components in the Reserve area (39.9 percent of platforms present). This contrasts with a significantly lower percentage of biface flakes in this assemblage. LA 78439 also contains a very large percentage of obsidian, which is comparatively fragile and prone to breakage during reduction. Perhaps the smaller percentage of biface flakes is due to flake breakage and consequent difficulty in defining biface flakes versus core flakes.

The remaining atypical components are not very atypical when platform modification is considered. In fact, both Late Pithouse components from the Reserve area (LA 43786 and LA 70196) appear to be from the same population, though the association is rather weak (chi-square = 2.598, df = 1, significance = .27285; Cramer's V = .06854). LA 70185 is one of two Late Pueblo components from the Luna area; the other is LA 3279. While these components differ in percentages of platform types, the LA 70185 assemblage contains considerably smaller percentages of modified (4.6 percent versus 12.4 percent) and cortical platforms (4.5 percent versus 11.7 percent). Chi-square analysis weakly suggests that these components represent different populations (chi-square = 138.418, df = 2, significance = <.000005; Cramer's V = .17072). As far as platform categories go, neither of the possibly atypical Mogollon components resembles the Archaic components.

In general, this analysis indicates that cortical platforms are more common in Reserve area assemblages. This is to be expected considering the much higher percentage of flakes exhibiting dorsal cortex in those assemblages. There are also temporal trends in types and amounts of platform modification. Platform modification appears to decline steadily through time, and the use of platform retouch versus simple abrasion decreases significantly in occurrence after the Archaic period.

Archaic and protohistoric assemblages are similar in some ways, but are very different in others. While large percentages of modified platforms occur in assemblages from both periods, types of modification are different. Abrasion and retouch occur in similar percentages in the Archaic assemblage, while abrasion is almost four times as common in the protohistoric assemblage. Though the projectile point analysis suggested that LA 37917 might be of Archaic affinity, platform analysis indicates that the two Protohistoric components represent a single population, though the association between them is usually weak.

Flake Portions

Flake breakage patterns can be indicative of reduction strategy. Much flake breakage is caused by secondary compression, in which outward bending causes flakes to snap (Sollberger 1986). Long, thin flakes are particularly vulnerable to this type of fracture. Sollberger (1986:102) notes that when a flake reaches sufficient length that outward bending occurs, it can fracture when that bending exceeds the tensile strength of the material. Breaks caused by secondary compression are diagnostic, but were unfortunately not recorded in this analysis. However, this mechanical process can still be used as a diagnostic tool. Experiments suggest there are differences in fracture patterns between flakes struck from cores and tools (Moore n.d.a). While reduction techniques are more controlled during tool manufacture, flake breakage increases as reduction proceeds because debitage get long and thin, and secondary compression becomes more of a factor. Thus, there should be more broken flakes in assemblages in which tools were manufactured than in those that mostly reflect core reduction. However, trampling, erosional movement, and other post-reduction impacts can also cause breakage and must be taken into account. Equivalent numbers of distal and proximal fragments in an assemblage can suggest post-reduction breakage by trampling or other natural processes. If distal fragments significantly outnumber proximal fragments, most breakage probably occurred during reduction. This situation arises because our analytical scheme identifies whole flakes as artifacts with striking platforms and natural terminations. While some breaks attributable to secondary compression can be identified on proximal fragments, others are indistinguishable from natural terminations on whole flakes. Thus, some artifacts classified as whole flakes with hinge or step terminations may actually be the proximal ends of broken flakes. In addition, observations made during experimental flintknapping suggest that proximal ends

Table 3.68. Platform Types by Study Area; Frequencies and Column Percentages

Platform Type	Luna Area	Reserve Area	Total
Cortical	569 4.6	1,958 11.1	2,527 8.4
Single facet	3,035 24.6	4,352 24.6	7,387 24.6
Single facet and abraded	215 1.7	586 3.3	801 2.7
Multifacet	2,149 17.5	2,398 13.5	4,547 15.1
Multifacet and abraded	266 2.2	524 3.0	790 2.6
Retouched	239 1.9	362 2.0	601 2.0
Retouched and abraded	175 1.4	239 1.4	414 1.4
Abraded	64 0.5	130 0.7	194 0.7
Collapsed	2,679 21.8	3,542 20.0	6,221 20.7
Crushed	334 2.7	468 2.6	802 2.7
Absent	2,569 20.9	3,127 17.6	5,696 19.0
Obscured	20 0.2	42 0.2	62 0.2
Total Percent	12,314 41.0	17,728 59.0	30,042 100.0

Table 3.69. Platform Categories by Temporal Group and Area; Frequencies and Row Percentages

Area	Period	Cortical	Faceted	Modified	Total
Luna	Archaic	33 7.1	139 29.8	295 63.2	467 7.0
	Pithouse	107 6.2	1,408 81.6	210 12.2	1,725 25.7
	Pueblo	429 9.5	3,637 80.5	454 10.0	4,520 67.3
Reserve	Archaic	137 4.2	2,269 70.3	821 25.4	3,227 30.6
	Late Archaic	47 17.9	111 42.2	105 39.9	263 2.5
	Pithouse	467 25.1	1,095 58.7	302 16.2	1,864 17.7
	Pueblo	1,173 25.6	3,003 65.4	415 8.0	4,591 43.5

Area	Period	Cortical	Faceted	Modified	Total
	Protohistoric	134 22.2	272 45.0	198 32.8	604 5.7

Table 3.70. Modified Versus Unmodified Platforms through Time; Row Percentages

Period	Unmodified Platforms	Modified Platforms
Archaic	69.1	30.9
Early Pithouse	79.3	20.7
Late Pithouse	87.5	12.5
Early Pueblo	89.5	10.5
Late Pueblo	91.0	9.0
Protohistoric	67.2	32.8

Table 3.71. Platform Modification Categories by Temporal Group; Row Percentages

Temporal Group	Abraded Platforms	Retouched Platforms
Archaic	50.0	50.0
Pithouse	79.1	20.9
Pueblo	70.3	29.7
Protohistoric	78.3	21.7

often shatter during reduction (particularly tool manufacture), leaving only medial or distal fragments. If proximal fragments significantly outnumber distal fragments it is likely that many pieces lacking platforms were assigned to the angular debris category because they lacked sufficient diagnostic attributes to be correctly defined.

Table 3.72 shows the distribution of flake portions for all components. Two categories contain few examples overall. When a flake is struck with too much force the platform may separate from the flake body and, when large enough, can be recovered. These fragments are classified as collapsed platforms, only four examples of which were found. Debitage is occasionally identified as flake fragments, but cannot be classified as a specific portion. These are categorized as indeterminate fragments, 32 examples of which were recovered. Whole flakes dominate each assemblage, followed by proximal and distal fragments in varying proportions. In only one case (LA 9721) do proximal fragments comprise a significantly larger portion of an assemblage than distal fragments. However, the size of the flake assemblage from LA 9721 was so small that sample error is probably the cause of this distribution.

Breakage by trampling, erosion, or other surface processes is unlikely in most cases. Of the 20 components in this sample, 3 (15 percent) were recovered entirely from below the surface, 5 (25 percent) had higher percentages of complete flakes in surface than in subsurface contexts, 6 (30 percent) had fairly even percentages of whole and fragmentary flakes in surface and subsurface contexts, and in 1 case (5 percent) there were too few specimens available for analysis (LA 9721). In only 5 cases (25 percent) is it possible that higher percentages of broken flakes on the surface might be due to natural damage rather than breakage during reduction. These components include LA 39968, LA 39969, the Early Pithouse assemblage at LA 39972, LA 43786, and LA 45507. If these assemblages are found to be atypical it is possible that damage subsequent to deposition has affected them.

Percentages of whole and broken flakes by time period are shown for dated components in Table 3.73. By far the smallest percentages of whole flakes were found in Archaic components. However, it is interesting to note that the only component in this category with more than 70 percent whole flakes is LA 78439, which has already been discussed as atypical of the Archaic period. This component contains 71.8 percent whole flakes, very close to percentages for later Mogollon periods. Indeed, the large percentage of whole flakes indicates that flake breakage is probably not responsible for the comparatively small percentage of biface flakes relative to other Archaic components. Interestingly, protohistoric components contained smaller percentages of whole flakes than any of the Mogollon components, though in some cases the differences are not large.

Table 3.74 illustrates the results of a series of chi-square tests on components from each temporal group for both study areas. Only two temporal groups could be examined for the Luna area, and the components seem to weakly represent different populations. Results for the Reserve area are quite different, and at the 99.9 percent confidence level they weakly suggest that components from the Early Pithouse, Late Pithouse, Late Pueblo, and protohistoric periods belong to the same populations. Thus, while overall distributions of whole and broken flakes vary widely, in the Reserve area there is a correspondence between components from the same time periods. Four of five possibly atypical components were in the Reserve area, three of which were from the Archaic and Early Pueblo periods. These periods are the only ones for which there was no correspondence between percentages of whole and fragmentary flakes. It is possible that these components contain atypical breakage patterns possibly attributable to surface impact. Unfortunately, after these components are removed from consideration only the Archaic period contains enough components for statistical analysis, and a chi-square test weakly suggests no significant correspondence (chi-square = 24.142, df = 2, significance = .00001; Cramer's V = .06245). Thus, this possibility must remain undemonstrated.

From earlier discussions of artifact morphology and platform modification it is apparent that evidence for the manufacture of large bifacial tools is more prevalent in Archaic assemblages than any other time period. Analysis of flake portions shows that broken flakes are most common in Archaic assemblages. This helps to verify experimental observations that more flake breakage tends to accompany tool manufacture.

Flake to Angular Debris Ratios

Since tool manufacture is generally more controlled than core reduction, fewer pieces of recoverable angular debris should be produced. Thus, a high ratio of flakes to angular debris in an assemblage should indicate tool manufacture, while a low ratio should suggest core reduction. Unfortunately, this is a bit simplistic because the production of angular debris is also dependent upon the type of material worked, the technique used to remove flakes, and the amount of force applied. Brittle materials shatter more easily than elastic materials, and hard hammer percussion tends to produce more recoverable pieces of angular debris than soft hammer percussion or pressure flaking. The use of excessive force can also cause materials to shatter. In general though, as reduction proceeds the ratio of flakes to angular debris should increase. Thus, late-stage core reduction and tool manufacture should produce high ratios of flakes to angular debris.

Flake to angular debris ratios are shown for time periods and study areas in Table 3.76. Overall, Archaic components have the highest ratios, followed rather closely by the protohistoric components. Mogollon components have lower flake to angular debris ratios, but only the Late Pueblo period has an extremely low ratio. In general, these figures are what might be expected. It is interesting that the protohistoric ratio is similar to that of the Archaic, and this may indicate a similar reduction strategy.

Flake to angular debris ratios from a multicomponent Archaic site near San Ildefonso (LA 65006) ranged from 6.68:1 to 14.55:1 (Moore n.d.a). This range is fairly high, and is related to a focus on biface manufacture in all components. In addition, obsidian was transported to the site in a partly reduced state, which tends to minimize further shattering because the initial stages of reduction have already been accomplished. Vierra (1990:67) provides flake to angular debris ratios from sites in northwestern New Mexico. The average ratio for Archaic sites is 4.34:1; Anasazi residential sites have a flake to angular debris ratio of 2.52:1, while Anasazi limited-use locales have a mean ratio of 3.40:1. Ratios of 2.42:1 and 3.12:1 were derived for Valdez phase sites near Taos (Moore 1994), and are similar to those presented by Vierra. The mean ratio for Reserve-Luna Archaic assemblages (Table 3.75) is similar to that for northwest New Mexico, but smaller than the ratio from LA 65006. Since the latter site is highly focused on biface manufacture, this suggests that our components were less focused on tool production. Flake to angular debris ratios for Early Pithouse through Early Pueblo components are rather high when compared with Anasazi residential sites from northwest New Mexico, and also do not fit well with the Taos data. However, they are similar to ratios derived for Anasazi limited-use sites in northwest New Mexico. Late Pueblo components have very low ratios, considerably lower than those exhibited by either comparative sample. The protohistoric ratio is similar to that of the Archaic components.

Table 3.72. Flake Breakage Patterns by Component; Frequencies and Row Percentages

Component	Whole	Proximal Fragment	Medial Fragment	Distal Fragment	Lateral Fragment	Indeterminate Fragment	Collasped Platform	Total
LA 3279	4,747	377	119	1,523	178	18	0	6,962
	68.2	5.4	1.7	21.9	2.6	0.3	0.0	23.9
LA 3563	1,090	156	29	131	78	0	0	1,484
	73.5	10.5	2.0	8.8	5.3	0.0	0.0	5.1
LA 9721	16	4	0	0	1	0	0	21
	76.2	19.0	0.0	0.0	4.8	0.0	0.0	0.1
LA 37917	369	57	8	60	15	1	0	510
	72.4	11.2	1.6	11.8	2.9	0.2	0.0	1.8
LA 37919	377	77	21	74	27	0	1	577
	65.3	13.3	3.6	12.8	4.7	0.0	0.2	2.0
LA 39968	1,779	281	67	343	101	0	0	2,571
	69.2	10.9	2.6	13.3	3.9	0.0	0.0	8.8
LA 39969	1,547	161	27	234	58	7	0	2,034
	76.1	7.9	1.3	11.5	2.9	0.3	0.0	7.0
LA 39972	642	20	7	81	24	1	0	775
	82.8	2.6	0.9	10.5	3.1	0.1	0.0	2.7
LA 39975	952	137	14	115	47	0	0	1,265
	75.3	10.8	1.1	9.1	3.7	0.0	0.0	4.3
LA 43766	1,054	211	53	358	16	0	0	1,692
	62.3	12.5	3.1	21.2	0.9	0.0	0.0	5.8
LA 43786	67	8	0	5	2	0	1	83
	80.7	9.6	0.0	6.0	2.4	0.0	1.2	0.3
LA 45507	1,344	136	22	96	28	0	0	1,626
	82.7	8.4	1.4	5.9	1.7	0.0	0.0	5.6
LA 45508	596	215	100	190	66	0	2	1,169
	51.0	18.4	8.6	16.3	5.6	0.0	0.2	4.0
LA 45510	411	97	47	148	79	0	0	782
	52.6	12.4	6.0	18.9	10.1	0.0	0.0	2.7
LA 70185	1,409	160	29	154	23	0	0	1,775
	79.4	9.0	1.6	8.7	1.3	0.0	0.0	6.1
LA 70188	2,457	644	231	695	75	1	0	4,103
	59.9	15.7	5.6	16.9	1.8	0.02	0.0	14.1
LA 70196	514	70	17	111	23	0	0	735
	69.9	9.5	2.3	15.1	3.1	0.0	0.0	2.5
LA 70201	300	51	20	92	31	1	0	495
	60.6	10.3	4.0	18.6	6.3	0.2	0.0	1.7
LA 78439	315	44	12	44	21	3	0	439
	71.8	10.0	2.7	10.0	4.8	0.7	0.0	1.5
Total	19,986	2,906	823	4,454	893	32	4	29,098
Percent	68.7	10.0	2.8	15.3	3.1	0.1	0.01	100.0

Table 3.73. Distribution of Flake Fragments by Time Period for Dated Components; Row Percentages

Period	Whole Flakes	Broken Flakes
Archaic	59.7	40.3
Early Pithouse	76.4	23.6
Late Pithouse	72.4	27.6
Early Pueblo	72.7	27.1
Late Pueblo	70.2	29.8
Protohistoric	68.6	31.4

Table 3.74. Results of Chi-Square Analyses on Flake Portions by Time Period for Each Study Area (Periods with Two or More Examples Only)

Area	Temporal Group	Chi-square	Df	Significance	Cramer's v
Luna	Late Pithouse	242.050	1	< .000005	.31705
	Late Pueblo	85.177	1	< .000005	.09874
Reserve	Archaic	24.403	2	.00001	.06257
	Early Pithouse	4.656	1	.03095	.05451
	Late Pithouse	4.220	1	.03995	.07183
	Early Pueblo	133.805	2	<.000005	.16471
	Late Pueblo	0.479	1	.48900	.01359
	Protohistoric	6.18780	1	.01286	.07545

Table 3.75. Flake to Angular Debris Ratios by Time Period and Location

Period	Ratio	Location	Ratio
Archaic	4.71:1	Luna	3.67:1
		Reserve	4.98:1
Early Pithouse	3.78:1	Luna	-
		Reserve	3.78:1
Late Pithouse	3.35:1	Luna	2.74:1
		Reserve	9.51:1
Early Pueblo	3.75:1	Luna	-
		Reserve	3.75:1
Late Pueblo	1.40:1	Luna	1.33:1
		Reserve	1.73:1
Protohistoric	4.52:1	Luna	-
		Reserve	4.52:1

Table 3.76. Flake to Angular Debris Ratios by Time Period and Location (Luna Blue Agate Separated Out)

Period	Overall Ratios		Pct Luna Blue	Location	Period Ratios		Pct Luna Blue
	Luna Blue	Other Materials			Luna Blue	Other Materials	
Archaic	1.89:1	6.80:1	21.6	Luna	2.45:1	6.32:1	50.8
				Reserve	1.63:1	6.85:1	15.7
Early Pithouse	2.58:1	4.49:1	28.0	Luna	-	-	-
				Reserve	2.58:1	4.49:1	28.0
Late Pithouse	2.72:1	3.89:1	39.9	Luna	2.61:1	2.87:1	47.4
				Reserve	5.44:1	10.59:1	12.8
Early Pueblo	1.37:1	4.53:1	12.2	Luna	-	-	-
				Reserve	1.37:1	4.53:1	12.2
Late Pueblo	0.98:1	2.78:1	63.2	Luna	1.00:1	3.33:1	73.9
				Reserve	0.78:1	2.25:1	23.1
Protohistoric	1.78:1	6.94:1	23.4	Luna	-	-	-
				Reserve	1.78:1	6.94:1	23.4

In general, flake to angular debris ratios for Luna components are lower than those for the Reserve area. As Table 3.76 suggests, this may be due to the use of much larger amounts of Luna blue agate in that area, which is brittle and prone to shattering. Luna blue agate has much lower flake to angular debris ratios when compared to the array of other materials used in these components. This is true for both the overall distribution by period and when broken down by study area. Comparatively low percentages of Luna blue agate in the Early Pithouse, Early Pueblo, and protohistoric assemblages are deceptive, since those periods are only represented in the Reserve area where the use of Luna blue agate was much lower. Overall, 67.8 percent of the Luna area assemblages are composed of Luna blue agate, while only 17.8 percent of the Reserve assemblages are comprised of this material. When periods represented in both study areas are compared, percentages of Luna blue agate in Reserve assemblages are significantly lower than in Luna assemblages.

With Luna blue agate removed from the picture (Table 3.76), the difference between Archaic and Mogollon assemblages is more striking, and appears to indicate either higher amounts of tool manufacture or more careful core reduction in the former to maximize the number of flakes struck. Ratios for the Early Pithouse through Early Pueblo periods remain similar, and there is still a striking difference between these periods and the Late Pueblo period that is not completely due to the heavy use of Luna blue agate during the later period. However, the Late Pueblo ratio when Luna blue agate is dropped resembles that of Anasazi residential sites from northwest New Mexico (Vierra 1990:67). The protohistoric components remain similar to the Archaic components.

Artifact Dimensions

Three dimensions were measured on each artifact: length, width, and thickness. Table 3.77 summarizes mean dimensions for all complete flakes. It is interesting to note that mean core flake dimensions for the Reserve area are larger than those for similar periods in the Luna area, with the exception of the Archaic components. This either suggests that larger nodules were available for reduction in the Reserve area, or that nodules were, on the average, reduced to a greater extent in the Luna area.

Dimensional data are graphed by flake type, time period, and study area in Figures 3.20 through 3.23. Since Archaic peoples produced larger bifaces, on the average, than later occupants of the region, we might expect Archaic biface flakes to be the largest. However, this is not the case; Archaic core flakes tend to be the smallest in all dimensions for both areas. Archaic biface flakes average the smallest dimensions except for width (second smallest) for the Luna area, and have the second smallest mean dimensions for the Reserve area. While there appears to have been a slight drop-off in mean core flake width and thickness between the Late Pithouse and Late Pueblo periods in the Luna area, the difference is probably insignificant.

Mean core flake lengths and widths are normally distributed in the Reserve area, reaching a maximum in the Early Pueblo period, and then beginning a downward trend. However, the maximum thickness occurs in the Late Pueblo period. While there is comparatively little variance in mean core flake thickness for other periods, Late Pueblo period flakes seem to be significantly thicker.

Smaller biface flake dimensions during the Archaic is surprising, considering our expectations. It appears that large bifaces manufactured in all but the Late Pithouse period in the Reserve area were larger (on the average) than those made during the Late Archaic. What is missing from this picture is debitage resulting from the manufacture of small bifaces, which are rarely recovered. While biface flakes are relatively common in Archaic components, they comprise much smaller percentages of Mogollon assemblages. While it seems like large Mogollon bifaces were bigger than those produced during the Archaic, they were also comparatively much less common.

Using analysis of variance (ANOVA), flake lengths were compared for different combinations of components and the results of this analysis are shown in Table 3.78. Only results that showed a significant relationship between components or are otherwise discussed are included. When core flakes and biface flakes were compared for all time periods in the sample, no significant association was found. This was also true when the same assemblages were divided by study area and compared.

Only three time periods are represented in the Luna area—Archaic, Late Pithouse, and Late Pueblo. As noted above, when all three periods were compared, no significant association was found. However, when the Archaic component was dropped, core flakes from the remaining periods appear to represent the same population. However, there was no similar correspondence between biface flakes for those periods. ANOVA tests were then run on flake widths and thicknesses to determine whether any other significant associations exist. Results of this analysis suggest there is a significant association between these periods in core flake width (F = .847, significance = .357), but not thickness (F = 27.048, significance = <.0005). As was the case for biface flake lengths, there was also no correspondence between widths (F = 15.329, significance = <.0005) for these periods.

All time periods are represented in the Reserve area. Again, when flakes from all six periods were compared, no significant association in lengths was found. Interestingly, when flake lengths for the Archaic and protohistoric periods were compared there was no significant correspondence between core flake populations, but it was weakly suggested that the biface flakes represent the same population. When all Mogollon periods were compared, assemblages of biface flakes and core flakes appear to represent different populations. However, when the Early Pueblo period is dropped for core flakes, assemblages from the three remaining periods represent a single population. Similarly, when the Late Pithouse period is dropped for biface flakes, the three remaining periods also seem to represent a single population. Thus far, analysis suggests that the Early Pueblo assemblages represent multiple populations, while assemblages from other Mogollon periods are weakly suggested to represent single populations in terms of debitage ratios and flake portions. Clearly, the Early Pueblo period components bear closer inspection.

It may be easier to explain why Late Pithouse period biface flake dimensions are much smaller than those of any other Mogollon assemblage in the Reserve area. Four components from that period were examined for the area—LA 43786, LA 45507, LA 45510, and LA 70196. Mean biface flake length for two of these assemblages was over 15.5 mm (LA 45507, LA 45510) and for the other two it was less than 13 mm (LA 43786, LA 70196). The LA 43786 assemblage contains only 1 biface flake, so its contribution to this discrepancy is negligible. However, LA 70196 contains 80 biface flakes, which comprise 11.5 percent of its debitage assemblage. This was discussed earlier as an atypically high proportion for Mogollon assemblages. Most biface flakes from this component (92.5 percent) are obsidian, and nodules of this material from nearby sources tend to be rather small, usually less than 10 cm in diameter. It is even more interesting that 94.7 percent of the biface flakes (including 94.1 percent of the obsidian biface flakes) were found in the fill of the only pithouse excavated at the site. While this might suggest that most biface flakes from LA 70196 derive from a single manufacturing episode, EDXRF analysis of obsidian from the structure indicates that materials from three different sources are present. Therefore, this material could represent debris from the manufacture of three or more obsidian bifaces. Whether this occurred during a single reduction episode or was spread out over decades cannot be determined with available data. While it is possible that we are isolating a technological rather than a behavioral phenomenon, this is uncertain. Unfortunately, with LA 70196 removed from consideration, the size of the Reserve area Late Pithouse biface flake sample is too small for accurate comparison to other periods.

Table 3.77. Mean Whole Flake Dimensions by Area and Artifact Morphology (All Measurements in Millimeters)

Area	Period	Flake Type	Length	Width	Thickness
Luna	Archaic	Core	19.67	17.50	5.42
		Biface	16.41	12.43	1.82
	Late Pithouse	Core	23.77	20.86	7.04
		Biface	16.40	11.10	2.47
	Late Pueblo	Core	24.16	20.57	6.35
		Biface	19.50	13.41	3.15
Reserve	Archaic	Core	18.58	16.89	4.41
		Biface	15.80	12.73	2.14
	Early Pithouse	Core	27.51	24.25	8.14
		Biface	18.27	13.71	3.45
	Late Pithouse	Core	28.45	24.94	8.07
		Biface	12.60	9.91	2.00
	Early Pueblo	Core	31.62	27.27	8.82
		Biface	18.93	14.83	3.19
	Late Pueblo	Core	27.90	24.30	19.70
		Biface	20.73	14.23	3.77
	Protohistoric	Core	22.44	19.70	6.81
		Biface	16.82	12.82	2.34

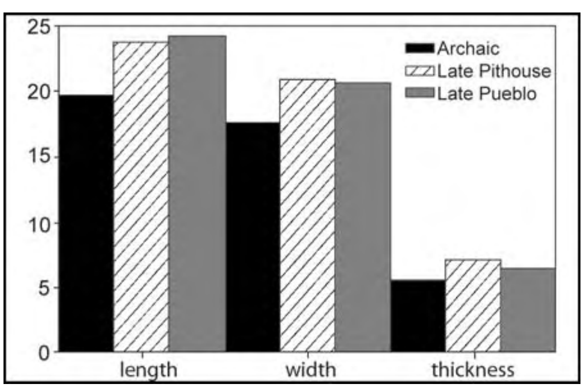

Figure 3.20.Luna area core flake dimensions (mm).

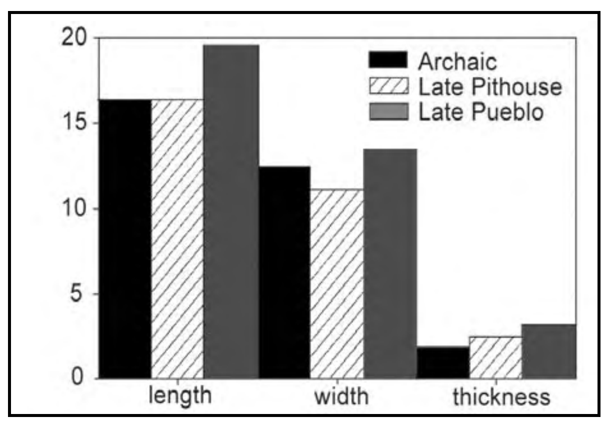

Figure 3.21. Luna area biface flake dimensions (mm).

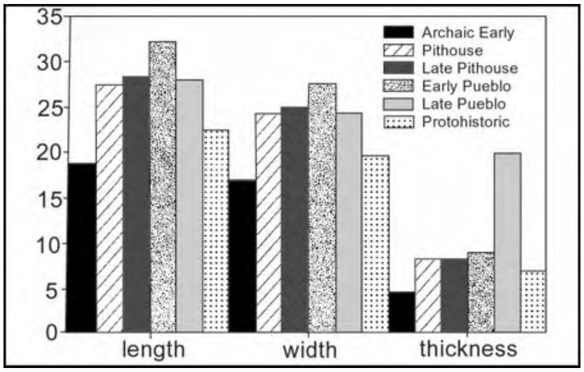

Figure 3.22. Reserve area core flake dimensions (mm).

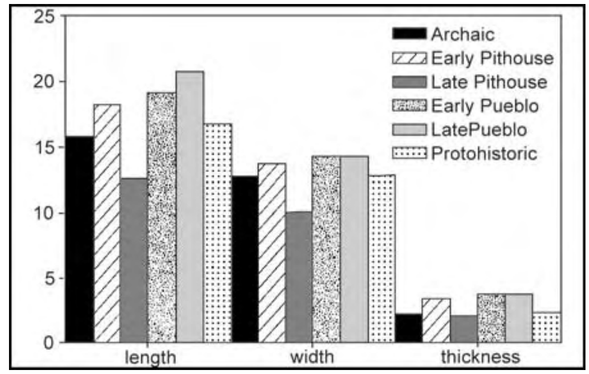

Figure 3.23. Reserve area biface flake dimensions (mm).

Table 3.78. Results of ANOVA Run on Flake Lengths

Area	Period	Flake Type	F	Significance of f
Luna, Reserve	All	Core	350.669	<.0005
		Biface	18.987	<.0005
Luna	All	Core	27.418	<.0005
		Biface	13.994	<.0005
Reserve	All	Core	313.967	<.0005
		Biface	18.638	<.0005
Luna	Late Pithouse and Late Pueblo	Core	0.847	0.357
		Biface	15.329	<.0005
Reserve	Archaic and Protohistoric	Core	379.953	<.0005
		Biface	6.438	0.011
Luna	Early Pithouse through Late Pueblo	Core	47.011	<.0005
		Biface	19.032	<.0005
Reserve	Early Pithouse, Late Pithouse, Late Pueblo	Core	1.106	0.331
		Biface	2.151	0.120

Analysis of the Unmixed Core Assemblages

Table 3.79 illustrates the array of cores in each component. LA 3279 dominates this assemblage, and contains a third of the cores recovered. LA 39968 and LA 39969 also contain large numbers of cores, and together these three assemblages comprise over 60 percent of the core assemblage for the unmixed components. It is interesting that these components all date to the Pueblo period, LA 39969 to the Early Pueblo, and the others to the Late Pueblo period. However, since those components comprise 49 percent of the total unmixed assemblage, this percentage is only slightly higher than expected.

Tested cobbles are nodules from which one or two flakes were removed to determine whether they contained useable material. Overall, only 8.1 percent of the unmixed assemblage is comprised of this category. Technically, these artifacts should not be considered with the other cores because the minimal amount of reduction present either means they were rejected for further use or were tested elsewhere, transported to the site, and then never used. However, since we cannot be certain that this is the case, they will continue to be included in this analysis. This category was relatively rare in most periods except the protohistoric, as shown in Table 3.80.

Undifferentiated cores exhibit no bulb of percussion and have at least three negative scars originating from one or more surfaces. This category is a catch-all for cores that could not be placed in a more specific group. Unidirectional cores have flakes removed in the same direction from one platform, bidirectional cores have flakes removed from two opposing platforms, and multidirectional cores have flakes removed from numerous platforms. The latter are the most common type in every period except the protohistoric. Pyramidal cores are a specialized type that are shaped like cones, have one platform, and terminate in a point at the end opposite the platform. Only one specimen of this type was recovered. Bipolar cores represent the remaining nuclei of nodules that were smashed between an anvil and hammerstone, generally because they were too small for freehand reduction. This type, too, is quite rare in our assemblage, with only two examples being recovered. No single core type is diagnostic of any specific period or level of mobility in this assemblage. Though the pyramidal and bipolar cores only occur in Late Pueblo assemblages, they are so rare that they are useless for differentiating between periods.

Materials can be combined into classes to allow us to more easily examine this attribute. For example, since silicified woods are rare, they can be merged with other chert materials. The distribution of cores by material class and time period is shown in Table 3.81. Since there is only one component in the general Pithouse period category, it is ignored in this discussion. Except for the Early Pueblo period, Luna blue agate is the most common material class. Rhyolite is the most common material class in the Early Pueblo period, but occurred in much smaller percentages in other time periods. Chert is the second most common material class in every case, and is generally followed by either undifferentiated igneous materials or rhyolite. Obsidian cores are rare, and occur only in Archaic and Pueblo period assemblages.

Table 3.82 compares the distribution of material classes for cores and debitage by time period. Some of the differences in proportions in this table may be meaningful. Proportions of chert cores and debitage are rather similar except for the Archaic period. In that case the percentage of chert debitage is nearly double that of cores. The contrast between proportions is even greater for basalt, where the percentage of debitage is nearly 10 times that of cores. In both cases, the much higher debitage percentages are probably indicative of tool manufacture. Materials were either brought to sites in an already reduced state or flakes were struck on-site and then worked into formal tools. In contrast, both Luna blue agate and undifferentiated igneous materials have much higher core percentages, suggesting they were less suitable for tool manufacture and only a few flakes were struck from them. A similar meaning can probably be ascribed to discrepancies in other periods for Luna blue agate (Late Pithouse, protohistoric) and undifferentiated igneous materials (Late Pithouse, Late Pueblo, protohistoric). This situation is reversed for Luna blue agate in the Early and Late Pueblo periods, suggesting that it was reduced to a much further extent during those periods.

Except for the Archaic components, obsidian cores are either absent or comprise a very small percentage in comparison with debitage. Obsidian is very easily worked and possesses the sharpest edges of any of these materials. It is likely that most obsidian cores were reduced until exhausted and then smashed to obtain small useable pieces.

Table 3.83 shows mean core volume and flake to core ratios for each period. In order to account for sample error caused by outliers, the top and bottom 5 percent of the distribution for each time period was dropped. Through time there is a general upward trend in core size, except for the protohistoric period. Pithouse period cores are larger than those of the Archaic, and Pueblo period cores are larger than those of the Pithouse period. The mean volume of protohistoric period cores is larger than those of the Pithouse periods, but much smaller than those of the Pueblo periods.

Meaningful differences are also visible in the ratio of flakes to cores. There is a large and immediate reduction in the ratio of flakes to cores between the Archaic and Early Pithouse period. Interestingly, the potentially atypical Archaic component—LA 78439—has the lowest flake to core ratio at 31.36:1. The reason for the large discrepancy in flake to core ratios between the Early Pithouse and other Mogollon periods (particularly the Late Pithouse and Early Pueblo periods) is unknown, but may be related to sample error. The Early Pithouse assemblage is, by far, the smallest of the Mogollon assemblages. If that period is discounted, Mogollon ratios are moderately low, and at least three times smaller than the Archaic ratio. In contrast, the protohistoric flake to core ratio is only about half that of the Archaic. However, the possible Archaic component represented in the protohistoric components (LA 37917) has a much smaller flake to core ratio than does the other protohistoric component (LA 37919)—36.43:1 versus 144.25:1.

An increase in mean core volume with a concomitant decrease in flake to core ratio suggests that Mogollon cores were not reduced to the same degree as Archaic cores. The extraordinarily high flake to core ratio for the Archaic period is probably also indicative of more large biface manufacture. The production of bifacial tools can create a very large number of flakes. The larger the tool, the more flakes removed from it, and the more likely they will be recovered. While the number of bifacial tools produced probably did not

Table 3.79. Core Types for Unmixed Components; Frequencies and Row Percentages

Component	Tested Cobble	Undiffernitiated	Unidirectional	Bidirectional	Multidirectional	Pyramidal	Bipolar	Total
LA 3279	12 3.3	2 0.6	11 3.0	7 1.9	327 90.6	0 0.0	2 0.6	361 33.2
LA 3563	7 9.2	1 1.3	6 7.9	10 13.2	52 68.4	0 0.0	0 0.0	76 7.0
LA 9721	0 0.0	1 50.0	0 0.0	0 0.0	1 50.0	0 0.0	0 0.0	2 0.2
LA 37917	4 28.6	5 35.7	2 14.3	2 14.3	1 7.1	0 0.0	0 0.0	14 1.3
LA 37919	1 25.0	0 0.0	0 0.0	0 0.0	3 75.0	0 0.0	0 0.0	4 0.4
LA 39968	24 13.2	7 3.8	13 7.1	4 2.2	133 73.1	1 0.5	0 0.0	182 16.7
LA 39969	10 9.2	7 6.4	10 9.2	9 8.3	73 67.0	0 0.0	0 0.0	109 10.0
LA 39972	3 8.8	1 2.9	3 8.8	5 14.7	22 64.7	0 0.0	0 0.0	34 3.1
LA 39975	13 17.1	2 2.6	13 17.1	16 21.1	32 42.1	0 0.0	0 0.0	76 7.0
LA 43766	0 0.0	0 0.0	0 0.0	0 0.0	5 100.0	0 0.0	0 0.0	5 0.5
LA 43786	0 0.0	0 0.0	0 0.0	0 0.0	1 100.0	0 0.0	0 0.0	1 0.1
LA 45507	3 4.7	39 60.9	8 12.5	2 3.1	12 18.8	0 0.0	0 0.0	64 5.9
LA 45508	2 11.1	2 11.1	0 0.0	5 27.8	9 50.0	0 0.0	0 0.0	18 1.7
LA 45510	1 7.7	0 0.0	0 0.0	1 7.7	11 84.6	0 0.0	0 0.0	13 1.2
LA 70185	2 5.0	1 2.5	6 15.0	7 17.5	24 60.0	0 0.0	0 0.0	40 3.7
LA 70188	0 0.0	8 27.6	4 13.8	0 0.0	17 58.6	0 0.0	0 0.0	29 2.7
LA 70196	2 18.2	0 0.0	2 18.2	0 0.0	7 63.6	0 0.0	0 0.0	11 1.0
LA 70201	2 11.1	0 0.0	3 16.7	3 16.7	10 55.6	0 0.0	0 0.0	18 1.7
LA 75792	0 0.0	0 0.0	3 16.7	0 0.0	15 83.3	0 0.0	0 0.0.	48 1.7

Component	Tested Cobble	Undiffferntiated	Unidirectional	Bidirectional	Multidirectional	Pyramidal	Bipolar	Total
LA 78439	2 14.3	5 35.7	1 7.1	1 7.1	5 35.7	0 0.0	0 0.0	14 1.3
Total Percent	88 8.1	81 7.4	85 7.8	72 6.6	760 69.8	1 0.1	2 0.2	1,089 100.0

Table 3.80. Core Morphology by Time Period; Frequencies and Row Percentages

Period	Tested Cobble	Undifferentiated	Unidirectional	Bidirectional	Multidirectional	Pyramidal	Bipolar	Total
Archaic	4 6.1	15 22.7	5 7.6	6 9.1	36 54.5	0 0.0	0 0.0	66 6.1
Early Pithouse	15 15.8	3 3.2	15 15.8	20 21.1	42 44.2	0 0.0	0 0.0	95 8.7
Late Pithouse	6 6.7	39 43.8	10 11.2	3 3.4	31 34.8	0 0.0	0 0.0	89 8.2
Early Pueblo	18 9.0	8 4.0	17 8.5	20 10.0	137 68.5	0 0.0	0 0.0	218 20.3
Late Pueblo	38 6.5	11 1.9	30 5.1	18 3.1	485 82.9	1 0.2	2 0.3	585 53.7
Protohistoric	5 27.8	5 27.8	2 11.1	2 11.1	4 22.2	0 0.0	0 0.0	18 1.7

Table 3.81. Core Material Classes for Each Time Period; Frequencies and Column Percentages

Material Class	Archaic	Early Pithouse	Late Pithouse	Pithouse	Early Pueblo	Late Pueblo	Protohistoric	Total
Chert	18 27.3	32 33.7	20 22.5	1 5.6	50 22.9	138 23.6	6 33.3	263 24.6
Luna Blue	29 43.9	31 32.6	43 48.3	1 5.6	13 6.0	232 39.7	8 44.4	356 33.2
Obsidian	3 4.5	0 0.0	0 0.0	0 0.0	1 0.5	3 0.5	0 0.0	6 0.6
Igneous	7 10.6	9 9.5	6 6.7	0 0.0	42 19.3	86 14.7	3 16.7	152 14.2
Basalt	1 1.5	3 3.2	1 1.1	0 0.0	19 8.7	15 2.6	0 0.0	39 3.6
Rhyolite	5 7.6	12 12.6	15 16.9	16 88.9	77 35.3	70 12.0	1 5.6	184 17.2

Material Class	Archaic	Early Pithouse	Late Pithouse	Pithouse	Early Pueblo	Late Pueblo	Protohistoric	Total
Sedimentary	0 0.0	4 4.2	0 0.0	0 0.0	2 1.0	4 0.7	0 0.0	10 0.9
Metamorphic	3 4.5	4 4.2	4 4.5	0 0.0	14 6.4	37 6.3	0 0.0	61 5.7
Total Percent	66 6.1	95 8.7	89 8.2	18 1.7	218 20.3	585 53.7	18 1.7	1,089 100.0

Table 3.82. Material Classes for Cores Versus Debitage for Each Time Period; Column Percentages

Material Class	Archaic		Early Pithouse		Late Pithouse		Pithouse		Early Pueblo		Late Pueblo		Protohistoric	
	Cores	Debitage	Cores	Debitage	Cores	Debitage	Cores	Debitage	Cores	Debitage	Cores	Debitage	Cores	Debitage
Chert	27.3	51.8	33.7	35.4	22.5	27.2	5.6	6.5	22.9	24.6	23.6	18.6	33.3	39.0
Luna Blue	43.9	21.6	32.6	28.0	48.3	39.9	5.6	5.4	6.0	12.2	39.7	63.2	44.4	23.4
Obsidian	4.5	2.4	0.0	2.3	0.0	7.4	0.0	1.9	0.5	1.8	0.5	2.4	0.0	10.6
Igneous	10.6	1.1	9.5	7.2	6.7	3.0	0.0	1.1	19.3	16.9	14.7	6.4	16.7	5.6
Basalt	1.5	14.8	3.2	3.3	1.1	0.5	0.0	0.2	8.7	3.5	2.6	1.2	0.0	5.4
Rhyolite	7.6	6.9	12.6	17.6	16.9	19.7	88.9	83.7	35.3	36.4	12.0	5.1	5.6	13.9
Sedimentary	0.0	0.1	4.2	1.4	0.0	0.1	0.0	0.0	.9	0.4	0.7	0.4	0.0	0.0
Metamorphic	4.5	1.3	4.2	4.7	4.5	2.2	0.0	1.1	6.4	4.1	6.3	2.8	0.0	2.1

Table 3.83. Core Data by Period

Period	Mean Core Volume (Cm^3)	Flake to Core Ratio
Archaic	2,271.27	112.17:1
Early Pithouse	3,281.60	16.50:1
Late Pithouse	3,029.70	36.25:1
Early Pueblo	3,847.40	28.65:1
Late Pueblo	4,562.19	19.37:1
Protohistoric	3,378.33	60.39:1

decline after the Archaic period (and in fact may have increased), mean tool size did decrease. This is because fewer large generalized bifaces were used, and projectile point size decreased because of the adoption of the bow. At the same time, the likelihood that debitage from the manufacture of small bifacial tools would be recovered also decreased. Thus, Mogollon debitage assemblages are more indicative of core reduction because the size and recoverability of debitage resulting from biface manufacture decreased tremendously.

There are also differences in the mean size of cores and amount of cortex remaining for the Luna and Reserve areas (Table 3.84). Overall, Luna area cores are smaller than those from the Reserve area and exhibit smaller amounts of cortical coverage. This tendency carries over into most core categories, with the exception of unidirectional cores, which are larger and have more cortical coverage in the Luna area. These attributes are probably closely related; the more cores have been reduced, the smaller they are and the less cortex that remains. Instead of nodules being smaller in the Luna area, they appear to have been reduced to a greater extent than in the Reserve area. Thus, percentages of primary flakes are larger for the Reserve area because fewer flakes were struck from core interiors. Similarly, mean flake sizes are smaller for the Luna area because flakes get smaller as cores are reduced. The difference in materials between these areas was not in the size of nodules, but in amounts of materials available for use. Suitable materials appear to have been less common in the Luna area, leading to a more intensive reduction of cores before they were discarded.

A final point concerning cores is that when materials are combined to even out potential discrepancies in original nodule size, one would expect the degree of reduction to be reflected in mean volume. Thus, unidirectional cores (which possess only a single platform) should be larger than bidirectional cores (which possess two opposed platforms), and bidirectional cores should be larger than multidirectional cores (which possess multiple platforms). Logically, tested cobbles should be the largest category of all because less material has been removed from them. Undifferentiated cores are expected to be the smallest, since they could not be assigned to a more specific category. The degree of reduction should also be reflected by dorsal cortex percentages. Pyramidal and bipolar cores are not considered because samples of these types are too small.

Again, in order to eliminate potential sample error due to outlying cases, the upper and lower 5 percent of the distribution for each type is dropped. As Table 3.85 illustrates, several of our expectations are upheld by the data. Unidirectional cores have the largest mean volume, followed by the bidirectional and multidirectional categories. Unidirectional and bidirectional cores have similar mean percentages of dorsal cortex, and the multidirectional category has somewhat less. Tested cobbles and undifferentiated cores have the highest mean dorsal cortex percentages, but have smaller mean volumes than the other categories. This suggests that "tested cobble" may be a misnomer in this case. Core testing should occur in quarries rather than at sites, since transporting unsuitable nodules would be a waste of effort. These artifacts may simply represent small nodules that were minimally reduced to procure flakes and then discarded when further efforts were unlikely to produce useable debitage. Similarly, most of the undifferentiated cores may also fall into this category.

Table 3.84. Mean Volumes and Cortex Percentages of Major Core Types for the Luna and Reserve Areas

Core Type	Luna Area		Reserve Area	
	Cortex (pct)	Core Volume (cm^3)	Cortex (pct)	Core Volume (cm^3)
Tested cobble	48.5	1,083.08	57.5	1,595.37
Unidirectional	38.2	1,851.96	35.7	1,230.16
Bidirectional	17.2	2,408.84	43.3	2,604.97
Multidirectional	24.6	1,244.96	44.2	1,564.23
Overall	21.0	1,442.62	36.7	1,874.42

Table 3.85. Mean Volumes and Dorsal Cortex Percentages by Core Types

Core Type	Mean Volume (cm^3)	Mean Dorsal Cortex
Tested cobble	2,170.97	70.42
Undifferentiated	2,200.12	64.34
Unidirectional	3,392.94	55.56
Bidirectional	2,294.49	56.72
Multidirectional	2,062.26	43.73

CHARACTERIZING ASSEMBLAGES FROM DIFFERENT PERIODS

From the numerous data explored thus far, one might conclude that the various temporal assemblages are more characterized by diversity than similarity. This may be true of the Mogollon components, but there are certainly enough differences between them, the Archaic, and perhaps the protohistoric components to allow us to define general attributes that characterize each of these broad temporal periods. The two study areas can also be compared and contrasted in order to determine how location may have affected material use and reduction strategy.

Archaic Assemblages

Four Archaic components were examined—LA 43766, LA 45508, LA 70188, and LA 78439. The projectile point analysis (see *Projectile Points*) suggests that the main occupations at these sites all occurred during the Late Archaic period. While some Early and Middle Archaic points were found in unmixed deposits at some sites, in nearly every case they seem to represent curated tools rather than evidence of site use at an earlier date. The only exceptions to this were Pelona points from LA 43766, and our analysis indicates that use of this type probably persisted into the Late Archaic period. Thus, the presence of earlier projectile point styles notwithstanding, these components all appear to have been occupied during the Late Archaic period.

LA 78439 may be our earliest Archaic component, with a potential occupational date ca. 1950 B.C. Even considering the likelihood that this date reflects the use of old wood, an occupation very near the beginning of the Late Archaic period is indicated. LA 43766 is the second oldest component, with occupations dating between ca. 1260 and 884 B.C. At least two occupations were noted, but have not been separated into individual components in this analysis. When debitage assemblages from these strata are compared, they seem to represent a single population, though the association is weak (chi-square = 17.865, df = 12, significance = .11985; Cramer's V = .05587). Platform modification data also weakly suggest that a single population is represented (chi-square = 6.065, df = 4, significance = .19436; Cramer's V = .09090). Thus, this component will continue to be treated as a single assemblage.

Absolute dates were not obtained for the Archaic component at LA 45508, and it was assigned a general Late Archaic affiliation based on projectile point styles. The Archaic component at LA 70188 may be the latest of those examined, with a suggested date between 50 B.C. and A.D. 40. However, there were also earlier dates for this site indicating that it could have been occupied between 2000 B.C. and A.D. 40. With one component dating to the early part of the Late Archaic period, one nearer the middle, one either near the middle or the end of the period, and one that cannot be accurately placed it is no wonder that there was little correspondence between these assemblages.

In general, Archaic assemblages are characterized by high percentages of biface flakes and low percentages of angular debris. LA 78439 is a partial exception to this since it contains fairly low percentages of angular debris (14.8 percent) and biface flakes (8.3 percent). In general, fewer pieces of angular debris were recovered from Reserve area components than Luna components. This tendency is visible in the Archaic assemblages; only one Archaic component was investigated in the Luna area (LA 45508), and it had the largest percentage of angular debris for the period.

Overall, percentages of primary flakes are low and percentages of noncortical interior flakes are high for all Archaic components. However, the LA 78439 assemblage contains a comparatively high percentage of cortical debitage, nearly as high as that of Pithouse period components from the same area (Reserve). Though Reserve area Archaic components (except for LA 78439) contain a slightly higher percentage of cortical flakes than the Luna area component, they all represent a single population, though the association is weak (chi-square = 2.299, df = 2, significance = .3168; Cramer's V = .01817).

Modification of flake platforms is also a characteristic of Archaic components. With missing and obscured platforms dropped, between 23.0 and 63.2 percent of flake platforms in Archaic components were modified. These percentages only overlap with three Mogollon components, one of which contains very few artifacts (LA 9721); the high percentage of modified platforms in that instance is probably due to sample error. Interestingly, platform retouch is much more prevalent in Archaic components than in those from later periods. As far as this attribute is concerned, LA 78439 fits with the other Archaic components, both in general and with those from the Reserve area. Indeed, this component has the highest percentage of modified platforms for the Reserve area, and the second highest overall. This contrasts with a comparatively small percentage of biface flakes, suggesting that the latter percentage may be illusory, and more biface manufacture may have been occurring in this component than is indicated by the same percentages. Platforms are modified on 76.5 percent of the biface flakes and 34.5 percent of the core flakes in this assemblage. It is possible that most core flakes with modified platforms were removed during early stage tool manufacture when it is often difficult to distinguish between core and biface flakes, even considering the flexibility of the polythetic set used to define flake types. This may in part explain the difference in debitage assemblage composition between this and the other Archaic components. Conversely, it may simply be an indication of more careful core reduction, with platforms on both bifaces and cores being modified to facilitate flake removal.

As expected, Archaic components also contain the smallest percentage of whole flakes overall. However, the percentage of whole flakes for LA 78439 was much higher than the other Archaic components, and close to those of the Mogollon periods. Again, this could be evidence for early-stage biface reduction. As tool manufacture proceeds, flakes become progressively thinner and more prone to breakage by secondary compression. Thus, the presence of high percentages of modified platforms in conjunction with smaller percentages of broken flakes may indicate early-stage biface reduction. However, this could also indicate a higher reliance on careful core reduction rather than biface manufacture.

The amount of Luna blue agate reduced in a component had a profound effect on the proportion of angular debris produced. For all time periods in both study areas the flake to angular debris ratio for Luna blue agate was considerably lower than it was for all other materials combined. Table 3.86 shows how the presence of Luna blue agate affected flake to angular debris ratios for the Archaic components. When all materials are considered, LA 45508 has the lowest flake to angular debris ratio, and is the only Archaic component from the Luna area. With Luna blue agate removed, all flake to angular debris ratios increase except for LA 43766, which remains much the same because that assemblage contains few pieces of Luna blue agate. Interestingly, LA 78439 has the second highest and highest flake to angular debris ratio when Luna blue agate was included, respectively, and excluded from these calculations. Conversely, it has the smallest flake to core ratio of the Archaic components, though that ratio is larger than that of any Mogollon period except the Late Pithouse. In general, Archaic cores are the smallest in volume. This along with generally high flake to core ratios suggests that Archaic cores were reduced to a greater extent than those of later time periods.

Except for a few differences that can mostly be attributed to more reduction of Luna blue agate in the Luna component, assemblages from both areas are more similar to one another for this period than are components of the later periods represented in both areas. Percentages of biface flakes and modified platforms in most Archaic components suggest a considerable amount of large biface manufacture. Platform modification differs from that of later periods in that more retouch is evident, though abrasion without retouch is also common. More flake breakage is generally visible in these assemblages than in those from later periods, and flake to angular debris and flake to core ratios are higher. All of these factors point to a high degree of large biface manufacture, probably in anticipation of need in a highly mobile system.

Table 3.86. Flake to Angular Debris Ratios for Archaic Components, With and Without Luna Blue Agate

Component	All Materials	Luna Blue Excluded
LA 43766	6.39:1	6.38:1
LA 45508	3.67:1	6.32:1
LA 70188	4.50:1	7.05:1
LA 78439	5.78:1	7.49:1

Mogollon Assemblages

Eleven Mogollon assemblages dating to five periods were examined, including the Early Pithouse period (LA 39972 and LA 39975), Late Pithouse period (LA 45510, LA 43786, LA 45507, and LA 70196), general Pithouse period (LA 70201), Early Pueblo period (LA 3563, LA 39969, LA 39972, and LA 75792), and Late Pueblo period (LA 3279, LA 9721, LA 39968, and LA 70185). Only the Late Pithouse (LA 45510 and LA 45507) and Late Pueblo periods (LA 3279 and LA 70185) were represented in the Luna area; all other Mogollon components were in the Reserve area. Since either pithouses or roomblocks were associated with each of these sites, they all represent residential locales.

In general, Mogollon assemblages are characterized by low percentages of biface flakes. However, both LA 70185 and LA 70196 contain higher than expected percentages. In the case of LA 70196 there may be a satisfactory explanation for this variation. Most biface flakes from that component were recovered from fill in a pithouse, and most of those artifacts are obsidian and may derive from a single reduction episode. Thus, we appear to have a situation where several large bifaces were manufactured and the debris was tossed into an abandoned pithouse, or the debris was discarded near an occupied pithouse and subsequently washed in. Whatever the cause, this is an anomalous situation. LA 70185 cannot be as satisfactorily explained. Biface flakes were not clustered in this component, but were scattered over a fairly wide area. Either there was more large biface manufacture in this component than expected, or it is contaminated by an Archaic occupation that went unnoticed during excavation. The former is considered most likely. Even though percentages of biface flakes are larger than expected in these assemblages, they are much lower than Archaic percentages, with the exception of LA 78439.

Overall, Archaic components contain 17.5 percent angular debris and Mogollon components 33.4 percent. While Mogollon assemblages usually contain higher proportions of angular debris than the Archaic assemblages, there is quite a bit of variation from component to component and from area to area, so this relationship does not always hold true. For example, LA 70185 contains the smallest percentage of angular debris for the Luna area, and LA 70196 is in the middle of the pack for the Reserve area, but is lower than all of the Archaic components.

As a group, Mogollon components tend to contain smaller percentages of noncortical interior flakes and higher percentages of cortical flakes than Archaic components. However, these figures vary considerably by study area as shown in Table 3.87. Archaic components from both areas have similar percentages of noncortical and cortical flakes. Figures for the Luna area are similar for Archaic and Mogollon components, while Mogollon assemblages from the Reserve area contain considerably more cortical flakes. Thus, locational as well as temporal considerations must be taken into account for this variable.

There is generally much less evidence of platform modification in Mogollon assemblages than in Archaic components. As noted earlier, there are only three cases where Mogollon assemblages overlap with Archaic components for this attribute, and in one case this is probably due to sample error. The other cases include Early Pithouse (LA 39972) and Late Pithouse (LA 45510) components. Some differences in type of platform modification also occur in these assemblages. Retouch is most prevalent during the Archaic period, with abrasion dominating the Mogollon assemblage. However, percentages of retouched platforms vary considerably within individual periods—8.9 percent for the Early Pithouse (213 cases), 29.9 percent for the Late Pithouse period (284 cases), 11.2 percent for the Early Pueblo period (329 cases), and 41.0 percent for the Late Pueblo period (539 cases). Thus, by itself this variable is not a definitive characteristic.

Table 3.87. Variation In Dorsal Cortex Percentages on Flakes between Occupational Periods in the Luna and Reserve Areas

Occupational Period	Luna Area			Reserve Area		
	0%	1-49%	50-100%	0%	1-49%	50-100%
Archaic	89.6	6.2	4.2	86.6	7.9	5.5
Mogollon	87.9	6.2	5.9	57.6	23.8	18.6

While there is quite a bit of variation by time period, Mogollon assemblages tend to contain higher percentages of whole flakes than Archaic components. Flake to angular debris ratios are also lower for Mogollon components, particularly when Luna blue agate is discounted. Mogollon cores tend to be larger than those of the Archaic, and the ratio of flakes to cores is generally much lower. Thus, Mogollon assemblages tend to be distinct from those of the Archaic. Most importantly, there is considerably less evidence for the manufacture of large bifaces in Mogollon assemblages. Even though the amount of debris from large biface reduction tends to vary from site to site, few (if any) of the Mogollon assemblages could be mistaken for an Archaic assemblage from the same area. Analysis suggests that expedient core-flake reduction predominated in each Mogollon assemblage. Evidence of this takes the form of relatively high percentages of angular debris (in many cases), low flake to angular debris and flake to core ratios, and relatively small percentages of biface flakes and modified platforms.

Even though Mogollon and Archaic assemblages can be distinguished from one another, it is difficult to discriminate between assemblages from the various Mogollon periods. However, certain trends are visible in the data. Chi-square analyses of Mogollon flake assemblages (Table 3.62) weakly suggest that single populations are represented for the Early Pithouse and Late Pithouse periods. With LA 70185 and LA 70196 (the possibly anomalous components) removed, there are weak indications that all but the Early Pueblo components represent single populations. However, while there is some association between components *within* time periods, there is no correspondence *between* time periods.

A trend was visible in amount and type of platform modification through time. As Table 3.70 showed, percentages of modified platforms decreased steadily through time from the Archaic through Late Pueblo periods. However, the largest drops were between Archaic and Early Pithouse periods, and Early Pithouse and Late Pithouse periods. There was no correspondence between Mogollon period and amount of platform retouch versus abrasion (Table 3.71). Similarly, no real trends were visible in percentages of whole versus broken flakes (Table 3.73).

Flake to angular debris ratios dropped sharply between the Archaic and Early Pithouse periods, but remain relatively steady until the Late Pueblo period, when they again drop sharply (Table 3.75). These trends remain when Luna blue agate is dropped from consideration (Table 3.76), indicating that while the amount of this tough, brittle material used in an assemblage tends to lower the flake to angular debris ratio, it is not the only factor responsible for these trends.

Flake size data provided some interesting insights into these assemblages. A series of ANOVA tests run on whole flake lengths suggest there is a significant correspondence between core flakes from Late Pithouse and Late Pueblo components in the Luna area (Table 3.78). Significant associations were found between both core and biface flake lengths when Early Pithouse, Late Pithouse, and Late Pueblo assemblages were compared for the Reserve area (Table 3.79). However, when Early Pueblo period assemblages were factored in, the results indicate that different populations are represented. Thus, in terms of flake length, the Early Pueblo components are distinct from other Mogollon assemblages from that area.

This analysis suggests that while there is temporal variation in the distribution of many attributes, Early Pithouse, Late Pithouse, and Late Pueblo assemblages tend to be fairly similar to one another. Early Pueblo period assemblages are similar to the others in some ways, but in others are quite different. It may be possible to date assemblages that are mixed or of questionable temporal association by comparing them with data from this analysis, but it is likely that such assignments will have to be made to very general Archaic or Mogollon periods.

Protohistoric Assemblages

Two potential protohistoric components were examined—LA 37917 and LA 37919. Projectile point analysis suggested that LA 37917 either represents an Archaic component or a multicomponent locale. However, data provided by this analysis suggest that this conclusion may not be correct. In some ways protohistoric components resemble those of the Archaic, in others they are similar to Mogollon components, and in still others they are more similar to one another than they are to assemblages from any other time period.

Table 3.88 compares debitage percentages for major time periods and by area. Overall, there is no correspondence in assemblage composition between these periods (chi-square = 2542.907, df = 4, significance = <.000005; Cramer's V = .24323). Protohistoric and Archaic angular debris percentages are similar, as are percentages of biface flakes for the Mogollon and potohistoric components. These trends continue to hold up when just the Reserve area is examined, and the protohistoric assemblages resemble neither of those from the Luna area. Table 3.89 illustrates debitage percentages by period for the Reserve area. Again, there is no overall correspondence between assemblages (chi-square = 3193.769, df = 12, significance = <.000005; Cramer's V = .27258). The closest resemblance is between the Early Pithouse and protohistoric periods, and a chi-square test weakly suggests that these assemblages could be from the same population (chi-square = 4.766, df = 2, significance = .09228; Cramer's V = .03795). While this does not indicate that these components date to the same period, it does suggest that there might be some technological similarities. When the protohistoric components are compared, a chi-square test weakly suggests that they represent the same population (chi-square = 3.904, df = 2, significance = .14196; Cramer's V = .05424).

Dorsal cortex percentages for flakes from major time periods are compared in Table 3.90. There is no overall correspondence in these assemblage (chi-square = 648.340, df = 4, significance = <.000005; Cramer's V = .08828). When broken down by areas, assemblages remain quite different. Table 3.91 examines dorsal cortex percentages on flakes by period for the Reserve area. The only real similarity is in the relatively low percentages of noncortical flakes exhibited by Mogollon and protohistoric components. However, a chi-square test suggests there is no significant relationship between these assemblages (chi-square = 322.101, df = 8, significance = <.000005; Cramer's V = .10929). The similarity seen in Early Pithouse and protohistoric period debitage percentages is not repeated for this attribute (chi-square = 19.550, df = 2, significance = .00006; Cramer's V = .07686). When the protohistoric components were compared, chi-square analysis suggested that they represent the same population at the 99.9 percent confidence level, though this is a weak association that is not highly significant.

When platform modification is considered, the protohistoric assemblages are more similar to the Archaic than they are the Mogollon assemblages. Indeed, a chi-square test suggests that the Archaic and protohistoric components represent a single population (chi-square = .906, df = 1, significance = .34124; Cramer's V = .01409). While this relationship is signifi cant, it is also very weak. When protohistoric components are compared, similar results are derived; there is a significant but weak association (chi-square = .347, df = 1, significance = .556; Cramer's V = .02396).

When type of platform modification is examined the protohistoric components are more similar to Mogollon than Archaic assemblages (see Table 3.72). When Pithouse, Pueblo, and protohistoric components are compared, there is no significant association (chi-square = 17.807, df = 2, significance = .00014, Cramer's V = .10885). When just the Pithouse and protohistoric periods are compared, there is a very weak but significant correlation between them (chi-square = .011, df = 1, significance = .91784; Cramer's V = .00391). When Early and Late Pithouse periods are separated and compared with protohistoric components, the significant relationship disappears (chi-square = 28.757, df = 2, significance = <.000005; Cramer's V = .20564). Thus, there may be a statistical relationship between the general Pithouse period and the protohistoric period for this variable, but it is unlikely that there is any real correlation. When both protohistoric assemblages are compared, there is a weak but significant correlation (chi-square = .347, df = 1, significance = .556; Cramer's V = .02396).

The distribution of whole and broken flakes appears to be rather similar for the protohistoric and Mogollon assemblages (Table 3.73). However, when this is tested, no significant relationship between components from these periods is demonstrated (chi-square = 71.948, df = 4, significance = <.000005; Cramer's V = .05829). While there appears to be a significant relationship between Late Pueblo and protohistoric components, it is very weak (chi-square = 1.213, df = 1, significance = .27074; Cramer's V = .00989). A similar comparison between protohistoric components suggests that they represent a single population, but the relationship is weak and not highly significant (chi-square = 6.442, df = 1, significance = .01115; Cramer's V = .07702).

Protohistoric flake to angular debris ratios are higher than any of the Mogollon components, and very similar to those of the Archaic assemblages (Table 3.75). When Luna blue agate is eliminated, the disparity between protohistoric and Mogollon flake to angular debris ratios increases, and the protohistoric ratio is slightly higher than that of the Archaic components (Table 3.76). It is possible that the protohistoric components represent a single population, but the relationship between them is weak and not highly significant (chi-square = 3.241, df = 1, significance = .07181; Cramer's V = .04942).

When cores are considered, the protohistoric components do not closely resemble any earlier assemblage. The mean volume of protohistoric cores is larger than that of the Archaic and Pithouse periods, but smaller than that of the Pueblo periods (Table 3.83). While the protohistoric flake to core ratio is only slightly more than half that of the Archaic, it is much larger than those of the Pithouse and Pueblo periods (Table 3.84). Unfortunately, core assemblages from these sites are not directly comparable because the LA 37917 assemblage is nearly four times as large as the LA 37919 assemblage, and there are few specimens from the latter. Since similar numbers of flakes occur in these assemblages, there is no correspondence between their flake to core ratios. In fact, LA 37919 is more responsible for the high ratio (at 144.25:1) than is LA 37917 (at 36.43:1).

Table 3.88. Comparison of Debitage Percentages by Major Time Periods; Frequencies and Row Percentages

Period	Angular Debris	Core Flake	Biface Flake	Area	Angular Debris	Core Flake	Biface Flake
Archaic	1,571 17.5	5,201 58.0	2,202 24.5	Luna	319 21.4	757 50.9	412 27.7
				Reserve	1,252 16.7	4,444 59.4	1,790 23.9
Mogollon	10,812 33.4	20,627 63.7	928 2.9	Luna	7,470 40.1	10,540 56.6	605 3.3
				Reserve	3,213 24.3	10,087 73.4	323 2.4
Protohistoric	240 18.1	1,043 78.6	44 3.3	Reserve	240 18.1	1,043 78.6	44 3.3

Table 3.89. Comparison of Debitage Percentages by Period for the Reserve Area; Frequencies and Row Percentages

Period	Angular Debris	Core Flake	Biface Flake
Archaic	1,252 16.7	4,444 59.4	1,790 23.9
Early Pithouse	415 20.9	1,493 75.3	74 3.7
Late Pithouse	86 9.5	723 80.0	95 10.5
Early Pueblo	1,314 21.0	4,825 77.2	110 1.8
Late Pueblo	1,500 36.6	2,563 62.6	32 0.8
Protohistoric	240 18.1	1,043 78.6	44 3.3

Table 3.90. Comparison of Dorsal Cortex Percentages on Flakes by Major Time Periods; Row Percentages

Period	0%	1 to 49%	50 to 100%	Area	0%	1 to 49%	50 to 100%
Archaic	87.0	8.2	4.7	Luna	87.4	8.4	4.2
				Reserve	87.0	8.2	4.8
Mogollon	73.3	14.7	12.0	Luna	87.9	6.2	5.9
				Reserve	57.6	23.8	18.6
Protohistoric	64.7	26.1	9.3	Reserve	64.7	26.1	9.3

Table 3.91. Comparison of Dorsal Cortex Percentages on Flakes by Period for the Reserve Area; Row Percentages

Period	0%	1 to 49%	50 to 100%
Archaic	87.0	8.2	4.8
Early Pithouse	61.1	24.5	14.4
Late Pithouse	61.4	23.3	15.3
Early Pueblo	53.6.2	27.6	18.8
Late Pueblo	66.8	17.5	15.8
Protohistoric	64.7	26.1	9.3

While there are some similarities between protohistoric and Archaic or Mogollon assemblages, the protohistoric components are more similar to one another than they are to assemblages from any other period. This creates a quandary. While radiocarbon samples suggest a protohistoric date for LA 37917, the projectile point analysis suggested that it either contains an Archaic component or was perhaps mostly Archaic with a thin veneer of protohistoric materials. There is no good evidence for multiple components at LA 37919, which appears to represent a "pure" protohistoric component. Since these assemblages are very similar in composition, they are either both Archaic (which is unlikely since they don't really resemble the Archaic assemblages), or they are both protohistoric. The latter is likely, and it is probable that the Archaic projectile points recovered from LA 37917 were all curated.

Thus, the protohistoric components seem to have a distinct character that is not quite Archaic or Mogollon. These assemblages contain relatively low percentages of angular debris and biface flakes. In this they are somewhat similar to the Early Pithouse components. Percentages of flakes that lack dorsal cortex are comparatively low, and more similar to the Mogollon components than the Archaic. Even though biface flakes form only a small part of the debitage assemblage, there is a considerable amount of platform modification in the protohistoric assemblages, an amount that is statistically similar to that of the Archaic. However, different types of modification were used in these periods, with considerably less platform retouch occurring in protohistoric than in Archaic assemblages. Protohistoric components contain higher percentages of broken flakes than the Archaic assemblages, but flake to angular debris ratios are high and very similar to those of the Archaic. There is no resemblance between the protohistoric core assemblage and any other period; mean core size falls in the middle of the pack—above that of the Archaic and Pithouse periods and below that of the Pueblo periods. Finally, there is a fairly high ratio of flakes to cores in protohistoric assemblages, on the average much larger than those of any Mogollon period, but considerably lower than the Archaic mean.

Exploring the Mixed Assemblages

We have thus far examined the unmixed assemblages and produced a set of what hopefully are defining characteristics for each major period. Data from the mixed assemblages will now be examined and compared to those sets of attributes. Hopefully, this will allow us to speculate about the character of the mixed assemblages and determine whether they mostly represent materials from a single component or are so mixed that they cannot be separated.

Mixed assemblages were defined for nine sites, and can be divided into several categories depending upon the dates of the components thought to be present. Mixed Late Archaic and Mogollon components were defined for three sites. In addition to Archaic assemblages, LA 43766 may contain Early Pithouse materials, and LA 89847 may contain artifacts from both the Pithouse and Pueblo periods. Two components (LA 70188 and LA 89846) evidence Archaic, Mogollon, and protohistoric use. LA 78439 seems to contain Archaic and Mogollon materials. Two components (LA 39972 and LA 70191) contain materials from the Early Pithouse and Early Pueblo periods. Finally, two components (LA 70189 and LA 75791) contain mixed Mogollon and protohistoric assemblages. Tables 3.92 through 3.99 contain summary data for these components; while they are not discussed in detail, they provide data comparable to those presented for the unmixed assemblages.

The last section presented attribute and ratio summaries for each major time period. Chipped stone assemblages from these periods were distinct enough to be differentiated from the others, and their more definitive characteristics can be tabulated for comparison with the mixed assemblages. Hopefully, this will allow us to suggest whether the mixed assemblages are representative of a single time period, or contain significant numbers of artifacts from multiple periods.

Table 3.92. Chipped Stone Assemblage Data for All Mixed Components; Frequencies and Row Percentages

Component	Debitage	Core	Cobble Tool	Flaked Tool	Total
LA 43766	4,217 97.6	16 0.4	0 0.0	87 2.0	4,320 23.2
LA 45508	940 97.0	15 1.5	0 0.0	14 1.4	969 5.2
LA 70188	10,686 97.4	104 0.9	3 0.03	174 1.6	10,967 58.8
LA 70189	308 95.7	11 3.4	0 0.0	3 0.9	322 1.7
LA 70191	179 97.8	1 0.5	0 0.0	3 1.6	183 1.0
LA 75791	138 95.2	5 3.4	0 0.0	2 1.4	145 0.8
LA 78439	219 90.5	10 4.1	3 1.2	10 4.1	242 1.3
LA 89846	1,078 98.4	6 0.5	0 0.0	12 1.1	1,096 5.9
LA 89847	398 99.0	2 0.5	0 0.0	2 0.5	402 2.2
Total Percent	18,163 97.4	170 1.0	6 0.003	307 1.7	18,640 100.0

Table 3.93. Debitage Types for the Mixed Components; Frequencies and Row Percentages

Component	Angular Debris	Core Flake	Biface Flake	Total
LA 43766	786 18.6	2,299 54.5	1,132 26.8	4,217 23.2
LA 45508	150 16.0	538 57.2	252 26.8	940 5.2
LA 70188	2,005 18.8	5,676 53.1	3,005 28.1	10,686 58.8
LA 70189	67 21.8	227 73.7	14 4.5	308 1.7
LA 70191	26 14.5	116 64.8	37 20.7	179 1.0
LA 75791	11 8.0	121 87.7	6 4.3	138 0.8
LA 78439	38 17.4	172 78.5	9 4.1	219 1.2
LA 89846	520 48.2	551 51.1	7 0.6	1,078 5.9
LA 89847	196 49.2	194 48.7	8 2.0	398 2.2
Total Percent	3,799 20.9	9,894 54.5	4,470 24.6	18,163 100.0

Table 3.94. Amount of Dorsal Cortex on Flakes for Mixed Components by Location; Frequencies and Row Percentages

Location	Component	0%	1 to 49%	50 to 100%	Total
Luna	LA 45508	696 88.1	50 6.3	44 5.6	790 5.5
	LA 89846	458 82.1	51 9.1	49 8.8	558 3.9
	LA 89847	188 93.1	4 2.0	10 5.0	202 1.4
Reserve	LA 43766	2,806 81.8	329 9.6	296 8.6	3,431 23.9
	LA 70188	7,639 88.0	660 7.6	382 4.4	8,681 60.4
	LA 70189	168 69.7	38 15.8	35 14.5	241 1.7
	LA 70191	106 69.3	25 16.3	22 14.4	153 1.1
	LA 75791	70 55.1	37 29.1	20 15.7	127 0.9
	LA 78439	118 65.2	41 22.7	22 12.2	181 1.3

Analysis of the unmixed assemblages suggested that while no one attribute can discriminate between assemblages from different time periods, an array of attributes can be used as fairly accurate indicators. These attributes are shown in Table 3.100 and, for the most part, are only useful in placing assemblages in major time divisions such as Archaic, Mogollon, or protohistoric. We may be able to suggest membership in temporal subdivisions of these periods, but this will be much more tentative. Each mixed assemblages is discussed separately in relation to the components thought to be present. One difference from the preceding discussion is that all cores are considered when determining mean core volume, rather than dropping the upper and lower 5 percent.

Luna Area Sites

LA 45508, Humming Wire. While the north part of this site seemed to contain unmixed Archaic materials, the south part contained a mixture of Archaic and Early Pithouse deposits. The Archaic assemblage was discussed in the context of the unmixed assemblages, and is available for comparative purposes.

When compared with the overall Archaic attributes in Table 3.100, the mixed assemblage from LA 45508 shows many similarities. It contains a higher percentage of biface flakes than both the overall and Luna Archaic assemblages. There is a slightly lower percentage of angular debris in this component than in the overall assemblage, and a much smaller percentage than the unmixed Luna Archaic assemblage. The percentage of interior flakes is slightly higher than in either of the comparative assemblages. Modified platforms are much more common in the mixed LA 45508 assemblage than in the overall Archaic assemblage, but they are less common than in the unmixed Luna Archaic assemblage. Retouched platforms occur in higher percentages than in either of the comparative assemblages, while the proportion of whole flakes is somewhat larger than the overall assemblage and smaller than the unmixed Luna assemblage. The flake to angular debris ratio is higher than either comparative assemblage, and the flake to core ratio is lower. However, the latter is much larger than the Mogollon component means in both comparative assemblages. Finally, mean core volume is higher than either comparative assemblage, and is closer to that of the Mogollon assemblages from the Luna area.

Table 3.95. Platform Types for the Mixed Components; Frequencies and Row Percentages

Component	Cortical	Single Facet	Single Facet and Abraded	Multifacet	Multifacet and Abraded	Retouched	Retouched and Abraded	Abraded	Collasped	Crushed	Absent	Obscured	Total
LA 43766	152 4.4	560 16.3	105 3.1	492 14.3	119 3.5	143 4.2	96 2.8	21 0.6	932 27.2	9 0.3	798 23.3	4 0.1	3,431 23.9
LA 45508	28 3.5	56 7.1	35 4.4	56 7.1	27 3.4	36 4.6	66 8.4	17 2.2	259 32.8	36 4.6	173 21.9	1 0.1	790 5.5
LA 70188	276 3.2	1,767 20.4	350 4.0	1,657 19.1	376 4.3	277 3.2	213 2.5	148 1.7	1,351 15.6	212 2.4	2,030 23.4	24 0.3	8,681 60.4
LA 70189	24 10.0	42 17.4	26 10.8	42 17.4	11 4.6	1 0.4	1 0.4	3 1.2	47 19.5	7 2.9	37 15.4	0 0.0	241 1.7
LA 70191	12 7.8	27 17.6	9 5.9	11 7.2	6 3.9	5 3.3	4 2.6	3 2.0	35 22.9	2 1.3	38 24.8	1 0.7	153 1.1
LA 75791	18 14.2	28 22.0	3 2.4	14 11.0	5 3.9	2 1.6	0 0.0	1 0.8	34 26.8	2 1.6	20 15.8	0 0.0	127 0.9
LA 78439	19 10.5	32 17.7	4 2.2	29 16.0	10 5.5	11 6.1	2 1.1	5 2.8	30 16.6	11 6.1	27 14.9	1 0.6	181 1.3
LA 89846	20 3.6	96 17.2	2 0.4	65 11.7	8 1.4	8 1.4	6 1.1	3 0.5	145 26.0	11 2.0	193 36.6	0 0.0	557 3.9
LA 89847	5 2.5	50 24.8	0 0.0	20 9.9	2 1.0	10 5.0	5 2.5	1 0.5	71 35.1	3 1.5	35 17.3	0 0.0	202 1.4
Total Percent	554 3.9	2,659 18.5	534 3.7	2,386 16.6	564 3.9	493 3.4	393 2.7	202 1.4	2,904 20.2	393 2.0	3,531 23.3	31 0.2	14,363 100.0

Table 3.96. Flake Breakage Patterns for the Mixed Components; Frequencies and Row Percentages

Component	Whole	Proximal	Medial	Distal	Lateral	Collasped Platform	Indeterminate	Total
LA 43766	2,166 63.1	428 12.5	146 4.3	649 18.9	41 1.2	0 0.0	1 0.03	3,431 23.9
LA 45508	427 54.1	141 17.8	43 5.4	118 14.9	60 7.6	1 0.1	0 0.0	790 5.5
LA 70188	5,264 60.6	1,248 14.4	422 4.9	1,539 17.7	206 2.4	1 0.01	1 0.01	8,681 60.4
LA 70189	173 71.8	23 9.5	7 2.9	26 10.8	12 5.0	0 0.0	0 0.0	241 1.7
LA 70191	89 58.2	23 15.0	7 4.6	30 19.6	4 2.6	0 0.0	0 0.0	153 1.1
LA 75791	94 74.0	9 7.1	9 7.1	11 8.7	4 3.1	0 0.0	0 0.0	127 0.9
LA 78439	125 69.1	23 12.7	5 2.8	22 12.2	6 3.3	0 0.0	0 0.0	181 1.3
LA 89846	323 57.9	32 5.7	16 2.9	170 30.5	17 3.0	0 0.0	0 0.0	558 3.9
LA 89847	135 66.8	28 13.9	6 3.0	29 14.4	4 2.0	0 0.0	0 0.0	202 1.4
Total Percent	8,796 61.2	1,955 13.6	661 4.6	2,594 18.1	354 2.5	2 0.01	2 0.01	14,364 100.0

Table 3.97. Mean Whole Flake Lengths by Morphology for Each Mixed Component

Location	Component	Core Flake	Biface Flake
Luna	LA 45508	21.01	19.08
	LA 89846	18.38	14.17
	LA 89847	21.34	18.50
Reserve	LA 70188	18.69	15.42
	LA 70189	24.14	18.80
	LA 70191	20.60	13.97
	LA 75791	29.58	11.33
	LA 78439	29.42	13.57
	LA 43766	21.62	17.09

Table 3.98. Core Morphology for Mixed Components; Frequencies and Two Percentages

Component	Tested Cobble	Undifferentiated	Unidirectional	Bidirectional	Multidirectional	Total
LA 43766	0 0.0	1 6.3	0 0.0	3 18.8	12 75.0	16 9.4
LA 45508	2 13.3	4 26.7	0 0.0	2 13.3	7 46.7	15 8.8
LA 70188	8 7.7	8 7.7	9 8.7	11 10.6	68 65.4	104 61.2
LA 70189	1 9.1	0 0.0	4 36.4	0 0.0	6 54.5	11 6.5
LA 70191	1 100.0	0 0.0	0 0.0	0 0.0	0 0.0	1 0.6

Component	Tested Cobble	Undifferentiated	Unidirectional	Bidirectional	Multidirectional	Total
LA 75791	0 0.0	0 0.0	1 20.0	1 20.0	3 60.0	5 2.9
LA 78439	2 20.0	3 30.0	0 0.0	0 0.0	5 50.0	10 5.9
LA 89846	0 0.0	0 0.0	1 16.7	0 0.0	5 83.3	6 3.5
LA 89847	1 50.0	0 0.0	0 0.0	0 0.0	1 50.0	2 1.2
Total Percent	15 8.8	16 9.4	15 8.8	17 10.0	107 62.9	170 100.0

Table 3.99. Core Data for Mixed Components

Location	Component	Mean Volume (cm^3)	Flake to Core Ratio
Luna	LA 45508	867.41	52.67
	LA 89846	1,894.19	93.00
	LA 89847	478.40	101.00
Reserve	LA 43766	683.11	214.44
	LA 70188	978.49	83.47
	LA 70189	1,317.87	21.91
	LA 70191	528.08	153.00
	LA 75791	1,445.86	25.40
	LA 78439	2,289.67	18.10

Note: Top and bottom 5 percent dropped for core volume except in cases where few specimens were recovered.

Overall, these assemblage traits suggest that the Archaic component dominates the mixed assemblage from LA 45508. Table 3.101 compares assemblage traits from unmixed and mixed components. Slightly lower percentages of biface flakes, interior flakes, modified platforms, and a lower flake to core ratio coupled with slightly higher percentages of angular debris and a larger mean core volume all suggest that the dominant Archaic assemblage has been somewhat diluted by the Early Pithouse period assemblage. Thus, it is likely that most of the mixed assemblage from LA 45508 is related to the Archaic occupation, but a fair amount of material was also deposited during the Early Pithouse period.

LA 89846, Haca Negra. The lowest occupied zone at this site contained features dated to the Late Archaic period. An intermediate zone contained artifacts that appear to have been washed down from a Late Pueblo site, and an upper zone yielded protohistoric dates. These deposits were concluded to be inextricably mixed.

When compared with overall attribute means and ratios in Table 3.100, this assemblage appears to most closely resemble the overall and Luna area Mogollon assemblages. However, there are also differences that suggest contamination by earlier or later occupations. The percentage of biface flakes in the mixed assemblage is lower than any of the comparative assemblage means. There is a higher percentage of angular debris for this component than any of the comparative assemblages, while the proportion of interior flakes is lower than the overall and Luna area Mogollon assemblages. The percentage of modified platforms is slightly higher than either of these comparative assemblages, but much lower than any of the comparative Archaic and protohistoric assemblages. At the same time there is more evidence for platform retouch than is normal for Mogollon assemblages, and this percentage is similar to that of the Archaic assemblages. The proportion of whole flakes is much lower than the norm for Mogollon assemblages, and is similar to the Luna Archaic components. While the flake to angular debris ratio is extremely low, the flake to core ratio is much higher than expected for a Mogollon assemblage. However, mean core volume is very high, and more in line with the Reserve area

Table 3.100. Potential Temporally Diagnostic Assemblage Traits for Major Time Periods and the Mixed Assemblages

Location	Period/ Component	Percent						Flake: Angular Debris	Flake: Core	Mean Core Volume
		Biface Flake	Angular Debris	Interior Flake	Modified Platform	Retouched Platform	Whole Flake			
Overall	Archaic	24.5	17.5	87.0	30.9	50.0	59.7	4.71:1	112.17:1	1,058.02
	Mogollon	2.9	33.4	73.3	10.9	26.2	71.3	1.99:1	21.44:1	1,714.55
	Protohistoric	3.3	18.1	64.7	32.8	21.7	68.6	4.53:1	60.39:1	1,559.46
Luna area	Archaic	27.7	21.4	87.4	63.2	49.5	51.0	3.67:1	64.94:1	1,299.05
	Mogollon	3.3	40.1	87.9	10.6	40.4	71.0	1.49:1	23.32:1	1,448.03
Reserve area	Archaic	23.9	16.7	87.0	26.5	50.1	61.4	5.91:1	129.88:1	967.64
	Mogollon	2.4	24.3	57.6	11.1	13.1	71.7	3.11:1	19.74:1	1,956.29
	Protohistoric	3.3	18.1	64.7	32.8	21.7	68.6	4.53:1	60.39:1	1,559.46
Mixed sites--Luna	LA 45508	26.8	16.0	88.1	56.4	56.4	54.1	5.27	52.67:1	1,380.22
	LA 89846	0.6	48.2	82.1	13.0	51.9	57.9	1.07	93.00:1	1,912.81
	LA 89847	2.0	49.2	93.1	19.4	83.3	66.8	1.03	101.00:1	452.32
Mixed sites--Reserve	LA 43766	26.8	18.6	81.8	28.7	49.4	63.1	4.37	70.75:1	749.14
	LA 70188	28.1	18.8	88.0	26.9	35.9	60.6	4.33	83.47:1	1,247.27
	LA 70189	4.5	21.8	69.7	28.0	4.8	71.8	3.60	21.91:1	1,296.20
	LA 70191	20.7	14.5	69.3	35.1	33.3	58.2	5.89	153.00:1	528.08
	LA 75791	4.3	8.0	55.1	15.5	18.2	74.0	11.55	25.4:1	1,445.86
	LA 78439	4.1	17.4	65.2	28.9	40.6	69.1	4.76	18.10:1	2,352.58

Table 3.101. Comparison of Assemblage Attributes for Sites Containing Mixed and Unmixed Deposits

Site	Component	Percent						Flake:angular Debris	Flake:core	Mean Core Volume
		Biface Flake	Angular Debris	Interior Flake	Modified Platform	Retouched Platform	Whole Flake			
LA 43766	Archaic	28.7	13.5	83.9	33.5	78.2	62.3	6.39	338.4	644.50
	Mixed	26.8	18.6	81.8	28.7	49.4	63.1	4.37	70.75	749.14
LA 45508	Archaic	27.7	13.5	89.6	63.2	49.5	61.5	3.67	64.94:1	1,299.05
	Mixed	26.8	16.0	88.1	56.4	56.4	54.1	5.27	52.67:1	1,380.22
LA 70188	Archaic	23.6	18.2	89.9	23.0	40.9	59.9	4.50	141.48	756.52
	Mixed	28.1	18.8	88.0	26.9	35.9	60.6	4.33	83.47	1,247.27
LA 78439	Archaic	8.3	14.8	66.1	39.9	32.4	71.8	5.78	43.9	1,520.36
	Mixed	4.1	17.4	65.2	28.9	40.6	69.1	4.76	18.10	2,352.58
	Entire assemblage	7.1	15.5	65.8	36.5	34.3	71.0	5.44	25.83	1,867.12

Table 3.102. Temporal Trends in Diagnostic Assemblage Traits

Period	Percent						Flake:angular Debris	Flake:core	Mean Core Volume
	Biface Flake	Angular Debris	Interior Flake	Modified Platform	Retouched Platform	Whole Flake			
Archaic	25.5	17.7	88.4	30.2	51.6	59.0	4.66	133.92	933.55
Early Pithouse	3.7	20.9	59.3	20.7	8.9	76.4	3.78	16.50	1,493.19
Late Pithouse	7.5	23.0	85.2	12.5	29.9	72.4	3.35	36.25	1,445.82
Early Pueblo	1.8	21.0	53.6	10.5	11.2	72.7	3.76	22.64	2,194.23
Late Pueblo	2.2	41.7	81.2	9.0	41.0	70.2	1.40	19.37	1,557.40
Protohistoric	3.3	18.1	69.4	32.8	21.7	68.6	4.53	60.39	1,559.46

Mogollon components.

For the most part, this assemblage is consistent with a Mogollon occupation. Since most artifacts appear to have been redeposited from a Late Pueblo site located upslope, the flake to core ratio is very high because cores are heavy and less prone to erosional movement, so they are probably underrepresented. The comparatively small percentage of whole flakes may also be attributable to this process, with breakage occurring during transport. With these inconsistencies potentially explained, most other attributes point to a Mogollon affinity. While features with Late Archaic dates certainly indicate the presence of a component from that period, it is likely that little of the assemblage was deposited at that time. Unfortunately, no distinctive protohistoric attributes are visible, so it is uncertain how much (if any) of the assemblage can be assigned to that occupation.

LA 89847, Red Ear. While there was evidence for Archaic, Pithouse period, Pueblo period, and protohistoric occupations at this site, deposits appeared to be inextricably mixed. In many ways, the attributes shown in Table 3.100 are contradictory and suggest an extreme amount of mixing. Attributes such as a low percentage of biface flakes, high percentage of angular debris, moderately low percentage of modified platforms, and low flake to angular debris ratios are in line with the overall and Luna area Mogollon assemblages. However, other attributes such as high percentage of interior flakes and retouched platforms, low percentage of whole flakes, high flake to core ratio, and very low mean core volume are more similar to the Archaic assemblages. A few attributes might also be indicative of protohistoric influence, including low percentages of whole flakes and biface flakes. While some of the strongest indicators suggest that post-Archaic occupations dominate this assemblage, others are more characteristic of Archaic use. This analysis suggests that the LA 89847 assemblage is badly mixed and contains significant amounts of materials from Archaic and Mogollon (and perhaps protohistoric) occupations that cannot be separated.

Reserve Area Sites

LA 43766, Old Peralta. While it is likely that most of the artifacts from this site derive from Archaic occupations, materials from a nearby Early Pueblo period site have potentially contaminated a significant portion of the deposits investigated. The Archaic assemblage was discussed in the context of the unmixed assemblages, and is available for comparative purposes. When compared with overall and Reserve area Archaic attributes in Table 3.100, the mixed assemblage from LA 43766 is very similar. It has a slightly higher percentage of biface flakes and angular debris than the comparative assemblages, and the proportion of interior flakes is somewhat lower. The percentage of modified platforms is slightly lower than the overall Archaic assemblage, but higher than the Reserve assemblage, and nearly the same percentage of retouched platforms occurs in each assemblage. The percentage of whole flakes is slightly higher than in either comparative Archaic assemblage, but it is much lower than any of the comparative Mogollon assemblages. The flake to angular debris and flake to core ratios are lower than either comparative Archaic assemblage, but are much higher than the comparative Mogollon assemblages. The mean core volume is very low, which is consistent with other Archaic components from the Reserve area.

Archaic and mixed assemblage attributes are compared for LA 43766 in Table 3.101. While it is likely that Archaic materials dominate the mixed assemblage, this table also suggests that there has been some dilution by the Mogollon materials that were washed in. The Archaic assemblage contains slightly higher percentages of biface flakes, interior flakes, modified platforms, and retouched platforms, as well as lower percentages of angular debris and whole flakes. Both flake to angular debris and flake to core ratios are much higher than they are for the mixed assemblage, and mean core size is smaller. While there is a fair amount of comparability between these assemblages, there appears to be some dilution of this predominantly Archaic assemblage with Mogollon materials.

LA 70188, Raven's Roost. The main occupation of this site appears to have been during the Late Archaic period. However, the occurrence of Mogollon sherds and protohistoric radiocarbon dates suggest that it was reused on several occasions. The ceramic assemblage indicates Mogollon occupations in the Early Pithouse and general Pueblo periods. Thus, this site may have been occupied during as many as four different periods.

Percentages of biface flakes, angular debris, and interior flakes are slightly higher than they are for the overall and Reserve area Archaic comparative assemblages (Table 3.100). The percentage of modified platforms is slightly lower than the overall assemblage, but very close to that of the Reserve assemblage. Similarly, the percentage of whole flakes is slightly higher than the overall assemblage and slightly lower than the Reserve area assemblage. A much smaller percentage of retouched platforms was encountered in this component than in either comparative assemblage, and flake to angular debris and flake to core ratios are lower than the Archaic comparative assemblages, but higher than any of the Mogollon comparative assemblages. Mean core volume is also larger than either of the Archaic comparative assemblages, but is much lower than for any later period.

Archaic and mixed assemblage attributes are compared for LA 70188 in Table 3.101. While it is likely that Archaic materials dominate the mixed assemblage, there also appears to have been some dilution by later occupations. Some attributes suggest that the mixed assemblage contains nearly pure Archaic materials, including slightly higher percentages of biface flakes and modified platforms than the unmixed assemblage. However, the mixed assemblage also contains slightly higher percentages of angular debris and whole flakes, and slightly lower percentages of interior flakes and retouched platforms. Both flake to angular debris and flake to core ratios are lower for the mixed assemblage, and mean core volume is considerably higher. The mixed assemblage from LA 70188 appears to predominantly contain Archaic materials, but small differences in attribute percentages suggest there is also some mixing with later materials.

LA 70189, Lightning Strike. Temporally diagnostic artifacts and samples suggest that this site contains a mixture of Early Pueblo and protohistoric materials. Materials from the earlier occupation probably dominate the assemblage. When mean attributes for this component are compared with overall and Reserve area Mogollon assemblages, this dominance is visible. However, there are also indications that the assemblage is diluted by protohistoric materials. While the percentage of biface flakes is higher than the overall assemblage, Reserve area Mogollon, and protohistoric assemblages, it is still very low. The percentage of angular debris is lower than both Mogollon comparative assemblages, and is about midway between the Reserve area Mogollon and protohistoric assemblages. The percentage of interior flakes is lower than the overall assemblage, but higher than the Reserve area and protohistoric assemblages. The percentage of modified platforms is much higher than either Mogollon comparative assemblage, and is nearly as high as the protohistoric assemblage. Only a very small percentage of platforms were modified by retouch, which is more indicative of a Mogollon affinity. The percentage of whole flakes in the assemblage is nearly the same as the overall Mogollon assemblage, and only slightly lower than the Reserve area assemblage. While both flake to angular debris and flake to core ratios are somewhat higher than either comparative Mogollon assemblage, they are both much lower than the protohistoric assemblage. Mean core volume is much lower than either comparative Mogollon assemblage.

While most diagnostic attributes seem indicative of a Mogollon affinity, there is enough variation to suggest that some protohistoric materials may also be present. In particular, the somewhat lower than expected percentage of angular debris, higher than expected percentage of modified platforms, and higher than expected flake to angular debris ratio may be indicative of mixing. While most of the mixed assemblage is probably attributable to the Early Pueblo occupation, evidence for mixing with later protohistoric materials also potentially exists.

LA 70191, The Black Hole. This site appears to entirely consist of materials redeposited from one or more sites located upslope. Most of the assemblage may be attributable to a nearby Early Pithouse site, but artifacts from an Early Pueblo site may also have washed in, and it may be impossible to determine whether materials from more than one Mogollon period are present.

Unfortunately, the character of this assemblage as shown in Table 3.101 appears to be more Archaic than Mogollon. It has comparatively high percentages of biface flakes, modified platforms, retouched platforms, and high flake to angular debris and flake to core ratios. These are accompanied by comparatively low percentages of interior flakes, angular debris, whole flakes and a low mean core volume. But, while most of these attributes are similar to those of the comparative Archaic assemblage, there are also potentially important differences such as much lower percentages of interior flakes and retouched platforms than in the comparative Archaic assemblages.

The percentage of biface flakes in this component is much higher than any of the unmixed Mogollon assemblages. While the percentage of angular debris is low, it falls in the range of variation for both the Early Pithouse and Early Pueblo periods. The percentage of modified platforms is similar to the Early Pithouse component at LA 39972. However, neither Early Pithouse component has percentages of retouched platforms approaching the levels seen at LA 70191. There are no similarities in platform treatment between the Early Pueblo components and LA 70191.

This is a confusing component. In some ways it is similar to an Archaic assemblage and in others to a Mogollon assemblage. The only projectile point recovered was a medium corner-notched specimen that could not be assigned to either the dart or arrow category. The assemblage is quite different from those assigned to the Early Pueblo period. There are a few superficial similarities to at least one Early Pithouse component, otherwise it does not resemble assemblages from that period either. It is possible most materials from this site were redeposited from the Early Pithouse period site situated upstream. This may account for the very large flake to core ratio and relatively small percentage of whole flakes, as discussed for LA 89846. If so, this component contains evidence for considerably more large biface manufacture than other Mogollon components. This could be indicative of an occupation very early in the Early Pithouse period when the transition from a fairly mobile to a fairly sedentary lifestyle was occurring, but this is conjectural.

LA 75791, Ladybug Junction. Ceramic analysis and radiocarbon dates suggest there were Late Pithouse and protohistoric period occupations at this site. Unfortunately, materials from these occupations were badly mixed and could not be separated.

The low percentage of biface flakes in this assemblage could be indicative of either occupation (Table 3.100). However, the very small percentage of angular debris is more suggestive of a protohistoric occupation, since percentages for both comparative Mogollon assemblages (overall and Reserve area) are much higher. While the percentage of interior flakes is smaller than either comparative Mogollon assemblage, it is more similar to the Reserve area Mogollon than the protohistoric assemblage. The percentage of modified platforms is less than half that of the protohistoric comparative assemblage, and slightly higher than either Mogollon comparative assemblage. In both cases a moderately low percentage of retouched platforms was expected. The percentage derived for LA 70191 falls between the Reserve area Mogollon and protohistoric assemblages, but it is closer to the latter. The percentage of whole flakes is almost exactly the expected for a Reserve area Mogollon site, but the flake to angular debris ratio was much higher than expected for either time period. Mean core volume is smaller than expected for both periods, though it is closer to the protohistoric period, and the flake to core ratio is slightly higher than the Mogollon comparative assemblages, but less than half that of the protohistoric assemblage. In short, there is a mixture of traits in this assemblage, but most seem more similar to the Mogollon assemblages. However, there appears to be contamination from a protohistoric occupation, perhaps more than was initially expected.

LA 78439, Leaping Deer Ridge. Radiocarbon samples suggest that this site was occupied during the Late Archaic and Late Mogollon periods. Ceramic analysis also suggested the presence of a Mogollon occupation of indeterminate date. Thus, two to three periods of occupation were defined including Late Archaic, Mogollon, and protohistoric. Two components were separated for this site—a probable Late Archaic assemblage and a mixed assemblage containing Archaic, Mogollon, and protohistoric materials.

Examining Table 3.100, we see a jumble of temporally diagnostic assemblage traits that could fit into several periods. The low biface flake ratio could fit either the Mogollon (overall and Reserve area) or protohistoric comparative assemblages. The low percentage of angular debris fits the overall Archaic assemblage almost exactly, and is close to that of the Reserve Archaic assemblages. However, it is also very similar to the protohistoric assemblage percentage. The rather low percentage of interior flakes resembles the protohistoric assemblage, and falls between the overall and Reserve Mogollon assemblages. While the percentage of modified platforms is similar to those of the Archaic and protohistoric assemblages, the amount of platform retouching is distinctly Archaic. The percentage of whole flakes is relatively high, and similar to those of the overall and Reserve area Mogollon and protohistoric assemblages. Though the flake to angular debris ratio is high enough to fit the protohistoric and both Archaic comparative assemblages, the flake to core ratio and mean core volume are both most similar to the Reserve Mogollon assemblage.

Archaic and mixed assemblage attributes are compared for LA 78439 in Table 3.101. The proportion of biface flakes in the Archaic assemblage is over twice that of the mixed assemblage, and it also contains a slightly lower percentage of angular debris. Percentages of interior flakes and whole flakes are fairly similar for both assemblages. While there is a much higher percentage of modified platforms in the Archaic assemblage, the mixed assemblage contains a much higher percentage of retouched platforms. Both the flake to angular debris and flake to core ratios are much higher for the Archaic assemblage, and the mean core volume is considerably smaller for that component. This comparison seems to suggest that if Archaic materials predominate in the mixed assemblage, materials from one or more later occupations are also common.

Differences were found between the Archaic assemblage from this site and others dating to the Archaic period raising the possibility that this site is dominated by its protohistoric component, with any earlier occupations having a rather negligible contribution to the assemblage. Table 3.101 shows figures for the entire assemblage at this site. Overall, it seems more similar to the protohistoric assemblage than it does the Archaic or Mogollon comparative assemblages for the Reserve area. There are also differences, but it must be remembered that the sample of protohistoric components is quite small. While this does not prove that LA 78439 primarily represents a protohistoric occupation, it does suggest that the Archaic date assigned to the unmixed component may be tenuous. Conversely, it may simply indicate that there were functional similarities between LA 78439 and the protohistoric components.

Discussion

In all but one or two cases these assemblages do appear to consist of mixed materials from multiple occupations. The only possible exceptions are LA 70191 and LA 78439. While the former may represent a pure Early Pithouse assemblage, it differs in many ways from other components of that period. It may be best to leave this assemblage with the mixed components, especially since it consists of redeposited materials. LA 78439 remains questionable. While Archaic materials may have been separated from a mixed component for this site, analysis was unable to demonstrate that it was indeed of Archaic affinity.

Conclusions

Diversity rather than similarity seems to characterize the assemblages examined in this report. While statistical tests suggest that assemblages from the same time period often seem to represent the same population, results are often not highly significant and are almost always weak. However, when components are examined by more gross time periods there appears to be real differences attributable to changes in reduction technology and the focus of tool-making activities. This is particularly true of the Archaic and Mogollon assemblages, and to a certain extent the protohistoric assemblage as well. While Archaic and Mogollon components are generally different enough from one another to be fairly easily distinguished, protohistoric assemblages are usually difficult to separate out.

Only two potentially unmixed protohistoric assemblages were identified, and appear to combine characteristics of the Archaic and Mogollon assemblages; both were defined on the basis of radiocarbon dates. All identifiable projectile points from LA 37917 are Archaic in appearance, leading us to believe that Archaic and protohistoric materials could be mixed at this site. Similarly, LA 37919 contained a few Mogollon sherds that might also indicate the presence of a second component. Yet in many ways these assemblages are more similar to one another than they are to components from any other time period. This should not be the case if one contains a mixture of Archaic and protohistoric materials and the other artifacts from Mogollon and protohistoric occupations. Lacking evidence to the contrary and in the absence of other comparative assemblages from this area, we must assume that these components are evidence of protohistoric occupations. If so, it is possible that the earlier artifacts were collected from nearby sites.

It is also interesting that many differences between assemblages from the Luna and Reserve areas are attributable to variation in material availability. Materials suitable for reduction other than Luna blue agate seem to have been somewhat scarcer in the Luna area. Luna area cores were reduced to a greater extent than those from the Reserve area, leading to differences in percentages of cortical flakes and mean flake size. In addition, Luna area residents also used considerably more Luna blue agate than did those living in the Reserve area. Luna blue agate is very hard and brittle, and this causes more shattering during reduction as shown by significantly lower flake to angular debris ratios for Luna blue agate than for all other materials combined. Thus, variations between these areas are attributable to material availability and selection factors rather than technological differences. However, it is interesting that these differences only really occur in Mogollon assemblages. Though Archaic assemblages were recovered from both areas, they do not display the degree of differentiation seen in the Mogollon assemblages, even though they contain a substantial amount of Luna blue agate as well.

Temporal Trends in Chipped Stone Assemblages

Using attributes of chipped stone assemblages to assign dates can be dangerous. There is simply too much variation from site to site as well as within and between regions to be successful in this type of endeavor. Earlier we examined the mixed components and attempted to determine whether they exemplify a fusion of assemblages from different periods or are actually representative of only a single occupation. This analysis was probably most successful for assemblages that could be separated into mixed and unmixed components, which provided a basis for comparing data sets from the same site. However, this was only possible in four cases. The five remaining assemblages could not be assessed in this way, and conclusions pertaining to them are more conjectural. In all but perhaps one case, analysis suggests that these assemblages contain materials from multiple occupations that have skewed their attributes to the point where they are not comparable to unmixed assemblages. While possible that these variations are normal for some sites and unrelated to any mixing of components, this can not be demonstrated. Thus, these assemblages must continue to be considered mixed.

Even though differences are visible between Luna and Reserve assemblages, it is preferable to combine data from these areas when examining overall temporal trends so that extreme variation is reduced. LA 78439 does not match the other Archaic assemblages, and at this time we are uncertain whether this is because of component mixing or incorrect data. Thus, this site is dropped from the array of Archaic components but is not added to the protohistoric site.

Table 3.102 shows temporally diagnostic assemblage attributes for each time period. As before, certain trends are visible in the data. Most differences between Mogollon assemblages are subtle, and some are the result of material availability. Archaic assemblages are characterized by attributes that suggest the manufacture of large bifaces was an important, if not dominant, activity. These characteristics include a large percentage of biface flakes and a correspondingly small percentage of angular debris, large percentages of interior flakes and modified platforms, and relatively high flake to angular debris and flake to core ratios. Other attributes that seem indicative of Archaic occupation but may not be directly related to biface manufacture include a large percentage of retouched platforms among those that are modified, and comparatively small cores.

Mogollon assemblages exhibit comparatively small percentages of biface flakes and large percentages of angular debris. The extremely high percentage of angular debris in the Late Pueblo period assemblage is due to reduction of a very large amount of Luna blue agate at LA 3279. Luna blue agate comprises 73.7 percent of the LA 3279 assemblage, which in turn makes up 78.9 percent of the Late Pueblo assemblage. This material comprises 85.9 percent of the angular debris at LA 3279. No other temporal assemblage contains as large a percentage of Luna blue agate, and this appears to have affected the character of this assemblage in more ways than one.

Variation is visible in percentages of interior flakes. Rather than representing a significant temporal trend, this is more reflective of the degree to which cores were reduced. As noted earlier, evidence suggests that cores in the Reserve area were not reduced to the same extent as they were in the Luna area. Rather low percentages of interior flakes occur in Early Pithouse, Early Pueblo, and protohistoric assemblages, and these periods are only represented in the Reserve area. Periods that contain large percentages of interior flakes are represented in both study areas. Referring back to Table 3.67, the Reserve Archaic assemblage contains a much higher percentage of interior flakes than any of the later assemblages from that area, but the same is not true for Luna. This is explained by the large amounts of biface manufacture represented in both Archaic assemblages. Tool manufacture tends to produce large amounts of noncortical debris, and this appears to have kept Archaic percentages consistent between study areas. In later assemblages, which exhibit little evidence for large biface manufacture, percentages of interior flakes are more representative of the degree to which cores were reduced.

Modified platforms are perhaps the most interesting of the temporally sensitive attributes. As Table 3.102 shows, there is a steady decline in percentages of modified platforms through time until the protohistoric period is reached. It is rather surprising to see such a high percentage of modified platforms coupled with a low percentage of biface flakes in that assemblage. Types of platform modification recorded during this analysis are generally considered indicative of tool manufacture rather than core reduction. It is possible that this assumption is incorrect for the protohistoric assemblages. Most platform modification consists of abrasion, which could also occur on core flakes when core platforms are heavily abraded to reduce the possibility of shattering. However, it is also possible that bifacial tools produced in these assemblages were not as heavily reduced and well-finished. This might result in a large percentage of biface flakes lacking enough of the characteristics of an idealized biface flake that they were not recognized as such. Unfortunately, this question must remain unanswered until more assemblages from this period are available for examination.

Platform modification by retouch may be temporally sensitive, but it is not consistent enough to be used alone or for a temporal assignment to be based upon. In general, there is considerably more retouch in Archaic assemblages than any other temporal period, though the Late Pueblo percentage approaches that level. Over 40 percent of the modified platforms in all three Archaic assemblages are retouched. Retouched platforms comprise over 20 percent of modified platforms in six Mogollon assemblages (40 percent), but in only two cases do they comprise over 40 percent. Retouched platforms comprise only 20 to 22 percent of the modified platforms in protohistoric assemblages. This suggests that assemblages in which large percentages of platform retouch occurs are probably of Archaic affinity.

The percentage of whole flakes in an assemblage has limited utility in defining temporality. Archaic assemblages tend to contain smaller percentages of whole flakes than do those from later periods, and this is probably due to breakage through secondary compression during tool manufacture. Flake to angular debris ratios are useful, but are partly obscured by the use of varying quantities of Luna blue agate. In general, this ratio decreases through time in both study areas (Table 3.75), with the exception of the Late Pithouse period in the Reserve area. Only small percentages of angular debris were found in both Late Pithouse assemblages from that area. The extreme drop in flake to angular debris ratio for the Late Pueblo period appears to be real rather than related to the large percentage of Luna blue agate used during that period (Table 3.76).

Core to flake ratios are useful, but have limited temporal value. High ratios for Archaic sites are due to two processes. Some materials were probably transported to these sites in partly reduced states—in particular, materials gathered for large biface manufacture. Thus, related cores are absent and the reduction of these materials into bifaces resulted in the production of flakes for which no cores are represented. Large biface manufacture also produces numerous waste flakes, significantly increasing the ratio between flakes and cores. It is likely that high flake to core ratios accompany a focus on tool manufacture, while smaller ratios are more indicative of core-flake reduction. Analysis of mean core volume also has limited temporal applicability. Archaic cores tend to be smallest, suggesting they were reduced to a greater extent than were later cores. Besides this, differences are minor and lack discriminating power.

These data suggest that there may have been several shifts in reduction strategy in this area. Archaic reduction focused on the manufacture of large bifaces, though the expedient reduction of cores to produce debitage useable as informal tools was also important. Beginning with the Early Pithouse period the reduction strategy shifted to a focus on production of debitage for use as informal tools. However, moderate flake to angular debris ratios suggest that core reduction was rather systematic and aimed at removing flakes from cores rather than simply producing any type of debitage with sharp edges. Another strategy change occurred in the Late Pueblo period. While still focused on the production of debitage for use as informal tools, core reduction was no longer systematic, and cores appear to have been reduced with little regard for the by-product produced.

The protohistoric assemblages present something of a problem. As discussed earlier, they are similar to Archaic assemblages in some ways and to Mogollon assemblages in others. Yet the components in this category are more similar to each another than they are to assemblages from any other time period. This suggests that they do, indeed, represent occupation by a group(s) differing from the earlier occupants of the region. These assemblages are characterized by evidence for careful reduction. Though biface flakes comprise only a small portion of debitage assemblages, platform modification is slightly more common, on the average, than it is in Archaic assemblages. Flake to angular debris ratios are similar to those of the Archaic, and there is a moderately high flake to core ratio. While there is a slightly smaller percentage of whole flakes in the protohistoric assemblage than in the Mogollon assemblage, this difference is probably not significant. Considering these attributes, the character of protohistoric components is distinctly different from that of the Archaic and Mogollon periods. It is possible that these attributes reflect manufacture of large bifaces that are not as well finished as those of the Archaic. Again, it is also possible that very careful and systematic core reduction is indicated. Whichever of these is more accurate, it certainly appears that the reduction strategy (and perhaps some of the techniques) expressed by these components are different from those found in earlier assemblages.

While no single attribute examined by this analysis can be used to accurately assign assemblages to the correct time period, several used in combination can help define variation in reduction strategies that appear to represent temporal changes. Some attributes use similar data and are rather repetitive. For instance, percentages of angular debris and flake to angular debris ratios essentially co-vary, and provide similar data. Some attributes are less sensitive to temporal trends than others. In particular, percentages of noncortical flakes and mean core volume provide some information, but are both heavily affected by the availability of suitable materials for reduction in a particular area.

The remaining attributes (with the addition of flake to angular debris ratios) were useful in defining differences in reduction strategies between rather gross temporal periods. That these periods also seem to represent different cultural traditions is important. Archaic hunter-gatherers broke rocks in different ways than did Mogollon farmers. The protohistoric population, perhaps Apacheans, broke their rocks in still another way. While lifestyle is perhaps most important in determining chipped stone reduction strategies, differences in the Mogollon assemblages suggest that significant variations can also occur within a single tradition, and may be just as important when examining human adaptations to an area through time.

FORMAL AND INFORMAL TOOL USE

David J. Hayden

Several researchers (notably Bamforth 1985, 1986; Binford 1973, 1977, 1979, 1980; Bleed 1986; Kelly 1988; Torrance 1983) have discussed the relationship between applied core reduction techniques and overall strategy within chipped stone tool kits. Following Bamforth (1985), "expedient" reduction strategies produce informal tools, with minimal modification of raw debris morphology, based on need; tools are discarded after use, when no longer useable, or when no longer needed. "Curated" reduction systems incorporate a suite of traits that may include tool forms for specific uses, greater investment of time and resources in initial production, recycling of tools for other uses until no longer possible, and transportation of tools from one locality of use to another. Binford (1979) describes these differences as forming a continuum, in which both forms are incorporated into systems based on need. Both systematic and unsystematic techniques can be used to produce informal tools; although initial stages of formal tool production need not be systematic, later stages must.

Resource availability and a related need for efficiency have frequently been suggested as causal for the role of these strategies within overall systems (Bamforth 1986; Kelly 1988). Kelly (1988) presents a model for the use of bifaces as a curated technological form; although it is based on research in the Great Basin, analogous assemblages have been identified in the Southwest (Moore n.d.a). Kelly (1988:718-723) outlines three generalized roles that bifaces play in technological systems: as cores for the production of both formal and informal tools; as long use-life tools that are resharpenable and thus recyclable; and as specialized forms.

Loosely based on several tool-use paradigms, particularly Kelly's (1988) model for biface use, as well as others (Bamforth 1985, 1985; Binford 1973, 1977, 1979, 1980; Bleed 1986; Torrance 1983), a great deal of this chapter is devoted to the discussion of technology in terms of both informal and formal tools, and their relationship to mobility. Particularly relevant here is the role that bifaces play in the general subsistence and mobility systems; following Kelly (1988), we believe that bifaces play multiple, overlapping roles in these systems, which interplay throughout the life-cycle of the tool.

More importantly, we believe that the nature of these roles is related largely to mobility, and to both the technological needs and level of efficiency that varying levels of mobility require. High mobility necessitates efficiency in terms of material and weight conservation, requiring a versatile, well-planned tool kit. Conversely, low mobility or long-term residence at one site largely eliminates these needs, and allows for much more wasteful technologies that focus on specialized tools without concern for their adaptability.

Except during the protohistoric period, mobility presumably decreases with time in the Mogollon Highlands. The Archaic Period and Late Pueblo Periods embody the extremes. Accordingly, we expect Archaic period assemblages to express broad usage of formal tools (particularly bifaces), with emphasis on maximizing their ability to be recycled and weight-reduction potential. Later, more sedentary periods should use these tools for specific activities, with less regard for the overall efficiency of the tool kit.

FORMAL TOOLS

A total of 1,038 formal tools or fragments were identified in 25 site assemblages, the vast majority of which were bifaces. Because several sites were temporally multicomponent, and 29 separate components were identified, assemblages are discussed by components rather than sites. For example, LA 43766 was almost entirely a Late Archaic site; however, some Pueblo period material was present in the upper deposits. The upper layers were inseparable, and are therefore discussed as mixed; the lower deposits are discussed as Late Archaic. Though projectile points are more thoroughly discussed elsewhere in this volume, they are included here to address the diversity of the formal tool assemblages. The projectile points are therefore represented in Table 3.104 as bifaces of varying morphological characteristics.

The temporal breadth and the spatially discrete nature of these assemblages provide a unique opportunity to examine the development and progression of entire technological systems through nearly all of the most populous time periods in the Mogollon Highlands. More particularly, the intent here is to depict the role of formal chipped stone tool forms within these overall systems. To be fully effective, this discussion must address not only the functional role (and therefore the presumed intended use) of these tool forms, but also the technological implications of their manufacture, use, and their relationship to overall cultural systems. These issues will be addressed in terms of morphology, material selection, and diagnostic

Table 3.103. Formal Tool Morphologies

Tool Type		Count	Percent
Cobble Tools	Undifferentiated	35	3.4%
	Unidirectional	4	.4%
	Bidirectional	18	1.7%
	Total	57	5.5
Unifaces	Undifferentiated	9	.9%
	Early Stage	14	1.3%
	Middle Stage	2	.2%
	Late Stage	4	.4%
	Total	29	2.8%
Bifaces	Undifferentiated	139	13.4%
	Early Stage	190	18.3%
	Middle Stage	274	26.4%
	Late Stage	334	32.1%
	Reworked Early	2	.2%
	Reworked Middle	4	.4%
	Reworked Late	8	.8%
	Total	951	91.5%
Non-specific	Undifferentiated	1	.1%
	Other	1	.1%
	Total	2	.2%
Grand Total		1039	100.0%

breakage. Though three morphologically distinct formal tool forms were identified within these assemblages (Table 3.103), bifacial tools represent the overwhelming majority. The resulting paucity of the remaining tool forms (cobble tools and unifaces) precludes an earnest discussion of their production, maintenance, and use. They are therefore presented below in a purely descriptive manner.

This discussion has two aims: to provide a general depiction of formal tool use in each of these assemblages and descriptively present relevant data; and to examine the validity of the proposed hypothesis. Toward that end, several monitored attributes (such as raw material selection) will be presented simply as context to the overall assemblages.

Unifaces

Only 29 unifaces were identified (Table 3.103). Production "stage" was determined by overall thickness and scar regularity (OAS Staff 1994:15). Early-stage unifaces are minimally thinned and have irregularly spaced flake scar patterns; middle- and late-stage unifaces are progressively thinner and more uniformly produced. Though "stages" implies terminally vectored production, unifaces are completed tools whenever they meet the need of a task, and stage, therefore, is not necessarily linked to completion.

Several tool forms are traditionally associated with unifaces, including scrapers, gravers, and spokeshaves; their presumed uses are self-explanatory, with scrapers used to process plant and animal materials, gravers used for carving or cutting grooves, and spokeshaves used for wood carving, particularly for stripping wooden shafts such as those used for arrows or atlatls. As Table 3.104 indicates, the majority of the unifaces recovered were classified either as scrapers or generalized artifacts. Perhaps owing to the small number of artifacts overall, there is no discernable relationship between their frequency and temporal classification. Similarly, with such a small sample it is difficult to develop associations between artifact function, and therefore site activities, and time period.

Cobble Tools

A similarly small number of cobble tools was recovered with these assemblages (Table 3.103), though most likely for different, and more tangible reasons. In nearly all of their uses, cobble tools are exceedingly durable and have a potentially very long use-life. Whereas chipped tools such as bifaces and unifaces are subject to frequent breakage (and discard) during both manufacture and use, cobble tools are less prone to this problem, and are likely discarded with much less frequency. Additionally, some cobble tools, such as hammerstones, may exhibit only subtle evidence of use, evidence that may not be discernable from natural battering. As a result many simple cobble tools may never be identified.

Cobble tools were morphologically described in three categories: undifferentiated, unidirectional, and bidirectional. Undifferentiated cobble tools consist primarily of morphologically unmodified cobbles that exhibit evidence of wear; several tools for which the nature of this modification was unclear were included here as well. Edges of unidirectional and bidirectional cobble tools were morphologically altered from one or both directions, respectively.

Table 3.104. Uniface Function by Time Period

			Count	Subtable Percent
Late Archaic	Artifact Function	spokeshave (notch)	1	100.0%
	Total		1	100.0%
Early Pithouse	Artifact Function	thumbnail scraper	1	100.0%
	Total		1	100.0%
Late Pithouse	Artifact Function	scraper, undifferentiated	1	100.0%
	Total		1	100.0%
Early Pueblo	Artifact Function	scraper, undifferentiated	4	100.0%
	Total		4	100.0%
Late Pueblo	Artifact Function	scraper, undifferentiated	7	87.5%
		uniface, undifferentiated	1	12.5%
	Total		8	100.0%
Protohistoric	Artifact Function	scraper, undifferentiated	1	33.3%
		uniface, undifferentiated	2	66.7%
	Total		3	100.0%
Mixed	Artifact Function	thumbnail scraper	1	9.1%
		scraper, undifferentiated	6	54.5%
		uniface, undifferentiated	3	27.3%
		end scraper	1	9.1%
	Total		11	100.0%

Table 3.105. Cobble Tool Function by Time

			Count	Subtable Percent
Late Archaic	Artifact Function	hammerstone	1	33.3%
		chopper	1	33.3%
		chopper-hammerstone	1	33.3%
	Total		3	100.0%
Early Pithouse	Artifact Function	hammerstone	1	33.3%
		graver	1	33.3%
		core-chopper	1	33.3%
	Total		3	100.0%
Late Pithouse	Artifact Function	hammerstone	15	100.0%
	Total		15	100.0%

			Count	Subtable Percent
Early Pueblo	Artifact Function	hammerstone	8	80.0%
		chopper	1	10.0%
		chopper-hammerstone	1	10.0%
	Total		10	100.0%
Late Pueblo	Artifact Function	hammerstone	17	85.0%
		chopper	1	5.0%
		chopper-hammerstone	1	5.0%
		axe	1	5.0%
	Total		20	100.0%
Mixed	Artifact Function	hammerstone	4	66.7%
		chopper	2	33.3%
	Total		6	100.0%

As with unifaces, relatively low frequencies of this artifact type preclude a thorough understanding of the relationship between this artifact type and time; however, more cobble tools were recovered from later residential sites (Table 3.105). Since nearly all of the identified cobble tools were hammerstones, this can most likely be attributed to extent of use. As an unmodified cobble tool, hammerstones are most likely selected from a nearby location based on immediate need. At short-term sites, they are likely discarded after use, or at the abandonment of the site since carrying such a large, unmodified, and easily replaced tool would be inefficient; conversely, hammerstones may be used for long periods of time at a residential site, where conservation of material for travel is not an issue. Though discard rates at short-term sites, such as most Archaic period components, would probably have been higher, the level of use invested in a particular cobble during a short episode may not produce enough wear to be distinguishable from natural mechanical weathering. As a result, hammerstones from residential sites, where extended use is more likely, may exhibit more recognizable wear, and are therefore recovered with more frequency. Additionally, since many of the local materials, such as Luna blue agate, appear well suited for use as both cobble tools and as raw material for chipped stone tools, some hammerstones may have subsequently been utilized as cores, therefore obscuring their original use.

Bifaces

Representing over 91 percent (Table 3.103) of the formal tool assemblages, bifaces were the most common chipped stone tool forms recovered, and therefore provide this project's most potentially diverse and informative tool form. Though intuitively representative of a curated tool form (Binford 1973, 1977, 1979, 1980; Bleed 1986; Torrance 1983), bifaces may also play a dual and overlapping role in both curated and expedient tool systems (Bamforth 1985, 1985; Kelly 1988). Kelly (1988), for example, outlines three generalized roles that bifaces play in technological systems: as cores for the production of informal tools; as long use-life tools that are resharpenable and thus recyclable; and as specialized forms. Logically, use as a core for expedient tools should result in biface reduction flakes with evidence of use-related wear; recycling of long use-life and specialized tools such as knives, drills, and projectile points should be expressed by resharpening.

Additionally, this depiction of biface use must incorporate the idea of cyclical, or transitional, use. Within this context, a particular biface may play one of several potential roles throughout its use-life. During initial production, for example, a minimally thinned and shaped biface may be an ideally efficient package for material transport, essentially acting as a generalized tool preform with a large amount of the wasted and bulky material removed. In this form, it is also an insurance policy, providing an expedient replacement for lost tools as necessary. It may also be an efficient source of expedient tools (in the form of removed flakes) when needed. When it is reduced into a more specialized tool form, such as a knife or projectile point, the resultant debitage may also be useful as expedient tools. A broken projectile point may not be recyclable into another projectile point, but it may make an adequate drill, knife, or scraper. Within this context, it is reasonable for an assemblage to contain a large number of bifaces and biface fragments to which no traditional tool style or function can be assigned.

Morphology. Morphologically, four biface types were identified during analysis, based primarily on stage of production (OAS Staff 1994:15). Early, middle, and late-stage bifaces were characterized somewhat subjectively (but relatively consistently) by the portions of the overall surface obscured by bifacial flake scars, the regularity of those scars, the relative thickness of the artifact to its overall size, and the evenness of the artifacts edge. Early-stage bifaces, therefore, are relatively thick, have partially unflaked surfaces and irregular edge outlines, and exhibit irregular flake scars; late-stage bifaces are thinner, have no unflaked surfaces, and exhibit even-edge outlines and regular scar patterns (Callahan 1979; OAS Staff 1994:15). The fourth category had no manufacturing stage connotations, and was used for undiagnostic fragments.

As an attempt to depict static periods in the inherently fluid continuum of biface production, these terms (see Table 3.103) are moderately accurate, and equally useful, but must be considered with caution. Though terms such as "early" and "late" imply initial and terminal production, it is important to point out that bifaces are functionally complete at any morphological stage if they meet the needs of a particular task. Bifaces may therefore be complete, and functional tools, without expressing the morphological character of a late-stage biface (Callahan 1979; OAS Staff 1994:15).

Function. Extracting from Kelly (1988), two biface functional categories can be identified: generalized and job specific. Kelly's third role for bifaces, that of a core for expedient tools, is processually related to both generalized bifaces and specific-use tools, and in fact represents a progressive range between the two during the tool's life-cycle. Further, these cores cannot be addressed directly from the biface itself, but must be implied by the presence of utilized biface reduction flakes.

Even more confusing is the depiction of this use as a functional category. While specific-use tools like projectile points and drills are physically manifested in form or functional attributes, generalized bifaces may represent several things at one time, including tool preform, informal tool core, and partially processed raw material package. Essentially, tools produced exclusively for one purpose are *static,* and tools produced as part of a more versatile, multifunctional, progressive system are *fluid*. Unfortunately, most special-use tools cannot be contextually associated with its producer's intent or its own history—projectile points that have had several other uses prior to their final form may not look any different than projectile points that were intended initially for that use. For the purpose of addressing the hypothesis presented above, all specific-use tools (i.e., projectile points and drills) will be considered static in contrast to generalized bifaces.

As Table 3.106 indicates, the majority of the formal tools are either generalized (undifferentiated) bifaces or bifacial projectile points. Since the functional categories used in this analysis are far more dependant on the expression of use-wear damage than on the intuitive implications of style and form, many tools have not been classified within traditional tool-type categories. The weakness of this approach is obvious. It does not provide a presumed function for every artifact in the assemblage. The strength, of course, is that it does not encourage excessive presumption.

Generalized bifaces most likely include bifacial cores, knives, drills, etc., but these specific characterizations are assigned only when an artifact exhibits wear patterns indicative of these uses, and many wear patterns are likely to be obscured. Biface production usually entails some level of edge modification, enabling better control of flake removal during thinning. Abrasion and retouch, both of which are common during manufacture, can be extremely difficult to distinguish from use-wear patterns.

Manufacture, Maintenance, and Use. Since the movement of tools into and away from a site cannot be quantitatively tracked, inferring the range and intensity of site activities from tools is inexact at best. Several examined attributes can, however, provide insight into tool manufacture, maintenance, and use. Biface fragments can provide information regarding both site activities and reduction strategies, perhaps more so than complete artifacts whose discard was very likely fortuitous. Since different activities frequently result in distinct break patterns, these break patterns can be used to infer activity, particularly manufacture and use-related breaks.

Breakage patterns were recorded for all bifacial tools, which in many cases can be indicative of cause. For this analysis, two general break types were documented: *manufacture breaks* (edge bites, lateral snaps, outre passé, perverse fractures, and reverse

Table 3.106. Biface Function through Time

		Count	Subtable Percent
Late Archaic	spokeshave (notch)	1	.7%
	biface, undifferentiated	88	57.5%
	projectile point	64	41.8%
	Total	153	100.0%
Early Pithouse	biface, undifferentiated	10	45.5%
	projectile point	11	50.0%
	drill	1	4.5%
	Total	22	100.0%
Late Pithouse	biface, undifferentiated	19	23.2%
	projectile point	59	72.0%
	drill	4	4.9%
	Total	82	100.0%
Pithouse	projectile point	4	100.0%
	Total	4	100.0%
Early Pueblo	biface, undifferentiated	14	38.9%
	projectile point	18	50.0%
	drill	2	5.6%
	denticulate	1	2.8%
	knife	1	2.8%
	Total	36	100.0%
Late Pueblo	biface, undifferentiated	169	48.4%
	projectile point	159	45.6%
	drill	17	4.9%
	denticulate	1	.3%
	knife	3	.9%
	Total	349	100.0%
Protohistoric	biface, undifferentiated	7	46.7%
	projectile point	8	53.3%
	Total	15	100.0%
Mixed	biface, undifferentiated	153	52.8%
	projectile point	134	46.2%
	drill	3	1.0%
	Total	290	100.0%

Table 3.107. Generalized Biface Breakage Patterns

		Manufacture		Indeterminate		Whole	
		Count	Percent	Count	Percent	Count	Percent
Late Archaic	43766	5	27.8	5	27.8	8	44.4
	45508	2	7.4	2	7.4	23	85.2
	70188	6	16.2	8	21.6	23	62.2
	78439	1	16.7			5	83.3
	Total	14	15.9	15	17.0	59	67.0
Early Pithouse	39972	2	40.0	2	40.0	1	20.0
	39975	2	33.3			4	66.7
	Total	4	36.4	2	18.2	5	45.5
Late Pithouse	43786					1	100.0
	45507					1	100.0
	45510	1	8.3	4	33.3	7	58.3
	70196	3	33.3			6	66.7
	Total	4	17.4	4	17.4	15	65.2
Early Pueblo	39972	2	66.7			1	33.3
	3563	1	20.0			4	80.0
	39969	2	22.2	1	11.1	6	66.7
	75792	2	100.0				
	Total	7	29.4	1	5.9	11	64.7
Late Pueblo	3279	32	20.1	14	8.8	113	71.1
	39968	5	29.4	1	5.9	11	64.7
	70185	5	38.5	2	15.4	6	46.2
	Total	42	22.2	17	9.0	130	68.8
Protohistoric	37917	2	40.0	1	20.0	2	40.0
	37919	1	50.0			1	50.0
	Total	3	42.9	1	14.3	3	42.9
Mixed	43766	15	30.6	9	18.4	25	51.0
	70188	23	25.8	12	13.5	54	60.7
	78439	1	16.7			5	83.3
	70191					1	100.0
	75791	1	100.0				
	89846			2	28.6	5	71.4
	89847					1	100.0
	Total	40	26.9	23	14.7	91	58.3

fractures); and *snaps* (indeterminate/noncultural). Additionally, use-related breaks (impact fractures and haft snaps) were recorded for projectile points.

Though the comparatively large number of biface reduction flakes recovered at Archaic sites seems to indicate a stronger emphasis on biface production or maintenance, the formal tool assemblage does not support it. As Table 3.107 indicates, generalized biface manufacture is evidenced by manufacture-related breaks in nearly all time periods, and in all but five of the site assemblages in which generalized bifaces were recovered. Based on these data, no consistent association between temporal component and level of biface manufacture is discernable. The variability between time periods, and in fact between sites, seems related more to assemblage size than to technology. The projectile point assemblages present a similar distribution (Table 3.108), indicating varied amounts of both use and manufacture-related breaks in all but six site assemblages and across all time periods. Interestingly, the frequency of breakage generally decreases with time and is more than twice as likely during the Late Archaic period than the Late Pueblo period.

Biface portions can also help depict the nature of site activities. Although portion was recorded for all artifacts, its usefulness is usually limited to discussions of identified tool types like projectile points, since generalized bifaces often cannot be oriented well enough to establish a working edge. Conversely, projectile point fragments coupled with breakage patterns can frequently depict the type of activity for which they were last used. Projectile point tips, for example, frequently break off on impact, and may remain lodged within the flesh of an animal. Thus, the presence of these fragments in a site assemblage may indicate that killed game or meat packages were brought to the site and processed. Additionally, the presence of basal fragments with use-related breaks may indicate weapon refurbishing—the removal and replacement of broken projectile points from the haft.

Table 3.109 is a cross-tabulation of portion and break pattern. Tips with use-related breaks have likely arrived at the site in a meat package; bases with use-related breaks were probably removed from the haft on-site during refurbishment. Since "whole" was an indication of completeness in terms of measurement, some points listed here as whole also have break patterns recorded. Small numbers of use-broken basal fragments were recovered from 16 of the 29 listed components, and from nearly all of the site assemblages, indicating some amount (though in many cases minimal) of weapon refurbishing at the majority of the sites, and during all time periods except the protohistoric. LA 43766, LA 70188, and LA 3279 have relatively large numbers of use-broken bases, indicating a comparatively greater emphasis on weapon repair.

Common sense implies that the recovery of kill-related point tip fragments should be fairly uncommon at best, primarily because of their small size. Though no assemblage contained large numbers, eight site assemblages included between one and five use-broken tips each (Table 3.109). Since their recovery is relatively fortuitous, these data cannot depict any semblance of scale, but imply the inclusion of game processing in the suite of site activities.

A general measure of artifact size is difficult to quantify for a number of reasons. Overall length, width, and thickness were measured for each artifact, however, these individual measurements are frequently misrepresented because so few of the recovered artifacts were whole. Artifact size may, in most cases, have much more to do with an artifact's position in its use-life than its original intended use. However, size may provide a coarse, but adequate manner of evaluating this intent in a comparative fashion. For this purpose, size was quantified in cubic millimeters, by multiplying length, thickness, and width—regardless of artifact portion.

As a generalized tool form, tool preform, and expedient tool core, generalized bifaces should be larger; conversely, if bifaces were primarily used as specialized tool forms, particularly small ones such as projectile points and drills, then they should generally be smaller. Following this assumption, if bifaces were used in a broader manner during the more mobile Archaic period and primarily as specialized tools during more residential periods, then it follows that Archaic period bifaces should be larger, particularly since Archaic period specialized tool forms, such as atlatl darts, are generally larger than their arrow point counterparts in later time periods.

Quantitatively, Figure 3.103 provides little information. Because *large* and *small* have not been truly defined, it is clear that size is related to time. As expected, recovered bifaces and biface fragments are much larger during the Archaic period than in almost any other. What was not expected was the comparatively large, in fact almost equally large, biface size during the Early Pithouse and Early Pueblo periods. An analysis of variance (ANOVA) (Fig. 3.24) indicates that, at the .01 level, the Late Archaic, Early Pithouse, and Early Pueblo periods are the same population in terms of biface size, with the other time periods comprising a second. The Pithouse period must be discounted here because of the extremely small sample size; the series of outliers in the Late Pueblo period are portions of large knives.

Table 3.108. Projectile Point Breakage Patterns

		Manufacture		Use		Indeterminate		Whole	
		Count	Percent	Count	Percent	Count	Percent	Count	Percent
Late Archaic	43766	13	24.5	18	34.0	13	24.5	9	17.0
	45508	8	44.4	2	11.1	5	27.8	3	16.7
	70188	25	23.8	32	30.5	31	29.5	17	16.2
	78439							1	100.0
	Total	46	25.0	57	31.0	50	27.2	31	16.8
Early Pithouse	39972	2	33.3	3	50.0	1	16.7		
	39975	1	16.7	4	66.7			1	16.7
	45510	1	5.0	8	40.0	6	30.0	5	25.0
	Total	4	12.5	15	46.9	7	21.9	6	18.8
Late Pithouse	43786					1	100.0		
	45507	4	19.0	4	19.0	5	23.8	8	38.1
	70196	5	29.4	4	23.5	4	23.5	4	23.5
	Total	9	23.1	8	20.5	10	25.6	12	30.8
Pithouse	70201	1	25.0			2	50.0	1	25.0
	Total	1	25.0			2	50.0	1	25.0
Early Pueblo	3563	1	50.0			1	50.0		
	39969	1	7.7	4	30.8	3	23.1	5	38.5
	39972	1	50.0	1	50.0				
	75792	1	20.0	2	40.0			2	40.0
	Total	4	17.6	7	29.4	4	23.5	7	29.4
Late Pueblo	3279	19	17.1	38	34.2	16	14.4	38	34.2
	9721							1	100.0
	39968	3	23.1	3	23.1			7	53.8
	70185	6	20.7	5	17.2	6	20.7	12	41.4
	Total	28	18.2	46	29.9	22	14.3	58	37.7
Protohistoric	37917			5	71.4	1	14.3	1	14.3
	37919					1	100.0		
	Total					1	100.0		
Mixed	70191	1	50.0	1	50.0				
	75791					1	100.0		
	78439					1	50.0	1	50.0
	89846	1	25.0	1	25.0	2	50.0		
	89847			1	100.0				
	Total	1	20.0	3	33.3	4	26.7	1	20.0

Table 3.109. Projectile Point Breakage Patterns by Portion; Whole Points and Small or Unidentifiable Fragments not Considered

Period	Site	Portion	Manufacture Break	Use Break	Indeterminate Break
Late Archaic	LA 43766	base	6 20.7	14 48.3	9 31.0
		blade	7 50.0	4 28.6	3 21.4
	LA 45508	base	0 0.0	1 33.3	2 66.7
		blade	8 66.7	1 8.3	3 25.0
	LA 70188	base	8 19.5	20 48.8	13 31.7
		blade	17 37.8	12 26.7	16 35.6
Early Pithouse	LA 39972	base	3 50.0	2 33.3	1 16.7
		blade	0 0.0	2 100.0	0 0.0
	LA 39975	base	1 25.0	3 75.0	0 0.0
		blade	0 0.0	1 100.0	0 0.0
	LA 45510	base	0 0.0	4 50.0	4 50.0
		blade	1 14.3	8 53.3	2 28.6
Late Pithouse	LA 43786	base	0 0.0	0 0.0	1 100.0
	LA 45507	base	1 50.0	0 0.0	1 50.0
		blade	3 27.3	4 36.4	4 36.4
	LA 70196	base	1 20.0	4 80.0	0 0.0
		blade	4 50.0	0 0.0	4 50.0
Pithouse	LA 70201	base	0 0.0	0 0.0	1 100.0
		blade	1 50.0	0 0.0	1 50.0
Early Pueblo	LA 3563	base	1 50.0	1 50.0	0 0.0
	LA 39969	base	0 0.0	3 60.0	2 40.0
		blade	1 50.0	1 50.0	0 0.0

Period	Site	Portion	Manufacture Break	Use Break	Indeterminate Break
	LA 39972	base	3 50.0	2 33.0	1 16.7
		blade	0 0.0	2 100.0	0 0.0
	LA 75792	base	1 33.3	2 66.7	0 0.0
Late Pueblo	LA 3279	base	7 19.4	18 50.0	11 30.6
		blade	11 30.6	20 55.6	5 13.9
	LA 39968	base	2 100.0	0 0.0	0 0.0
		blade	1 25.0	3 75.0	0 0.0
	LA 70185	base	2 25.0	3 37.5	3 37.5
		blade	4 44.4	2 22.2	3 33.3
Protohistoric	LA 37917	base	0 0.0	2 66.7	1 33.3
		blade	0 0.0	3 100.0	0 0.0
	LA 37919	blade	0 0.0	0 0.0	1 100.0
Mixed	LA 70191	base	1 100.0	0 0.0	0 0.0
		blade	0 0.0	1 100.0	0 0.0
	LA 75791	base	0 0.0	0 0.0	1 100.0
	LA 78439	blade	0 0.0	0 0.0	1 100.0
	LA 89846	base	0 0.0	1 50.0	1 50.0
		blade	1 50.0	0 0.0	1 50.0
	LA 89847	blade	0 0.0	1 100.0	0 0.0

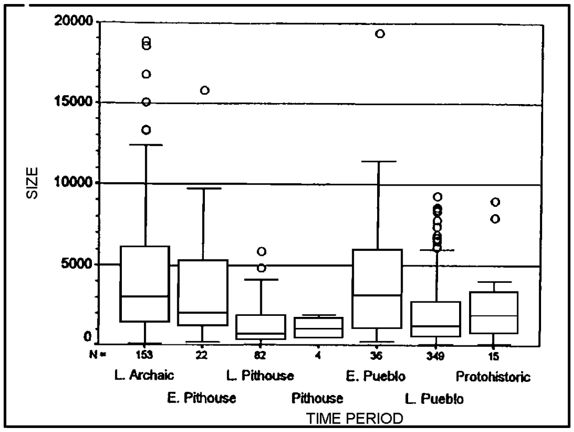

Figure 3.24. Box plot of biface size by time period.

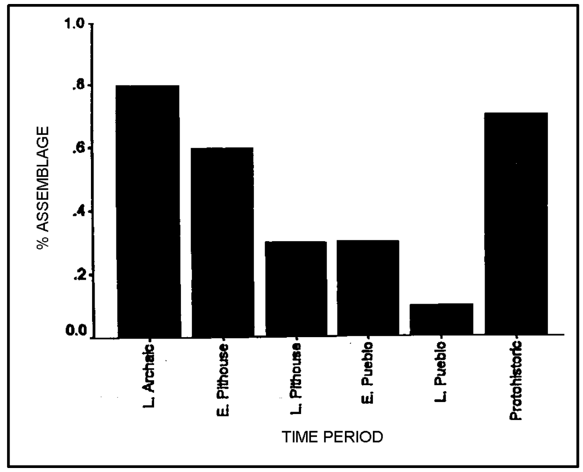

Figure 3.25. Utilized biface reduction flakes (portion of overall assemblages).

Though bifacial cores may be indistinguishable from other generalized bifaces, the resultant informal tools are likely identifiable within the debitage assemblage. Biface reduction flakes were identified using a polythetic set (see *Chipped Stone Analytical Methods*, this volume), and all debitage was monitored for indications of wear. Following the assumption that the use of generalized bifaces as cores for expedient tools is more common during periods of high mobility, certain types of Archaic period sites should exhibit more frequent use of this tactic. As Figure 3.25 indicates, this is the case here, and the occurrence of utilized biface reduction flakes is much more common during the Archaic period than in assemblages from later residential sites.

Raw Material. Locally available materials constitute the majority of the formal tool assemblage (Table 3.110). As could reasonably be expected, most of the bifaces and unifaces are made of fine-grained, predominantly crypto-crystalline materials (Table 3.111); the cobble tools are predominantly of medium to coarse-grained materials. Several of the local materials possess qualities that are not intuitively associated, and it is important to point out this issue's relationship to formal tool production. Luna blue agate, for example, is a high-quality, fine-grained material suitable for flaking, but is also incredibly durable and suitable for many cobble tool forms. Unless it is heated, it can often only be broken with massive bipolar blows. As Table 3.111 indicates, it has been broadly used for all tool types, and comprises more than a third of the identified hammerstones. The fine-grained texture and overall high quality of the local basalt is indicated by its use for both unifaces and bifaces (Table 3.112). Common in the Late Archaic period components, it comprises nearly all of the Archaic Period projectile points at LA 43766.

With the exception of obsidian, no exotic materials were identified within the formal tool assemblage. In general, obsidian was used for formal tool production with more frequency during later periods, and then most often for small projectile points. The glassy texture of obsidian and easily controlled fracture properties make it well suited to the high-detail pressure-flaking that the production of these points requires.

Table 3.110. Formal Tool Raw Materials

Material	Cobble Tool		Uniface		Biface		Other	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Chert	7	12.3	10	34.5	319	33.5		
Luna Blue	16	28.1	3	10.3	221	23.2		
Obsidian			2	6.9	258	27.1		
Igneous	11	19.3	4	13.8	15	1.6	1	50.0
Basalt	6	10.5	3	10.3	112	11.8	1	50.0
Rhyolite	1	1.8	5	17.2	24	2.5		
Metamorphic	16	28.1	2	6.9	2	0.2		

Table 3.111. Formal Tool Material Quality

		Nondurable		Durable		Luna Blue Agate	
		Count	Percent	Count	Percent	Count	Percent
Cobble Tools	hammerstone	3	6.5	27	58.7	16	34.8
	chopper	2	40.0	3	60.0		
	axe			1	100.0		
	graver	1	100.0				
	core-chopper			1	100.0		
	chopper-hammerstone	1	33.3	2	66.7		
	Total	7	12.3	34	59.6	16	28.1
Unifaces	spokeshave (notch)	1	100.0				
	scraper, undifferentiated	8	42.1	8	42.1	3	15.8
	end scraper			1	100.0		
	thumbnail scraper	2	100.0				
	uniface, undifferentiated	1	16.7	5	83.3		
	Total	12	41.4	14	48.3	3	10.3
Bifaces	spokeshave (notch)	1	100.0				
	drill	15	55.6	4	14.8	8	29.6
	denticulate	2	100.0				
	biface, undifferentiated	254	55.2	68	14.8	138	30.0
	knife	3	75.0	1	25.0		
	projectile point	302	66.1	80	17.5	75	16.4
	Total	577	60.7	153	16.1	221	23.2
Nonspecific	projectile point			1	100.0		
	agave/mescal knife			1	100.0		
	Total			2	100.0		

Table 3.112. Basalt Use in Formal Tools

		Basalt		Other	
		Count	Percent	Count	Percent
Cobble Tools	hammerstone	5	10.9	41	89.1
	chopper			5	100.0
	axe	1	100.0		
	graver			1	100.0
	core-chopper			1	100.0
	chopper-hammerstone			3	100.0
	Total	6	10.5	51	89.5

		Basalt		Other	
		Count	Percent	Count	Percent
Unifaces	spokeshave (notch)			1	100.0
	scraper, undifferentiated	2	10.5	17	89.5
	end scraper			1	100.0
	thumbnail scraper			2	100.0
	uniface, undifferentiated	1	16.7	5	83.3
	Total	3	10.3	26	89.7
Bifaces	spokeshave (notch)			1	100.0
	drill	3	11.1	24	88.9
	denticulate			2	100.0
	biface, undifferentiated	43	9.3	417	90.7
	knife	1	25.0	3	75.0
	projectile point	65	14.2	392	85.8
	Total	112	11.8	839	88.2
Nonspecific	projectile point	1	100.0		
	agave/mescal knife			1	100.0
	Total	1	50.0	1	50.0

This reliance on local materials is further stressed by the geographic diversity of the sites. Spread across the Pine Lawn Valley and eastern slope of the San Francisco Mountains, the majority of the sites are located in the lower elevations of the San Francisco River Valley; the remainder are at a much higher elevation on the western slope and in the alpine Luna Valley. As discussed earlier (see Moiola, this volume), material availability is distinct between these two areas: the Pine Lawn-Reserve area is rich in cherts and fine-grained basalts, while local agates such as Luna blue are more common in the Luna area. As Table 3.113 indicates, both unifacial and bifacial tools were primarily manufactured from the predominant local materials in each area. Interestingly, obsidian, which is essentially exotic to the project area, was selected far more frequently for biface production in the Luna area than the Reserve area.

Discussion

Though far less robust than expected, these data generally confirm the proposed model of formal tool use throughout time; the consistency of these data seems to rely largely on the size of the assemblage removed from particular sites, with larger assemblages providing stronger, more relevant relationships to the hypotheses.

In general, all of the Late Archaic period tool assemblages show an emphasis on biface production-maintenance, but more specifically on hunting tool and weapons-related activities. Three of the five Archaic components show significant evidence of weapon construction, and four of weapon refurbishment (Table 3.114). As a temporally confusing assemblage, it is not surprising that LA 78439 stands out as unique for this time period; it was culled from mixed components where spatial distinction was difficult and various dating methods provided conflicting results.

Surprisingly, biface production is evidenced at nearly all of the later period sites as well, and weapon construction or refurbishment is indicated at several of the larger residential sites. With two exceptions, the debitage assemblages reflect these data with only minimal numbers of biface reduction flakes, and biface production is indicated only by the presence of manufacture-broken biface fragments. Unique among the Pithouse and Pueblo assemblages are LA 70196 and 70185, both of which include biface reduction flakes in numbers well exceeding 10 percent of their overall assemblage.

Table 3.113. Material Types for Unifaces and Bifaces by Location

Area	Tool Type	Chert	Luna Blue Agate	Silicified Wood	Obsidian	Basalt	Andesite	Rhyolite	Quartzite	Quartzitic Sandstone	Massive Quartz	Totals
Luna	Unifaces	1	2	0	1	0	0	0	0	0	0	4
		25.0	50.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
	Bifaces	60	184	0	162	12	1	3	1	0	0	423
		14.2	43.5	0.0	38.3	2.8	0.2	0.7	0.2	0.0	0.0	99.1
	Totals	61	186	0	163	12	1	3	1	0	0	427
		14.3	43.6	0.0	38.2	2.8	0.2	0.7	0.2	0.0	0.0	100.0
Reserve	Unifaces	9	1	0	1	3	3	6	0	1	1	25
		36.0	4.0	0.0	4.0	12.0	12.0	24.0	0.0	4.0	4.0	4.6
	Bifaces	245	44	1	91	97	4	31	0	1	0	514
		47.7	8.6	0.2	17.7	18.9	0.8	6.0	0.0	0.2	0.0	95.4
	Totals	254	45	1	92	100	7	37	2	1	0	539
		47.1	8.3	0.2	17.1	18.6	1.3	6.9	0.4	0.2	0.0	100.0

Table 3.114. Tool Associated Activities by Site

Time	Site	General Biface Production/maintenance	Weapon Construction	Weapon Refurbishment	Game Processing	Wood Working/vegetative Processing
Late Archaic	37917	X		X		
	43766	XX	X	X		X
	45508	X	X	X	X	
	70188	XX	X	X	X	X
	78439	X				
Early Pithouse	39972	X	X	X		X
	39975	X	X	X	X	X
	45510			X		X
Late Pithouse	43786					X
	45507		X		X	
	70196	XX	X	X		X
Pithouse	70201		X			
Early Pueblo	3563	X	X			
	39969	X		X		X
	39972	X	X	X	X	X
	75792	X	X	X		X
Late Pueblo	3279	X	X	X	X	X
	9721					
	39968	X	X		X	X
	70185	XX	X	X	X	X
Protohistoric	37919	X				
Mixed	43766	XX				
	70188	XX				X
	70189					
	70191	X	X	X		
	75791	X				
	78439	X				X
	89846		X	X		
	89847			X		

Game processing, implied by the presence of projectile point tips (and indirectly meat packages), is evidenced at only two of the Archaic period sites. LA 70188, which provided the largest chipped stone assemblage in the project, appears to have been continually reoccupied over a long period of time. Though the majority of these occupations were during the Late Archaic, individual occupations within this period are a palimpsest. The result is an enormous assemblage with evidence of numerous activities. Conversely, LA 43766 appears to have been deposited by two discrete, Late Archaic period occupations. The large number of use-broken bases, presence of several broken-in-manufacture bifaces, and large number of late-stage biface reduction flakes indicate a strong emphasis on biface manufacture. More particularly, the presence of spokeshaves may indicate the refurbishing of atlatl dart shafts. Whereas the assemblage at LA 70188 was likely deposited during many episodes of occupation and reflects many types of activities, LA 43766 appears to have been used more intensely for the purpose of gearing up, repairing and preparing weapons prior to a hunt.

Sites from the later occupational periods provided less consistent, and harder to characterize, assemblages in terms of overall site activities, perhaps owing partially to the type of sample the excavation provided. LA 39975, LA 70196, LA 3279, LA 70185, and LA 39968, for example, all provided rather large assemblages, and in general one would expect that increasingly large assemblages should incorporate increasing diversity; conversely, other large sites (i.e., LA 39969 and LA 45507) may have yielded far fewer artifacts because of the site portions available for excavation. Contrasted among themselves, the only reoccurring pattern in the residential period assemblages seems to be related to assemblage size, and may therefore be related to sampling or occupation length and magnitude. Following this, it seems more likely that the implied differences in site activities between the LA 3279 and LA 9721 assemblages may be far more related to the diversity of excavated areas than to the distinction of site roles.

With this in mind, several patterns can, in fact, be observed. Biface production, for example, is typically associated with mobility, and accordingly with earlier time periods such as the Paleoindian and Archaic. However, these data indicate that bifaces played a significant (though perhaps narrower) role throughout the more sedentary periods as well. Though the frequency of biface reduction flakes in these later site assemblages is much lower, generalized bifaces were recovered in every time period, as were biface fragments with manufacture-related breaks.

The way in which bifaces are incorporated into overall strategy does, however, seem to change through time. As portions of each assemblage as a whole, generalized bifaces decrease in importance after the Archaic period, except during the Late Pueblo period, where they are nearly as common (Fig. 3.26). Projectile points become more common in later assemblages, except during the Early Pueblo period. More significantly, the use of biface reduction flakes as informal tools, and therefore the use of bifaces as cores for expedient tools, co-varies with mobility (Fig. 3.26); presumably mobility decreases after the Archaic period, with the highest levels of sedentism occurring during the Late Pueblo period. The protohistoric period probably represents the use of the region by mobile Athabaskan groups.

Informal Tools

Informal, or expedient, tools were defined as utilized artifacts whose morphology was not intentionally altered to meet the needs of a task. Unlike formal tools, which are usually identified by morphological characteristics, expedient tools are distinguishable from other debitage or debris only by the presence of use-related damage or minor edge modification. This analysis identified nine different wear patterns including unidirectional and bidirectional wear, retouch, rounding, rotary, battering, abrasion, serration,

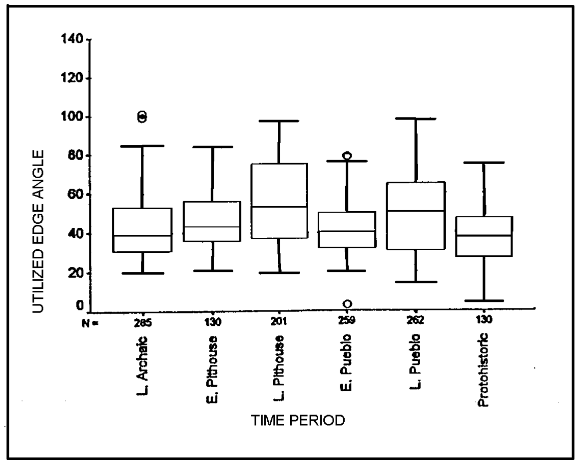

Figure 3.26. Box plot of edge angles on informal tools.

and composite. Debitage with consistent edge scars a minimum of 2 mm long were assigned to retouch categories. Flake or angular debris edges that appeared to be ground were considered abraded. Both unidirectional and bidirectional utilization may produce scars that include feathers, steps, and scallops less than 2 mm long. Moving an edge transversely across an object (scraping) is usually associated with the former, and lateral (cutting) movements result in the latter. All wear patterns were carefully monitored and noted only for artifacts that appeared not to be affected by post-depositional processes, had consistent patterning, and were from a subsurface context.

Because it relies entirely on the presence and (perhaps more importantly) observation of recognizable use-wear patterns along potential use-surfaces, identifying informal tools is difficult at best. Several studies have shown that certain variables (particularly raw material type and length of use prior to discard) can make these patterns difficult to observe. Three general limitations to use-wear identification in the context of this analysis include: (1) insufficient magnification, (2) nature of tool use (Schutt 1980), and (3) limitations of material types (Foix and Bradley 1985; Schutt 1980; Toll 1978; and Vaughn 1985).

In order to evaluate wear patterns, Schutt (1980) performed a variety of tool experiments that simulated resource procurement and tool manufacturing activities. Flakes were used to process plant material, tan hides, flesh meat from bone, and make tools such as foreshafts and bone awls. The process of cutting and scraping yucca or hides produced little or no edge damage that could be considered use-wear. Foreshafts were produced by scraping, slicing, and whittling pieces of hardwood. Some edge damage was noted, but no distinct wear patterns were visible. The only consistent edge damage occurred when lithic materials were worked intentionally against bone or other hard surfaces. The results of these experiments show that although flake tool utilization frequently (but not always) produces edge damage, it is not necessarily task specific. For example, unidirectional edge scars were the result of both cutting and scraping motions. The experiments did note that tools could be utilized longer by changing the angle in which they were worked against the medium, and that angles less than 40 degrees are better for cutting implements, and those with over 40 degree angles were well suited for chopping.

Other experiments describe the difficulty in identifying use-wear patterns on informal tools in relation to material type and use. Coarse-grained materials such as rhyolite and quartzite are quite effective and durable materials, but often weather moderate use without demonstrating consistently observable patterns of wear (Foix and Bradley 1985; Toll 1978). Toward that end, identification of informal tools made from these materials may be problematic. Our experiments with the local materials suggest similar results, and imply that not only do some materials inhibit wear-pattern development, but some actually exaggerate it. While local rhyolites and quartzites may be used repeatedly for long periods of time with little observable attrition, materials like obsidian develop significant damage almost immediately.

Further, the core of many use-wear studies has been examination through high power microscopes, ranging from 100x to scanning electron microscopes. While these studies have resulted in more consistent results (Vaughn 1985), they are often difficult to replicate and are not efficient enough to be applied to large assemblages.

With this in mind, it seems likely that the informal tools, once segregated from the other artifacts in each assemblage, will reflect only a portion of those actually present. Further, it is likely that this group will be particularly biased in favor of some raw materials (particularly obsidian and fine-grained chert), some particular uses, and those tools that were subjected to heavy use. While this certainly does not provide a comprehensive representation or reflective sample of informal tool use, it does provide a glimpse at some disarticulated portions of an overall technological approach.

Results

Although the proposed technological framework suggests that informal tool use should change through time, these data suggest remarkable homogeneity among the examined assemblages. The greatest difference between each of the temporally discrete groups is the relative proportion that informal tools constitute (Table 3.115). A chi-square analysis of these data indicates that the sites are significantly different well beyond the .001 level, with percentages ranging between 2.0 and 11.6 percent (Table 3.115), and an extreme value during the protohistoric period. Since this variation doesn't appear to follow a particular pattern, it is not clear if it is culturally significant, or the product of sampling problems.

Table 3.115. Informal Tool Counts by Time Period

Time Period	Informal Tool		Nontool	
	Count	Percent	Count	Percent
Late Archaic	392	3.9	9761	96.1
Early Pithouse	175	8.3	1928	91.7
Late Pithouse	285	6.5	4092	93.5
Early Pueblo	343	6.3	5086	93.7
Late Pueblo	408	2.0	19978	98.0
Protohistoric	158	11.6	1205	88.4
TOTAL	2481	4.0	60106	96.0

Chi-Square Test Nominal by Nominal: Value=.123; Approx. Sig.=.000

Table 3.116. Informal Tool Morphology by Time Period

Time Period	Angular Debris		Core Flake		Biface Flake		Core	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Late Archaic	10	3.6	198	71.7	65	23.6	3	1.1
Early Pithouse	6	4.2	128	90.1	8	5.6		
Late Pithouse	7	3.4	168	82.0	28	13.7	2	1.0
Early Pueblo	19	5.9	289	89.2	11	3.4	5	1.5
Late Pueblo	21	8.7	194	80.2	18	7.4	9	3.7
Protohistoric	5	3.5	124	86.7	14	9.8		

While use level seems to vary through time, the character of this use does not. Artifact morphology, with one exception, corresponds tightly with overall debitage morphology, suggesting that tool choice is not guided by reduction strategy (Table 3.116). An increase in utilized biface reduction flakes during the Late Pithouse period may be explained by increased use of obsidian for biface production during that period, and the ease with which obsidian exhibits use-wear patterns.

Dominated by edge-attrition types, use-wear patterns are also fairly consistent through time, except the Late Pithouse and Late Pueblo periods where retouched patterns are far more frequent than unidirectional or bidirectional forms (Fig. 3.117).

At first glance, material selection does not appear to fit this pattern, and while some cherts and Luna blue agate seem to be selected less frequently, obsidian is more frequently chosen. Two possible explanations seem likely for this pattern: some materials are better suited for informal tool use, and are therefore selected with more frequency than others; or some materials express evidence of use-wear more easily than others, and are therefore identified more frequently during analysis. In fact, both of these issues likely play a role. Our limited local material tests indicate that most of the local cherts, rhyolites, agates, basalts, and quartzites do not consistently show discernable wear after moderate use, particularly if that use is discontinued as soon as a drop in tool efficiency due to edge dulling is noted. Other materials, such as obsidian, frequently show wear with very minimal use. Further, while most of the local materials are suitable for basic tasks such as cutting and scraping, obsidian and Luna blue agate seem particularly well suited. As with most natural glasses, Red Hill and Mule Creek obsidian provides an extremely sharp edge when a flake is first struck, and, although this edge deteriorates quickly, it is far superior to almost any other material for many precision cutting tasks. Luna blue, though much coarser and not quite as sharp, is incredibly durable and produces a relatively sharp, long-lasting edge. A careful examination of Table 3.118 reveals that, although the selection of raw materials for informal tools does not directly parallel overall material selection, obsidian use is exaggerated in the Late Pithouse and protohistoric periods where general obsidian use is high.

Although several researchers have suggested a relationship between use activity and edge angle (and therefore use-wear pattern and edge angle), these data do not entirely support that idea. As Table 3.119 indicates, there is relative homogeneity between unidirectional and bidirectional wear across all but one time period. An examination of these data using histograms indicates that edge angle distributions are unimodal for all time periods, and do not cluster around values above and below 40 degrees as Schutt (1980) proposes, but instead cluster around a mean value of 40. There are significant differences in edge angles for informal tools exhibiting unidirectional and bidirectional wear patterns versus those exhibiting marginal retouch in all but two time periods (Table 3.118).

Discussion

While the homogeneity between artifacts with unidirectional and bidirectional wear patterns is difficult to explain, several factors may explain their distinction from retouched artifacts. The most obvious, and perhaps most significant, is that retouching generally increases edge angles, both by design and by default. Presumably, at least two activities could result in a retouched edge: edge attrition due to extended or intensive use, and intentional edge modification to obtain an appropriate edge angle for a particular task. In many cases, the former activity may precipitate the need or desire for the latter, once a tool's effectiveness as an acute-edged implement (such as a knife) is gone, it may be easily employed as a steep edged tool (such as a scraper).

Table 3.117. Wear Pattern by Time

Time	Unidirectional		Bidirectional		Retouched		Rounding		Rotary		Battering		Abrasion		Serrated		Compound	
	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Late Archaic	189	48.2	65	16.6	31	7.9	12	3.1	1	0.3	4	1	11	2.8	1	0.3	78	19.9
Early Pithouse	73	41.7	46	26.3	11	6.3	8	4.6			2	1.1	7	4.0	2	1.1	26	14.9
Late Pithouse	69	24.2	56	19.6	76	26.7	8	2.8	4	1.4	6	2.1	12	4.2	3	1.1	51	17.9
Early Pueblo	154	44.9	84	24.5	21	6.1	14	4.1			8	2.3	7	2.0	7	2.0	48	14.0
Late Pueblo	147	36.0	51	12.5	64	15.7	23	5.6	9	2.2	5	1.2	4	1.0	4	1.0	101	24.8
Protohistoric	73	46.2	54	34.2	3	1.9	3	1.9			1	0.6	1	0.6	4	2.5	19	12.0

Table 3.118. Informal Tools by Material Type for Each Period; Silicified Wood Combined with Cherts

Period	Chert	Luna Blue Agate	Obsidian	Basalt	Andesite	Rhyolite	Limestone	Siltstone	Quartzite	Quartzitic Sandstone	Massive Quartz	Totals
Late Archaic	138	114	53	30	4	43	0	0	3	2	0	387
	35.7	29.5	13.7	7.8	1.0	11.1	0.0	0.0	0.8	0.5	0.0	21.4
Early Pithouse	68	33	8	6	12	40	0	3	3	2	0	175
	38.9	18.9	4.6	3.4	6.9	22.9	0.0	1.7	1.7	1.1	0.0	9.7
Late Pithouse	75	80	67	1	1	56	0	0	2	1	0	283
	26.5	28.3	23.7	0.4	0.4	19.8	0.0	0.0	0.7	0.4	0.0	15.7
Pithouse	15	4	6	0	0	43	0	0	0	0	0	68
	22.1	5.9	8.8	0.0	0.0	63.2	0.0	0.0	0.0	0.0	0.0	3.8
Early Pueblo	86	19	27	5	25	168	0	2	5	1	0	338
	25.4	5.6	8.0	1.5	7.4	49.7	0.0	0.6	1.5	0.3	0.0	18.7
Late Pueblo	126	166	40	4	20	34	1	2	1	4	1	399
	31.6	41.6	10.0	1.0	5.0	8.5	0.3	0.5	0.3	1.0	0.3	22.1
Protohistoric	50	15	44	10	6	31	0	0	2	0	0	158
	31.6	9.5	27.8	6.3	3.8	19.6	0.0	0.0	1.3	0.0	0.0	8.7

Table 3.119. Informal Tool Edge Angles

Time Period	Mean Edge Angle			Anova Significance		
	Unidirectional	Bidirectional	Retouched	Unidirectional/ Bidirectional	Unidirectional/ Retouch	Bidirectional/ Retouch
Late Archaic	44	37	51	.002	.018	.000[1]
Early Pithouse	48	40	66	.000[1]	.000[1]	.000[1]
Late Pithouse	43	43	75	.980	.000[1]	.000[1]
Early Pueblo	41	40	58	.393	.000[1]	.000[1]
Late Pueblo	48	46	58	.419	.000[1]	.000[1]
Protohistoric	40	35	36	.039	.594	.920

[1] Significantly different at the .001 level.

CONCLUSIONS

While all components contain an array of formal and informal tools, there are important temporal differences in tool use and types recovered. Large generalized bifaces and specialized bifaces occur throughout the sequence, the former dominate Archaic components and the latter dominate the Mogollon. While these data were not as robust as expected, they do fit in with our proposed model of tool use. Additionally, while the size and character of generalized bifaces remains relatively static through time, specialized bifaces (particularly projectile points) decrease considerably in size with the introduction of the bow early in the Pithouse period. As a result, the relatively small obsidian nodules from nearby sources become an effective material choice for biface manufacture.

Generalized bifaces are an efficient raw material package; they can be used as preforms for specialized tools or as tools without modification. Thus, they occur throughout the temporal sequence. It is in the level of importance that these tools represent in temporal components that differences can be distinguished. While generalized bifaces represent a major focus of Archaic reduction systems, they represent relatively minor foci in Mogollon reduction systems. This distinction in reduction strategy is likely related to level of mobility, as discussed in a later chapter.

While the identified informal tool assemblage likely represents only a fraction of the actual number present, it suggests relatively consistent use through time. The number of identified tools is proportionately similar through time, as is the distribution of use-wear patterns, suggesting similar employment of these tools for similar activities in all of the examined time periods.

OBSIDIAN SOURCING

David J. Hayden

As an exotic material, obsidian can potentially provide significant information about raw material acquisition. Though obsidian represents only small portions of each assemblage, its source-specific chemical makeup allows a more accurate depiction of a primary source than any other material in these assemblages. As a result, it can provide valuable insights into raw material use and potentially about trade and mobility patterns. These assemblages provide a rare opportunity to examine a large collection of obsidian artifacts from sites ranging in date from the Late Archaic to the Late Pueblo period. More significantly, it is the first such opportunity to examine a lithic assemblage this large from the Highland Mogollon region.

Several earlier studies, notably Findlow and Bolognese (1982), relied on optical characteristics to determine the source of obsidian artifacts. After examining materials collected from the Cow Canyon, Gwynn Canyon, Mule Creek, and Red Hill source areas (Shackley 1992, 1995), we were convinced that there was far too much overlap in color and quality to reliably distinguish these materials. While a trace-element analysis of the entire obsidian assemblage was financially impossible, we decided that a sizeable, randomly selected sample would be far more accurate than any attempt at visual material sorting.

A total of 181 obsidian samples was source-analyzed using the Energy Dispersive X-Ray Fluorescence (EDXRF) method (Shackley 1988, 1990, 1992, 1996a). Part of this sample (n = 101) was sent before temporal components were determined for these sites, and since our goal was to track obsidian source use through time, it was necessary to reorganize our sampling strategy after these components were isolated.

Six broad temporal periods were examined: Archaic, Early Pithouse (Pinelawn and Georgetown phases), Late Pithouse (San Francisco and Three Circle phase), Early Pueblo (Reserve phase), Late Pueblo (Tularosa phase), and protohistoric (Apache, Navajo, Zuni, etc.). With the exception of the Late Pithouse and protohistoric periods, obsidian use appears to have been relatively consistent through time (Table 3.120), representing a relatively small portion of the recovered artifact assemblages. Since only 16 sites incorporated discrete components, only 78 of the previously sent samples were useful to this part of the study (Table 3.121; sample 1 is the prior of the two sample sets). Toward that end, an additional 80 samples were sent to equally represent each time period. All samples were randomly selected from each site, and the total number contributed by each site was weighted based on the total amount of obsidian in each assemblage; projectile points and projectile point fragments were not considered.

Table 3.120. Obsidian Portion of Temporal Assemblages

Time Period	Obsidian	Other Material
Late Archaic	2.6	97.4
Early Pithouse	2.4	97.6
Late Pithouse	8.5	91.5
Early Pueblo	2.0	98.0
Late Pueblo	2.9	97.1
Protohistoric	10.6	89.4

RESULTS

Discussed in a series of short reports, the raw analysis data and results are available in Appendixes 3.1-3.4 (Shackley, this volume). Obsidian from five source areas were identified in the randomly selected sample (Table 3.122): Cow Canyon, Cerro Toledo, Gwynn Canyon, Mule Creek, and Red Hill. As the source of 75 percent of these samples, the Mule Creek area dominates the assemblage (Table 3.123). Further, when considered together with its geographically close neighbor, Cow Canyon, obsidian from the Mimbres area represent over 85 percent of the tested artifacts. Conversely, the Gwynn Canyon and Red Hill sources, which are geographically much closer to the project area, yielded a combined total of 13 percent. Cerro Toledo, a northern Jemez Mountain obsidian, can be found in Rio Grande gravels at least as far south as Socorro and is the most likely procurement area for the samples recovered here (Shackley, this volume).

Table 3.121. Obsidian Sample

Time Period	Site	Group 1	Group 2	Site Total	Time Period Total
Archaic	43766	4	0	4	28
	45508	6	3	9	
	70188	12	3	15	
Early Pithouse	39972-B	2	8	10	28
	39975	5	13	18	
Late Pithouse	3563	5	0	5	28
	45507	6	3	9	
	45510	5	0	5	
	70196	5	4	9	
Early Pueblo	39969	6	10	16	23
	39972-A	2	0	2	
	75792	5	0	5	
Late Pueblo	3279	0	18	18	23
	39968	5	0	5	
Protohistoric	37917	5	13	18	28
	37919	5	5	10	
Total		78	80	158	158

Table 3.122. Source Location Summary

Source	Location	Prehistoric Cultural Affiliation	Distance
Cerro Toledo	Northern Jemez Mountains, NM	Proto Piro at secondary source	approx. 350 miles to source approx. 100 miles to sec source in Rio Grande near Socorro, NM
Cow Canyon	Mule Creek, NM area	Mimbres	approx. 100 miles SW
Gwynn Canyon	Tularosa Mts, east of Reserve, NM	Highland Mogollon	approx. 50 miles SE
Mule Creek	Mule Creek, NM area	Mimbres	approx. 100 miles SW
Red Hill	west of Quemado, NM	Highland Mogollon/Anasazi	approx. 40 miles NW

Table 3.123. Obsidian Source by Time Period and Site

		Red Hill		Gwynn Canyon		Cow Canyon		Cerro Toledo		Mule Creek (All)		Total	
		CountC	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct	Count	Pct
Archaic	43766			2	50.0					2	50.0	4	100.0
	45508					2	22.2			7	77.8	9	100.0
	70188					1	6.7			14	93.3	15	100.0
	Total			2	7.1	3	10.7			23	82.1	28	100.0
Early Pithouse	39972	3	30.0			1	10.0			6	60.0	10	100.0
	39975			1	5.6	1	5.6	2	11.1	14	77.8	18	100.0
	Total	3	10.7	1	3.6	2	7.1	2	7.1	20	71.4	28	100.0
Late Pithouse	3563									5	100.0	5	100.0
	45507	4	44.4			1	11.1			4	44.4	9	100.0
	45510									5	100.0	5	100.0
	70196	3	33.3	1	11.1					5	55.6	9	100.0
	Total	7	25.0	1	3.6	1	3.6			19	67.9	28	100.0
Early Pueblo	39969			2	12.5					14	87.5	16	100.0
	39972			1	50.0					1	50.0	2	100.0
	75792					1	20.0			4	80.0	5	100.0
	Total			3	13.0	1	4.3			19	82.6	23	100.0
Late Pueblo	3279	1	5.6	2	11.1	5	27.8			10	55.6	18	100.0
	39968									5	100.0	5	100.0
	Total	1	4.3	2	8.7	5	21.7			15	65.2	23	100.0
Protohistoric	37917									18	100.0	18	100.0
	37919					4	40.0			6	60.0	10	100.0
	Total					4	14.3			24	85.7	28	100.0
Table Total		11	6.9	9	6.3	16	10.6	2	1.3	120	75.0	158	100.0

DISCUSSION

When examined in terms of general source area and procurement vector (Table 3.124), obsidian selection is considerably different in the Late Pithouse than in any other period, with a much higher portion of the assemblage being derived from Highland Mogollon sources than Mimbres area sources. Also interesting is the almost exclusive use of Mimbres area sources during the more mobile Archaic and protohistoric periods. At first glance, this apparent preference for Mimbres area obsidian over more local sources such as Red Hill and Gwynn Canyon glass is striking, and begs a strong cultural explanation; however, several subtler causalities may in fact be at work.

Table 3.124. General Source Areas

Time Period	Mogollon Highland	Mimbres	Other
Late Archaic	7%	93%	
Early Pithouse	14%	79%	7%
Late Pithouse	29%	71%	
Early Pueblo	13%	87%	
Late Pueblo	13%	87%	
Protohistoric		100%	

By limiting the breadth of technological approaches, raw obsidian nodule size and quality may have played a role in source selection; size limits transpose themselves on final tool form, and quality affects the predictability of manufacture. While Gwynn Canyon glass is generally of a better quality than Mimbres area obsidian, it is also less abundant and is most often found in smaller cobbles (Shackley 1988, 1992). Red Hill nodules appear to be of lesser quality than Gwynn Canyon glass, and are similarly small. Further, a general reconnaissance during the project failed to yield any cobbles larger than 5 cm at either source. While an examination of relative artifact size in relation to material source would more fully address this issue, and a contrast of tool manufacture and breakage with source would better characterize technological adaptability to material quality, the limited size of the sample data set precludes an earnest attempt.

This quantitative failure may, in fact, be insignificant in light of a broader, more intuitive issue—the difference between these two general source areas in terms of access. While the Mimbres area sources are abundantly exposed in a fairly unobstructed and accessible series of drainages, the Red Hill and Gwynn Canyon sources are not. In its high-altitude location, the Gwynn Canyon source is difficult to access, and is separated from most viable year-round residential locations by very rugged terrain. Geographically, the Red Hill source is much more accessible, however, the glass-bearing deposits are well buried, and cobbles are visible on the surface only after extreme erosional episodes or mechanical grading along modern roadways, effectively concealing the abundance of raw material at this source (Shakley, pers. comm.).

Within this context of accessibility lies the issue of convenience. Perhaps the greatest distinction between the Highland Mogollon and Mimbres sources occurs during the presumably more sedentary Pithouse and Pueblo periods, and is characterized by long-term residential sites. While the areas surrounding the Mule Creek and Cow Canyon sources seem to have supported at least some residential use, this appears not to have been the case for Gwynn Canyon or Red Hill. Geographically and environmentally, this makes reasonable sense since neither of the Highland source areas is particularly well suited for long-term residence by farmers—Gwynn Canyon is at a high altitude and difficult to access, and Red Hill is in a low basin with few perennial water sources. Following this, Mimbres obsidian was likely available as a trade item with Mimbres area residents (and imports of other items from this area are well evidenced, see Wilson, Volume 4), while procuring Highland obsidian may have required task-specific forays.

Embedded within the pattern of general preference for Mimbres area obsidian is additional variation associated with time period assignments. The most significant of these is centered on the Late Pithouse period (Table 3.124), characterized by an increased emphasis on the Highland (nearly all Red Hill) sources. Ironically, this period of decreased Mimbres obsidian acquisition also represents the peak importation of ceramic goods from the Mimbres area. Interestingly, obsidian comprises a larger portion of the Late Pithouse assemblages than during any other time period beside the protohistoric, and comprises nearly half of the biface reduction flakes recovered from Late Pithouse period sites (Table 3.125), suggesting not only an increased preference for obsidian as a raw material, but also an increased preference for its use in bifacial reduction. This figure is more than four times that of any other time period but the protohistoric, from which so few biface reduction flakes were recovered it is hardly comparable.

Table 3.125. Utilized Biface Flakes by Raw Material

Time Period	Obsidian		Other	
	Count	Pct	Count	Pct
Late Archaic	85	3.5	2364	95.5
Early Pithouse	6	8.1	68	91.9
Late Pithouse	138	43.9	176	56.1
Early Pueblo	9	9.3	88	90.7
Late Pueblo	34	8.2	382	91.8
Protohistoric	20	45.5	24	54.5

Within the Late Pithouse period assemblages, LA 70196 is strikingly different from other comparable components, with over 90 percent of its biface flakes having been produced from obsidian (Table 3.126). While this heavily weights the overall impression of the time period, other components within this time period show similar levels of obsidian biface reduction flakes, maintaining a higher mean portion of obsidian than other time periods without LA 70196's influence. Comparable disparity within other time periods (e.g., LA 78439, LA 39969, and LA 37917) is limited to extremely small assemblages.

Framing this parabolic trend for obsidian use in the Mogollon periods is an even stronger dependance upon the Mimbres area for raw obsidian. Two points are particularly relevant here: the first is that using the term *Mimbres* to describe this source area in either the Archaic or protohistoric period is inappropriate, since this culture manifestation was likely undeveloped during the former, and dispersed during the latter. The second point is particularly reliant on the first—that during both of these periods the Mimbres area sources were likely not surrounded by residential sites of the same character as during the Mogollon period.

With this in mind, it is reasonable to assume that trade networks developed during the Mogollon periods were unavailable, and that procurement from these sources was much more direct, making them no more convenient than the Highland area sources to these presumably mobile groups. Following this, it seems likely that the emphasis on Mule Creek and Cow Canyon obsidian during the Late Archaic and protohistoric periods is more tied to mobility vectors than trade. Rather than exploiting Mimbres area obsidian as nonlocal, but easily obtained materials, it may have been exploited in tandem with other seasonal mobility strategies. In this context, obsidian essentially becomes a "local" source by virtue of the expanded character of the term.

Table 3.126. Utilized Obsidian Biface Flakes by Site

Time	Site	Obsidian	
		Count	Pct
Late Archaic	43766		
	45508	37	5.6
	70188	16	1.4
	78439	32	74.4
	Total	85	3.5
Early Pithouse	39972		
	39975	6	9.7
	Total	6	8.1
Late Pithouse	43786		
	45507	38	25.3
	45510	15	21.7
	70196	85	90.4
	Total	138	43.9
Early Pueblo	3563	4	5.8
	39969	3	25.0
	39972	2	12.5
	Total	9	9.3
Late Pueblo	3279	19	11.6
	39968	5	15.6
	70185	10	4.5
	Total	34	8.2
Protohistoric	37917	14	77.8
	37919	6	23.1
	Total	20	45.5

SUMMARY

These data reveal several basic trends, centered primarily on the near-exclusive exploitation of Mimbres area obsidian over more local sources. We argue that this is related almost entirely to access rather than particular material qualities or cultural restrictions. As a source area with a sufficient cultural base to provide local procurement and exportation, the Mogollon period Mimbres area is equipped to provide the Mogollon Highland groups with more efficient access to obsidian through trade than they could secure from the Highland sources. During the Late Archaic and protohistoric periods, when this infrastructure is absent, the Mule Creek and Cow Canyon sources are likely embedded within seasonal mobility.

Unique among these assemblages is the Late Pithouse period, when general obsidian use, selection of obsidian for biface manufacture, and exploitation of local source areas peaked. Although the cause of these trends is unclear, presumably the increased use of obsidian encouraged a broader procurement system, which included an increased exploitation of less accessible resources.

CONCLUSIONS: APPLYING THE DATA TO THE RESEARCH DESIGN

James L. Moore

This analysis had several objectives, some overlapping, some quite distinct. In general, our examination of chipped stone assemblages was aimed at eliciting information on material selection, reduction strategy, and tool use. Variability between components and through time were necessary ingredients. In particular, we were interested in looking for differences between Archaic and Mogollon assemblages, Pithouse and Pueblo components, and how the protohistoric sites might differ from all others. Archaic sites were expected to exhibit evidence of a very mobile life style. Mobility was assumed to decline through the Mogollon occupation, culminating in a highly sedentary system by sometime in the Pueblo period. Protohistoric components were expected to evidence the same level of mobility as the Archaic components, and there should be subtle differences in reduction strategies if those components represent Athabaskan use of the region. We were also interested in determining how reliable projectile points are as temporal indicators, and what other information they might provide concerning changes in settlement and subsistence systems.

Examination of chipped stone material selection tendencies showed there were indeed differences in the way materials were selected through time. Similarly, analysis of reduction strategies also indicated temporal variation. However, in both cases local material availability was a factor, leading to differences between Luna and Reserve area assemblages that had little to do with variation in reduction strategy or settlement and subsistence systems.

While data from all components are used in this report, the results of analysis presented in *Chipped Stone Reduction: Debitage and Cores* suggest that most of the mixed assemblages do, indeed, consist of materials deposited by occupations during more than one time period. For that reason, obviously mixed assemblages are not included in most of this discussion.

CHANGING PATTERNS OF MATERIAL ACQUISITION

Moiola discussed topics related to the selection of raw materials for chipped stone reduction in *Chipped Stone Reduction: Material Selection*. Sample surveys of nearby source areas, primarily drainages and visible outcrops, established that there are differences in material availability between the Luna and Reserve areas. There appears to be a greater abundance and variety of cherts, rhyolites, and other igneous materials in Reserve area drainages. While these materials also occur in the Luna area, suitable nodules for reduction appear to be less common. However, Luna blue agate is quite abundant in the Luna area, and outcrops near all of the sites excavated there. Even though Luna blue agate is avidly sought by collectors and large amounts have been removed, examination of recent diggings along Stone Creek showed that this material is still plentiful in subsurface contexts. Thus, Luna blue agate is available from both primary and secondary sources in the Luna area. It is mostly available in secondary sources in the Reserve area.

Differences in material availability could potentially obscure significant variation in chipped stone assemblages, so it had to be taken into account in nearly every analysis. Overall, Luna blue agate (and chalcedony) was the most common material selected for use, and was slightly more abundant than the array of cherts. Rhyolite and basalt were the only other materials used in anything approaching abundance. Table 3.127 shows the difference in material class selection for the entire assemblage from both areas. Overall, two-thirds of the Luna assemblage is comprised of Luna blue agate, while this material makes up only about 18 percent of the Reserve assemblage.

With the exception of obsidian, all other material classes comprise greater percentages of the Reserve assemblage. Obsidian was somewhat more abundant in Luna components. While obsidian from various sources comprises different percentages of each area assemblage, statistically they represent the same population (Chi-square = 1.323, df = 2, significance = .51604; Cramer's V = .10167). Most obsidian from both areas was obtained from the Mule Creek-Cow Canyon source, with lesser amounts obtained from Red Hill and Gwynn Canyon. Obsidian is easily knapped, and is especially amenable to the manufacture of small projectile points by pressure. As Table 3.128 shows, obsidian was more often selected for the production of formal tools than were all other materials. However, the proportion of obsidian formal tools is much higher in the Luna assemblage than it is in the Reserve assemblage. Because other materials suitable for formal tool manufacture were less abundant in the Luna area,

Table 3.127. Differences in Overall Material Selection between the Luna and Reserve Areas; Frequencies and Column Percentages

Material Class	Luna Area	Reserve Area	Total
Chert	4,232 18.0	17,559 44.3	21,791 34.5
Luna Blue agate	15,511 66.0	6,957 17.6	22,468 35.6
Obsidian	847 3.6	1,012 2.6	1,859 2.9
Igneous	679 2.9	2,531 6.4	3,210 5.1
Basalt	289 1.2	4,479 11.3	4,768 7.6
Rhyolite	1,405 6.0	5,844 14.7	7,249 11.5
Sedimentary	69 0.3	158 0.4	227 0.4
Metamorphic	458 1.9	1,101 2.8	1,559 2.5
Total Percent	23,490 37.2	39,641 62.8	63,131 100.0

Table 3.128. Use of Obsidian versus Other Materials; Column Percentages

Artifact Type	Luna Area		Reserve Area	
	Obsidian	Other Material	Obsidian	Other Material
Debitage	80.5	96.6	90.9	97.0
Cores	0.7	2.3	0.2	1.9
Unifaces	0.1	0.01	0.1	0.1
Bifaces	4.0	0.7	3.3	0.6
Projectile points	14.6	0.4	5.6	0.5

an exotic material was more often selected for formal tool manufacture.

There are also differences in material selection parameters from period to period. Overall, chert and basalt were most commonly used in the Archaic period, rhyolites were most common in the Early Pithouse through Early Pueblo periods, and Luna blue agate by far dominated the Late Pueblo period. The protohistoric assemblage is relatively similar to the Archaic in that large amounts of chert were used. However, obsidian comprised a higher percentage of the protohistoric assemblage than any other period. Of course, there are differences between study areas. Both chert and basalt were less common in the Luna area Archaic assemblage; rhyolite was far more common in Luna area Mogollon assemblages; Luna blue agate was far more common in all periods in the Luna area. It appears that materials that were more amenable to tool manufacture were generally selected by the Archaic population of both areas, while this was not as important a concern in later periods (except the protohistoric). However, material selection was tempered by what was available around sites; there was little use of imported materials in any but the protohistoric period.

Cortex type is a useful indicator of material source. As Moiola discusses, our assemblages demonstrate important areal and temporal differences in material acquisition patterns. Overall, secondary gravel deposits were the main source of materials for both areas. However, there are some subtle differences. As Moiola notes, Luna blue agate was more often procured from primary sources in the Reserve area, and from secondary sources in the Luna area; obsidian in the Reserve area was more often acquired from primary sources while in the Luna area it was mostly procured from secondary sources. Both of these materials also demonstrate interesting temporal distributions, as shown in Table 3.129. During the Archaic and protohistoric periods, obsidian was mostly obtained from primary sources in both areas. More obsidian was procured from secondary deposits in the Pithouse period, but slightly more than half still appears to have come from primary sources. This changes radically in the Pueblo period, when most obsidian was obtained from secondary deposits. Acquisition patterns for Luna blue agate follow similar patterns in the Reserve area, but are somewhat different in the Luna area where slightly more than half of the Luna blue agate used during the Archaic was from primary sources, but secondary sources dominated in the other two periods represented.

When all materials are considered, significant differences are visible in the data presented by Moiola. Material acquisition from primary deposits became much less important in the Pueblo period, when nearly 80 percent of all materials were obtained from secondary sources. Gravel deposits, probably those along nearby streams, increased in importance as material sources in this period. This could reflect access to a smaller catchment area from which lithic materials could be obtained, or it could simply mean that the acquisition of higher quality materials from primary sources was no longer of great importance. A potential problem with materials procured from secondary sources is that battering often results in microcracks, especially near the surface of nodules of less durable materials like chert. This can cause unanticipated shattering, and may make it difficult to efficiently strike flakes. When all that is required is a sharp edge, this is not necessarily a problem. However, when efficiency or the production of large flakes for tool manufacture are the goals of reduction, this can cause difficulties.

Examination of material quality provided little information other than glassy and fine-grained materials tended to be selected for reduction during all periods. While there was a higher percentage of fine-grained materials and lower percentages of medium- and coarse-grained materials used in the Luna area, this is deceptive. The Luna area assemblage is dominated by Luna blue agate, which is predominantly fine-grained. When this material is removed from consideration, percentages become much closer, though

Table 3.129. Obsidian and Luna Blue Agate Acquisition Patterns through Time and by Area; Row Percentages, Indeterminate Data Dropped

Material	Period	Primary Source			Secondary Source		
		Overall	Luna	Reserve	Overall	Luna	Reserve
Obsidian	Archaic	87.9	89.7	87.1	5.1	3.4	5.7
	Early Pithouse	56.5	-	56.5	43.5	-	43.5
	Late Pithouse	56.7	66.7	50.8	37.1	27.8	42.6
	Early Pueblo	21.3	-	21.3	76.6	-	76.6
	Late Pueblo	8.0	7.8	10.0	80.2	80.2	80.0
	Protohistoric	86.1	-	86.1	12.5	-	12.5
Luna blue agate	Archaic	71.0	54.5	84.6	23.0	40.2	8.8
	Early Pithouse	65.1	-	65.1	33.7	-	33.7
	Late Pithouse	41.2	35.2	60.7	48.7	51.6	39.3
	Early Pueblo	19.6	-	19.6	80.0	-	80.0
	Late Pueblo	16.8	17.7	11.6	76.1	75.4	79.6
	Protohistoric	95.5	-	95.5	2.3	-	2.3

glassy materials were used with greater frequency in the Luna area, and coarse-grained materials were more common in the Reserve area.

While evidence of intentional and successful thermal alteration occurred in every time period, it seems to have been of less importance in the Archaic than in later periods. Only 2.7 percent of Archaic specimens exhibiting evidence of heat treatment appear to have been successfully and intentionally altered versus 10 percent overall for the Pithouse period, 12.9 percent for the Pueblo period, and 7.8 percent for the protohistoric period. Of course, these percentages may be illusory, because only populations of thermally altered materials were used to derive them. When entire debitage assemblages are considered, successful and intentionally altered artifacts comprise 0.4 percent of the Archaic assemblage, 1.7 percent of the Pithouse period assemblage, 1.3 percent of the Pueblo period assemblage, and 1.1 percent of the protohistoric assemblage. This suggests that thermal alteration may not have been as important during the Archaic period as it was during all later periods. This may be because more basalt, which is not amenable to thermal alteration, was used for tool manufacture during the Archaic. Another possible reason for this is that bifaces manufactured during the Archaic period were generally fairly large, and it is more difficult to successfully heat treat large and thick pieces of material than it is smaller flakes. Whatever the cause, it suggests that there was an important difference in reduction techniques between the Archaic and later periods.

Analysis of materials used for reduction in these assemblages suggests that there were indeed differences between the Archaic and later periods. Important variation was also seen among Mogollon assemblages. While the protohistoric components resembled aspects of earlier assemblages, they were also somewhat different. Archaic flintknappers tended to focus on cherts and basalts, though a wide range of other materials was also used. Igneous materials (especially rhyolite but not basalt) were more frequently used in the Early Pithouse through Early Pueblo periods. Luna blue agate also tended to comprise higher percentages of these assemblages, and dominated in the Late Pueblo period. Protohistoric flintknappers returned to using a high percentage of chert, with a moderately high use of obsidian as well. In this, the protohistoric assemblage resembles the Early Pithouse period.

Though there were some differences in procurement patterns attributable to variation in material availability between the Luna and Reserve areas, some trends were very clear. Overall material acquisition patterns suggested that secondary sources were much more commonly used during the Pueblo periods than at any other time. Interestingly, obsidian tended to be obtained from primary sources during both the Archaic and protohistoric periods. Since obsidian is a very fragile material, mechanical transport tends to fracture it. As obsidian moves away from an outcrop, nodules tend to grow progressively smaller. Thus, it is possible that the mobile populations were interested in procuring larger nodules and tended to use primary sources. It is also feasible that direct access to obsidian sources was more restricted during the Mogollon periods, and that those populations had to take what was available in the exchange system rather than collecting what they could at the source(s).

While differences in the texture of materials selected for reduction were relatively minor, there was less evidence of intentional thermal alteration during the Archaic than in any subsequent period. This probably had much to do with the size of bifacial tools produced during that period, and a heavier use of more durable materials that were not amenable to thermal alteration.

Evidence for Variation in Reduction Strategy

Variation in the array of available materials between the Luna and Reserve areas was also responsible for differences in some of the attributes used to examine reduction. Even so, certain trends are quite clear and indicate changes in the strategy applied to the reduction of chipped stone materials. Different approaches to reduction were used in the Archaic period, Early Pithouse to Early Pueblo periods, Late Pueblo period, and the protohistoric period.

Archaic and Mogollon Reduction Strategies

The Archaic reduction strategy had two foci—expedient reduction of local materials and manufacture of local materials into large generalized bifaces. Mogollon reduction strategies primarily focused on the expedient reduction of local materials. Our examination of reduction strategies involved the study of debris resulting from that process, including debitage and cores. Tools were examined separately because, once production is complete or they have been discarded, tools are no longer directly associated with the reduction process. While waste materials are generally discarded at or near the locus of reduction, tools often are not. This is particularly true of Archaic sites where the length of stay was usually brief. For most Archaic formal tools, the locus of production was rarely the locus of use and discard. This situation is often different at Mogollon sites where, because of more intensive and longer occupations, residential sites were usually the locus of use and discard, as well as manufacture for most tools. However, it is interesting to note that bifacial tools tend to comprise similar proportions of all assemblages through time (1.5

percent for Archaic through Late Pueblo components, 1.1 percent for protohistoric components).

Generalized bifaces are most common in Archaic components, comprising 0.8 percent of the total assemblage. For the Pithouse period that percentage is cut in half (0.4 percent). Generalized bifaces were nearly as common in the Pueblo periods as they were in the Archaic (0.7 percent), but are comparatively rare in protohistoric assemblages (0.5 percent). These figures are in disagreement with the results of debitage and core analysis. Biface flakes comprise an average of 24.5 percent of Archaic assemblages, 6.0 percent of Pithouse assemblages, 2.1 percent of Pueblo assemblages, and 3.3 percent of protohistoric assemblages. Percentages of modified platform modification steadily decrease through time from the Archaic through Pueblo periods, then increase significantly in the protohistoric period.

Biface flakes and evidence of platform modification in our assemblages are essentially tracking large biface manufacture. While that includes projectile points as well as large generalized bifaces in the Archaic and Early Pithouse periods, it mostly includes only the latter in later assemblages. Ratios were calculated comparing numbers of these bifaces in period assemblages to numbers of potential manufacturing flakes (biface flakes and core flakes with modified platforms). These ratios are shown in Table 3.130. Like percentages of modified platforms, the ratio of manufacturing debris to large bifaces also decreases through time, with a possible large increase in the protohistoric period, though we remain uncertain just what that means.

The high ratio of manufacturing debris to large bifaces for the Archaic period is almost certainly indicative of generalized biface and dart point manufacture. The Pithouse period ratio is slightly more than half the figure for the Archaic. This is mostly attributable to the Early Pithouse period, where the ratio is 21.5:1 versus 8.8:1 for the Late Pithouse period (not including obviously curated points). While this ratio is larger than that of the Archaic, this is deceptive. Nearly half of the Archaic large biface assemblage is comprised of projectile points, many of which are fragmentary and indicative of weapon refurbishing rather than in situ manufacture. If these tools are discounted, the Archaic ratio is 35:1. In any case, rather large manufacturing debris to large biface ratios for the Archaic and Early Pithouse periods suggests that large biface manufacture was common in those assemblages. It is likely that the large bifaces in question for the Early Pithouse period were primarily dart points, though some large generalized bifaces were also made.

The ratio of manufacturing debris to large bifaces is considerably lower from the Late Pithouse through Late Pueblo periods, and essentially decreases through time. Thus, all of our indicators suggest that few large generalized bifaces should have been manufactured in these periods, yet they continue to comprise a rather steady portion of our assemblages, not really varying until the protohistoric period. There are two possible explanations for this phenomenon. These tools could have been manufactured at nonresidential sites after the Archaic or Early Pithouse periods, perhaps at quarries. If so, those sites would be rather hard to distinguish from Archaic camps except that they should contain no large dart points and little evidence of a residential function. The second possibility is that many of the large bifaces (and fragments) that appear at Mogollon sites, particularly those from the Late Pueblo period, represent curated artifacts collected from earlier sites for reuse. While our data are insufficient to allow us to determine which, if either, of these possibilities might be correct, we feel that the latter is more likely.

Table 3.130. Ratios between Potential Manufacturing Debris and Large Bifaces in Period Assemblages

Period	Ratio
Archaic	19.8:1
Pithouse	10.6:1
Pueblo	6.8:1
Protohistoric	27.3:1

There is still a break in reduction strategy between the Archaic and Early Pithouse periods, no matter how high the manufacturing debris to large biface ratio is for the latter. Percentages of biface flakes and flakes with modified platforms both decrease dramatically after the Archaic period, suggesting there is no longer quite the focus on large generalized biface manufacture. Though the Early Pithouse biface flake to large biface ratio is moderately high, other indicators suggest that reduction during this period was more focused on the production of debitage for use as expedient tools. The proportion of whole flakes is relatively high, the flake to angular debris ratio is moderate, and the ratio of flakes to cores is very low for this period. These attributes are more indicative of core reduction. Relatively high percentages of modified platforms and a high biface flake to large biface ratio may simply be indications of the continuing importance of large dart points in the economy of this period, particularly before A.D. 500.

Two unmixed Early Pithouse period components were found—one at LA 39972 and the other at LA 39975. Analysis of projectile point assemblages and radiocarbon samples suggest that LA 39972 is the earlier site, and was probably occupied before A.D. 500, which is the approximate date for the introduction of the bow and arrow into the Southwest (Cordell 1984a). Presumably, only dart points should have been manufactured and used at LA 39972, while both arrow and dart points should have been made and used at LA 39975. If so, there should be less evidence of large biface manufacture in the later assemblage, providing that the use of large generalized bifaces declined after the end of the Archaic period. Table 3.131 compares several attributes for these sites, and provides rather contradictory results. While LA 39975 contains a higher percentage of biface flakes, if only flakes with remaining platforms are considered there is a much higher percentage of modified platforms in the LA 39972 assemblage. When these variables are combined to provide a total of potential biface flakes, LA 39972 holds a slight edge over LA 39975. However, both flake to angular debris and biface flake to large biface ratios are much higher for LA 39975, despite the fact that a much smaller percentage of Luna blue agate occurs in the LA 39972 assemblage. What these data seem to suggest is that even though more large biface manufacture occurred at LA 39972 than at LA 39975, that component was more focused on expedient core reduction. These data generally support our hypothesis. While the manufacture of large bifaces (both generalized and dart points) continued to be of moderate importance in the Early Pithouse period, there is much less evidence for formal tool manufacture than there is in the Archaic assemblages.

Table 3.131. Comparison of Assemblage Attributes for LA 39972 and LA 39975

Attribute	LA 39972	LA 39975
Percentage of biface flakes	2.4	4.2
Percentage of modified platforms	31.3	18.5
Percentage possible biface flakes	19.9	15.7
Flake to angular debris ratio	1.60	5.57
Biface flake:large bifaces	8.57	33.2

In general, the same reduction strategy was used between the Early Pithouse and Early Pueblo periods. Through time there appears to have been less and less emphasis on the manufacture of large bifaces, particularly after the Late Pithouse period. However, moderate flake to angular debris ratios suggest that core reduction was relatively careful and aimed at efficiently producing flakes for use as informal tools. This strategy appears to have changed significantly in the Late Pueblo period. Where the flake to angular debris ratio had been moderate through the early Mogollon periods, a sudden and steep drop in the Late Pueblo period suggests that reduction technique and perhaps strategy underwent a change.

No longer was reduction aimed at producing flakes suitable for use as expedient tools; now it appears that any sharp edge would do. Instead of rather careful reduction techniques, cores seem to have been smashed during the Late Pueblo period, producing large amounts of shatter. This change extends to how both Luna blue agate and all other materials were handled. The flake to angular debris ratio for Luna blue agate during this period is less than 1, indicating that more angular debris was produced than flakes. This is consistent with a reduction technology that sought to simply break nodules up rather than to remove flakes from them. When all other materials are combined (see Table 3.77) the flake to angular debris ratio is higher than that for Luna blue agate, but is still much lower than any other period. Luna blue agate appears to have been smashed up with little regard for flake production. Other materials were reduced in a way that resembles techniques used by other sedentary populations in the Southwest—reduction was probably aimed at removing flakes, but was less careful and efficient than it had been during earlier periods.

Protohistoric Reduction Strategy

In assessing the reduction strategy used during the protohistoric period, we are hampered by small sample size and a basic lack of knowledge concerning the cultural affinity of the people who occupied those sites. While there is an implicit assumption that the protohistoric components represent use by Athabaskans, this remains uncertain. It is also possible that logistical task groups from Zuni or the Piro pueblos also used this region during the early protohistoric period. Though analysis of the chipped stone assemblage is insufficient by itself to resolve this question, it may provide data that points more in one direction than the other.

The two protohistoric components (LA 37917 and LA 37919) provide interesting comparisons and contrasts to the earlier periods. In some ways they resemble the Archaic assemblages, in others they are more similar to Mogollon assemblages, and in still others they resemble neither. LA 37917 contained seven whole or fragmentary projectile points. Four (57 percent) are dart points, two of which are Augustín points, a Middle Archaic type. The three remaining points are fragmentary, but at least two are definite arrow points; the third is a tip that cannot be accurately assigned. The only point fragment recovered from LA 37919 also falls into the latter category. The large number of dart points, half of which are of an identifiable Archaic type, has led to some confusion over the dating of LA 37917. However, analysis of the debitage from this site suggests that it is more similar to LA 37919 than it is to Archaic or Mogollon assemblages. Thus, we concluded that the dart points from LA 37917 probably represent artifacts collected from earlier sites and reused then discarded (or lost) at this site.

The protohistoric assemblage contains a low percentage of angular debris, and consequently has a moderately high flake to angular debris ratio, similar to that of the Archaic assemblage. While the percentage of flakes with modified platforms was somewhat higher than that of the Archaic assemblage, the proportion of identifiable biface flakes was very low. Considering only modified platforms, the percentage of retouched platforms in the protohistoric assemblage was half that of the Archaic assemblage. While the flake to core ratio was rather high, it was slightly less than half that of the Archaic assemblage. The mean volume of protohistoric cores is much higher than that of Archaic cores, and is similar to that of the Late Pueblo assemblage.

Analysis of protohistoric debitage and cores concluded that while there are superficial similarities between protohistoric, Archaic, and Mogollon components, the protohistoric assemblage has a different character. The paucity of biface flakes and high percentage of modified platforms present a quandary. Either protohistoric bifaces were very crudely manufactured, primarily producing debitage that more resemble core flakes than biface flakes, or the focus of reduction was quite different than that of the Archaic and Mogollon periods. If the latter is correct, we may be seeing evidence for the careful reduction of cores using platform preparation to prevent edge shattering rather than a focus on the manufacture of large generalized bifaces. In essence, this may be a similar but different adaptation to perceived shortages of materials.

Examining Site Activities

Types of tools and debitage in chipped stone assemblages can be used to assess the range of activities that occurred at a site. Of course, the full range of activities will not be reflected—only those tasks for which stone tools were used and subsequently discarded at a site will be evidenced. While the types of stone tools that occur in an assemblage are usually indicative of some of the tasks that occurred at a site, they often do not reflect how common the performance of those tasks was. For instance, hide preparation might be one of the main tasks performed at a hunter-gatherer site, yet if no stone scrapers were broken or discarded, analysis of the chipped stone assemblage will provide little or no evidence of that task. Similarly, the informal use of debitage as tools often did not cause sufficient edge damage for informal tools to be identified. Thus, the presence of informal tools in an assemblage is an indication of their use, but rarely tells us how common such usage might have been.

Archaic Components

LA 45508 and LA 70188 both contained pit structures that were probably used during the warm season, and thus served as residential camps. Unfortunately, multiple occupations are represented at LA 70188 and cannot be physically separated. Multiple occupations were also found at LA 43766, at least two of which were isolated. However, it is necessary to combine those occupations to have sufficient data with which to discuss this component. LA 45508 and LA 78439 probably represent single occupations, though this is uncertain.

Tables 3.132 and 3.133 synthesize data from the Archaic components. Some explanation of these and subsequent tables for later time periods are in order. Tool classes in tables assessing tool use activities are major categories such as cobble tools or unifaces, and secondary categories such as the generalized and projectile point groups subsumed under bifaces. Percentages of all tool types included under the cobble tool and uniface categories will total 100, as will percentages of tool types included under specialized bifaces, the various debitage types, and cores. However, some data concerning generalized bifaces and projectile points are presented in both tables, and percentages for these classes will usually total 100 between tables. A rather wide range of activities is suggested for all of these sites, potentially including chipped stone reduction, wood-working, hunting, weapon refurbishing, leather-working, and vegetal processing. Each task is discussed separately, with evidence noted for each site.

Chipped Stone Reduction. Several lines of evidence suggest that both bifacial tool manufacture and core reduction were important activities at most, if not all, of the Archaic sites. Biface manufacture is evidenced by high percentages of biface flakes and modified platforms in the LA 43766, LA 45508, and LA 70188 assemblages. Each of these components also contains moderately high percentages of generalized bifaces and projectile points that were broken or discarded during manufacture. Limited evidence for tool refurbishing was also recovered in the form of resharpening flakes from LA 45508 and LA 70188.

Core reduction also seems to have been an important task at these sites, and core flake to angular debris ratios are low to moderate suggesting that this task was not necessarily focused on the efficient reduction of cores. Two types of tools may have been used in core reduction—hammerstones, and core-hammerstones. The latter represent cores that were reused, probably after their usefulness as sources for

Table 3.132. Assessment of Reduction Activities at Archaic Sites

Attribute	LA 43376	LA 45508	LA 70188	LA 78439
Percent biface flakes	28.7	27.7	23.6	8.3
Percent modified platforms	33.5	63.2	23.0	39.9
Core flake:angular debris	4.26:1	2.37:1	3.20:1	5.21:1
Percent unutilized cores	100.0	94.4	86.2	92.9
Percent generalized bifaces broken in manufacture	27.8	7.4	16.2	16.7
Percent projectile points broken or discarded in manufacture	17.7	38.5	21.7	0.0
Number of hammerstones (including utilized cores)	0	1	1	1
Number of resharpening flakes	0	2	1	0

Table 3.133. Assessment of Tool Use Activities at Archaic Sites;
Frequencies with Percentages of Tool Class in Parentheses

Attribute			LA 43766	LA 45508	LA 70188	LA 78439
Cobble tools	Hammerstone		0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)
	Chopper		0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)
	Chopper-Hammerstone		0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)
Unifaces	Scraper		0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Spokeshave		1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)
	Undifferentiated		0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Bifaces	Generalized	Whole	8 (44.4)	23 (85.2)	23 (62.2)	5 (83.3)
		Broken	5 (27.8)	2 (7.4)	8 (21.6)	0 (0.0)
	Projectile points	Whole	6 (33.3)	2 (15.4)	5 (21.7)	1 (100.0)
		Refurbishing	5 (27.8)	2 (15.4)	5 (21.7)	0 (0.0)
		Meat package	0 (0.0)	0 (0.0)	1 (4.4)	0 (0.0)
		Drill	1 (5.6)	1 (7.7)	0 (0.0)	0 (0.0)
		Other	3 (16.7)	3 (23.1)	7 (30.4)	0 (0.0)
Tabular knives			0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)
Informal tools	Biface flakes	Cutting	1 (16.7)	16 (69.6)	22 (61.1)	12 (80.0)
		Scraping	5 (83.3)	7 (30.4)	14 (38.9)	3 (20.0)
	Core flakes	Cutting	2 (10.0)	17 (31.5)	38 (47.5)	33 (44.6)
		Scraping	18 (90.0)	37 (68.5)	37 (46.3)	33 (44.6)
		Denticulate	0 (0.0)	0 (0.0)	1 (1.3)	0 (0.0)
		Drilling	0 (0.0)	0 (0.0)	1 (1.3)	0 (0.0)
		Leather-working	0 (0.0)	0 (0.0)	3 (3.8)	8 (10.7)

Attribute			LA 43766	LA 45508	LA 70188	LA 78439
	Angular debris	Cutting	0 (0.0)	1 (10.0)	0 (0.0)	1 (20.0)
		Scraping	0 (0.0)	9 (90.0)	4 (100.0)	4 (80.0)
	Cores	Chopping	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
		Hammering	0 (0.0)	1 (5.6)	0 (0.0)	0 (0.0)
		General	0 (0.0)	0 (0.0)	4 (13.8)	1 (7.1)

debitage was exhausted. The relative rarity of this class of tool in the Archaic components may reflect the importance of tool manufacture, which would have been dominated by soft-hammer percussion and pressure flaking. Conversely, it could simply mean that most hammerstones were transported away at the time of abandonment.

LA 78439 is different from the other Archaic sites in some respects. The presence of a rather low percentage of biface flakes coupled with a moderate percentage of bifaces broken during manufacture suggest that large biface production may have occurred at this site, but was not as important as it was in other Archaic components. A high percentage of modified platforms would normally be considered evidence of a significant amount of biface manufacture. However, the low percentage of biface flakes in this assemblage tends to argue against this. A moderately high core flake to angular debris ratio may be indicative of more careful core reduction than is visible in other Archaic components. Much of the modification seen on flake platforms may be related to this task rather than biface manufacture. Only one hammerstone was found in this assemblage, and there is no evidence for tool refurbishing or projectile point manufacture.

Wood and Bone-Working. There is a fair amount of evidence for wood and bone-working in all Archaic components. Tools that were almost certainly used for this task include spokeshaves, drills, and denticulates. Spokeshaves were recovered in two assemblages (LA 43766 and LA 78439). These tools were probably used in the manufacture of weapon shafts or other wooden implements that required rounded edges. Two types of drills were found in three components—projectile points that were reworked into this form and debitage that was informally used to bore holes. The only Archaic denticulate was recovered from LA 70188, and is an informally used core flake.

Utilized debitage can also be assigned to some tasks, though the assignment is usually less certain than it is for formal tools. Debitage with serrated edges and those that evidence rotary wear were used for sawing and drilling, and are included in the above discussion. Other wear patterns are difficult to assign to specific tasks, so we will rely on other types of data. Experiments conducted by Schutt (1980) concluded that edge angles of 40 degrees or more were not well suited to cutting activities. Thus, we assume that other types of utilized debitage with edge angles less than 40 degrees were used for cutting and those with angles of 40 degrees or more were used for scraping. While this is conjectural, it provides a crude measure of potential for these tools. Debitage that could have been used for cutting or scraping occurs in all four assemblages. Possible cutting tools are more common in the LA 70188 and LA 78439 assemblages, while those used for scraping are more common in the LA 43766 and LA 45508 assemblages. In general, core flakes represent the most often utilized type, followed by biface flakes; angular debris bring up a distant third. These informal tools were probably used to work wood or bone, but this cannot be definitively concluded.

Hunting. Projectile points are generally considered hunting tools, yet it is often difficult to demonstrate that they were actually used for that purpose. Analysis of breakage patterns can be used to provide information allowing us to make this assumption in some cases. In particular, it can be asserted that projectile point fragments exhibiting certain diagnostic breaks were returned to a site in a meat package. They include tips exhibiting haft snaps and medial fragments exhibiting haft snaps or impact fractures. These patterns suggest that points shattered upon impact and remained in the wound when the shaft was withdrawn. It is unlikely that they were discarded until the meat was processed, and they seem to indicate that a kill was returned to camp for processing and consumption.

A single projectile point fragment from LA 70188 falls into this category. Points categorized as "other" from LA 43766, LA 45508, and LA 70188 exhibit nonspecific snap fractures. While it is possible that some were also returned to camp in meat packages, this cannot be demonstrated with available data. Large generalized bifaces could have been used in hunting activities, and may have served as combination knives and chopping tools used for butchering. Again, however, this cannot be demonstrated by existing data.

Weapon Refurbishing. Projectile point bases or bases and midsections that exhibit impact fractures or haft snaps were most likely broken during use and discarded at the location where the shaft was refurbished. Evidence for weapon refurbishing was found at three Archaic sites, and was only lacking from LA 78439.

Leather-Working. Several tool types could have been used for this task. Scrapers are generally considered to be one of the main tools used in hide preparation, but none was found in our Archaic components. Informal tools were probably also used for leather-working; in particular, utilized debitage that exhibits rounded edges. While this wear pattern could feasibly be indicative of some types of vegetal processing, we feel it is more likely indicative of hide preparation. This type of tool was recovered from LA 70188 and LA 78439. While it is possible that other debitage was used to cut and scrape leather, it is unlikely that many of these are represented in our assemblages because the cutting of soft materials rarely creates recognizable wear patterns. Other types of utilized debitage in our assemblages are probably evidence for the processing of hard materials.

One other tool may have been used in leather-working. A large tabular knife from LA 70188 has edges that were rounded and polished by use. While this tool vaguely resembles agave or mescal knives reported elsewhere in the Southwest, the wear pattern seems more consistent with leather processing. Thus, it is tentatively assigned to that category. Even so, potential evidence for leather-working was only recovered from two sites—LA 70188 and LA 78439.

Vegetal Processing. Little evidence for the use of chipped stone tools for vegetal processing was recovered from the Archaic components. The only tools that possibly fit into this category are a chopper and three utilized cores from LA 70188, and a chopper-hammerstone from LA 78439.

Other Tools. Several tool categories are difficult to assess. Whole generalized bifaces and projectile points are difficult to account for in components that were not used for long-term residence. They could have been manufactured at those locations and discarded for some reason that was not apparent to the analyst. Conversely, they could have been lost or cached, though there was no real evidence for the latter.

Generalized bifaces and projectile points with nondiagnostic breaks are also difficult to account for. Were they discarded because they were broken, or was breakage post-depositional? The snap fractures exhibited by these tools are nondiagnostic because they can occur during manufacture as well as when tools are dropped or stepped on. Thus, they can be ascribed to no single cause. While it is likely that these tools were discarded because they were broken, we cannot determine what the cause of that breakage was.

Undifferentiated unifacial tools are also impossible to assign to a single use. These tools were purposely flaked on one surface, but their shapes are not indicative of the purpose(s) for which they were used. Thus, this class of tool could have been used in leather-working, wood-working, butchering, vegetal processing, and probably several other tasks.

Summary. The Archaic chipped stone assemblages suggest that each of these locations was used for a variety of activities. Tasks related to hunting appear to have been of importance at LA 43766, LA 45508, and LA 70188. Each of these assemblages contains plentiful evidence of projectile point and large generalized biface manufacture, as well as the replacement of broken projectile points. They also contain evidence for wood-working, though in only one case (LA 43766) is it possible for us to suggest that this included shaft manufacture or repair. Of these components, only LA 70188 also exhibits evidence for leather-working and vegetal processing activities. However, it must be remembered that this assemblage probably represents multiple occupations, which could easily be responsible for evidence of a wider range of activities than is exhibited by other Archaic components.

LA 78439 is different from the other Archaic assemblages. There is less evidence for large biface manufacture, and no direct evidence for projectile point manufacture or use for hunting. It is likely that this occupation was not as highly focused on hunting and related activities as were the other Archaic components. Reasons for this are difficult to determine from only chipped stone data. This component could have been occupied during a different season than were other Archaic locales, a time when resource acquisition was not focused on fauna. Indeed, a large roasting pit was ascribed to this component.

Pithouse Period Components

Data for the Pithouse period components are shown in Tables 3.134 and 3.135. Since structural remains were associated with each of these components, they are all considered evidence of residential use.

Chipped Stone Reduction. There is quite a bit of variation in reduction data for these sites. While both Early Pithouse period components contain small percentages of biface flakes, a large percentage of the platforms from LA 39972 and a moderate percentage of those from LA 39975 were modified. Both assemblages contain generalized bifaces that were broken during manufacture, and LA 39975 also contains evidence of projectile point manufacture.

All Late Pithouse components contain rather small percentages of biface flakes, except for LA 70196 where the percentage is moderate. However, a large proportion of platforms in the LA 45510 assemblage, and moderate proportions of platforms in the LA 43786 and LA 70196 assemblages are modified. Platform modification in these assemblages does not appear to accompany careful core reduction since the two components with the highest percentages of modified platforms (LA 39972 and LA 45510) also have the smallest core flake to angular debris ratios. Two of the four assemblages from this period contain generalized bifaces that were broken during manufacture, and three contain projectile points that were broken or discarded during production.

There is a great deal of variation in these assemblages that makes them difficult to compare. The assemblage with the largest core flake to angular debris ratio also contains very small percentages of biface flakes and flakes with modified platforms. The assemblages with the largest percentages of modified platforms contain only moderate percentages of biface flakes and have the smallest core flake to angular debris ratios. However, it is evident that core reduction dominates each of these assemblages, though large biface manufacture was also relatively important.

Hammerstones were probably used in core reduction, but are rather uncommon except at LA 45507. These tools also occur in the LA 39972 and LA 39975 assemblages, but neither the formal nor informal varieties are common in either.

Wood and Bone-Working. Tools that were potentially used in these tasks are fairly common at most Pithouse period sites. Formal and informal drills were recovered in four of seven assemblages, denticulates in three, and a graver in one. Only two assemblages (LA 39975 and LA 70196) contain both drills and denticulates. Informally utilized debitage was fairly common in all assemblages. The range of edge angles suggests that these tools were used for scraping far more frequently than for cutting except at LA 45510, where they appear to have been used in equivalent amounts for these tasks. Both direct and indirect evidence for wood and bone-working was found in every assemblage except for LA 45507. Only informal tools with assumed functions were recovered from that component.

Hunting. Projectile points that were probably returned to residential sites in meat packages occurred in all Pithouse period components except for LA 43786 and LA 70201. Whole large generalized bifaces, which may have also been used in hunting, were recovered from all Pithouse period sites except for LA 70201.

Weapon Refurbishing. Evidence of weapon refurbishing was found in only three components—LA 39975, LA 45510, and LA 70196. The refurbishing of weapons is probably better indirect evidence of hunting activities than is the presence of whole generalized bifaces, and strengthens our assumption that hunting was pursued by the residents of these sites.

Leather-Working. Formal scrapers were found in only two assemblages—LA 39972 and LA 70196. Informal scrapers were recovered from four components, LA 39972, LA 39975, LA 45507, and LA 45510. Only two components contain no evidence for leather-working activities, LA 43786 and LA 70201.

Vegetal Processing. No direct evidence for vegetal processing was found in the chipped stone assemblages of any of these components. Utilized cores with nonspecific wear patterns could have functioned in this capacity, but since they could also have been used in many other tasks, this is uncertain.

Other Tools. Unlike the Archaic components, which appear to represent short-term residential camps, the Pithouse period components probably represent much lengthier occupations, perhaps as long as several years. Thus, some of the tools whose presence was problematic in Archaic assemblages are easier to explain. Tools like generalized bifaces probably functioned as part of the hunting kit. Complete examples in these and later Mogollon assemblages might have been discarded for reasons that were intangible to the analyst, or simply may have been abandoned when site occupants moved to another location because they were easier to replace than to transport. Whole projectile points may have been lost, accidentally discarded, or forgotten at the time of abandonment. Again, it is difficult to account for bifaces and projectile points with nonspecific breakage patterns, since they could have fractured during manufacture, use, or inadvertently. Thus, they cannot be assigned to any one category.

Summary. Reduction activities in these components appear to have focused on the reduction of cores to produce debitage that could be modified into formal tools or used as informal tools. While large biface manufacture occurred in all assemblages, it appears to have been of variable importance. The role played by platform modification is questionable, since the assemblages that contain high percentages of modified platforms also have small core flake to angular debris ratios and rather small percentages of biface flakes.

Not every component contained direct evidence for the full range of tasks defined here. Those tasks include manufacture of large generalized bifaces and projectile points, hunting, weapon refurbishment, wood and bone-working, leather-working, and vegetal processing. Only LA 45510 and LA 70196 contain good evidence for most of these tasks, and possible evidence for vegetal processing. LA 39975 contains evidence for all but vegetal processing. A relatively wide range of tasks was evidenced at LA 39972 including hunting, wood and bone-working, leather-working, and large generalized biface manufacture. The LA 45507 assemblage contains direct evidence for hunting, leather-working, and projectile point manufacture.

Table 3.134. Assessment of Reduction Activities at Pithouse Period Sites

Attribute	Early Pithouse		Late Pithouse				Pithouse
	LA 39972	LA 39975	LA 45510	LA 43786	LA 45507	LA 70196	LA 70201
Percent biface flakes	2.4	4.2	5.8	1.1	7.1	11.5	2.3
Percent modified platforms	31.3	18.5	42.2	12.3	5.0	13.5	5.3
Core flake:angular debris	1.54:1	5.30:1	1.76:1	11.71:1	3.13:1	8.11:1	17.89:1
Percent unutilized cores	94.7	98.7	92.3	100.0	96.9	90.9	94.4
Percent generalized bifaces broken in manufacture	40.0	33.3	8.3	0.0	0.0	33.3	0.0
Percent projectile points broken or discarded in manufacture	0.0	16.7	5.3	0.0	15.0	22.2	33.3
Number of hammerstones (including utilized cores)	0	1	0	0	15	0	0
Number of resharpening flakes	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3.135. Assessment of Tool Use Activities at Pithouse Period Sites; Frequencies with Percentages of Tool Class in Parentheses

Attribute			Early Pithouse		Late Pithouse				Pithouse
			LA 39972	LA 39975	LA 43786	LA 45507	LA 45510	LA 70196	LA 70201
Cobble tools	Hammerstone		0 (0.0)	1 (100.0)	0 (0.0)	15 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Graver		1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Unifaces	Scraper		1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)
Bifaces	Specialized	Drills	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	1 (100.0)	2 (100.0)	0 (0.0)
	Generalized	Whole	1 (20.0)	4 (66.7)	1 (100.0)	1 (100.0)	7 (58.3)	6 (100.0)	0 (0.0)
		Broken	2 (40.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (33.3)	0 (0.0)	0 (0.0)
	Projectile points	Whole	0 (0.0)	1 (16.7)	0 (0.0)	8 (40.0)	5 (26.3)	4 (22.2)	1 (33.3)
		Refurbishing	0 (0.0)	3 (50.0)	0 (0.0)	0 (0.0)	3 (15.8)	4 (22.2)	0 (0.0)
		Meat Package	1 (50.0)	1 (16.7)	0 (0.0)	4 (20.0)	4 (21.1)	1 (5.6)	0 (0.0)
		Drill	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.3)	0 (0.0)	0 (0.0)
		Other	1 (50.0)	0 (0.0)	1 (100.0)	5 (25.0)	5 (26.3)	5 (27.8)	1 (33.3)

Attribute			Early Pithouse		Late Pithouse				Pithouse
			LA 39972	LA 39975	LA 43786	LA 45507	LA 45510	LA 70196	LA 70201
Informal tools	Biface flakes	Cutting	0 (0.0)	3 (33.3)	0 (0.0)	0 (0.0)	8 (72.7)	2 (16.7)	3 (50.0)
		Scraping	1 (100.0)	6 (66.7)	0 (0.0)	17 (100.0)	1 (9.1)	9 (75.0)	3 (50.0)
		Denticulate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (8.3)	0 (0.0)
		Drilling	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (18.2)	0 (0.0)	0 (0.0)
	Core flakes	Cutting	0 (0.0)	48 (32.2)	7 (43.8)	2 (2.5)	25 (39.7)	22 (32.8)	2 (3.3)
		Scraping	6 (100.0)	93 (62.4)	9 (56.3)	76 (96.2)	29 (46.0)	44 (65.7)	58 (95.1)
		Denticulate	0 (0.0)	2 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.5)	1 (1.6)
		Drilling	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.2)	0 (0.0)	0 (0.0)
		Leather-working	0 (0.0)	6 (4.0)	0 (0.0)	1 (1.3)	7 (11.1)	0 (0.0)	0 (0.0)
	Angular debris	Cutting	1 (33.3)	2 (33.3)	0 (0.0)	0 (0.0)	5 (35.7)	0 (0.0)	0 (0.0)
		Scraping	1 (33.3)	3 (60.0)	1 (100.0)	1 (100.0)	9 (64.3)	2 (100.0)	1 (100.0)
		Leather-working	1 (33.3)	1 (16.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Informal tools	Cores	Hammering	1 (5.3)	1 (1.3)	0 (0.0)	2 (3.1)	0 (0.0)	0 (0.0)	0 (0.0)
		General	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.7)	1 (9.1)	1 (5.6)

LA 43786 and LA 70201 exhibit evidence for very few tasks involving chipped stone tools. Wood and bone-working tools were recovered from both components, LA 70201 contained evidence for projectile point manufacture, and LA 43786 evidenced general biface production. The small number of activities reflected by LA 70201 is surprising, since that assemblage contains over 500 artifacts. However, it is not as surprising as LA 43786. That assemblage is the second smallest of all those examined, and is one of only two that contains less than 100 artifacts. Excavation of only the perimeter of the structural area probably accounts for the lack of activities reflected in this assemblage.

Pueblo Period Components

Data for the Pueblo period components are shown in Tables 3.136 and 3.137. Since structural remains were directly associated with each component except LA 9721, most are considered evidence of residential use. A rubble mound that may represent the remains of a small fieldhouse is located outside project limits at LA 9721 but could not be examined in detail, so it was not confirmed as the remains of a structure. In any case, it is likely that the few artifacts from LA 9721 represent a short-term use of that locale during the Pueblo period, either as an adjunct to farming activities or for an unknown purpose.

Chipped Stone Reduction. As was the case with the Pithouse period components, there is quite a bit of variation in these assemblages. However, overall there is less evidence for large biface manufacture. Only one Late Pueblo component (LA 70185) contains a moderate percentage of biface flakes, but this is coupled with a very small percentage of modified platforms. The LA 9721 assemblage contains a percentage of modified platforms approaching that of the Archaic, yet there is no accompanying evidence for biface manufacture. This is the smallest assemblage of those investigated, containing only 26 artifacts. It is likely that simple sample error is responsible for the high percentage of modified platforms, rather than any significant variation in reduction activities. Thus, percentages of biface flakes and modified platforms are much lower than in the Pithouse and Archaic period components.

Core flake to angular debris ratios are generally low, with the exception of LA 3563, LA 9721, and LA 75792. For LA 9721, this is probably due to sample error. However, this explanation certainly does not apply to the other sites. While the LA 3563 assemblage contains a comparatively high percentage of modified platforms, other assemblages with similar percentages of modified platforms have much lower core flake to angular debris ratios (LA 3279 and LA 39972). However, not only was LA 3563 in the Reserve area, it also contained the second smallest percentage of Luna blue agate of any Pueblo period assemblage. LA 75792 was also in the Reserve area. While this assemblage contains a moderately high core flake to angular debris ratio, percentages of biface flakes and modified platforms are both low, and this assemblage contains the lowest percentage of Luna blue agate of any Pueblo period assemblage. Material selection and perhaps more careful core reduction may be responsible for the high ratio derived for both of these components.

Except for LA 9721 and LA 75792, all Pueblo period assemblages contain fragments of large generalized bifaces that were broken in manufacture. Similarly, Pueblo period assemblages except for LA 9721, LA 39972, and LA 75792 contain fragments of projectile points that were broken during manufacture. Discounting the small assemblage from LA 9721, there is direct evidence for large biface production in all Pueblo period assemblages. However, small percentages of biface flakes and relatively small percentages of modified platforms in all of these assemblages also suggest that large biface manufacture did not dominate reduction activities. Instead, it appears to have played a minor role.

These assemblages were dominated by core reduction, producing debitage that could be used as informal tools or modified into formal tools. For the most part, cores that were no longer suitable for the production of debitage were discarded; only small percentages in some assemblages were themselves used as informal tools.

Formal and informal hammerstones occurred in most assemblages except for LA 3279, LA 9721, and LA 75792. Again, for LA 9721 this is probably a factor of sample error. However, this lack in other sites is surprising, since they contain substantial numbers of artifacts, and LA 3279 is by far the largest unmixed assemblage. Not even a hammerstone flake was recovered from either site. Nearly 80 percent of that assemblage is made up of Luna blue agate, which is a very hard material. Either these tools were not discarded at LA 3279 (which is unlikely), or they were used for only short periods of time before breaking, and so displayed too little wear to be recognized.

Wood and Bone-Working. Direct evidence of wood and bone-working was recovered from every Pueblo period component except for LA 9721. However, debitage that was probably used for cutting or scraping hard materials in that assemblage can probably be considered indirect evidence of this task. Drills and denticulates were recovered from six components, though only four assemblages contain both tool types (LA 3279, LA 39968, LA 39969, and LA 70185). Both formally flaked and informal versions of these tools were recovered. All eight assemblages from this period contain debitage that appears to have been used to cut or scrape hard materials. Debitage used for cutting outnumber those used for scraping in only three cases—LA 3279, LA 9721, and LA 39969.

Table 3.136. Assessment of Reduction Activities at Pueblo Period Sites

Attribute	Early Pueblo				Late Pueblo			
	LA 3563	LA 39969	LA 39972	LA 75792	LA 3279	LA 9721	LA 39968	LA 70185
Percent biface flakes	4.4	0.4	2.3	1.2	1.3	0.0	0.8	10.2
Percent modified platforms	17.4	6.8	10.0	7.6	12.4	27.3	5.7	4.6
Core flake:angular debris	15.05:1	2.32:1	2.06:1	7.22:1	1.10:1	10.5:1	1.70:1	4.6:1
Percent unutilized cores	96.1	80.7	80.0	94.4	98.3	100.0	89.6	97.5
Percent generalized bifaces broken in manufacture	20.0	22.2	66.7	0.0	20.1	0.0	29.4	38.5
Percent projectile points broken or discarded in manufacture	33.3	14.3	0.0	0.0	9.6	0.0	7.7	10.3
Number of hammerstones (including utilized cores)	2	25	2	0	0	0	27	4
Number of resharpening flakes	0	0	0	0	0	0	1	0

Table 3.137. Assessment of Tool Use Activities at Pueblo Period Sites; Frequencies with Percentages of Tool Class in Parentheses

Attribute			Early Pueblo				Late Pueblo			
			LA 3563	LA 39969	LA 39972	LA 75792	LA 3279	LA 9721	LA 39968	LA 70185
Cobble tools	Hammerstone		0 (0.0)	7 (77.8)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	13 86.7)	4 (100.0)
	Axe		0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (6.7)	0 (0.0)
	Chopper		0 (0.0)	1 (11.1)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Chopper-hammerstone		0 (0.0)	1 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (6.7)	0 (0.0)
Unifaces	Scraper		1 (100.0)	3 (100.0)	0 (0.0)	1 (100.0)	2 (100.0)	0 (0.0)	4 (80.0)	1 (100.0)
	Undifferentiated		0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (20.0)	0 (0.0)
Bifaces	Specialized	Drill	0 (0.0)	1 (33.3)	1 (100.0)	1 (100.0)	8 (72.7)	0 (0.0)	3 (100.0)	6 (100.0)
		Knife	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.0)	2 (18.2)	0 (0.0)	0 (0.0)	0 (0.0)
		Denticulate	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.0)	1 (9.1)	0 (0.0)	0 (0.0)	0 (0.0)
	Generalized	Whole	4 (80.0)	6 (66.7)	1 (33.3)	0 (0.0)	113 (71.1)	0 (0.0)	11 (64.7)	6 (46.2)
		Broken	0 (0.0)	1 (11.1)	0 (0.0)	1 (100.0)	14 (8.8)	0 (0.0)	1 (5.9)	2 (15.4)

Attribute			Early Pueblo				Late Pueblo			
			LA 3563	LA 39969	LA 39972	LA 75792	LA 3279	LA 9721	LA 39968	LA 70185
	Projectile points	Whole	0 (0.0)	5 (35.7)	0 (0.0)	2 (50.0)	42 (36.8)	1 (100.0)	8 (61.5)	12 (41.4)
		Refurbishing	0 (0.0)	4 (28.6)	1 (100.0)	2 (50.0)	25 (21.9)	0 (0.0)	2 (15.4)	6 (20.7)
		Meat Package	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	20 (17.5)	0 (0.0)	2 (15.4)	2 (6.9)
		Other	1 (33.3)	3 (21.4)	0 (0.0)	0 (0.0)	16 (14.0)	0 (0.0)	0 (0.0)	6 (20.7)
Tabular knives			0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)
Informal tools	Biface flakes	Cutting	2 (28.6)	5 (100.0)	2 (100.0)	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	2 (7.4)
		Scraping	4 (57.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	22 (81.5)
		Denticulate	1 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
		Drilling	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)	0 (0.0)	0 (0.0)	1 (3.7)
		Leather-working	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (7.4)
	Core flakes	Cutting	81 (31.7)	41 (57.7)	3 (25.0)	29 (21.5)	74 (70.5)	3 (60.0)	12 (14.8)	3 (2.5)
		Scraping	121 (56.3)	25 (35.2)	8 (66.7)	100 (74.1)	26 (24.8)	2 (40.0)	63 (77.8)	99 (81.8)
		Denticulate	4 (1.9)	2 (2.8)	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	2 (2.5)	0 (0.0)
Informal tools	Core flakes	Drilling	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	3 (2.9)	0 (0.0)	1 (1.2)	3 (2.5)
		Leather-working	9 (4.2)	3 (4.2)	1 (8.3)	5 (3.7)	1 (1.0)	0 (0.0)	2 (2.5)	16 (13.2)
	Angular debris	Cutting	2 (40.0)	4 (36.4)	0 (0.0)	1 (33.3)	18 (81.8)	0 (0.0)	2 (14.3)	0 (0.0)
		Scraping	3 (60.0)	6 (54.6)	3 (100.0)	2 (66.7)	4 (18.2)	0 (0.0)	12 (85.7)	9 (90.0)
		Leather-working	0 (0.0)	1 (9.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (10.0)
	Cores	Chopping	0 (0.0)	1 (0.9)	0 (0.0)	0 (0.0)	2 (0.6)	0 (0.0)	0 (0.0)	1 (2.5)
		Hammering	2 (2.6)	18 (16.5)	1 (6.7)	0 (0.0)	0 (0.0)	0 (0.0)	14 (7.7)	0 (0.0)
		General	1 (1.3)	2 (1.8)	2 (13.3)	1 (5.6)	4 (1.1)	0 (0.0)	5 (2.7)	0 (0.0)

Hunting. Projectile points that were probably returned to residential sites in meat packages occurred in four Pueblo period assemblages, including LA 3279, LA 3563, LA 39968, and LA 70185. Whole large generalized bifaces, which may have also been used in hunting, were recovered from all Pueblo period sites except for LA 9721, again probably because of sample error. Another tool type that was probably related to hunting makes its first appearance during the Pueblo period. While large dart points were probably used as knives in earlier periods, single-function bifacial knives first occur during the Early Pueblo period. These tools were found in only two assemblages (LA 3279 and LA 39969), and it is possible that medium-sized projectile points continued to fulfill this function in many cases.

Weapon Refurbishing. Evidence of weapon refurbishing was found in six assemblages; only LA 3563 and LA 9721 lack any evidence of it. The refurbishing of weapons is probably better indirect evidence of hunting activities than is the presence of whole generalized bifaces, and strengthens our assumption that hunting was pursued by the residents of these sites.

Leather-Working. Only LA 9721 lacks any evidence of leather-working, and this is probably once again due to small assemblage size. Unifacial scrapers were found in five assemblages, while debitage that was probably informally used in leather-working was recovered from six. A tabular knife, which might have been used for hide scraping, was recovered from LA 70185.

Vegetal Processing. Three types of chipped stone tools may have been used for vegetal processing including choppers, chopper-hammerstones, and cores that were informally used for chopping. It is likely that choppers were used to cut and shred vegetal material for consumption or equipment manufacture. When all three categories are combined, direct evidence of this task occurs in four assemblages. The exceptions are LA 3563, LA 9721, LA 39972, and LA 75792. Utilized cores with nonspecific wear patterns may also have functioned in this capacity, but since they could also have been used in other tasks, this is uncertain. These tools were found in six assemblages, including LA 3563, LA 39972, and LA 75792. Thus, potential evidence for vegetal processing occurs in all assemblages except LA 9721, which by this point should not be unexpected.

Other Tools. This category is essentially the same as that discussed for the Pithouse period.

Summary. Reduction activities in these components appear to have focused on reduction of cores to produce debitage that could be modified into formal tools or used as informal tools. While large biface manufacture is evidenced in all assemblages except LA 9721, it appears to have been of been of little importance. Platform modification appears less often than is evidenced in earlier components.

LA 9721 contained only a very small assemblage and was not definitely associated with structural remains. This component evidences very few activities, essentially only core reduction and perhaps hunting and some wood and bone-working. The former is indicated by the presence of a complete projectile point, and the latter by five informal tools. This assemblage differs greatly from other Pueblo period examples, and probably represents a short-term use of some sort. Both hunting (possibly associated with protecting fields) and wood and bone-working are activities that would not be inconsistent with a fieldhouse function.

The remaining components display the full range of tasks defined in the chipped stone assemblages. While direct evidence for hunting is absent from three components (LA 39969, LA 39972, and LA 75792), indirect evidence in the form of weapon refurbishing suggests that this task was also pursued in those assemblages. Direct evidence of wood and bone-working and leather-working was found in all seven components, and vegetal processing was directly suggested for four and indirectly for three. Each assemblage contains direct evidence for large biface manufacture, and five of seven for projectile point manufacture; only LA 39972 and LA 75792 lacked projectile points broken during manufacture.

Protohistoric Components

Neither unmixed protohistoric component contained an associated structure, and both appear to represent temporary camps. Data for these components are shown in Tables 3.138 and 3.139. Questions have been raised concerning the presence of minor secondary components in both cases.

Table 3.138. Assessment of Reduction Activities at Protohistoric Period Sites

Attribute	LA 37917	LA 37919
Percent biface flakes	2.8	3.8
Percent modified platforms	31.6	33.9
Core flake:angular debris	3.84	4.92
Percent unutilized cores	100.0	100.0
Percent generalized bifaces broken in manufacture	40.0	50.0
Percent projectile points broken or discarded in manufacture	0.0	0.0
Number of hammerstones (including utilized cores)	0	0
Number of resharpening flakes	0	0

Table 3.139. Assessment of Tool Use Activities at Protohistoric Period Sites; Frequencies with Percentages of Tool Class in Parentheses

Attribute			LA 37917	LA 37919
Unifaces	Scraper		1 (50.0)	0 (0.0)
	Undifferentiated		1 (50.0)	1 (100.0)
	Generalized	Broken	3 (60.0)	1 (50.0)
		Refurbishing	1 (20.0)	0 (0.0)
		Meat Package	3 (60.0)	0 (0.0)
		Other	1 (20.0)	1 (100.0)
Informal tools	Biface flakes	Cutting	5 (62.5)	5 (100.0)
		Scraping	1 (12.5)	0 (0.0)
		Denticulate	2 (25.0)	0 (0.0)
	Core flakes	Cutting	41 (47.7)	24 (49.0)
		Scraping	42 (48.8)	24 (49.0)
		Denticulate	0 (0.0)	1 (2.0)
		Leather-working	3 (3.5)	0 (0.0)
	Angular debris	Cutting	1 (16.7)	0 (0.0)
		Scraping	4 (66.7)	2 (100.0)
		Denticulate	1 (16.7)	0 (0.0)

Chipped Stone Reduction. These assemblages are fairly similar in many respects, as demonstrated during analysis in *Chipped Stone Reduction: Debitage and Cores*. Both contain small percentages of biface flakes and large percentages of modified platforms. In both cases there is also a moderate core flake to angular debris ratio, though these are not as large as might be expected considering the amount of platform modification. Both assemblages contain direct evidence of large biface manufacture, but neither contains any projectile points that were broken during manufacture. These assemblages are dominated by core reduction debris, and all cores that were no longer considered suitable for use were discarded without being used as informal tools. Hammerstones are missing from these assemblages, suggesting that they were either carried off as part of the maintainable tool kit, or exhibited few signs of use and were not identified during excavation. The former is considered more likely.

Wood and Bone-Working. The only direct evidence of wood and bone-working in either assemblage is debitage that was marginally modified to produce denticulates. Indirect evidence includes informally used debitage; examples used for cutting and scraping occur in essentially equivalent numbers.

Hunting. Direct evidence for hunting was found in only one assemblage; LA 37917 contains three projectile point fragments that appear to have been returned to the site in meat packages. The single point fragment from LA 37919 has a nonspecific snap fracture and it is not possible to determine how it was broken. The presence at both sites of large generalized bifaces indirectly suggests that hunting may also have occurred at LA 37919.

Weapon Refurbishing. Weapon refurbishing is evidenced by only one component; LA 37917 contains a projectile point fragment that appears to have been broken during use and discarded at this location when it was replaced.

Leather-Working. Tools used in leather-working include unifacial scrapers and debitage that were informally used to scrape hides. Evidence for this task was only recovered from LA 37917.

Vegetal Processing. No evidence of vegetal processing was found in either protohistoric chipped stone assemblage.

Other Tools. This category includes undifferentiated unifaces and fragments of large bifaces and projectile points with nonspecific breaks. As noted earlier, undifferentiated unifaces cannot be assigned to a single use and their shapes are not indicative of the purpose(s) for which they were made. Thus, these tools could have been used in nearly any chipped stone-using task. Fragments of large generalized bifaces and projectile points with nonspecific breaks were also discussed earlier. Because of the break patterns exhibited by these tools we cannot tell whether they fractured during manufacture, use, or after loss or discard. While the presence of these artifacts could be evidence for hunting, this is questionable and can only be asserted when other types of corroborating data exist.

Summary. Reduction data from these components is confusing. Small percentages of biface flakes suggest that little manufacture of large bifaces occurred at these sites. However, the presence of high percentages of modified platforms and at least one fragment of a biface that was broken during manufacture imply that large biface production did occur. If so, it is possible that only early stage reduction occurred at these sites, producing few pieces of debitage that are recognizable as debris from biface manufacture. However, most biface fragments from these components are pieces of tools from the middle and late stages of manufacture. How do we explain this apparent discrepancy?

In this case, it is possible that most (or all) biface breakage occurred during the removal of flakes for use as informal tools, rather than during manufacture. While biface flakes are uncommon in both assemblages, half of them in the LA 37917 assemblage and about 20 percent in the LA 37919 assemblage were utilized. Biface flakes and bifaces in both assemblages tend to be of the same materials. The only exceptions are basalt bifaces in the LA 37919 assemblage for which there are no corresponding biface flakes. It is likely that no bifaces were manufactured in these components; instead, flakes were removed for use as informal tools from finished bifaces that were manufactured elsewhere. Bifaces that broke during this process were discarded. Most reduction in these components appears to have focused on the removal of flakes from cores, and it is quite possible that core platforms were modified to facilitate this process, though this remains unproven.

The range of activities reflected by both protohistoric assemblages is rather limited when compared with the Archaic and Mogollon components. LA 37917 exhibits direct evidence for hunting, weapon refurbishing, and leather-working, and indirect evidence for wood and bone-working. Other than chipped stone reduction, the only task that is indirectly evidenced at LA 37919 is wood and bone-working. While the presence of fragments of a projectile point and large generalized bifaces may be evidence for hunting, this is by no means certain.

Applying the Model: The Transition from Curated to Expedient Reduction Strategies

Three major changes in reduction strategy have been posited, with breaks occurring between the Archaic and Early Pithouse periods, the Early and Late Pueblo periods, and the Late Pueblo and protohistoric periods. The most critical change is that which occurred between the Archaic and Early Pithouse periods, because it should represent a major shift in mobility structure. Archaic assemblages should contain evidence for considerable residential mobility, while those of the Mogollon periods should exhibit indications of little residential mobility.

While architecture is not a focus of chipped stone analysis, the few Archaic pit structures found by this project lacked indications of long-term use. A pit structure at LA 70188 was rather deep (85 cm below original ground surface), but was less than 3 m in diameter and lacked interior features. A probable pit structure at LA 45508 was somewhat larger (3.5-by-5.0 m), but was also shallower (.52 to .66 m). Again, there was no interior hearth, and the only structural features were five postholes. While occupational surfaces and extramural hearths occurred at LA 43766, no evidence of a structure was found. The only likely Archaic feature at LA 78439 was a roasting pit, and there was no evidence of an associated structure.

The two Archaic pit structures seem indicative of short-term use, and the absence of internal hearths may be evidence of warm-season occupation. While repeated, probably short-term uses are posited for LA 70188, a lack of discernable strata precluded separation of individual occupation layers during excavation. However, at least one substantial occupation was documented for this site, and included the pit structure, associated extramural hearths, and a work area. Evidence for at least two separate occupations was found in the unmixed portion of LA 43766. Both uses occurred during the Late Archaic period, and surfaces containing associated features were defined for each. It is likely that both remaining Archaic components represent single periods of occupation. In all cases, evidence points toward transitory use of residential sites during the Archaic period, much of which may have occurred during the warm season.

Interestingly, Shackley (1996a) presents a model positing a strong Late Archaic upland-lowland pattern of resource acquisition, with logistical groups moving into the highlands to procure piñon nuts and artiodactyls. He notes that the availability of these resources coincides in the fall when the piñon crop masts and many artiodactyls congregate for the rut (Shackley 1996a:11). During the rest of the year the population is thought to have resided in the lowlands.

Whittlesey and Ciolek-Torrello (1996:53) feel that the Late Archaic population in southeast Arizona was neither fully sedentary nor dependent on maize horticulture. At times their settlement system appears to have included transhument movement between floodplain settlements and upland camps. They consider the Early Formative period to be separate from the Late Archaic, and equate it with either a terminal Archaic period, similar to that described by Matson (1991), or with the early part of the Ceramic period. Chipped stone assemblages from Early Ceramic period sites in Arizona (ca. A.D. 1 to 400) are considered transitional in nature, and primarily reflect an expedient reduction strategy similar to that found at later Hohokam sites (Whittlesey and Ciolek-Torrello 1996:58). They also

> . . . retain some characteristics of the curated technologies characteristic of more mobile Archaic populations, involving intensive tool recycling and maintenance manifested by more retouched and formal tools, the production of bifaces, less discard of useable tools, and the selection of higher-quality raw materials from a variety of different sources [Whittlesey and Ciolek-Torrello 1996:58].

Chipped stone assemblages from this period reflect an entirely expedient reduction strategy similar to that of later Hohokam periods (Whittlesey and Ciolek-Torrello 1996:59).

Whittlesey and Ciolek-Torrello (1996:60) feel that the Late Archaic population remained highly mobile. Archaic farming villages were temporarily occupied seasonal settlements that represent an adaptation to a new seasonally abundant resource—maize. They argue that the transition to a sedentary farming system began in the Late Archaic but was not completed until after the Early Formative period. This model is important to consider, because

> The Archaic-Formative continuum appears to provide support for the development of Mogollon and Hohokam from the San Pedro stage Cochise culture, and the recognizably similar material signature of Plain Ware horizon sites suggests that some aspects of this basal culture were widespread across the Southwest [Whittlesey and Ciolek-Torrello 1996:63].

They feel that similarities between Pioneer period Hohokam and Early Pithouse period Mogollon suggest a common root. Interaction between regions, which may have included population circulation, seems to have resulted in a sharing of new economic, social, and material developments. The archaeological diversity seen throughout the region is probably due to differences in how these developments were adapted to diverse environments and cultural traditions (Whittlesey and Ciolek-Torrello 1996:63). For the Mogollon region, the Plain Ware period is equated with the Early Pithouse period.

Wills (1996) also feels that the early Highland Mogollon retained a degree of residential mobility. Early investigations at the SU site (Martin 1943; Martin et al. 1940; Martin and Rinaldo 1947) and more recent studies at the same locale and in the surrounding region (Wills 1996) suggest that the Early Pithouse population may have been residentially mobile on a seasonal basis. In this view, the population occupied scattered summer farming sites and returned to winter villages like the SU site, where internal storage features are common. While we do not totally agree with this view, we concur that the Early Pithouse period population probably remained residentially mobile. However, this would have been on a different scale than is suggested for the Archaic. Where hunter-gatherers may have occupied most sites for no more than a few days to a few weeks, it is likely that the Early Pithouse population occupied residences for one or more seasons at a time.

Early Pithouse period components were examined at LA 39972 and LA 39975. No structural remains associated with this occupation were found at LA 39972, possibly because the area in which they were located is now part of the road bed. However, three pit structures were excavated at LA 39975. While no interior storage facilities were found, two had central hearths connoting a cold season occupation, such as that suggested for the SU site (Wills 1996). Whether structures of this type represent habitations occupied during the growing season, as Wills suggests, or were used year-round, is not important to this discussion. The significant aspect is evidence for cold-season (and perhaps year-round) occupation, as opposed to primarily warm-season occupation by the Archaic population.

Many of these ideas fit well with the model presented earlier in this volume. Rather than a radical shift in mobility between the Archaic and Mogollon periods, a transition can be expected. Chipped stone assemblages in Early Pithouse period sites should display attributes characteristic of an expedient reduction strategy, but they should also retain some aspects of a curated reduction strategy. This is because the population is expected to have remained residentially mobile, but on a much smaller scale than prevailed during the Archaic. Most aspects of a curated reduction strategy should disappear by the Late Pithouse period, when a fully expedient reduction system should be evidenced. By this time the population should have been more fully sedentary, though some degree of residential mobility probably continued to exist.

Archaic Mobility

One of the main questions posited in the research design concerning the Archaic components is whether they represent locales occupied by foragers, collectors, or both. A set of expectations was generated, and much of the analysis was aimed at providing data that would allow us to assess our expectations and perhaps answer this question. Unfortunately, because of the nature of much of our data, any answer must be considered tentative.

At least two of our Archaic sites are multioccupational locales, and it was not possible to adequately separate the different occupations and still produce useable data sets. This is often the nature of the beast when dealing with Archaic sites. Certain favorable locations were often repeatedly occupied, creating palimpsests of debris from numerous uses that are inextricably mixed. This can even be a problem when separate use surfaces are defined, such as at LA 43766. Unless surfaces are sealed by deposits that are difficult for insects and rodents to penetrate, mixing is inevitable. Hence, there was a layer of soil between use surfaces at LA 43766 that contained materials which are probably from both occupations. Instead of choosing to arbitrarily separate these components, we decided to combine them and take the analytical consequences. In two other cases we assume that single Archaic occupations are represented, but this cannot be conclusively demonstrated.

Interpretation of technological data can also be hampered by problems. As Kelly (1992:55-56) notes:

> First, there are no simple relationships between mobility and tool manufacture. Many other variables intervene—e.g., tool function, raw material type, and distribution, hafting, and risk. Second, the reconstruction of different tool manufacturing methods from debitage is fraught with interpretive difficulties. Third, stone tools are not routinely used to a significant extent by any living foragers, making it difficult to test ideas relating stone tools to mobility.

Some of these problems have already been encountered. Variation in material acquisition patterns between the Luna and Reserve areas introduced interpretive difficulties, but also provided an interesting view of changes in material procurement patterns. We have had difficulty explaining certain aspects of the reduction systems encountered in these assemblages. Left with only a partial picture and no living cognates, we must use experimental experience and comparisons with other assemblages to explain these remains. Thus, some misinterpretation is inevitable. While we are reasonably confident that certain trends in the data reflect variation in reduction strategies, we are on shakier ground when we begin to speculate on the specifics of those differences.

Foraging and collecting sites were modeled in the research design, and sets of expectations for each type of site were provided. Several varieties of materials suitable for chipped stone reduction commonly occur throughout the region. Examination of lithic resources determined that there are differences in the availability of certain materials between the Luna and Reserve areas, but this variation did not appear to affect Archaic reduction patterns. The four Archaic components can be divided into two groups. LA 43766, LA 45508, and LA 70188 all contain evidence for a considerable amount of large biface manufacture, and form the first group. There was little evidence for large biface manufacture at LA 78439, and it constitutes the second group.

Large biface manufacture and hunting were important tasks in the Group 1 components. Projectile points were manufactured at these locales, broken points were replaced in shafts, and at least one example from LA 70188 was probably returned to camp in a meat package. There is also evidence for wood-working, though only LA 43766 contains tools specifically designed for the manufacture or refurbishing of weapon shafts. While biface flakes were used as informal tools, bifaces do not appear to have primarily functioned as sources for informal tools. As Table 3.140 shows, percentages of utilized biface flakes are similar to percentages of biface flakes in overall debitage assemblages. There is no evidence that biface flakes were specifically struck for use as informal tools. Rather, they represent debitage discarded during the manufacture of bifacial tools, which were later selected for expedient use.

The character of LA 78439 is considerably different from the Group 1 components. Biface reduction was not as important an activity in this assemblage. The only potential evidence for tool manufacture consists of a few biface fragments that were discarded after being broken during reduction, and a small percentage of biface flakes, mostly obsidian. As Table 3.140 shows, the way in which biface flakes were selected for use also differs from the Group 1 components. While biface flakes comprise a smaller percentage of the informally used debitage at LA 78439, it is nearly twice the percentage that biface flakes represent in the overall debitage assemblage. Nearly 35 percent of the biface flakes show evidence of utilization, versus much smaller percentages in the Group 1 assemblages.

Table 3.140. Contrasting Utilized Biface Flakes in Archaic Assemblages

Site	Percentage of Utilized Debitage Comprised of Biface Flakes	Percentage of Biface Flakes in Assemblage	Percentage of Biface Flake Assemblage Utilized
LA 43766	23.1	28.7	1.8
LA 45508	26.4	27.8	5.6
LA 70188	29.8	23.6	3.0
LA 78439	15.3	8.3	34.9

The Group 1 components fit our expectations for residential locales. Two contain structures that appear to have functioned as warm-season residences, and all contain evidence for a relatively wide range of activities, including large generalized biface and projectile point manufacture, hunting, weapon refurbishing, and wood and bone-working. One component (LA 70188) may also contain indications of leather-working and vegetal processing. It is more difficult to determine whether these components represent forager or collector occupations. Most of these sites lack storage facilities, suggesting that they may not have functioned as logistical base camps. However, storage features were present at LA 70188, perhaps indicating a logistical function during at least one episode of occupation. Vierra (1990; Vierra and Doleman 1994) suggests that Southwestern Archaic hunter-gatherers were organized as foragers during the warm season and collectors during the cold season. Considering Shackley's (1996a) ideas about use of the highlands during the fall and circumstantial evidence for warm-season use of at least two of the Group 1 sites, it is likely that Late Archaic peoples mostly used this area as foragers. This is partly supported by lithic data that suggest several stone tool-using activities occurred at these locations, and that occupation did not concentrate on only one task. A heavy focus on the manufacture of bifacial tools suggests that part of our proposed model may be incorrect. Whether organized as foragers or collectors, large generalized bifaces appear to have been important components of the stone tool system. This suggests that some uncertainty often remained concerning the anticipated movement route; i.e., whether future residential locales would be in areas containing suitable lithic resources.

Evidence for the manufacture of bifacial tools in the LA 78439 assemblage is rather slim. While biface flakes and bifaces broken during reduction occur in this assemblage, differences in debitage utilization patterns suggest that, rather than representing manufacturing debris, these materials evidence the use of large generalized bifaces as cores. Some breakage apparently occurred, and broken tools were discarded. Evidence suggests that some wood and bone-working might also have occurred. However, most of the stone tool-using activity was probably focused on a single task. In general terms, LA 78439 fits our expectations for a logistical camp.

Mogollon Sedentism

By the Early Pithouse period there appears to have been a major change in chipped stone reduction strategy. Indicators such as flake to angular debris ratios, flake to core ratios, and basic debitage assemblage composition all suggest that the Mogollon chipped stone reduction system focused on expedient reduction of cores to produce debitage useable as informal tools. However, there is also enough temporal variation to suggest that the transition to a wholly expedient reduction system did not occur all at once.

First, it should be noted that expedient core reduction was also an important component of the Archaic reduction strategy, and most informal debitage tools in those assemblages were struck from cores. Biface flakes were casually used in the Group 1 sites, and percentages of examples exhibiting signs of use are fairly proportional to percentages of biface flakes in overall debitage assemblages. Flakes seem to have been specifically struck from bifaces for use at LA 78439; still, core debitage comprises an even larger percentage of the informal tools in this component. Thus, core reduction was an important part of all reduction systems represented in our sample of sites. As the level of mobility decreased, so did the need for generalized tools manufactured in anticipation of need. With the advent of sedentism, the use of large generalized bifaces appears to have declined, though they never completely went out of use.

A significant reduction in large generalized biface manufacture and use may have been almost immediate, since Early Pithouse period components contain much smaller percentages of biface flakes than the Archaic assemblages. However, it is interesting that percentages of modified platforms in flake assemblages remain moderately high in the Early Pithouse period. While percentages of modified platforms in Late Pithouse period flake assemblages are lower than those of the Early Pithouse period, the percentage of biface flakes is over twice as high. It is likely that sample error is responsible for some of these apparent discrepancies, since assemblages from these periods are not as large as those of the Archaic and Pueblo periods. In order to account for this possibility, assemblages are combined by major periods in Table 3.141. As this table shows, biface flakes are nearly three times as common in the Pithouse period than in the Pueblo period, and modified platforms are nearly one and a half times as common. This suggests that, while there appears to have been an immediate decline in the use of large generalized bifaces between the Archaic and Pithouse periods, they remained a moderately important tool until the Pueblo period. With the transition to multiroom above-ground structures, the use of large generalized bifaces once again declined.

It is interesting to note that there is no correspondingly significant decrease in flake to angular debris ratios between the Late Pithouse and Early Pueblo periods, nor is the decrease in platform modification as large as it was between the Archaic and Early Pithouse periods and the Early and Late Pithouse periods (see Table 3.102). However, there is a large and significant drop in flake to angular debris ratios between the Early and Late Pueblo periods that appears to indicate a major change in reduction technology if not strategy. An increase in the use of Luna blue agate

Table 3.141. Comparison of Reduction Information by Major Time Period

Time Period	Percent Biface Flakes	Percent Modified Platforms
Archaic	24.5	30.9
Pithouse	6.0	14.3
Pueblo	2.1	9.7
Protohistoric	3.3	32.8

during this period, especially in the Luna area, may be related. Indeed, when Luna blue agate and other materials were examined separately, flake to angular debris ratios were 0.98:1 and 2.78:1, respectively. The latter ratio is very similar to that derived for Anasazi residential sites in northwest New Mexico (Vierra 1990:67), and near Taos (J. Moore 1994). Most materials appear to have been expediently reduced using a core-flake trajectory similar to that found elsewhere in sedentary Anasazi sites. The very low flake to angular debris ratio for Luna blue agate suggests that it was simply smashed, probably because it is difficult to fracture.

Thus, a transition from heavy reliance on a curated reduction strategy to one that focused almost exclusively on expedient reduction is visible in our data. The manufacture and use of large generalized bifaces was a very important part of the Archaic reduction strategy, and we have some evidence for their manufacture at residential sites that were most likely occupied during the warm season, and their use at a logistical site. During the Early Pithouse period there is evidence for a decrease in residential mobility, signified by structures that could be occupied year-round. While residential mobility probably remained fairly high during the Pithouse period, the scale of movement was much lower than it was during the Archaic. Rather than moving every few days or weeks, people probably tended to remain in place for one or more seasons. The decrease in residential mobility is marked by a sharp decline in evidence for manufacture and use of large generalized bifaces.

Movement into multiroom above-ground structures is evidence for a further decrease in residential mobility, and reflects greater investment in domestic and storage facilities. Coincident with this trend we see a further decline in the amount of large generalized biface manufacture. The reduction strategy is almost entirely focused on expedient core reduction and the production of specialized bifacial tools by the Early Pueblo period. While some large generalized bifaces continued to be made, there is a sharp decline in the amount of debris generated by this activity when Early Pueblo and Late Pithouse period assemblages are compared. However, cores were still reduced in a moderately efficient manner.

There continues to be little evidence for the manufacture of large generalized bifaces in the Late Pueblo period, and another major change in reduction strategy is visible. Except for Luna blue agate, flake to angular debris ratios for this period are similar to those found in other sedentary farming populations in New Mexico, suggesting that the population was almost certainly fully sedentary by this time. Since these ratios are lower than those for the Early Pueblo period, it appears that core reduction became somewhat less efficient. Luna blue agate was reduced differently than other materials, apparently simply being smashed with little regard for the shape of most by-products. Curatable large generalized bifaces comprise a small part of the tool kit, and specialized biface use remained important, with this tool class primarily composed of projectile points.

Protohistoric Site Use

The two protohistoric components present several problems. We have noted that they are in some ways similar to Archaic assemblages, and in other ways they resemble those of the Mogollon. Interestingly, in *Chipped Stone Reduction: Debitage and Cores* we saw some similarity between these assemblages and the Late Archaic component at LA 78439, though important differences were also apparent. There are several potential explanations for this. First, it is possible that the protohistoric component at LA 78439 is more dominant than was originally thought. It is also feasible that the protohistoric occupations at both LA 37917 and LA 37919 consist of little more than small hearths and a few associated artifacts overlying a larger scatter of Archaic materials. Finally, it is possible that the differences in date are real, but types of occupations were very similar.

Unfortunately, it is simply not possible to adequately test the first two possibilities. While preliminary obsidian hydration dating results suggest Archaic dates for some artifacts in the protohistoric assemblages, we are uncertain what events are being dated. Certainly, the possibility that these artifacts were generated during the Archaic period is high, but were they struck by the residents of these locales, or were they mined from earlier sites for reuse during the protohistoric occupation? We cannot answer this question with the data currently available. Some use of earlier materials seems likely, since the LA 37917 assemblage contains both Archaic dart points and later arrow points. For the time being, we will continue to assume that protohistoric occupations are represented.

Earlier in this chapter we concluded that large generalized bifaces were probably not manufactured at these locations; rather, the protohistoric components appear to be loci where flakes were removed from bifaces for use as informal tools. In this they resemble

LA 78439. Table 3.142 compares biface flake utilization data from the protohistoric sites with information presented earlier for the Archaic sites. The protohistoric components resemble LA 78439 in the way biface flakes were used. In all three cases biface flakes are used out of proportion to their occurrence in overall debitage assemblages. The percentage of utilized biface flakes is also considerably higher in these components than in the Group 1 Archaic assemblages. This suggests that the protohistoric components represent logistical sites similar to LA 78439.

While the number of activities represented in the chipped stone assemblage from LA 37919 is rather limited, at least four possible activities (besides reduction) are evidenced in the LA 37917 assemblage. All of these activities could be related to a single task, however. If LA 37917 represents a hunting camp where game and hides were at least partly processed before being returned to a residential site, we can account for all of these activities. The occurrence of four fragments of burned deer bone at this site adds credence to this possibility, as does the lack of ground stone tools. There is no good evidence for hunting activities in the LA 37919 assemblage; the single projectile point from this site has a undiagnostic snap fracture. No faunal materials were found in this assemblage; however, it did contain five pieces of ground stone representing three individual tools. A pollen wash from a metate fragment yielded pine, grass, and sunflower pollen. Differences in chipped stone assemblages between these components could be related to variation in function. If they represent logistical sites, LA 37917 may have served as a hunting camp, while plant materials may have been gathered and processed at LA 37919.

Thus, the protohistoric assemblages resemble the array of materials from an Archaic logistical component at LA 78439. However, this analysis does not help to accurately place these components in a temporal framework. We are still unable to resolve whether they represent Archaic logistical sites overlain by a thin veneer of protohistoric features and materials or occupations by protohistoric groups whose chipped stone systems were organized similarly to those of the Archaic.

Summary

The array of unmixed assemblages contains evidence for temporal changes in chipped stone reduction strategy. There was a considerable reliance on expedient core reduction during all periods, but cores were broken up more efficiently during some periods than others. Efficient core reduction and heavy reliance on curatable bifaces are characteristics of the Archaic reduction strategy. The efficiency of core reduction declined somewhat in the Pithouse period, and large generalized bifaces became less important. Early Pueblo period core reduction efficiency was similar to that of the Pithouse period, yet the use of large generalized bifaces continued to decline, and this class of tool became a minor adjunct of the tool assemblage. There was a further decline in reduction efficiency in the Late Pueblo period, with large generalized bifaces continuing as minor tools. Finally, the protohistoric population seems to have used a reduction strategy similar to that of the Archaic. Each change in reduction strategy accompanies important variation in settlement and subsistence system and scale of mobility. The Archaic assemblages represent a period of high residential mobility, followed by a transition toward a sedentary lifestyle, which appears to have been fully attained by the Pueblo period. Following abandonment of this region by farmers, it was apparently again occupied by mobile hunter-gatherers.

CONSIDERING THE PROTOHISTORIC COMPONENTS: ARE THEY OR AREN'T THEY, AND IF THEY AREN'T, WHO ARE THEY?

The protohistoric components are very difficult to deal with because there are really no artifacts in the existing assemblages that provide any clues to the cultural affinity of the occupants of these sites. Most projectile points in the LA 37917 assemblage are of Archaic affinity, and all the sherds from LA 37919 are Mogollon. The only indications of protohistoric dates for these components are ^{14}C samples from small simple hearths. Are the artifacts associated with the hearths, or do they represent earlier occupations?

Analysis suggests that the protohistoric assemblages are more similar to one another than they are to assemblages from the Archaic and Mogollon periods. However, in many respects they are also similar to the unmixed assemblage from LA 78439, which presents us with yet another problem. Features at that site date to both the Late Archaic and protohistoric periods. While we are fairly confident that our attempt to separate Archaic and mixed materials was successful, the similarity of the "unmixed" materials to the probable protohistoric assemblages from LA 37917 and LA 37919 injects a note of uncertainty.

The meaning of this resemblance is difficult to determine. On one hand it could mean that our assumption that artifacts and protohistoric dates are associated at LA 37917 and LA 37919 is incorrect. On the other hand, it could simply mean that these three components represent similar uses by hunter-gatherer populations separated by several thousand years. Comparative information from other protohistoric hunter-gatherer sites in the Southwest might provide data upon which to base at least a tentative conclusion.

Table 3.142. Contrasting Utilized Biface Flakes in Archaic and Protohistoric Assemblages

Period	Component	Percentage of Utilized Debitage Comprised of Biface Flakes	Percent of Biface Flakes in Assemblage	Percentage of Biface Flake Assemblage Utilized
Archaic	LA 43766	23.1	28.7	1.8
	LA 45508	26.4	27.8	5.6
	LA 70188	29.8	23.6	3.0
	LA 78439	15.3	8.3	34.9
Protohistoric	LA 37917	8.8	2.8	50.0
	LA 37919	8.9	3.8	19.2

Comparative Information: Protohistoric Athabaskan Hunter-Gatherers

It is likely that protohistoric hunter-gatherers in the Luna-Reserve region were early Athabaskans. While some historians like Forbes (1960) believe that Athabaskans were in the Southwest as early as A.D. 700, there is no good archaeological evidence for this. Indeed, information given to Pedro de Casteñeda, chronicler of the Coronado expedition, suggests that Apaches arrived in the Southwest just before the Spanish (Winship 1896:148), perhaps in the early 1500s. This is partly confirmed by sites in northwest New Mexico that have been identified as Navajo and date to the early 1500s (see Towner 1996).

Other than early Navajo sites in northwest New Mexico, few definite Athabaskan sites dating to the sixteenth or seventeenth centuries are comprehensively reported. Thus, we will have to depend on those data for most of our comparisons. Our use of Navajo material for comparison is based on the implicit belief that Athabaskan material culture was as similar as their languages at least until the early Historic period. Young (1983:394) notes that linguistic studies suggest that the Proto-Apacheans were a homogeneous ethnic group at the time they separated from the Northern Athabaskan population around A.D. 950 to 1000. This close relationship may have lasted until around A.D. 1400 or so, when language studies suggest they began separating from one another. Hopefully, this relationship held up for at least another 100 years, which is the time period from which most of our comparative data derive. However, because we lack good comparative data from contemporary Apache sites, any similarities or differences cannot be considered conclusive.

Kearns (1996) provides the most comprehensive view of early Navajo chipped stone reduction technology in a synthesis of data from northwest New Mexico. His study concludes that most protohistoric and Early Historic Navajo assemblages are characterized by small size and considerable variability, yet they contain consistently recurring and diagnostic tools and attributes (Kearns 1996:100-111). Data from 37 sites were used in formulating his synthesis. The protohistoric and Early Historic Navajo reduction strategy included:

> . . . a mix of expedient core-flake, formal uniface, and formal biface technologies. The reduction strategies employed a combination of opportunistic percussion flaking to obtain blanks for expedient flake tools, percussion reduction of cobbles and nodules for core tools, production of flake blanks for use as curated, maintained uniface tools, and the controlled sequential percussion and pressure reduction of curated bifacial artifacts. The relatively common occurrence of a bifacial reduction strategy is a characteristic aspect of Athapaskan-early Navajo lithic technology, particularly during the protohistoric period [Kearns 1996:144].

He also notes that the recycling of materials from earlier sites is a characteristic of early Navajo and Ute tool kits (Kearns 1996:135).

Among the diagnostic artifacts noted are projectile points resembling the Cottonwood Triangular and Desert Side-Notched types of the Great Basin. A preference for siliceous materials is shown, and obsidian is a common exotic material. Other distinctive artifacts include small multidirectional microcores and elongated flake knives (Kearns 1996).

Brown and Hancock (1992) summarize the results of investigations at protohistoric Navajo sites in the La Plata Valley. They indicate that flake to angular debris ratios were slightly higher than Archaic values, though biface flakes occurred in smaller percentages. However, debris from small biface reduction tended to be more common. In a Navajo assemblage from a site in the San Juan Breaks, Elyea (1992:42) indicates that:

> Bifacial reduction and formal tool

> manufacture are evidenced by a small number of bifacial reduction and sharpening flakes, and by the relatively high proportion of flakes with retouched and ground platforms . . . .

Most of the early Navajo sites described by Brown (1991) near the La Plata Mine in northwest New Mexico contain evidence for biface manufacture. In all but two instances, biface flakes comprise 10 percent or more of debitage assemblages (Acklen et al. 1991:576). Again, protohistoric flake to angular debris ratios are slightly higher than those of nearby Archaic components. Summary statistics presented for protohistoric debitage suggest that the bifaces being manufactured were rather large, since biface flakes had a mean length of 2.14 cm (Acklen et al. 1991:583). Brown et al. (1991:560) note that the protohistoric tool assemblages are much more comparable to those of the Archaic occupation than they are to the Anasazi assemblage.

Elyea and Eschman (1985b) analyzed chipped stone assemblages from several sites in northwest New Mexico, including components occupied by Archaic, Anasazi, and Navajo peoples. They conclude that early Navajo components evidence the manufacture and use of bifaces, though not in as high a proportion as in Archaic assemblages. They also indicate that platform preparation was more common in Navajo assemblages than in Anasazi components.

The Luna-Reserve Protohistoric Assemblages

The two protohistoric assemblages from this project are difficult to compare with data presented in the previous section. Since these components seem to represent logistical camps, we cannot expect a wide range of tool types. Indeed, the only formal chipped stone tools in these components are projectile points and fragments of large generalized bifaces. Unfortunately, none of the chipped stone tools that Kearns (1996) considers diagnostic for early Navajo occupations are replicated in our assemblages. Thus, we can only make broad comparisons.

Most researchers agree that early Athabaskan sites contain projectile points similar to types defined as Desert Side-Notched and Cottonwood Triangular in the Great Basin. Kearns (1996) provides an argument for extending the use of these terms to the Southwest. Unfortunately, very similar types often occur in Mogollon assemblages, so their utility as diagnostics for that area is questionable. None of the projectile points in our protohistoric assemblages resemble these types. However, a point from LA 39719 that was lost before analysis is described as "a small Chiricahua-like point." This essentially fits the description of the Desert Side-Notched type, and is similar to points observed on early Jicarilla Apache sites in northeast New Mexico by the author. While this is less than definitive, it does provide some further evidence for a protohistoric Athabaskan occupation at this site.

Unfortunately, from the above assemblage descriptions, it seems likely that early Athabaskan assemblages bear a great deal of resemblance to those of the Archaic period. There is usually evidence for the manufacture and use of large generalized bifaces, diverse lithic materials, relatively careful core reduction, and common use of flake platform modification. Thus, lacking good diagnostic tool types, it may be impossible to differentiate between Archaic and protohistoric remains.

It is also not possible to determine whether these sites were occupied by protohistoric Puebloans. For the most part, we are in the dark concerning the chipped stone industries of Southwestern village dwellers at the brink of the Historic period. While it seems likely that their limited activity sites would demonstrate the use of an almost purely expedient reduction strategy, this is uncertain. Vierra (1990) shows that flake to angular debris ratios are higher on Anasazi limited activity sites in northwest New Mexico than on associated residential sites. This suggests that cores were reduced differently on limited activity sites than they were at home. At the La Plata Mine, Acklen et al. (1991:590) note that, "Lithic debitage data from the LMAP sites provide preliminary confirmation for the assertion that in task-specific situations, Puebloan lithic reduction assumes Archaic-like characteristics." In other words, debris from the manufacture and use of bifaces is more common in some Pueblo sites than expected, indicating the presence of a relatively well represented biface technology. Our data provide partial confirmation of this observation for the Pueblo period in the Mogollon Highlands. While evidence for large generalized biface manufacture and use is uncommon in Pueblo period sites, it is most certainly present. If, as asserted by Acklen et al. (1991), these tools are used in task-specific situations, it may be difficult to differentiate between logistical camps occupied by hunter-gatherers and sedentary peoples unless temporally and culturally diagnostic artifacts are common.

Thus, this discussion has been less than satisfactory. Using primarily chipped stone data, it is not possible to determine whether these components (LA 37917 and LA 37919) represent Archaic or protohistoric logistical camps. If a protohistoric date is indeed correct, lacking good diagnostic artifacts it may not even be possible to differentiate between Athabaskan and Puebloan limited use locales.

CONCLUSIONS

Our analysis of chipped stone assemblages from 25 sites in the Luna-Reserve area was successful in examining most of the questions posed in the research design. We found evidence for a change in mobility between the Archaic and Early Pithouse periods, and it is likely that the transition between patterns of high residential mobility and full (or near-full) sedentism was a lengthy one that was not complete until the Late Pueblo period. Data were presented that allowed an examination of all components for evidence of site use, activities, and dating. The only area where our results are unsatisfactory is in the examination of protohistoric components. We simply do not currently have enough data to permit these assemblages to be definitively assigned to any one time period or cultural tradition. While they both yielded protohistoric dates, analysis of the chipped stone assemblages revealed enough similarities to an Archaic logistical camp to question the accuracy of these dates. However, a study of comparative data from Navajo sites in northwest New Mexico suggests that such similarities are to be expected, and that Archaic and protohistoric Athabaskan assemblages may be comparable in many ways.

Analysis of the projectile point assemblage provided quite a bit of interesting data. Many styles used throughout the Archaic period have cognates elsewhere in the Southwest, Great Basin, and beyond. Multiple styles may have been used by people in the same social group; at this time we simply do not know what meaning to ascribe to different styles. As noted in an earlier chapter, they could reflect affinal relationships, membership in ritual groups, use of different types by various age groups, etc. We simply don't know.

There is good evidence for the continued use of dart points into at least the Late Pueblo period in our assemblage. However, after the Late Archaic, as new point types were adopted for use, old types did not disappear but continued to be made, though in smaller quantities. Thus, the Mogollon projectile point assemblage is cumulative, and of little use in dating sites. The presence of certain types, like small side-notched arrow points, is indicative of occupation after a certain time, but cannot be used to assign an accurate date.

Analysis of chipped stone assemblages can provide information concerning mobility, site function, tool-using activities, and temporal variation. However, it cannot by itself provide a complete picture of human adaptations to a region. That is only possible when all available data are examined and compared.

GROUND STONE ANALYSIS

Dorothy A. Zamora

The ground stone recovered from the Luna project was collected from 18 sites that ranged from Archaic to nineteenth-century Athabaskan. A total of 1,321 ground stone artifacts were analyzed. This chapter discusses each by site (Table 3.143) and by temporal period. It then compares the Luna project database with that from other sites in the Mogollon Highlands and southwestern New Mexico. Research goals are addressed and conclusions regarding the changing use of ground stone through time in the Mogollon Highlands are presented.

RESEARCH GOALS
(adapted from Oakes and Zamora 1993)

The research focus of the Luna project is to examine subsistence strategies of the different cultural periods within the Mogollon Highlands to determine if they are influenced by dependence on agriculture. Therefore, if there is increasing sedentism through time because of increasing dependence on agricultural products (among other reasons), then that increasing dependence should be visible in the archaeological record. For example, the bulk of domesticated food should increase, storage containers and specific storage locales should increase, and ground stone should exhibit form and dimensional modifications to accommodate a growing dependency on cultigens.

Hard (1990) has developed a simple model to assist in the quantification of the degree of agricultural dependence. He uses a mean mano length index to show that through time, manos increase in length and grinding surface, which he believes suggests a greater dependence on cultigens. Hard's methods will be assessed through the ground stone database. Mean surface area of manos and metates will additionally be measured as a check on increasing agricultural dependence. Ethnobotanical samples, retrieved from ground stone artifacts, will also aid in the testing of his hypothesis. Mauldin (1993) has further developed the concept of relating changing mano and metate form to an increase in the practice of agriculture. He chooses to measure the grinding area of manos as a correlation of heavier dependence on cultigens. Comparisons with Mauldin's data will also be made using OAS data from the Luna project.

METHODOLOGY

The ground stone from the project was analyzed using the *Standardized Ground Stone Artifact Analysis: A Manual for the Office of Archaeological Studies* (Bullock et al. 1994). Each ground stone artifact surface was examined with a binocular microscope and measurements were taken by calipers. Artifacts were weighed on metric scales. The data were then entered into a computer database using Statistical Package for the Social Science (SPSS) Data Entry Program.

The data collected from the ground stone were used in determining the degree of dependence by prehistoric people on agriculture versus wild foods. Another purpose of the research was to compare Hard's (1990) and Mauldin's (1993) models, which attempt to provide a measure for agricultural dependence through comparisons of mean mano lengths and ground surface areas.

Attributes Examined

Several attributes were recorded on the ground stone assemblage; emphasis was placed on the ground area of whole manos and metates. The attributes recorded include material type, preform morphology, production input, shaping, length, width, thickness, weight, ground surface measurements, mano cross-section, plan view outline, flaked surface or margin, heat treatment, portion, function, ground surface cross-section, ground surface sharpening, number of uses, wear, alterations, striations, and adhesions.

Ground stone is usually massive and made to withstand heavy use and, thus, is very durable so that it can be reused even when broken (Moore 1996). Therefore, ground stone functions change as it begins to wear down. Measurements of length, width, thickness, weight, heat, portion, ground surface, sharpening, wear, alterations, and type of adhesions were used to demonstrate how use of these artifacts change as this process takes place. Mano cross-section, metate depth, and ground surface cross-section were used to monitor the regular wear they undergo as measures of relative tool age (Bullock et al. 1994).

Types of Ground Stone

There is a wide variety of ground stone from the 18 sites in the Mogollon Highlands. A total of 18 different categorical classes are present. These include manos, metates, indeterminate fragments, polishing stones, shaft straighteners, shaped slabs, pounding stones, palettes, lapidary stones, mortars, pestles, hammerstones, mauls, axes, stone bowls, cylindrical tools, and medicine stones.

Table 3.143. Ground Stone Artifacts from the Mogollon Highlands

CELLS: Count Row Pct Column Prt	Site																	ROW TOTAL
	3279	3563	37919	39968	39969	39972	39975	43766	45507	45508	45510	70185	70188	70189	70196	75792	78439	89846	
Indeterminate	57 26.5% 14.4%	2 .9% 22.2%	3 1.4% 60.0%	53 24.7% 25.2%	13 6.0% 10.7%		3 1.4% 9.7%	1 .5% 16.7%	42 19.5% 15.4%	11 5.1% 30.6%	4 1.9% 57.1%	15 7.0% 12.6%	5 2.3% 17.2%	2 .9% 40.0%	2 .9% 8.3%	1 .5% 7.1%		1 .5% 33.3%	215 100.0% 16.3%
Polishing Stone	5 35.7% 1.3%			2 14.3% 1.0%	3 21.4% 2.5%	1 7.1% 3.4%			2 14.3% .7%			1 7.1% .8%							14 100.0% 1.1%
Abrading Stone	41 47.1% 10.4%	1 1.1% 11.1%		18 20.7% 8.6%	2 2.3% 1.7%		2 2.3% 6.5%		12 13.8% 4.4%			4 4.6% 3.4%		1 1.1% 20.0%	3 3.4% 12.5%	2 2.3% 14.3%		1 1.1% 33.3%	87 100.0% 6.6%
Shaft Straightener					1 33.3% .8%	1 33.3% 3.4%						1 33.3% .8%							3 100.0% .2%
Shaped Slab		4 13.8% 44.4%		9 31.0% 4.3%	5 17.2% 4.1%		1 3.4% 3.2%		4 13.8% 1.5%			4 13.8% 3.4%			2 6.9% 8.3%				29 100.0% 2.2%
Anvil				1 50.0% .5%	1 50.0% .8%														2 100.0% .2%
Pounding Stone				1 33.3% .5%	1 33.3% .8%		1 33.3% 3.2%												3 100.0% .2%
Palette	1 10.0% .3%			2 20.0% 1.0%	3 30.0% 2.5%				4 40.0% 1.5%										10 100.0% .8%
Lap Stone	35 25.9% 8.8%	1 .7% 11.1%		12 8.9% 5.7%	22 16.3% 18.2%	3 2.2% 10.3%	10 7.4% 32.3%		38 28.1% 13.9%			7 5.2% 5.9%	4 3.0% 13.8%	1 .7% 20.0%	1 .7% 4.2%		1 .7% 25.0%		135 100.0% 10.2%
Mortar	2 28.6% .5%			2 28.6% 1.0%					2 28.6% .7%			1 14.3% .8%							7 100.0% .5%
Pestle	2 40.0% .5%			1 20.0% .5%					2 40.0% .7%^										5 100.0% .4%
Hammerstone					1 100.0% .8%														1 100.0% .1%
Mano	27 28.4% 6.8%			12 12.6% 5.7%	6 5.3% 4.1%				16 16.8% 5.9%	8 8.4% 22.2%		20 21.1% 16.8%	2 2.1% 6.9%	1 1.1% 20.0%	2 2.1% 8.3%	2 2.1% 14.3%			95 100.0% 7.2%
One-hand Mano	20 16.0% 5.1%	1 .8% 11.1%		27 21.6% 12.9%	8 6.4% 6.6%	3 2.4% 10.3%		1 .8% 16.7%	40 32.0% 14.7%	7 5.6% 19.4%		6 4.8% 5.0%	4 3.2% 13.8%		4 3.2% 16.7%	1 .8% 7.1%	2 1.6% 50.0%	1 .8% 33.3%	125 100.0% 9.5%
Two-Hand Mano	136 44.2% 34.3%			28 9.1% 13.3%	35 11.4% 28.9%	3 1.0% 10.3%	9 2.9% 29.0%		46 14.9% 16.8%	4 1.3% 11.1%	1 .3% 14.3%	33 10.7% 27.7%			9 2.9% 37.5%	4 1.3% 28.6%			308 100.0% 23.3%
Metate	15 20.3% 3.8%			14 18.9% 6.7%	4 5.4% 3.3%	7 9.5% 24.1%	4 5.4% 12.9%	3 4.1% 50.0%	8 10.8% 2.9%	5 6.8% 13.9%	2 2.7% 28.6%	7 9.5% 5.9%	5 6.8% 17.2%						74 100.0% 5.6%
Basin Metate	1 50.0% .3%					1 50.0% 3.4													2 100.0% .2%

CELLS: Count Row Pct Column Prt	Site 3279	3563	37919	39968	39969	39972	39975	43766	45507	45508	45510	70185	70188	70189	70196	75792	78439	89846	ROW TOTAL
Trough Metate	25 26.3% 6.3%			9 9.5% 4.3%	6 6.3% 5.0%				42 44.2% 15.4%			11 11.6% 9.2%			1 1.1% 4.2%	1 1.1% 7.1%			95 100.0% 7.2%
Slab Metate	23 26.1% 5.8%		2 2.3% 40.0%	11 12.5% 5.2%	10 11.4% 8.3%	8 9.1% 27.6%		1 1.1% 16.7%	14 15.9% 5.1%	1 1.1% 2.8		5 5.7% 4.2%	9 10.32 31.0%			3 3.4% 21.4%	1 1.1% 25.0%		88 100.0% 6.7%
Maul						2 66.7% 6.9%	1 33.3% 3.2%												3 100.0% .2%
Axe	2 14.3% .5%			6 42.9% 2.9%	1 7.1% .8%				1 7.1% .4%			4 28.6% 3.4%							14 100.0% 1.1%
Stone Bowl	3 100.0% .8%																		3 100.0% .2%
Cylindrical Tool				1 100.0% .5%															1 100.0% .1%
Medicine Stone	1 100.0% .3%																		1 100.0% .1%
Shaped Stone				1 100.0% .5%															1 100.0% .1%
COLUMN TOTAL	396 30.0% 100.0%	9 .7% 100.0%	5 .4% 100.0%	210 15.9% 100.0%	121 9.2% 100.0%	29 2.2% 100.0%	31 2.3% 100.0%	6 .5% 100.0%	273 20.7% 100.0%	36 2.7% 100.0%	7 .5% 100.0%	119 9.0% 100.0%	29 2.2% 100.0%	5 .4% 100.0%	24 1.8% 100.0%	14 1.1% 100.0%	4 .3% 100.0%	3 .2% 100.0%	1321 100.0% 100.0%

Although the axes, mauls, shaft straighteners, palettes, cylindrical tools, and medicine stones are included in the ground stone assemblage, they were analyzed separately and are described under Miscellaneous Ground Stone.

GROUND STONE ASSEMBLAGE

Manos (N = 432)

Manos are the tools that move back and forth on a grinding surface in order to crush or pulverize a substance. They are shaped by pecking, flaking, or grinding the edges, and are usually designed so they are easy to hold (J. Adams 1995:43-114). Some manos, such as those used on trough metates, exhibit different use-wear patterns. There were 125 one-hand manos and 307 two-hand manos recovered from the Luna project. Explanation of the basis for distinguishing the two is provided later in this chapter.

One-hand manos were identified as ground stone artifacts that were used with basin or slab metates employing one hand (Fig. 3.27). The stone is generally selected so that it fits the hand comfortably. Usually there is a single use-surface, although two are not uncommon and faceting may be present. One-hand types are usually used on slab metates; the ones with circular use-wear are mostly used on basin metates.

Two-hand manos are grinding tools that are used with two hands instead of one (Fig. 3.27). They are usually associated with trough as well as slab metates. Two-hand mano shapes have been categorized as either trough, slab, or loaf. The trough manos are distinguishable by the up-curved ends that are worn down from the edges coming into contact with the sides of the trough metate (Fig. 3.27f). The grinding surfaces of the slab manos are generally flat from use on flat metates. A loaf-shaped mano is large and heavy with a transverse cross-section resembling a loaf of bread (Bullock et al. 1994).

There was also a category of two-hand mano that was "not further specified." This included all two-hand mano fragments that could not be placed in any of the above groups. They were flattened cobbles and slabs that were shaped by flaking and grinding to produce a rectangular to subrectangular form, and were relatively thin in relation to length and width. They occasionally had opposing use surfaces and were faceted at times.

Metates (N = 259)

A total of 259 metates were recovered from the sites and include indeterminate fragments, and basin, slab, and trough types. Indeterminate fragments (n = 80) are pieces that cannot be placed in a specific category.

Basin metates (n = 2) are large cobbles that have been shaped by flaking and battering on the margins to achieve rectangular to subrectangular outline form. One side may exhibit flaking, grinding, or battering to increase stability. Although both surfaces may have use-wear, usually only one will develop a use surface with a circular to oval depression.

Trough metates were further divided into open-ended, one open end, and ends closed. There was a category called trough metate, not further specified, which includes trough metate fragments (n = 67). The characteristics for the trough metates include a flat cobble or slab in which a trough is formed by the mano not extendeding across the complete surface of the metate during use (Fig. 3.28b, c).

A trough metate (n = 13) with open ends is formed the same as above; however, the trough is not bounded by the edges at the ends. A trough metate (n = 1) with ends closed is also formed in the same manner, but the trough does not extend completely to the edges of the metate. A trough metate with one end open is formed likewise except the trough is opened at one end; the opposing end exhibits a shelf or roughly finished margins.

A slab metate in the Mogollon Highlands (n = 88) is usually a flat cobble with carefully shaped rectangular margins (Fig. 3.28a). The use surfaces are flat, but can be slightly concave from end to end. Pecking is generally used to maintain the surface grinding texture. The mano used with a slab metate usually covers the full width of the surface, eliminating formation of a trough.

Abrading Stones (N = 87)

Abraders are hand-sized stones that have rough surfaces and are useful in tool manufacture or for abrading the surfaces of other items (J. Adams 1995:43-114). Abraders exhibit wear patterns, such as striations, and may have different types of grooves worn into them (Fig. 3.29).

Abraders exhibiting U-shaped grooves are used for shaping objects such as wooden arrow shafts, spindles, prayer sticks, or strung beads (Jernigan 1978). V-shaped grooves are used to sharpen or shape needles, awls, or possibly to dull edges on stone tools (J. Adams 1995:43-114). Grooved abraders are also known as shaft straighteners.

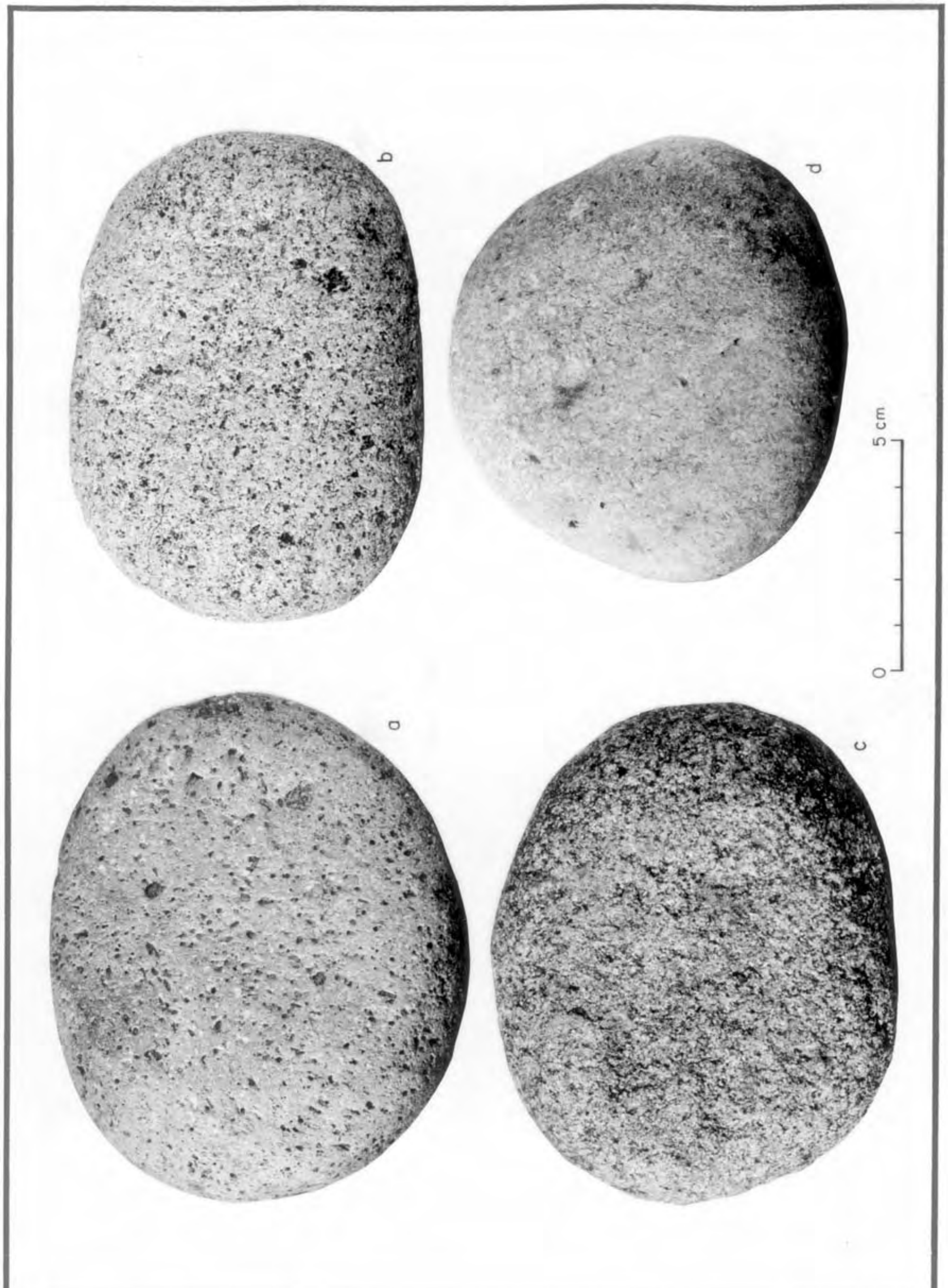

Figure 3.27. Manos from the Luna project: (a) One-hand mano from LA 78439; (b) one-hand mano from LA 3279; (c) one-hand mano from LA 43766; (d) one-hand mano from LA 70188.

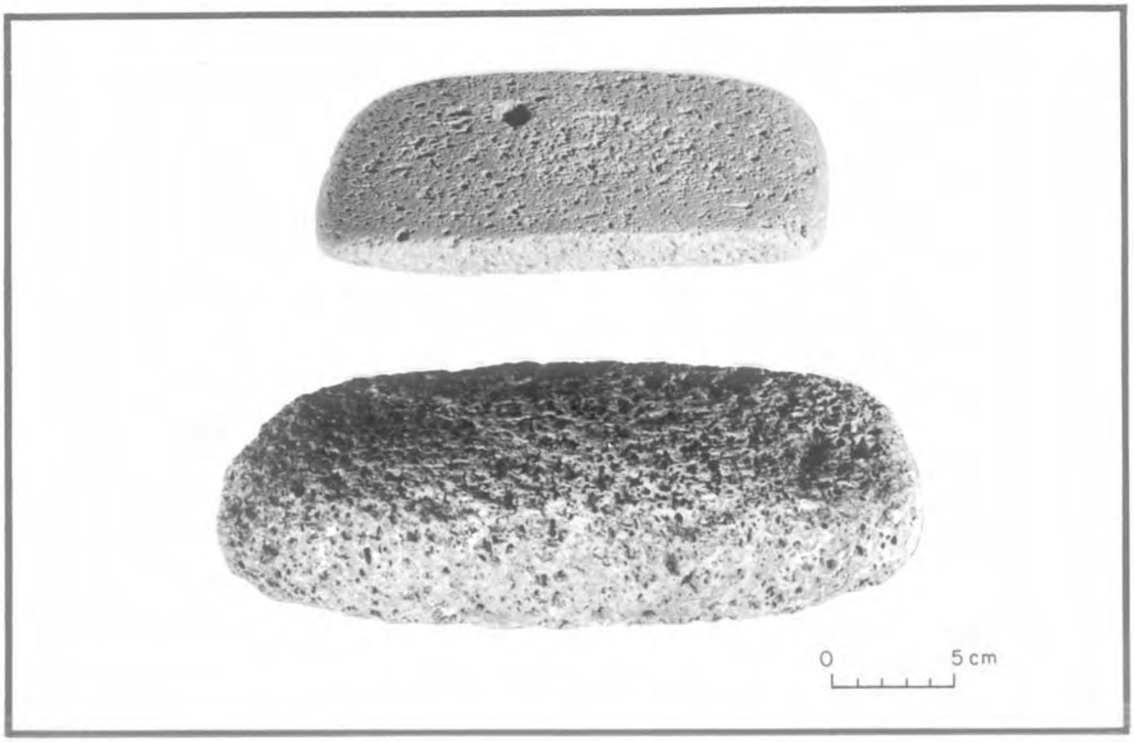

Figure 3.27. (continued) Manos from the Luna Project: (e) two-hand mano from LA 3279; (f) two-hand mano from LA 3279.

Shaped Slabs (N = 29)

These constitute all sizes of slabs whose edges are shaped by flaking or grinding. Usually there is little to no wear visible on the flat surfaces and the shape varies. It is difficult to determine if these were preforms for metates or if they were being shaped for architectural purposes since most exhibit little surface wear.

Anvils (N = 2)

Anvils are large stones that are used as bases when shaping other artifacts. J. Adams (1995:43-114) states that anvils usually rest on the floor, exhibit impact fractures, and have surface abrasions from supporting other artifacts that are being formed.

Pounding Stones (N = 9)

These are characterized as small hand-size cobbles having localized pits on the use surface that exhibit grinding wear. They frequently are reworked manos exhibiting battering commonly found along the edges or margins.

Lapstone (N = 135)

Lapstones are small flat cobbles exhibiting grinding, polishing, or a sheen on the surface. A majority (58.0 percent) of the lapstones from the Luna project exhibited polishing. Grinding was also noted on some. Many of the lapstones were reused manos of both one-hand and two-hand types. The striations were usually obliterated by polishing or grinding.

Mortars (N = 7)

The mortars from the project were medium to large rounded cobbles that had been pecked and ground to shape. The use surfaces are generally slightly ground from surface preparation. The depressions averaged 14.5 cm in diameter with an average depth of 5.8 cm. Damage wear consisted of battering, pitting, grinding, or striations. Striations run vertically within the depression. Battering and pitting was caused by pounding. One small mortar from the DZ site exhibited circular striations within the depression. At the Hough site, one mortar had random lengthwise and circular striations. Two small, almost pebble, mortars were also recovered from the Hough site (Fig. 3.30).

Pestles (N = 5)

Pestles are hand-sized oblong cobbles shaped by flaking, pecking, and grinding to achieve a fairly regular cylindrical shape (Fig. 3.30c). The ends may exhibit battering and grinding. Pestles that have use-wear on the sides of the tool are considered to be used mainly for food processing (J. Adams 1995:43-114).

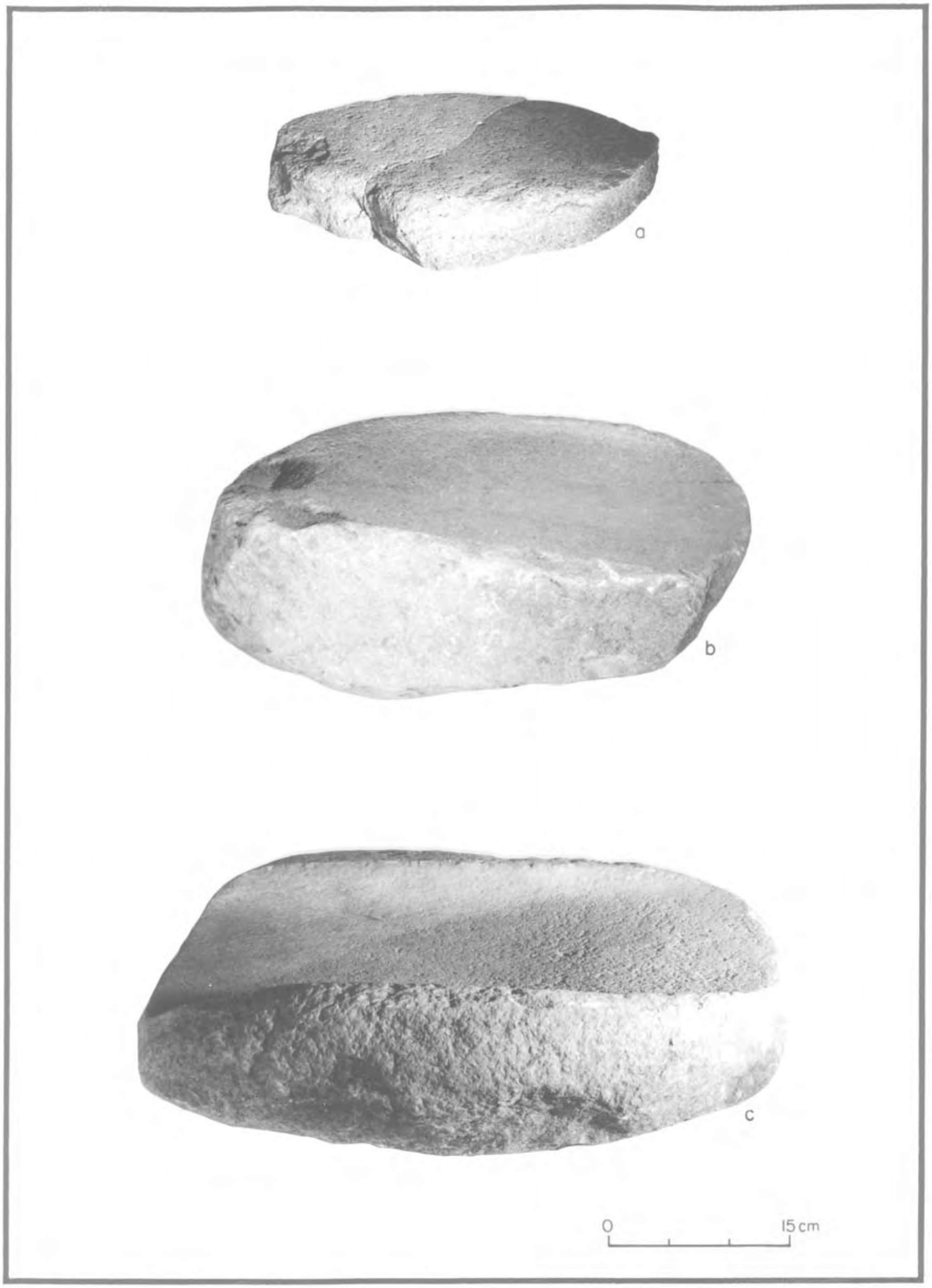

Figure 3.28. Metates from the Luna project: (a) slab metate from LA 39972; (b) Trough metate from LA 39968; (c) trough metate from LA 39968.

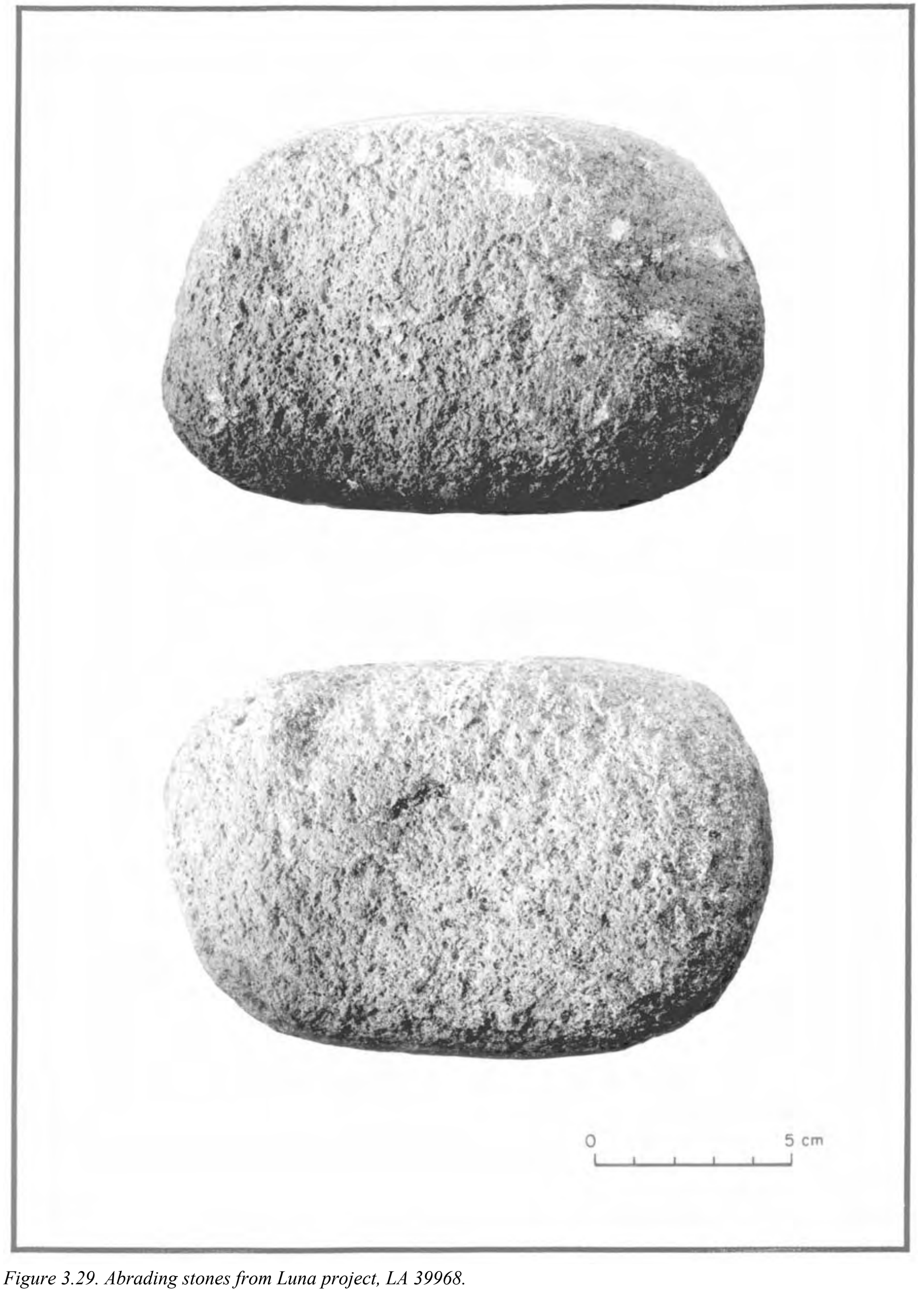

Figure 3.29. Abrading stones from Luna project, LA 39968.

Two of the Luna pestles had use-wear extending up the sides suggesting this type of processing. At Walpi, pestles were used to crush mesquite pods (Euler and Dobyns 1983:56). Sayles and Sayles (1948:29) observed a Maricopa woman crushing clay with a pestle, another possible prehistoric use.

Hammerstones (N = 1)

A hammerstone is a cobble that has minimal shaping and use-damage can indicate pounding, hammering, and heavy blows. The surfaces exhibit mostly crushing, and at times flaking, where the material has chipped away from the blows. One basalt hammerstone was found and analyzed with the ground stone because it was faceted. All others were analyzed with the chipped stone assemblage. Three one-hand manos were used as hammerstones as a secondary function. One was recovered from the floor of the pit structure at Spurgeon Draw and the other two from the floor of Pit Structure 3 at Luna Village.

Cylindrical Tool (N = 1)

This category is for tools that are cylindrical in shape, but with an unknown function. Some artifacts that could be coded within this category are fragments from pestles, corn maidens, unfinished pipes, and unfinished mauls. Most of them have been modified, however.

Medicine Stone (N = 1)

One small medicine stone or cylinder was recovered from the great kiva at Hough Pueblo. It was placed in this category after comparing it to one at Pecos Pueblo recovered by Kidder (1932:92). This highly polished artifact is 2.4 cm in length .30 cm in width and thickness and is made from argillite. This material is common in southern Arizona and not uncommon in New Mexico.

Site Data

Hough Pueblo, LA 3279

The Hough site, a Late Tularosa phase site, consisted of 10 excavated rooms and a great kiva, and produced 396 ground stone artifacts (Table 3.144). Two-hand manos dominate the assemblage (34.3 percent); however, there are 6.8 percent that are indeterminate mano fragments, indicating that there could be more present. There are a few one-hand manos, which might suggest seed processing, as would the basin metate found. The predominant use of trough and slab metates on the site probably accounts for the high number of two-hand manos. One large basin metate was also recovered. Rhyolite is the material of choice for the assemblage, especially for the metates (Table 3.145). Out of 64 metates, all but 8 are rhyolite. Sandstone was used more frequently for two-hand manos (32.8 percent). Basalt, another igneous material, present at 20.1 percent, was also commonly used. More ground stone is undoubtedly present on the unexcavated portion of the Hough site.

Lapstones are identified as small elongated stones that have been used usually on both flat surfaces and comprise 8.9 percent of the assemblage. Abrading stones were also high in the assemblage (10.4 percent). Adams (1994) describes them as hand stones that are useful in tool manufacturing, or for abrading the surfaces of other items. Most of the manos and metates had some type of abrading evident on the ground surfaces, possibly to sharpen the surfaces.

A few pieces of ground stone were found in the hearths of several rooms; however, most of the ground stone that exhibited some type of burning was found in the fill of the rooms (Table 3.146). It could be possible that many were originally on the pueblo roof, which burned after occupation.

Corn pollen and corn cupules were found in the pollen and flotation samples obtained from ground stone. Table 3.147 indicates the results from the pollen and pollen washes and reveals that the pollen washes are an excellent source of botanical information. The flotation samples found corn in almost every sample, confirming the widespread use on the site.

South Leggett Pueblo, LA 3563

LA 3563 was previously excavated by Martin and Rinaldo (1950a). He collected some ground stone from the site that included 4 slab metates, 2 trough metates, and 25 manos of both one and two-hand types. Miscellaneous stone, such as a stone bowl and 9 rubbing stones, were also recovered.

During OAS excavations, nine pieces of ground stone were recovered (Table 3.148). The most common material type used for the ground stone was rhyolite (88.8 percent). Most of the artifacts are fragments (88.8 percent) and possibly discards from Martin and Rinaldo's (1950a) excavations. Pollen samples were taken from the ground stone artifacts; however, pollen was not found on the artifacts.

Apache Woods, LA 37919

This site dates to the Athabaskan period. Five ground stone artifacts were recovered (Tables 3.149, 3.150).

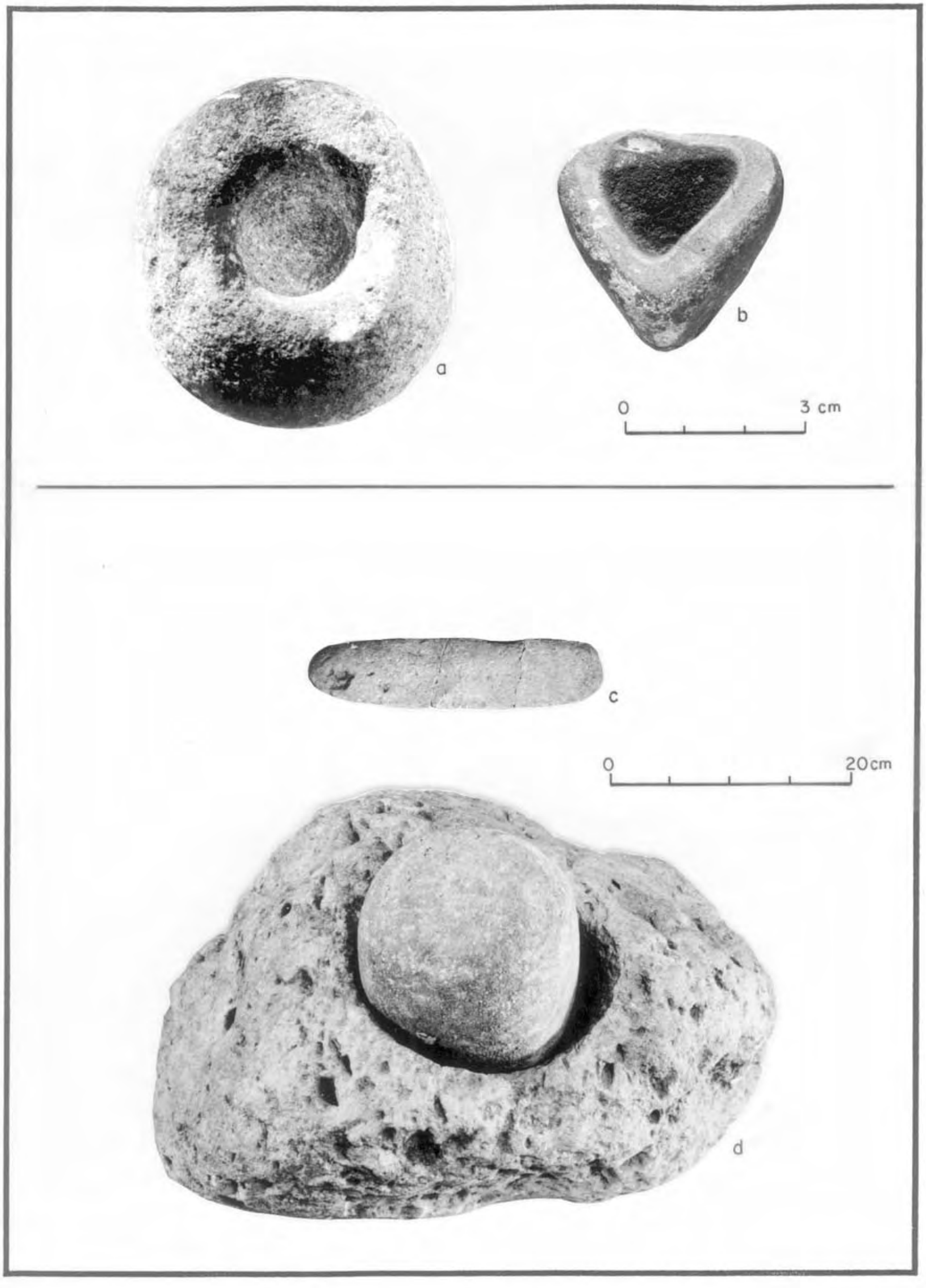

Figure 3.30. Mortars from the Luna project: (a) pebble mortar from LA 3279; (b) pebble mortar from LA 39968; (c) pestle from LA 39968; (d) pestle and mortar from LA 3279.

Table 3.144. Ground Stone Artifacts from LA 3279

Cells: Count Row Pct Column Pct	Provenience															Row Total
	General Fill	Trash Midden	Room 2	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12	Room 13	Kiva	North Side	Wendrof Assemblage	
Indeterminate	3 5.3% 10.7%	6 10.5% 46.2%	3 5.3% 7.3%	1 1.8% 12.5%	5 8.8% 11.4%	3 5.3% 5.6%	1 1.8% 2.9%	1 1.8% 3.4%	1 1.8% 7.1%	11 19.3% 28.2%	1 1.8% 16.7%	3 5.3% 17.6%	10 17.5% 19.2%	8 14.8% 66.7%		57 100.0% 14.4%
Polishing Stone						3 60.0% 5.6%	1 25.0% 2.9%	1 25.0% 3.4%								5 100.0% 1.3%
Abrading Stone		1 2.4% 7.7%	6 14.6% 14.6%	1 2.4% 12.5%	2 4.9% 4.5%	4 9.8% 7.4%	4 9.8% 11.4%	2 4.9% 6.9%		6 14.6% 15.4%	3 7.3% 50.0%	3 7.3% 17.6%	7 17.1% 13.5%	1 2.4% 8.3%	1 2.4% 25.0%	41 100.0% 10.4%
Palette									1 100.0% 7.1%							1 100.0% .3%
Lap Stone	2 5.7% 7.1%	1 2.9% 7.7%	6 17.1% 14.6%		3 8.6% 6.8%	9 25.7% 16.7%	4 11.4% 11.4%	2 5.7% 6.9%		4 11.1% 10.3%		2 5.7% 11.8%	2 5.7% 3.8%			35 10.0% 8.8%
Mortar				1 50.0% 12.5%				1 50.0% 3.4%								2 100.0% .5%
Pestle					1 50.0% 2.3%	1 50.0% 1.9%										2 100.0% .5%
Mano	7 25.9% 25.0%				6 22.2% 13.6%	4 14.8% 7.4%	4 14.8% 11.4%					2 7.4% 11.8%	3 11.1% 5.8%		1 3.7% 25.0%	27 100.0% 6.8%
One-hand Mano	3 15.0% 10.7%	3 15.0% 23.1%	2 10.0% 4.9%	1 5.0% 12.5%	2 10.0% 4.5%		2 10.0% 5.7%	1 5.0% 3.4%					3 15.0% 5.8%	2 10.0% 16.7%	1 5.0% 25.0%	20 100.0% 5.1%
Two-hand Mano	4 2.9% 14.3%	1 .7% 7.7%	12 8.8% 29.3%	3 2.2% 37.5%	21 15.4% 47.7%	24 17.6% 44.4%	14 10.3% 40.0%	11 8.1% 37.9%	8 5.9% 57.1%	16 11.8% 41.0%	1 .7% 16.7%	6 4.4% 35.3%	14 10.3% 26.9%		1 .7% 25.0%	136 100.0% 34.3%
Metate	4 26.7% 14.3%		2 13.3% 4.9%		2 13.3% 4.5%		2 13.3% 5.7%	3 20.0% 10.3%				1 6.7% 5.9%	1 6.7% 1.9%			25 100.0% 3.8%
Basin Metate					1 100.0% 2.3%											1 100.0% .3%
Trough Metate	2 8.0% 7.1%		6 22.0% 14.6%	1 4.0% 12.5%	1 4.0% 2.3%	1 4.0% 1.9%	2 8.0% 5.7%	3 12.0% 10.3%	1 4.0% 7.1%	1 4.0% 2.6%	1 4.0% 16.7%		6 24.0% 11.5%			26 100.0% 6.6%
Slab Metate	3 13.3% 10.7%	1 4.3% 7.7%	4 17.4% 9.8%			4 17.4% 7.4%	1 4.3% 2.9%	3 13.0% 10.3%	2 8.7% 14.3%	1 4.3% 2.6%			4 17.4% 7.7%			23 100.0% 5.8%
Axe								1 50.0% 3.4%						1 50.0% 8.3%		2 100.0% .3%

Cells: Count Row Pct Column Pct	Provenience															Row Total
	General Fill	Trash Midden	Room 2	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12	Room 13	Kiva	North Side	Wendrof Assemblage	
Stone Bowl						1 33.3% 1.9%			1 33.3% 7.1%				1 33.3% 1.9%			3 100.0% .8%
Medicine Stone													1 100.0% 1.9%			1 100.0% .3%
Column Total	28 7.1% 100.0%	13 3.3% 100.0%	41 10.4% 100.0%	8 2.0% 100.0%	44 11.1% 100.0%	54 13.6% 100.0%	35 8.8% 100.0%	29 7.3% 100.0%	14 3.5% 100.0%	39 9.8% 100.0%	6 1.5% 100.0%	17 4.3% 100.0%	52 13.1% 100.0%	12 3.0% 100.0%	4 1.0% 100.0%	396 100.0% 100.0%

Table 3.145. Ground Stone Material Types from LA 3279

Cells: Count Row Pct Column Pct	Provenience															Row Total
	General Fill	Trash Midden	Room 2	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12	Room 13	Kiva	North Side	Wendrof Assemblage	
Basalt	8 10.0%	28.6%	2 2.5% 15.4%	8 10.0% 19.5%		14 17.5% 31.8%	14 17.5% 25.9%	4 5.0%	11.4%	12 15.0%	41.4%	2 2.5% 15.4%	3 3.8% 5.8%	4 5.0% 33.3%		80 100.0% 20.3%
Rhyolite	15 9.9% 53.6%	4 2.6% 30.8%	17 11.3% 41.5%	4 2.6% 50.0%	13 8.6% 29.5%	18 11.9% 33.3%	14 9.3% 40.0%	10 6.6% 34.5%	6 3.3% 38.5%	13 8.6% 33.3%	2 1.3% 33.3%	4 2.6% 23.5%	25 16.6% 48.1%	5 3.3% 41.7%	2 1.3% 50.0%	152 100.0% 38.2%
Tuff													3 100.0% 5.8%			3 100.0% .8%
Andesite		1 33.3% 7.7%	1 33.3% 2.4%				1 33.3% 2.9%									3 100.0% .8%
Rhyolitic Tuff			1 5.9% 2.4%			5 29.4% 9.3%	1 5.9% 2.9%	1 5.9% 3.4%	1 5.9% 7.7%	5 29.4% 12.8%		1 5.9% 5.9%	2 11.8% 3.8%			17 100.0% 4.3%
Pumice						1 33.3% 1.9%	1 33.3% 2.9%	1 33.3% 3.4%								3 100.0% .8%
Limestone			1 20.0% 2.4%		1 20.0% 2.3%	2 40.0% 3.7%				1 20.0% 2.6%						5 100.0% 1.3%
Sandstone	4 3.7% 14.3%	3 2.8% 23.1%	10 9.2% 24.4%	4 3.7% 50.0%	11 10.1% 25.0%	14 12.8% 25.9%	12 1.0% 34.3%	4 3.7% 13.8%	4 3.7% 30.8%	13 11.9% 33.3%	2 1.8% 33.3%	8 7.3% 47.1%	17 15.6% 32.7%	1 .9% 8.3%	2 1.8% 50.0%	109 100.0% 27.6%
Siltstone		1 16.7% 7.7%			5 83.8% 11.4%											6 100.0% 1.5%

Cells: Count Row Pct Column Pct	Provenience															Row Total
	General Fill	Trash Midden	Room 2	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12	Room 13	Kiva	North Side	Wendrof Assemblage	
Catlinite													1 100.0% 1.9%			1 100.0% .3%
Quartzite		1 16.7% 7.7%						1 16.7% 3.4%	1 6.7% 7.7%		1 16.7% 16.7%	1 16.7% 5.9%	1 16.7% 1.9%			6 100.0% 1.5%
Quartzitic Sandstone	1 9.1% 3.6%	1 9.1% 7.7%	3 27.3% 7.3%				2 18.2% 5.7%			1 9.1% 2.6%		1 9.1% 5.9%		2 18.2% 16.7%		11 100.0% 2.8%
Column Total	28 7.1% 100.0%	13 3.3% 100.0%	41 10.4% 100.0%	8 2.0% 100.0%	44 11.1% 100.0%	54 13.7% 100.0%	35 8.9% 100.0%	29 7.3% 100.0%	13 3.3% 100.0%	39 9.9% 100.0%	6 1.5% 100.0%	17 4.3% 100.0%	52 13.2% 100.0%	12 3.0% 100.0%	4 1.0% 100.0%	396 100.0% 100.0%

Table 3.146. Ground Stone Attributes from LA 3279

Cells: Count Row Percent Column Percent	Portion		Row Total	Attributes	
	Whole	Fragment		Burned	More than One Use Surface
Indeterminate	2 3.5% 1.4%	55 96.5% 21.6%	57 100.0% 14.4%	25	19
Polishing Stone	5 100.0% 3.6%		5 100.0% 1.3%	2	2
Abrading Stone	21 51.2% 15.0%	20 48.8% 7.8%	41 100.0% 10.4%	21	29
Lap Stone	21 60.0% 15.0%	14 40.0% 5.5%	35 100.0% 8.9%	12	23
Mortar	2 100.0% 1.4%		2 100.0% .5%	1	1
Pestle	2 100.0% 1.4%		2 100.0% .5%	1	2
Indeterminate Mano		27 100.0% 10.6%	27 100.0% 6.8%	7	22
One-hand Mano	12 60.0% 8.6%	8 40.0% 3.1%	20 100.0% 5.1%	7	13
Two-hand Mano	61 44.9% 43.6%	75 55.1% 29.4%	136 100.0% 34.4%	81	115
Indeterminate Metate		15 100.0% 5.9%	15 100.0% 3.8%	5	2
Basin Metate	1 100.0% .7%		1 100.0% .3%	1	
Trough Metate	4 16.0% 2.9%	21 84.0% 8.2%	25 100.0% 6.3%	11	1
Slab Metate	6 26.1% 4.3%	17 73.9% 6.7%	23 100.0% 5.8%	11	3
Stone Bowl	2 66.7% 1.4%	1 33.3% .4	3 100.0% .8%	1	
Axe		2 100.0% .8%	2 100.0% .5%		
Medicine Stone	1 100.0% .7%		1 100.0% .3%		
Column Total	139 35.4% 100.0%	255 64.6% 100.0%	395 100.0% 100.0%	164 41.5%	194 49.1%

Table 3.147. Pollen and Pollen Wash Results from LA 3279

Room	Level	Ground Stone	Pollen
6	Pit 15 fill	Indeterminate	Chen-am
7	Roof fall	Stone bowl	Pine, cheno-am, composite
7	Floor	Mano	Oak, pinon, cheno-am, grass, composite, sagebrush
9	Floor	Lapidary stone	Piñon, cheno-am
9	Roof fall	Stone bowl	Piñon, cheno-am, composite, sagebrush
10	Fill	Metate	Cheno-am, composite, corn
10	Fill	Mano	Piñon, cheno-am

Table 3.148. Ground Stone Artifacts from LA 3563

Cells: Count Row Pct Column Pct	Provenience		Row Total
	General Fill	Pit Structure	
Fragment		2 100.0% 22.2%	2 100.0% 22.2%
Abrading Stone		1 100.0% 14.3%	1 100.0% 14.3%
Shaped Stone		4 100.0% 57.1%	4 100.0% 44.4%
Lap Stone	1 100.0% 50.0%		1 100.0% 11.1%
One-hand Mano	1 100.0% 50.0%		1 100.0% 11.1%
Column Total	2 22.2% 100.0%	7 78.7% 100.0%	9 100.0% 100.0%

Table 3.149. Ground Stone from LA 37919

Cells: Count Row Pct Column Pct	Provenience General Fill	Row Total
Fragment	3 100.0% 60.0%	3 100.0% 60.0%
Slab Metate	2 100.0% 40.0%	2 100.0% 40.0%
Column Total	5 100.0% 100.0%	5 100.0% 100.0%

Table 3.150. Ground Stone Material Type from LA 37919

Cell: Count Row Pct Column Pct	Provenience General Fill	Row Total
Rhyolite	4 100.0% 80.0%	4 100.0% 80.0%
Sandstone	1 100.0% 20.0%	1 100.0% 20.0%
Column Total	5 100.0% 100.0%	5 100.0% 100.0%

Table 3.151. Ground Stone Attributes from LA 37919

Cells: Count Row Pct Column Pct	Portion		Row Total	Attributes	
	Whole	Fragment		Burned	More than One Use Surface
Indeterminate		3 100.0% 75.0%	3 100.0% 60.0%		
Slab Metate	1 50.0% 100.0%	1 50.0% 25.0%	2 100.0% 40.0%	1	2
Column Total	1 20.0% 100.0%	4 80.0% 100.0%	5 100.0% 100.0%	1 20.0%	2 40.0%

Table 3.152. Ground Stone Artifacts from LA 39968

Cells: Count Row Pct Column Pct	Provenience						Row Total
	General Fill	Water Catchment	Pit Structure	Room Block 1	Room Block 2	Jacal	
Fragment	19 35.8% 37.3%	1 1.9% 33.3%	21 39.6% 20.0%	9 17.0% 25.7%	1 1.9% 11.1%	2 3.8% 28.6%	53 100.0% 25.2%
Polishing Stone			2 100.0% 1.9%				2 100.0% 1.0%
Abrading Stone	7 38.9% 13.7%		5 27.8% 4.8%	6 33.3% 17.1%			18 100.0% 8.6%
Shaped Slab			8 88.9% 7.6%		1 11.1% 11.1%		9 100.0% 4.3%
Anvil			1 100.0% 1.0%				1 100.0% .5%
Pounding Stone				1 100.0% 2.9%			1 10.0% .5%
Palette	2 100.0% 3.9%						2 100.0% 1.0%
Lap Stone	3 25.0% 5.9%		5 41.7% 4.8%	3 25.0% 8.6%		1 8.3% 14.3%	12 100.0% 5.7%
Mortar			2 100.0% 1.9%				2 100.0% 1.0%
Pestle	1 10.0% 2.0%						1 100.0% .5%
Mano	3 25.0% 5.9%		5 41.7% 4.8%	3 25.0% 8.6%	1 8.3% 11.1%		12 100.0% 5.7%
One-hand Mano	6 22.2% 11.8%	2 7.4% 66.7%	15 55.6% 14.3%	2 7.4% 5.7%		2 7.1% 28.6%	27 100.0% 12.9%

Cells: Count Row Pct Column Pct	Provenience General Fill	 Water Catchment	 Pit Structure	 Room Block 1	 Room Block 2	 Jacal	Row Total
Two-hand Mano	5		12	8	2	1	28
	17.9%		42.9%	28.6%	7.1%	3.6%	100.0%
	9.8%		11.4%	22.9%	22.2%	14.3%	13.3%
Metate	1		12	1	2.9%		14
	7.1%		85.7%	7.1%			100.0%
	2.0%		11.4%				6.7%
Trough Metate	1		8				9
	11.1%		88.9%				100.0%4.
	2.0%		7.6%				3%
Slab Metate	2		7	1	1		11
	18.2%		63.6%	9.1%	9.1%		100.0%
	3.9%		6.7%	2.9%	11.1%		5.2%
Axe	1		1	1	2	1	6
	16.7%		16.7%	16.7%	33.3%	16.7%	100.0%
	2.0%		1.0%	2.9%	22.2%	14.3%	2.9%
Cylindrical Tool					1		1
					100.0%		100.0%
					11.1%		.5%
Shaped Stone			1				1
			100.0%				100.0%
			1.0%				.5%
Column Total	51	3	105	35	9	7	210
	24.3%	1.4%	50.0%	16.7%	4.3%	3.3%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Most of the artifacts were made of rhyolite and were fragmented with the exception of one slab metate (Table 3.151). It is possible that the ground stone was scavenged from the roomblock south of the site. The palynological analyses on the ground stone were negative.

Spurgeon Draw, LA 39968

The Spurgeon Draw site consists of two small roomblocks with a pit structure, jacal structure, and a water retention basin. A total of 214 ground stone artifacts were recovered, of which 50.9 percent came from the pit structure fill (Table 3.152). Ground stone processing on the roof of the structure seems likely. A large amount of indeterminate ground stone was also recorded (25.2 percent). The percentage of one-hand and two-hand manos are almost even. The metate category makes up 16.2 percent of the assemblage. Rhyolite is the most used material; however, softer materials, such as sandstone and tuff, are also being used (Table 3.153).

A high amount (64.8 percent) of the ground stone was fragmented. However, some of the fragments were portions of one larger artifact and were sometimes classified as individual items. Burning was monitored on the ground stone and was found on 8.6 percent of the assemblage.

Palynological analytical results were available on 17 artifacts. These were from soils collected from the surface of the artifacts and pollen washes. The pollen from nine metates produced pine, nightshade, cheno-ams, grass, composites, cactus, sagebrush, juniper, and small amounts of corn. The pollen washes contained cheno-am, pine, oak composites, grass, and corn. Two stone bowls were recovered; one contained cheno-ams and the other lacked any pollen. Low counts of corn were also found in a mortar. Three metates were recovered from the floor of the pit structure. Two had pine, cheno-am, grass, and composites; the third metate had no pollen.

Haury's Site, LA 39969

Haury's site is small Early Pueblo roomblock containing three rooms and a jacal structure. Stone paving is present in areas on the floors and outside the rooms. A total of 121 ground stone artifacts were recovered from the site (Table 3.154). Room 3, the largest of the rooms, produced 29.8 percent of the assemblage. Volcanic materials, such as basalt, rhyolite, and andesite, are available throughout the area and were used in the manufacture of ground stone. The most commonly used material is rhyolite (Table 3.155) and it represents over half of the materials in the assemblage (62.1 percent).

Table 3.153. Ground Stone Material Types from LA 39968

Cells: Count Row Percent Column Percent	Provenience						Row Total
	General Fill	Water Catchment	Pit Structure	Room Block 1	Room Block 2	Jacal	
Chert			1 100.0% 1.0%				1 100.0% .5%
Basalt	5 35.3% 11.8%		4 23.5% 3.8%	3 17.6% 8.6%	4 23.5% 44.4%		17 100.0% 8.1%
Rhyolite	22 25.6% 43.1%		48 55.8% 45.7%	11 12.8% 31.4%	3 2.3% 22.2%	3 3.5% 42.9%	86 100.0% 41.0%
Tuff			1 100.0% .1.0%				1 100.0% .5%
Andesite	1 10.0% 2.0%	1 10.0% 33.3%	4 40.0% 3.8%	3 30.0% 8.6%		1 10.0% 14.3%	10 100.0% 4.8%
Rhyolitic Tuff	8 21.6% 15.7%		23 62.2% 21.9%	4 10.8% 11.4%	1 2.7% 11.1%	1 2.7% 14.3%	37 100.0% 17.6%
Pumice			1 100.0% 1.0%				1 100.0% .5%
Limestone	1 6.3% 2.0%		10 62.5% 9.5%	4 25.0% 11.1%	1 6.3% 11.1%		16 100.0% 7.6%
Sandstone	9 45.0% 17.6%	1 5.0% 33.3%	4 20.0% 3.8%	5 25.0% 14.3%		1 5.0% 14.3%	20 100.0% 9.5%
Siltstone			2 66.7% 1.9%	1 33.3% 2.9%			3 100.0% 1.4%
Quartzite	2 15.4% 3.9%	1 7.7% 33.3%	7 53.8% 6.7%	2 15.4% 5.7%		1 7.7% 14.3%	13 100.0% 6.2%
Quartzitic Sandstone	1 33.3% 2.0%			1 33.3% 2.9%	1 33.3% 11.1%		3 100.0% 1.4%
Schist	1 100.0% 2.0%						1 100.0% .5%
Column Total	51 24.3% 100.0%	3 1.4% 100.0%	105 50.0% 100.0%	35 16.7% 100.0%	7 3.3% 100.0%	9 4.3% 100.0%	210 100.0% 100.0%

Table 3.154. Ground Stone Artifacts from LA 39969

Cells: Count Row Pct Column Pct	Provenience								Row Total
	General Fill	Trash Pit	Jacal	Slab Lined Area	Room 1	Room 2	Room 3	Unprovenienced	
Fragment	3 23.1% 11.1%	1 7.7% 7.1%	1 7.7% 25.0%		1 7.7% 7.1%		4 30.8% 1.1%	3 23.1% 60.0%	13 100.0% 10.7%
Polishing Stone		1 33.3% 7.1%					2 66.7% 5.6%		3 100.0% 2.5%
Abrading Stone						1 50.0% 5.9%	1 50.0% 2.8%		2 100.0% 1.7%
Shaft Straightener		1 10.0% 7.1%							1 100.0% .8%
Shaped Slab		1 20.0% 7.1%			3 60.0% 21.4%		1 20.0% 2.8%		5 100.0% 4.1%
Anvil							1 100.0% 2.8%		1 100.0% .8%
Pounding Stone						1 100.0% 5.9%			1 100.0% .8%
Palette	1 33.3% 3.7%						2 66.7% 5.6%		3 100.0% 2.5%
Lap Stone	5 22.7% 18.5%	3 13.6% 21.4%			2 9.1% 14.3%	2 9.1% 11.8%	8 36.4% 22.2%	2 9.1% 40.0%	22 100.0% 18.2%
Hammerstone							1 100.0% 2.8%		1 100.0% .8%
Mano		1 20.0% 7.1%	1 20.0% 25.0%			1 20.0% 5.9%	2 40.0% 5.6%		5 100.0% 4.1%
One-hand Mano	2 25.0% 7.4%	2 25.0% 14.3%				2 25.0% 11.8%	2 25.0% 5.6%		8 100.0% 6.6%
Two-hand Mano	10 28.6% 37.0%	2 5.7% 14.3%	2 5.7% 50.0%	1 2.9% 25.0%	6 17.1% 42.9%	5 14.3% 29.4%	9 25.7% 25.0%		35 100.0% 28.9%
Metate				2 50.0% 50.0%		2 50.0% 11.8%			4 100.0% 3.3%
Trough Metate	4 66.7% 14.8%	1 16.7% 7.1%			1 16.7% 7.1%				6 100.0% 5.0%
Slab Metate	2 20.0% 7.4%	1 10.0% 7.1%		1 10.0% 25.0%	1 10.0% 7.1%	3 30.0% 17.6%	2 20.0% 5.6%		10 100.0% 8.3%
Axe							1 100.0% 2.8%		1 100.0% .8%
Column Total	27 22.3% 100.0%	14 11.6% 100.0%	4 3.3% 100.0%	4 3.3% 100.0%	14 11.6% 100.0%	17 14.0% 100.0%	36 29.8% 100.0%	5 4.1% 100.0%	121 100.0% 100.0%

Table 3.155. Ground Stone Material from LA 39969

Cells: Count Row Pct Column Pct	Major Provenience								Row Total
	General Fill	Large Pit	Jacal	Slab Lined Area	Room 1	Room 2	Room 3	Unprovenienced	
Basalt	2		1		5		5		13
	15.4%		7.7%		38.5%		38.5%		100.0%
	7.4%		25.0%		35.7%		13.9%		10.7%
Rhyolite	18	8	1	4	7	12	18	4	72
	25.0%	11.1%	1.4%	5.6%	9.7%	16.7%	25.0%	5.6%	100.0%
	66.7%	57.1%	25.0%	100.0%	50.0%	70.6%	50.0%	80.0%	59.5%
Andesite						1	1		2
						50.0%	50.0%		100.0%
						5.9%	2.8%		1.7%
Rhyolitic Tuff	1		1				3		5
	20.0%		20.0%				60.0%		100.0%
	3.7%		25.0%				8.3%		4.1%
Limestone	1	2				2	4		9
	11.1%	22.2%				22.2%	44.4%		100.0%
	3.7%	14.3%				11.8%	11.1%		7.4%
Sandstone	3	3			1	1	2	1	11
	27.3%	27.3%			9.1%	9.1%	18.2%	9.1%	100.0%
	11.1%	21.4%			7.1%	5.9%	5.6%	20.0%	9.1%
Serpentine							2		2
							100.0%		100.0%
							5.6%		1.7%
Quartzite	1	1			1		1		4
	25.0%	25.0%			25.0%		25.0%		100.0%
	3.7%	7.1%			7.1%		2.8%		3.3%
Quartzitic Sandstone	1		1			1			3
	33.3%		33.3%			33.3%			100.0%
	3.7%		25.0%			5.9%			2.5%
Column Total	27	14	4	4	14	17	36	5	121
	22.3%	11.6%	3.3%	3.3%	11.6%	14.0%	29.8%	4.1%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

There are two distinct types of metates present on the site, slab and trough metates. The slab metates were distributed throughout the rooms; Room 2 contained five specimens. Most of the trough metates were found in general fill.

The manos found at Haury's site were both one-hand and two-hand types. Some indeterminate mano fragments were also analyzed. Of the two type of manos, the two-hand types are more common.

There is also a high number of lapstones present (n = 22). Lapstones are small hand-held stones usually exhibiting a sheen. J. Adams (1995:73) states this is caused by an artifact being rubbed against its surface. Hide-working is one activity suggested by Hayes and Lancaster (1975:159) from evidence found at Badger House. It is possible that this type of activity may have been pursued at Haury's site.

Pollen from one mano, in the fill of Room 2, contained pine, grass, cheno-am composites, and low counts of corn. The other artifact, a metate, from the fill of Room 2 had pine, cheno-am, composites, sagebrush, and grass. The pollen washes, however, recovered pollen from the surfaces of ten artifacts. The pollen identified was pine, grass, cheno-ams, oak, juniper, and corn. A two-hand mano found in the trash pit was the only artifact that contained low counts of corn pollen.

SU Tanks, LA 39972

SU Tanks is a multicomponent site consisting of Pinelawn and Reserve phase components. The ground stone recovered from this site totaled 29 items (Table 3.156). In comparing the ground stone artifacts from the two phases, there are some differences worth mentioning. Both phases contain one-hand and two-hand manos; however, the two-hand manos are represented in the Reserve phase at 80 percent while the Pinelawn phase has 20 percent. The basin metates

Table 3.156. Ground Stone Artifacts from LA 39972

Cells: Count Row Pct Column Pct	Period Reserve	 Early Pithouse	Row Total
Polishing Stone	1		1
	10.0%		100.0%
	6.7%		3.4%
Shaft Straightener	1		1
	100.0%		100.0%
	6.7%		3.4%
Lap Stone		3	3
		100.0%	100.0%
		21.4%	10.3%
One-hand Mano	2	1	3
	66.7%	33.3%	100.0%
	13.3%	7.1%	10.3%
Two-hand Mano	2	1	3
	66.7%	33.3%	100.0%
	13.3%	7.1%	10.3%
Metate	3	4	7
	42.9%	57.1%	100.0%
	20.0%	28.6%	24.1%
Basin Metate		1	1
		100.0%	100.0%
		7.1%	3.4%
Slab Metate	4	4	8
	50.0%	50.0%	100.0%
	26.7%	28.6%	27.6%
Maul	2		2
	100.0%		100.0%
	13.3%		6.9%
Column Total	15	14	29
	51.7%	48.3%	100.0%
	100.0%	100.0%	100.0%

Table 3.157. Ground Stone Material Types from LA 39972

Cells:count Row Pct Column Pct	Period Reserve	 Early Pithouse	Row Total
Chert	1		1
	100.0%		100.0%
	6.7%		3.4%
Igneous	1		1
	100.0%		100.0%
	6.7%		3.4%
Basalt	4	2	6
	66.7%	33.3%	100.0%
	26.7%	14.3%	20.7%
Rhyolite	9	9	18
	50.0%	50.0%	100.0%
	60.0%	64.3	62.1%
Andesite		1	1
		100.0%	100.0%
		7.1%	3.4%
Sandstone		1	1
		100.0%	100.0%
		7.1%	3.4%
Quartzitic Sandstone		1	1
		100.0%	100.0%
		7.1%	3.4%
Column Total	15	14	29
	51.7%	48.3%	100.0%
	100.0%	100.0%	100.0%

are found only in the early period. Slab metates are present in both components. Slightly more were recovered from the Early Pithouse period (55.6 percent).

It is not surprising that rhyolite (Table 3.157) is the most often material; it is available everywhere. It is fairly dominant throughout all assemblages in all time periods. Most of the materials used are volcanic; however there are some sedimentary rocks. Sandstone, although in low frequencies, was use during the Early Pithouse period on this site and absent during the Late Pueblo period.

There is a high frequency of ground stone fragments from the site (67.6 percent). This may not be all that unusual. Ground stone, when discarded, is often reused for some other function, depending on its size, usually as a hearth stone or for construction material. A recovered shaft straightener was possibly a reused mano. There were a few burned artifacts; however, they were not associated with thermal features. Almost half of the manos (both one and two-hand) had more than one use surface. One basin metate and one slab metate also had more than one use surface.

The pollen washes from six pieces of ground stone identified pine, cheno-ams, oak, grasses, nightshade, and composites. The shaft straightener contained pollen from pine and grasses. No corn was found.

Lazy Meadows, LA 39975

Lazy Meadows is a Pinelawn phase site that had four shallow pit structures. The ground stone recovered from the site totaled 31 pieces (Table 3.158). Pit Structure 1, the largest and deepest of the structures, contained 35.5 percent of the ground stone artifacts. In Table 3.159 it is evident that rhyolite (74.2 percent) is the dominant material type. The number of whole artifacts versus fragmented ones is larger at Lazy Meadows than at other sites (51.6 percent). Burning was present on only one mano. Eleven ground stone artifacts had more than one use-surface.

Several ground stone artifacts were recovered from the floor of Pit Structure 1. Among these were three rhyolite and one sandstone two-hand manos. It is interesting that no one-hand manos were found at this

Table 3.158. Ground Stone Artifacts from LA 39975

Cells: Count Row Pct Column Pct	Provenience					Row Total
	General Fill	Pit 1	Pit Structure 1	Pit Structure 2	Pit Structure 3	
Fragment	1 33.3% 10.0%	1 33.3% 100.0%			1 33.3% 12.5%	3 10.0% 9.7%
Abrading Stone	1 50.0% 10.0%		1 50.0% 9.1%			2 100.0% 6.5%
Shaped Slab			1 100.0% 9.1%			1 100.0% 3.2%
Pounding Stone	1 100.0% 10.0%					1 100.0% 3.2%
Lap Stone	3 30.0% 30.0%		1 10.0% 9.1%	1 10.0% 100.0%	5 50.0% 62.5%	10 100.0% 32.3%
Two-hand Mano	2 22.2% 20.0%		6 66.7% 54.5%		1 11.1% 12.5%	9 100.0% 29.0%
Metate	2 50.0% 20.0%		1 25.0% 9.1%		1 25.0% 12.5%	4 100.0% 12.9%
Maul			1 100.0% 9.1%			1 100.0% 3.2%
Column Total	10 32.3% 100.0%	1 3.2% 100.0%	11 35.5% 100.0%	1 2.2% 100.0%	8 25.8% 100.0%	31 100.0% 100.0%

Table 3.159. Ground Stone Material Types from LA 39975

Cells:count Row Pct Column Pct	Provenience					Row Total
	General Fill	Pit 1	Pit Structure 1	Pit Structure 2	Pit Structure 3	
Basalt	2 66.7% 25.0%		1 33.3% 9.1%			3 100.0% 9.7%
Rhyolite	5 26.1% 60.0%		8 34.8% 72.7%	1 4.3% 100.0%	8 34.8% 100.0%	22 100.0% 74.2%
Sandstone	2 50.0% 20.0%	1 25.0% 100.0%	1 25.0% 9.1%			4 100.0% 12.9%
Column Total	10 32.3% 100.0	1 3.2% 100.0%	11 35.5% 100.0%	1 3.2% 100.0%	8 25.8% 100.0%	31 100.0% 100.0%

early site. A full-grooved limestone maul was also collected from the floor. The ground stone from Pit Structures 2 and 3 were found in the upper fill. Rhyolite was used for eight of the two-hand manos, and one was sandstone. All of the metates were rhyolite and the abrading stones were made of basalt.

Pollen from five ground stone artifacts included pine, cheno-ams, composites, sagebrush, oak, mormon tea, juniper, and small amounts of corn. One worked stone, was recovered from the floor of Pit Structure 1 and had traces of corn pollen.

Old Peralta, LA 43766

The Old Peralta site had an Archaic and Reserve phase occupation with a small ground stone assemblage

(Table 3.160). More than half of the assemblage is composed of metates. A single one-hand mano made of quartzite was recovered from the silt layer at the base of the Archaic cultural features (Table 3.161). The rest of the ground stone was recovered in the upper fill and derived from the nearby Reserve phase site, located a short distance upstream. The majority was fragmented, with the exception of one metate. One mano had more than one use surface. Burning was absent on the ground stone.

Five pollen washes from ground stone surfaces were taken. Two of the five contained pine, grass, cheno-ams, and composites. The others were negative.

Luna Village, LA 45507

Luna Village was recorded and partially excavated by Walter Hough (1907). It is a Late Pithouse period site from which 273 ground stone artifacts were recovered from three pit structures and one trash pit. As seen in Table 3.162, the number of two-hand manos and one-hand manos are fairly close; however, there are few basin metates (1.0 percent). The number of trough metates are in proportion to the number of two-hand manos. The material types used for the ground stone are presented in Table 3.163 and indicate that igneous materials are the most used material; rhyolite dominates the assemblage.

Table 3.160. Ground Stone Artifacts, LA 43766

Cells: Count Row Pct Column Pct	Provenience General Fill	Row Total
Fragment	1 100.0% 16.7%	1 100.0% 16.7%
One-hand Mano	1 100.0% 16.7%	1 100.0% 16.7%
Metate	3 100.0% 50.0%	3 100.0% 50.0%
Slab Metate	1 100.0% 16.7%	1 10.0% 16.7%
Column Total	6 100.0% 100.0%	6 100.0% 100.0%

Table 3.161. Ground Stone Material Types, LA 43766

Cells: Count Row Pct Column Pct	General Fill	Row Total
Rhyolite	5 100.0% 83.3%	5 100.0% 83.3%
Quartzite	1 100.0% 16.7%	1 100.0% 16.7%
Column Total	6 100.0% 100.0%	6 100.0% 100.0%

Table 3.162. Ground Stone Artifacts from LA 45507

Cells: Count Row Pct Column Pct	Provenience							Row Total
	General Fill	Trash Pit	Pit Structure 1	Pit Structure 3	Pit Structure 9	Pit Structure 12	Pit Structure 13	
Fragment	16 38.1% 18.8%	4 9.5%	6 14.3% 21.4%	6 14.3% 16.7%	4 9.5% 40.0%	4 9.5% 9.1%	2 4.8% 6.7%	42 100.0% 15.4%
Polishing Stone						2 100.0% 4.5%		2 100.0% .7%
Abrading Stone	6 50.0% 7.1%		2 16.7% 7.1%			4 33.3% 9.1%		12 100.0% 4.4%
Shaped Slab				2 50.0% 5.6%			2 50.0% 6.7%	4 100.0% 1.5%

Cells: Count Row Pct Column Pct	Provenience							Row Total
	General Fill	Trash Pit	Pit Structure 1	Pit Structure 3	Pit Structure 9	Pit Structure 12	Pit Structure 13	
Palette				2 50.0% 5.6%		2 50.0% 4.5%		4 100.0% 1.5%
Lap Stone	18 47.4% 21.2%	2 5.3% 5.0%	4 10.5% 14.3%			8 21.1% 18.2%	6 15.8% 20.0%	38 100.0% 13.9%
Mortar	2 100.0% 2.4%							2 100.0% .7%
Pestle	2 100.0% 2.4%							2 100.0% .7%
Mano	4 25.0% 4.7%	4 25.0% 10.0%		2 12.5% 5.6%		2 12.5% 4.5%	4 25.0% 13.3%	16 100.0% 5.9%
One-hand Mano	6 15.0% 7.1%		8 20.0% 28.6%	6 15.0% 16.7%		8 20.0% 18.2%	12 30.0% 40.0%	40 100.0% 14.7%
Two-hand Mano	16 34.8% 18.8%		4 8.7% 14.3%	10 21.7% 27.8%	6 13.0% 60.0%	8 17.4% 18.2%	2 4.3% 6.7%	46 100.0% 16.8%
Metate		2 25.0% 5.0%					2 25.0% 6.7%	8 100.0% 2.9%
Trough Metate	6 14.3% 7.1%	26 61.9% 65.0%	2 4.8% 7.1%	2 4.8% 5.6%		6 14.3% 13.6%		42 100.0% 15.4%
Slab Metate	4 28.6% 4.7%	2 14.3% 5.0%	2 14.3% 7.1%	6 42.9% 16.7%				14 100.0% 5.1%
Axe	1 100.0% 1.2%							1 100.0% .4%
Column Total	85 31.1% 100.0%	40 14.7% 100.0 %	28 10.3% 100.0%	36 13.2% 100.0%	10 3.7% 100.0%	44 16.1% 100.0%	30 11.0% 100.0%	273 100.0% 100.0%

Table 3.163. Ground Stone Material Types from LA 45507

Cells: Count Row Pct Column Pct	Provenience							Row Total
	General Fill	Trash Pit	Pit Structure 1	Pit Structure 3	Pit Structure 9	Pit Structure 12	Pit Structure 13	
Basalt	16 38.1% 18.8%	2 4.8% 5.0%	8 19.0% 28.6%	4 9.5% 11.1%		12 28.6% 27.3%		14 100.0% 5.1%
Rhyolite	45 31.5% 52.9%	34 23.8% 85.0%	8 5.6% 28.6%	18 12.6% 50.0%		26 18.2% 59.1%	12 8.4% 40.0%	143 100.0% 52.4%
Tuff			4 50.0% 14.3%				4 50.0% 13.3%	8 100.0% 2.9%

Cells: Count Row Pct Column Pct	Provenience							Row Total
	General Fill	Trash Pit	Pit Structure 1	Pit Structure 3	Pit Structure 9	Pit Structure 12	Pit Structure 13	
Andesite	8 26.7% 9.4%	4 13.3% 10.0%		6 20.0% 16.7%	6 20.0% 60.0%		6 20.0% 20.0%	30 100.0% 11.0%
Rhyolitic Tuff	8 50.0% 9.4%			4 25.0% 11.1%	4 25.0% 40.0%			16 100.0% 5.9%
Sandstone	6 60.0% 7.1%			2 20.0% 5.6%			2 20.0% 6.7%	10 100.0% 3.7%
Quartzite				2 100.0% 5.6%				2 100.0% .7%
Quartzitic Sandstone							2 100.0% 6.7%	2 100.0% .7%
Igneous	2 14.3% 2.4%		8 57.1% 28.6%				4 28.6% 13.3%	14 100.0% 5.1%
Sedimentar y						6 100.0% 13.6%		6 100.0% 2.2%
Column Total	85 31.1% 100.0%	40 14.7% 100.0%	28 10.3% 100.0%	36 13.2% 100.0%	10 3.7% 100.0%	44 16.1% 100.0%	30 11.0% 100.0%	273 100.0% 100.0%

Although a large amount of the ground stone came from general fill (31.9 percent), Pit Structure 12 contained the greatest portion of the assemblage. This structure was also the largest on the site, and had a bench, inset postholes, a central hearth, and a ventilator shaft. It may have been a domestic habitation and additionally used ceremonially.

Over half of the ground stone assemblage is fragmented. The manos show the highest amount of breakage. Several ground stone artifacts were recycled as hearth stones, exhibiting reddening and crazing from the heat.

Pollen from Luna Village ground stone consisted of pine, grasses, cheno-ams, composites, sagebrush, and globe mallow. The artifacts selected for pollen washes were chosen from each of the pit structures (Table 3.164). The pollen washes produced, in addition to the list above, corn, corn starch, rose species, knotweed, greasewood, buttercup, bellflower, juniper, and elm. Very little corn was found in either the pollen or pollen washes.

Luna Village cover a wide area on the first terrace above the San Francisco River, making farming ideal. The ground stone does not confirm a heavy use of agricultural products however, suggesting that corn was used to supplement the diet while using more wild resources for subsistence.

Humming Wire, LA 45508

The Humming Wire site is multicomponent with an Archaic occupation and two Georgetown phase pit structures. Pit Structure 1 contained 61.1 percent of the ground stone assemblage (Table 3.165). Little was found in Pit Structure 2, which consisted of one indeterminate ground stone fragment and one mano fragment. Igneous materials were the most commonly used; however, some sandstone was employed (Table 3.166). Softer materials such as tuff and rhyolitic tuff were also present.

The ground stone assemblage is small at Humming Wire, and nearly 95 percent of it is fragmented. There is some burning present on the surfaces; however, the artifacts were not in association with hearths. All of the ground stone was recovered from the upper fill of the pit structures. In this assemblage, all the artifacts had more than one use surface.

The pollen recovered from the ground stone artifacts produced pine, grass, cheno-ams, sagebrush, composites, nightshade, buckwheat, Russian olive, cactus, and corn starch.

SAK Site, LA 45510

Unfortunately the main portion of the site was outside the right-of-way limits. It is a Late Pithouse site from

Table 3.164. Pollen Wash Results from LA 45507

Pit Structure	Level	Ground Stone	Pollen
1	Floor	Indeterminate fragment	Pine, grass, composites, sagebrush
1	Floor	Trough metate	Pine, cheno-am, globe mallow
3	Fill	Indeterminate fragment	Pine, composites, sagebrush, mormon tea, cactus, grass
3	Fill	Trough metate	Pine, grass, cheno-am, sagebrush
3	Fill	Slab metate	Pine, grass, cheno-am, sagebrush
3	Fill	Two-hand mano	Pine, grass, cheno-am sagebrush
3	Fill	Slab metate	Pine, grass, cheno-am, composites, corn starch
9	Floor	Mano	Pine, grass, cheno-am, composites, sagebrush, corn and corn starch
9	Floor	Two-hand mano	Pine, grass, composites, corn starch
12	Floor	Metate	Pine, juniper, oak, elm, rose species, knotweed, greasewood, buttercup, bellflower, grass, cheno-am, composites, sagebrush, corn starch
12	Fill	Mano	Grass, composites
12	Fill	Metate	Elm, cheno-am
13	Fill	Mano	Grass, cheno-am, composites, corn starch
13	Floor	Mano	Pine, cheno-am, composite, sagebrush, corn starch
13	Floor	Mano	Pine, juniper, grass, cheno-am, composite, sagebrush

Table 3.165. Ground Stone Artifacts from LA 45508

Cells: Count Row Percent Column Percent	Provenience			Row Total
	General Fill	Pit Structure 1	Pit Structure 2	
Fragment	4 36.4% 33.3%	6 54.6% 27.3%	1 9.1% 50.0%	11 100.0% 30.6%
Mano	1 12.5% 8.3%	6 75.0% 27.3%	1 12.5% 50.0%	8 100.0% 22.2%
One-hand Mano	4 57.1% 33.3%	3 42.9% 13.6%		7 100.0% 19.4%
Two-hand Mano		4 100.0% 18.2%		4 100.0% 11.1%
Metate	3 50.0% 25.0%	3 50.0% 13.6%		6 100.0% 16.7%
Column Total	12 33.3% 100.0%	22 61.1% 100.0%	2 5.6% 100.0%	36 100.0% 100.0%

Table 3.166. Ground Stone Material Types from LA 45508

Cells: Count Row Percent Column Percent	Provenience: General Fill	Provenience: Pit Structure 1	Provenience: Pit Structure 2	Row Total
Basalt	2 40.0% 16.7%	3 60.0% 13.6%		5 100.0% 13.9%
Rhyolite	9 52.9% 75.0%	7 41.2% 31.8%	1 5.9% 50.0%	17 100.0% 47.2%
Tuff		3 100.0% 13.6%		3 100.0% 8.3%
Andesite		5 100.0% 22.7%		5 100.0% 13.9%
Rhyolitic Tuff		2 66.7% 9.1%	1 33.3% 50.0%	3 100.0% 8.3%
Sandstone	1 33.3% 8.3%	2 66.7% 9.1%		3 100.0% 8.3%
Column Total	12 33.3% 100.0%	22 61.1% 100.0%	2 5.6% 100.0%	36 100.0% 100.0%

which seven ground stone artifacts were recovered. Rhyolite (57.1 percent) was the most common material type. All artifacts were fragmented and one exhibited burning (Tables 3.167, 3.168).

Results of the pollen washes from the ground stone are shown in Table 3.169. The flotation samples recovered uncharred noncultural taxa. Corn was absent in the flotations; however, corn starch was found in small amounts on the surfaces of the ground stone.

DZ Site, LA 70185

The DZ site is a Late Pueblo site, of which four rooms were excavated. Rooms 1 and 2 contained most of the ground stone artifacts, excluding general fill (Table 3.170). There is a high density of two-hand manos and a few one-hand manos. Trough metates found at the DZ site were large and heavy suggesting that they were permanent fixtures. Two large trough metates were found in Room 1 in a shallow pit. Each one had a brown ware bowl at the end that served as a catchment for ground materials. The metates were large boulders with troughs that measured 11 cm and 5 cm in depth. A couple of two-hand manos were associated with the metates. Three fragmented trough metates were also found on the floor.

Table 3.167. Ground Stone Artifacts from LA 45510

Cells: Count Row Pct Column Pct	Provenience: General Fill	Row Total
Fragment	4 100.0% 57.1%	4 100.0% 57.1%
Two-hand Mano	1 100.0% 14.3%	1 100.0% 14.3%
Metate	2 100.0% 28.6%	2 100.0% 28.6%
Column Total	7 100.0% 100.0%	7 100.0% 100.0%

Although more ground stone was found in Room 2, only two lapstones and one trough metate fragment were recovered from the fill. Ground stone from the floor consisted of a shaped slab, a two-hand slab mano, and a mortar. A three-quarter grooved axe made of rhyolite was also recovered from the fill.

Table 3.168. Ground Stone Material Types from LA 45510

Cells: Count Row Pct Column Pct	Provenience General Fill	Row Total
Basalt	1 100.0% 14.3%	1 100.0% 14.3%
Rhyolite	4 100.0% 57.1%	4 100.0% 57.1%
Andesite	1 100.0% 14.3%	1 100.0% 14.3%
Sandstone	1 100.0% 14.3%	1 100.0% 14.3%
Column Total	7 100.0% 100.0%	7 100.0% 100.0%

Table 3.169. Results from Ground Stone Pollen Washes, LA 45510

Pit Structure	Ground Stone	Level	Pollen
1	Two-hand mano	Fill	Pine, grass, cheno-am, sagebrush, corn starch
1	Indeterminate fragment	Fill	Pine, grass, cheno-am, composites, sagebrush
2	Metate	Fill	Pine, sagebrush, corn starch
2	Metate	Fill	Grass, cheno-am, composites, corn starch
2	Indeterminate fragment	Fill	Cheno-am, cactus, corn starch

Igneous materials constitute most of the assemblage; however sandstone is present in high density (Table 3.171). Rhyolite is the dominant material and is found more frequently in manos, especially two-hand varieties. Most of the metates are either basalt or rhyolite. There are also three sandstone trough metates and several sandstone manos.

Of the 119 artifacts recovered, 71.2 percent are fragments and 10.2 percent are burned. It seems as if intensive grinding activities were performed on the site. The burned artifacts were usually fragments but were not associated with hearths. The ones found in the rooms were in the upper fill of the units and the ones from general fill and outside the roomblock were usually at a distance from the rooms. A trash pit was found immediately southwest of Room 3 and several fragments of ground stone were recovered from this area. Most of the manos, both one and two-hand, have more than one use surface as did lapstones and the abraders.

Several pollen samples produced pine, grass, composites, cheno-ams, sagebrush, juniper, elm, corn, and corn starch. The flotation samples found charred goosefoot, corn, and pine. Both the pollen washes and flotations contained small amounts of corn. Two metates from Room 1 had pine, elm, grass, cheno-ams, sagebrush, and corn present on the grinding surfaces. Two associated two-hand manos found near the metates had the identical pollen present.

Raven's Roost, LA 70188

Raven's Roost is an Archaic site that contained several pits and one pit structure. It also has an Athabaskan component that consisted of a stone ring and rock pile and a possible rock-lined surface. A small assemblage of ground stone was recovered from the site (Table 3.172) and all but one is from the Archaic component. Pit 3 contained 20.7 percent of the assemblage; however more than half of the ground stone was recovered from general fill.

The ground stone, quite small in size, has only a few identifiable artifacts. There are several one-hand manos that do not fit with the single trough metate recovered but could fit with the slab metates. The trough metate was near the surface and may be from a later occupation of the site.

Igneous materials comprise most of the assemblage; however, there are a few sedimentary materials. Rhyolite is the dominant material type and comprises 79.3 percent of ground stone assemblage (Table 3.173). Over half of the assemblage is fragmented, burned, and comes from the pits on the site. It appears they had been recycled for lining the pits or perhaps used in roasting. A wide variety of ground stone artifacts had more than one use surface.

The pollen and flotation samples produced a number of different taxa. Nine ground stone artifacts were pollen washed and produced pine, nightshade, grass, cheno-ams, composite, sagebrush, Mormon tea, and corn starch. Pollen wash proveniences are presented in Table 3.174. One of the indeterminate ground stone fragments, near Pit Structure 1, had corn starch present. The flotation samples identified juniper, pine, seepweed, and evening primrose.

Lightning Strike, LA 70189

Lightning Strike was occupied during the Reserve phase and probably later by the Athabaskan. Five

Table 3.170. Ground Stone Artifacts from LA 70185

Cells: Count Row Pct Column Pct	Provenience						Row Total
	General Fill	Pit 1	Room 1	Room 2	Room 3	Room 4	
Fragment	4		3	8			15
	26.7%		20.0%	53.3%			100.0%
	6.2%		14.3%	27.6%			12.6%
Polishing Stone	1						1
	100.0%						100.0%
	1.5%						.8%
Abrading Stone	1		1	2			4
	25.0%		25.0%	50.0%			100.0%
	1.5%		4.8%	6.9%			3.4%
Shaft Straightener			1				1
			100.0%				100.0%
			4.8%				.8%
Shaped Slab	1		1	2			4
	25.0%		25.0%	50.0%			100.0%
	1.5%		4.0%	6.9%			3.4%
Lap Stone	4			3			7
	57.1%			42.9%			100.0%
	6.2%			10.3%			5.9%
Mortar				1			1
				100.0%			100.0%..8
				3.4%			%
Mano	16			4			20
	80.0%			20.0%			100.0%
	24.6%			13.8%			16.8%
One-hand Mano	2	1	2	1			6
	33.3%	16.7%	33.3%	16.7%			100.0%
	3.1%	100.0%	9.5%	3.4%			5.0%
Two-hand Mano	17		7	6	2	1	33
	51.5%		21.2%	18.2%	6.1%	3.0%	100.0%
	26.2%		33.3%	20.7%	100.0%	100.0%	27.7%
Metate	6			1			7
	85.7%			14.3%			100.0%
	9.2%			3.4%			5.9%
Trough Metate	8		3				11
	72.7%		27.3%				100.0%
	12.3%		14.3%				9.2%
Slab Metate	3		2				4
	60.0%		40.0%				100.0%
	4.6%		9.5%				3.4%
Axe	2		1	1			4
	50.0%		25.0%	25.0%			100.0%
	3.1%		4.8%	3.4%			3.4%
Column Total	65	1	21	29	2	1	119
	54.6%	.8%	17.6%	24.4%	1.7%	.8%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3.171. Ground Stone Material Types from LA 70185

Cells: Count Row Pct Column Pct	Provenience						Row Total
	General Fill	Pit 1	Room 1	Room 2	Room 3	Room 4	
Basalt	15		4	4			23
	65.2%		17.4%	17.4%			100.0%
	23.1%		19.0%	13.8%			19.3%
Rhyolite	27		7	10		1	45
	60.0%		15.6%	22.2%		2.2%	100.0%
	41.5%		33.3%	34.5%		100.0%	37.8%
Andesite	1		1	1			3
	33.3%		33.3%	33.3%			100.0%
	1.5%		4.8%	3.4%			2.5%
Rhyolitic Tuff	4		4	7			15
	26.7%		26.7%	46.7%			100.0%
	6.2%		19.0%	24.1%			12.6%
Sandstone	16	1	5	7	2		31
	51.6%	3.2%	16.1	22.6%	6.5%		100.0%
	24.6%	100.0%	23.8%	24.1%	100.0%		26.1%
Fibrolite	1						1
	100.0%						100.0%
	1.5%						.8%
Hematite	1						1
	100.0%						100.0%
	1.5%						.8%
Column Total	65	1	21	29	2	1	119
	54.6%	.8%	17.6%	24.4%	1.7%	.8%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3.172. Ground Stone Artifacts from LA 70188

Cells: Count Row Percent Column Percent	Provenience					Row Total
	General Fill	Pit 1	Pit 2	Pit 3	Pit Structure	
Fragment	4			1		5
	80.0%			20.0%		100.0%
	20.0%			16.7%		17.2%
Lap Stone	2			2		4
	50.0%			50.0%		100.0%
	10.0%			33.3%		13.8%
Mano	1			1		2
	50.0%			50.0%		100.0%
	5.0%			16.7%		6.9%
One-hand Mano	3			1		4
	75.0%			25.0%		100.0%
	15.0%			16.7%		13.8%
Metate	5					5
	100.0%					100.0%
	25.0%					17.2%
Trough Metate				1		1
				100.0%		100.0%
				16.7%		3.4
Slab Metate	5	1	1		1	8
	62.5%	12.5%	12.5%		12.5%	100.0%
	25.0%	100.0%	100.0%		100.0%	27.6%
Column Total	20	1	1	6	1	29
	69.0%	3.4%	3.4%	20.7%	3.4%	100.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3.173. Ground Stone Material Types from LA 70188

Cells: Count / Row Percent / Column Percent	Provenience					Row Total
	General Fill	Pit 1	Pit 2	Pit 3	Pit Structure	
Basalt	1 50.0% 5.0%			1 50.0% 16.7%		2 100.0% 6.9%
Rhyolite	17 73.9% 85.0%	1 4.3% 100.0%	1 4.3% 100.0%	3 13.0% 50.0%	1 4.3% 100.0%	23 100.0% 79.3%
Andesite	1 50.0% 5.0%			1 50.0% 16.7%		2 100.0% 6.9%
Sandstone				1 100.0% 16.7%		1 100.0% 3.4%
Quartzite	1 100.0% 5.0%					1 100.0% 3.4%
Column Total	20 69.0% 100.0%	1 3.4% 100.0%	1 3.4% 100.0%	6 20.7% 100.0%	1 3.4% 100.0%	29 100.0% 100.0%

Table 3.174. Pollen Wash Results from LA 70188

Feature	Level	Ground Stone	Pollen
Pit Structure 1	Fill	Metate	Pine, nightshade, grass, cheno-am, composites, corn starch
Pit Structure 1	Fill	Slab Metate	Pine, cheno-am, sagebrush
Pit 3	Fill	Trough Metate	Pine
Pit 3	Fill	Lap stone	Pine, grass, cheno-am, composites, sagebrush

Table 3.175. Ground Stone from LA 70189

Cells: Count / Row Pct / Column Pct	Provenience		Row Total
	General Fill	Pit Structure	
Fragment	2 100.0% 50.0%		2 100.0% 40.0%
Abrading Stone	1 100.0% 25.0%		1 100.0% 20.0%
Lap Stone		1 100.0% 100.0%	1 100.0% 20.0%
Mano	1 100.0% 25.0%		1 100.0% 20.0%
Column Total	4 80.0% 100.0%	1 20.0% 100.0%	5 100.0% 100.0%

Table 3.176. Ground Stone Material Types from LA 70189

Cells: Count / Row Pct / Column Pct	Provenience		Row Total
	General Fill	Pit Structure	
Basalt	1 100.0% 25.0%		1 100.0% 20.0%
Rhyolite	3 75.0% 75.0%	1 25.0% 100.0%	4 100.0% 80.0%
Column Total	4 80.0% 100.0%	1 20.0% 100.0%	5 100.0% 100.0%

ground stone artifacts were recovered from the site with over half coming from general fill (Table 3.175). One lapstone fragment was recovered from the pit structure that may date to the Athabaskan period.

Material types from Lightning Strike are igneous. Rhyolite is the most commonly used material (Table 3.176) for all but one fragment. The mano was the only ground stone artifact that exhibited more than one grinding surface. Sixty percent of the assemblage showed burning; however hearths were not present.

Pollen samples collected from the site identified pine, corn, composites, and Mormon tea. The flotation samples had goosefoot, pine, yucca, and corn. The corn was low in both the flotation and pollen samples. Because of the shallow nature of the cultural features, association of the corn with the Athabaskan occupation is not possible.

Fence Corner, LA 70196

The Fence Corner site dates to the Late Pithouse period with one pit structure excavated. The total number of ground stone artifacts was small (Table 3.177), of which 83.3 percent were from the pit structure. There is proportionally a large amount of one-hand and two-hand manos present on the site. However, only one trough metate and one lapstone were found. There are two shaped slabs that did not exhibit intense wear and the surfaces were very rough. Shaping of the slabs occurred by flaking and grinding the edges and it is possible that they were being shaped for use as metates.

Table 3.177. Ground Stone Artifacts from LA 70196

Cells: Count Row Pct Column Pct	Provenience General Fill	 Pit Structure	Row Total
Fragment		2 100.0%	2 100.0% 8.3%
Abrading Stone	2 66.7% 50.0%	1 33.3% 5.0%	3 100.0% 12.5%
Shaped Slab		2 100.0% 10.0%	2 100.0% 8.3%
Lap Stone		1 100.0% 5.0%	1 100.0% 8.3%
Mano	1 50.0% 25.0%	1 50.0% 5.0%	2 100.0% 8.3%
One-hand Mano		5 100.0% 25.0%	5 100.0% 20.8%
Two-hand Mano	1 12.5% 25.0%	7 87.5% 35.0%	8 100.0% 33.3%
Trough Metate		1 100.0% 5.0%	1 100.0% 4.2%
Column Total	4 16.7% 100.0%	20 83.3% 100.0%	24 100.0% 100.0%

The different types of materials from Fence Corner are found in Table 3.178. Most of the assemblage is comprised of igneous materials, of which rhyolite is the most used at 54.2 percent. Andesite, a rarely used material in the Mogollon Highlands, was the next most common material type. The one-hand manos were mostly rhyolite and quartzite and the two-hand manos consisted of mostly rhyolite, along with basalt and andesite.

In the Fence Corner assemblage, 66.7 percent of the assemblage is whole. There is a higher amount of one-hand manos with more than one use surface as opposed to the two-hand manos. Very few were burned.

The pit structure had 11 (45.8 percent) ground stone artifacts on the floor. This included the two shaped stones, three one-hand manos, five two-hand manos, and the trough metate. The pit structure fill contained 37.5 percent of the assemblage and general fill 14.7 percent.

Table 3.178. Ground Stone Material Types from LA 70196

Cells: Count Row Pct Column Pct	Provenience General Fill	 Pit Structure	Row Total
Igneous		1 100.0% 5.0%	1 100.0% 4.2%
Basalt	1 50.0% 25.0%	1 50.0% 5.0%	2 100.0% 8.3%
Rhyolite	1 7.7% 25.0%	12 92.3% 60.0%	13 100.0% 54.2%
Andesite	2 40.0% 50.0%	3 60.0% 15.0%	5 100.0% 20.8%
Limestone		1 100.0% 5.0%	1 100.0% 4.2%
Sandstone		1 100.0% 5.0%	1 100.0% 4.2%
Quartzite		1 100.0% 5.0%	1 100.0% 4.2%
Column Total	4 16.7% 100.0%	20 83.3% 100.0%	24 100.0% 100.0%

Table 3.179. Pollen Wash Results from LA 70196

Ground Stone	Level	Pollen
One-hand mano	Floor	Pine, oak, cheno-am, composites, corn starch
Two-hand mano	Floor	Pine, cheno-am, composites
Trough metate	Floor	Pine, grass, cheno-am, sagebrush, corn starch
Two-hand mano	Floor	Pine, cheno-am, composites, corn, corn starch
Two-hand mano	Floor	Pine, cheno-am, corn, corn starch

Both the pollen and flotation samples contained either corn or corn starch. The pollen contained remains of pine, oak, cheno-ams, composites, corn, and corn starch. The results of several pollen washes from the surfaces of the ground stone retrieved from the floor of the pit structure are shown in Table 3.179. In the flotation samples, corn kernels were found in samples taken from under a slab in roof fall. Pine was the only other taxa found in the flotation samples.

Thunder Ridge, LA 75792

Thunder Ridge dates to the Early Pueblo period and contains a roomblock immediately west of the right-of-way boundary. Excavation of a shallow, ramada-like area contained a small ground stone assemblage (Table 3.180); however, the majority of the artifacts were from general fill (78.8 percent). The ratio of one-hand to two-hand manos is 4:1.

Table 3.180. Ground Stone Artifacts from 75792

Cells: Count Row Pct Column Pct	Provenience		Row Total
	General Fill	Ramada Area	
Fragment	1 100.0% 9.1%		1 100.0% 7.1%
Abrading Stone	2 100.0% 18.2%		2 100.0% 14.3%
Mano	2 100.0% 18.2%		2 100.0% 14.3%
One-hand Mano	1 100.0% 9.1%		1 100.0% 7.1%
Two-hand Mano	4 100.0$ 36.4		4 100.0% 28.6
Trough Metate		1 100.0% 33.3%	1 100.0% 7.1%
Slab Metate	1 33.3% 9.1%	2 66.7% 66.7%	3 100.0% 21.4%
Column Total	11 78.6% 100.0%	3 21.4% 100.0%	14 100.0% 100.0%

Rhyolite is the most commonly used material type; rhyolitic tuff is second in preference (Table 3.181), which is surprising because, usually, harder materials dominate the assemblages. A one-hand mano, two-hand mano, and an indeterminate fragment were made of rhyolitic tuff . Of the metates recovered, one is made from basalt, while the others are rhyolite.

Ground stone fragments comprise 71.4 percent of the assemblage at Thunder Ridge. Although some of the artifacts are burned they were not associated with a thermal feature. In looking at the number of surfaces used, only two-hand manos had more than one surface utilized.

Table 3.181. Ground Stone Material Types from LA 75792

Cells: Count Row Pct Column Pct	Major Provenience		Row Total
	General Fill	Ramada Area	
Basalt		1 100.0% 33.3%	1 100.0% 7.1%
Rhyolite	6 75.0% 54.5%	2 25.0% 66.7%	8 100.0% 57.1%
Andesite	1 100.0% 9.1%		1 100.0% 7.1%
Rhyolitic Tuff	3 100.0% 27.3%		3 100.0% 21.4%
Sandstone	1 100.0% 9.1%		1 100.0% 7.1%
Column Total	11 78.6% 100.0%	3 21.4% 100.0%	14 100.0% 100.0%

In the ramada area, a trough metate was found on a compact surface. The two slab metates were found in the upper fill of the feature. Some surface ground stone artifacts were recovered; however, most were from general fill.

Leaping Deer Ridge, LA 78439

Leaping Deer Ridge contains an Archaic component and a Late Pueblo occupation, which has a extremely small assemblage (Table 3.182). The Archaic component consists of a large roasting pit while the Late Pueblo occupation consists of five thermal features. Two ground stone artifacts, a one-hand mano and slab metate, are definitely associated with the Late Pueblo period. The other two ground stone artifacts were not associated with any feature and it is impossible to assign them to a cultural period.

All but one artifact, a one-hand mano, were made of rhyolite (Table 3.183). The percentage of whole artifacts versus fragmented ones is evenly divided. One mano was burned and was found near the thermal features, suggesting that it might have been used in the hearth at one time.

The pollen samples collected from Leaping Deer

Ridge were negative, and the flotation samples, which were separated by period, contained evening primrose, juniper, pine, cheno-ams, purslane, and goosefoot for the Archaic. The Late Pueblo samples contained seepweed, buckwheat, juniper, and purslane.

Table 3.182. Ground Stone Artifacts from LA 78439

Cells: Count Row Pct Column Pct	Provenience General Fill	Row Total
Lap Stone	1 10.0% 25.0%	1 100.0% 25.0%
One-hand Mano	2 100.0% 50.0%	2 100.0% 50.0%
Slab Metate	1 100.0% 25.0%	1 100.0% 25.0%
Column Total	4 100.0% 100.0%	4 10.0% 100.0%

Table 3.183. Ground Stone Material Types from LA 78439

Cells: Count Row Pct Column Pct	Provenience General Fill	Row Total
Rhyolite	3 100.0% 75.0%	3 100.0% 75.0%
Quartzite	1 100.0% 25.0%	1 100.0% 25.0%
Column Total	4 100.0% 100.0%	4 100.0% 100.0%

Haca Negra, LA 89846

The Haca Negra site is multicomponent with an Archaic hearth 1 m below the ground surface and an Athabaskan component just below the present ground surface. The ground stone recovered from the site (n = 3) was interspersed between both occupations. It is believed that they have been redeposited from a Reserve phase site that is located at the top of the ridge to the north.

The artifacts recovered consist of an indeterminate fragment, a one-hand mano, and an abrading stone made from rhyolite. Both the abrading stone and one-hand mano are whole, with the abrader exhibiting burning and having more than one use surface.

The flotation samples identified goosefoot and pine; the pollen samples were negative.

Variation of Ground Stone by Cultural Period

The ground stone assemblage consists of more than simply grinding implements such as manos and metates. However, since our focus is on the two categories to determine subsistence adaptations, we have separated them from the other artifacts for detailed examination by cultural period.

Archaic

Four sites had Archaic components present; however only two had ground stone associated with them, Old Peralta and Raven's Roost. The ground stone from the Old Peralta site is from an Archaic occupation that dates to the Middle Archaic (990 B.C.). A single one-hand mano was associated with this occupation. The wear found on the mano exhibited striations that were widthwise on both surfaces. It had a ground surface area of 42.0 sq cm. The slab metate had lengthwise striations and a ground surface area of 475.0 sq cm. Corn was absent from this artifact, suggesting that perhaps only wild resources were being ground and processed.

Raven's Roost dates to the Late Archaic (50 B.C. to A.D. 40). Present at Raven's Roost was a small pit structure measuring 2.5 m by 2.85 m and 1.07 m in depth. Most of the ground stone was found in general fill (69.0 percent) and in Pit 3 (20.7 percent), and a slab metate was found in the pit structure. Four whole one-hand manos and nine slab metates were recovered. One mano was fully shaped by grinding and pecking. Six metates were fully shaped by the methods of pecking, grinding, and flaking. Striation patterns for the manos ran lengthwise, widthwise, and both length and widthwise with a mean ground surface area of 65.0 sq cm. The striations ran the same on the metates, and the ground surface area ranges between 100.0 sq cm and 583 sq cm with an average area of 279.5 sq cm.

Corn pollen, in minute amounts, was present on the surfaces of a mano and a metate, and was absent in the macrobotanical samples. This would suggest that corn was processed, but in small amounts. Other taxa were dominant in both the palynological and macrobotanical samples, implying that the inhabitants were definitely processing wild resources.

Early Pithouse

The Early Pithouse period is represented by Lazy Meadows, Humming Wire, and a portion of SU Tanks. Both Lazy Meadows and Humming Wire had pit structures present. Lazy Meadows dates to the Late Pinelawn/Georgetown phase (A.D. 550 to A.D. 700). The ground stone assemblage was small (n = 13). Most of it was from Pit Structure 1. Eight whole two-hand manos were recovered from the site and have a ground surface area ranging between 101.0 sq cm and 193.0 sq cm with an average of 144.2 sq cm. The one-hand mano had a ground surface area of 78.0 sq cm. All the manos were fully shaped by either pecking or grinding. The ground surfaces exhibited widthwise striations on opposing surfaces. The metates (n = 4) were all fragmented so a ground surface area could not be taken. The edges of the metates were shaped and the surfaces exhibited lengthwise (n = 3) and widthwise (n = 1) striations.

Corn (in the form of corn starch) is present on the site from a pollen wash from one of the metate fragments. Four macrobotanical samples from Pit Structure 1 also contained corn. It is evident that corn was being processed at Lazy Meadows; however, other wild food resources are dominant, possibly implying that corn subsidized the diet and was not considered a major part of subsistence.

The Humming Wire site contains two components, an Archaic pit structure and a Georgetown phase pit structure. No ground stone was recovered from the Archaic component. The Georgetown (A.D. 600) pit structure contained 19 manos and 6 metates. The one-hand manos dominate the assemblage and are fully shaped by pecking and grinding (n = 7). The striations found on the surfaces are lengthwise, widthwise, random, and both length and widthwise. Although the number of one-hand manos is high, only one is complete and it has a ground surface area of 43.0 sq cm. The others have a portion of the edges missing so the ground surface area was not measured. Four two-hand mano fragments were also recovered. They had been shaped by grinding and pecking and exhibited widthwise striations.

One slab metate was recovered from the pit structure and has been fully shaped by grinding and pecking. The striations are lengthwise and the ground surface area is 571 sq cm. The other metates are fragments (n = 5) and cannot be identified except by their thickness and large size. Usually they are mid-portions with the ends missing.

Food processing activities at Humming Wire are indicated by the substances found on the ground stone. Corn starch was recovered in the pollen washes from two manos. The macrobotanical samples were void of corn, but other taxa were identified that indicate wild food resources may have been processed more than corn.

The Early Pithouse period component at SU Tanks has a C-14 date of A.D. 30 (Pinelawn phase). The manos and metates totaled five. Two manos, both a one and two-hand variety, are present. Both were fully shaped by either grinding or pecking. Striations on the surfaces were widthwise and both length and widthwise. Both were fragments and ground surface area was not monitored. Two slab metates were also recovered, of which one was complete. Both had been shaped by grinding and the striations were widthwise and random. The ground surface area of the whole metate is 512.0 sq cm. Food processing was performed at SU Tanks; however, corn was apparently not one of the foods being processed.

Late Pithouse

OAS excavated four sites in the Mogollon Highlands dating to the Late Pithouse period. These sites are South Leggett Pueblo, Luna Village, the SAK site, and Fence Corner.

South Leggett Pueblo contained a pithouse that was excavated by Martin and Rinaldo in 1949. A ceramic date of A.D. 900 to A.D. 1000 (Three Circle phase) was given to the feature. After reexcavation of a portion of the pit structure, eight ground stone artifacts were collected. Most were fragments, probably left from Martin's excavations. A fragment of a one-hand mano was recovered that had not been shaped. The striations found on the surface were random.

Luna Village is one the largest sites excavated from the Three Circle phase (A.D. 710 to A.D. 970). There is a large amount of ground stone present and the frequency for the manos and metates are also high. There is a slight increase in two-hand manos (n = 46) during the occupation of Luna Village. All of the two-hand, but not all the one-hand manos (n = 40) have been shaped. These show attributes of flaking and pecking. The striations found on the surfaces are widthwise, random, and length and widthwise. The whole one-hand manos (n = 18) have a ground surface area ranging between 25.0 and 66.0 sq cm, averaging 47.7 sq cm in area.

Ninety-one percent of the two-hand manos have been shaped by grinding and pecking. The surfaces display widthwise and length and widthwise striations. The ground surface area of the whole two-hand manos ranges between 90.0 sq cm and 253 sq cm, averaging 142.4 sq cm in area.

A majority of the metates are trough type (n = 38) with depths ranging between .5 cm and 2.5 cm and averaging 2.4 cm. However, slab (n = 14) metates are also present. All have been shaped by grinding, flaking, and pecking. The striations found on the ground surfaces are lengthwise, widthwise, and length and widthwise.

Intense food processing was performed at Luna Village. Corn, although not in large quantities, was found in the macrobotanical and palynological samples.

Pollen washes revealed corn remains on four two-hand manos and a basin metate.

The ceramics from the SAK site place it within the Three Circle phase at A.D. 950 to A.D. 1000. The portion excavated at the site was an outside activity area related to the unexcavated structure. The assemblage is very small; manos and metates total three. There is a two-hand mano fragment that was shaped by pecking and grinding and exhibits widthwise striations. The metates consist of two fragments that do not seem to have been shaped and have both lengthwise and widthwise striations on one surface. Since they are fragments, a ground surface area was not measured. Corn is absent at SAK; the macrobotanical samples found other wild food resources and the palynological samples were negative.

At Fence Corner, a small assemblage of manos and metates were recovered (n = 16). More two-hand than one-hand manos were recovered and all were fully shaped by pecking and grinding. The striations were widthwise and random on the surfaces. The ground surface area ranges between 99.0 sq cm and 248.0 sq cm with an average of 159.5 sq cm. The one-hand manos (n = 5) consisted of three that had been shaped by pecking and grinding and exhibited striations that were widthwise and both length and widthwise. The ground surface area ranged from 38.0 sq cm to 68.0 sq cm, averaging 55.4 sq cm in area.

One trough metate was recovered that had a depression 5.6 cm deep and produced cornstarch pollen from its surface. (Two of the manos also had cornstarch present on the ground surface.) The striations were lengthwise and the ground surface area was 966.0 sq cm. Food processing was definitely performed at the SAK site. Corn was present in small amounts in both the palynological and macrobotanical samples. However, other food resources dominated the assemblage.

Early Pueblo

The Haury site, SU Tanks, and Thunder Ridge were the three Early Pueblo sites excavated during the Luna project. The ground stone assemblages at two of these sites (SU Tanks and Thunder Ridge) is fairly small.

The Haury site is a small Reserve phase (A.D. 1000s) pueblo consisting of three rooms and a jacal-type structure. The manos and metates from the site vary greatly. Two-hand manos dominate the assemblage (n = 33). All the two-hand manos have been shaped by grinding, pecking, and flaking. The surface striations are widthwise and length and widthwise, with ground surface areas ranging between 77.0 sq cm and 190 sq cm and having an average of 148.3 sq cm. The one-hand manos (n = 10) have been shaped by grinding and pecking. The striations are widthwise, random, and length and width with ground surface areas ranging from 13.0 sq cm to 126.0 sq cm producing an average of 80.7 sq cm.

A total of 20 metates were recovered from the Haury site. From this total, there are 6 trough and 10 slab metates and the rest were indeterminate fragments. The trough metates have an average depth of 4.0 cm; one had a trough depth of 9.0 cm. Shaping was monitored and consisted of grinding, flaking, and pecking. The use surface striations were lengthwise and widthwise. There were only two whole trough metates with ground surfaces areas of 200.0 sq cm and 880.0 sq cm, averaging 540 sq cm. The slab metates were shaped by methods of pecking, grinding, and flaking. The striations noted were widthwise, lengthwise, and random. The two whole slab metates had ground surface areas of 165.0 sq cm and 855.0 sq cm for an average of 510 sq cm.

In Room 1, corn was found on one of the two-hand manos. Cornstarch was also found on another two-hand mano from the large trash pit outside the roomblock. A macrobotanical sample from Room 3 also produced corn. Food processing is evident at the Haury site. The trough metate that had a depth of 9.0 cm would suggest that it was intensely used, not necessarily for corn grinding, but possibly for other food resources.

SU Tanks contains two components, a Pinelawn phase (A.D. 380) and a Reserve phase (A.D. 1000 to A.D. 1100). The Reserve phase component contained 4 manos and 13 metates. The manos are distributed evenly between one and two-hand. Shaping on one of the one-hand manos was by grinding and pecking, the other had not been shaped. Both two-hand manos were shaped by grinding and pecking. Striations on the ground surfaces were lengthwise for the one-hand types and lengthwise and widthwise for the two-hand ones. Only one complete one-hand mano was recovered and its ground surface area was 16.0 sq cm.

Although 13 metates were recovered, there were 6 that were indeterminate, the rest were slab (n = 6) and basin (n = 1). Both the slab and basin metates were fully shaped by grinding, flaking, and pecking. Wear was primarily from grinding. Striations were lengthwise, widthwise, random, and length and widthwise for the slabs and circular for the basin metate. One complete slab metate had a ground surface area of 447.0 sq cm.

Processing wild food resources was evident during the Reserve phase on this site. Corn was absent in all the macrobotanical and palynological samples. However, only a small portion of the site was excavated.

Thunder Ridge is a small Reserve phase (A.D. 1000 to A.D. 1100) pueblo. A portion of the site was excavated which included a ramada area. The mano and metate assemblage is small (n = 11). Both one-hand and two-hand manos are present, and the two-hand types are dominant. The shaping for the two-hand manos was by grinding and pecking, and they had lengthwise and widthwise striations on both surfaces; however, only one is complete with a ground surface area of 160.0 sq cm. The one-hand mano is complete, but does not exhibit any shaping. The striations on the two surfaces are length and widthwise and both have a ground surface area of 70.0 sq cm.

The metates consist of trough (n = 1) and slab (n = 3) types. The slab metates exhibit some type of shaping except for one. They include pecking and grinding and their surface exhibits lengthwise and random striations. The trough metate has a trough that is 6.0 cm deep with lengthwise striations only. The ground surface area is 1,280.0 sq cm. This is one of the largest trough metates found from the Early Pueblo period.

A pollen wash taken from the surface of the trough metate contained cornstarch. With the depth of the trough on the metate, use must have been intense. The macrobotanical samples found other food remains, but not corn, suggesting other resources may have been more important to their diet and corn was used as a supplement.

Late Pueblo

The Late Pueblo period contains four sites; the Hough site, Spurgeon Draw, the DZ site, and a portion of Leaping Deer Ridge. All of the sites were occupied during the Tularosa phase.

The Hough site (A.D. 1300) is a large pueblo with 30 plus rooms and a great kiva. It has the largest ground stone assemblage from the Luna Project. The manos and metates total 247. Both types of manos are present on the site. The two-hand types are ten times higher in frequency than the one-hand types. Many of the two-hand manos have opposing use surfaces. The striations on the surfaces are lengthwise, widthwise, random, and length and widthwise with ground surface areas ranging between 13.7 sq cm and 270.0 sq cm with a mean area of 153.9 sq cm.

Half of the one-hand manos exhibited shaping such as grinding, pecking, and flaking. The majority have two opposing surfaces with striations such as lengthwise, widthwise, circular, random, and both length and widthwise. The ground surface areas range between 30.0 sq cm and 138.0 sq cm with a mean area of 49.2 sq cm.

There are three type of metates at the Hough site and they include trough, slab, and basin. The trough and slab metates are almost evenly distributed. The majority of the trough metates have been shaped by grinding, pecking, or flaking. The troughs have a depth ranging from .3 cm to 8.2 cm, and averaged a depth of 2.0 cm. They exhibit lengthwise, widthwise, random, and both length and widthwise striations. The ground surface area ranges between 586.0 sq cm and 1,325.0 sq cm with a mean ground surface of 821.0 sq cm.

The slab metates have been marginally and facially shaped by grinding, pecking, or flaking. The utilized surfaces display lengthwise, widthwise, or length and widthwise striations. The surfaces have a ground area ranging between 130 sq cm and 593.0 sq cm and a mean surface area of 333.2 sq cm.

One basin metate was recovered from the site. It has been shaped by pecking and has a basin depth of 2.0 cm. The primary wear on the metate is from grinding and it has circular striations present. The ground surface area is 496.0 sq cm.

Food processing activities were intensely pursued at the Hough site. Corn is present in just about all of the macrobotanical samples taken from each room and feature. The palynological studies found corn on some of the manos, both one-hand and two-hand, and on surfaces of all three types of metates. Corn use seems to be more prevalent at the Hough site than in any of the other sites on the Luna project.

Spurgeon Draw (A.D. 1200) is a small pueblo with two roomblocks, each with four rooms, a pit structure in the center, a jacal type feature, and a water catchment basin. The mano and metate assemblage totaled 101. One-hand and two-hand manos are almost evenly distributed among the assemblage. Approximately 60 percent of the one-hand manos have been fully shaped by methods of grinding, pecking, or flaking. Five of the one-hand manos had opposing ground surfaces, the others had one ground surface. The striations present on the ground surfaces were lengthwise, widthwise, random, and length and widthwise. The ground surface area ranges from 24.0 sq cm to 67.0 sq cm, with a mean area of 36.8 sq cm.

Ninety-two percent of the two-hand manos have been fully shaped by grinding, pecking or flaking. Approximately 40 percent have opposing grinding surfaces that exhibit lengthwise, widthwise, or length and widthwise striations. The ground surface area ranges between 97.0 sq cm and 280.0 sq cm, with a mean ground area of 162.1 sq cm.

The metate assemblage consists of trough (n = 9) and slab (n = 11) artifacts. Both have been fully shaped by grinding, flaking, and pecking. The trough metates have a trough depth that ranges from 1.0 cm to 8.0 cm and exhibit lengthwise, widthwise, and length and widthwise striations. The ground surface area ranges between 660.0 sq cm and 1,323.0 sq cm with a mean surface area of 959.4 sq cm. The slab metates all have one ground surface which display lengthwise, random, and length and width striations. The ground surface area ranges between 504.0 sq cm and 1,485 sq cm and have a mean area of 1,048.0 sq cm.

Heavy use of the ground stone assemblage is indicated by the exhausted manos and the depth of the trough metates. The slab metates exhibit a great amount of use and have smooth surfaces, possibly from fine-grain milling. Corn is present on the site in both the palynological and macrobotanical samples taken from a trough metate and a two-hand mano (trough type) on the floor of the pit structure. Corn was also present on two other metates and a mortar recovered from the fill of the pit structure.

The DZ site (A.D. 1160) is another small pueblo consisting of four rooms. One room may have also been used for ceremonial purposes. The ground stone assemblage is fairly large as is the number of manos (n = 59) and metates (n = 23). Thirty percent of the mano assemblage are indeterminate fragments, which is high compared to the other sites on the project. Dominating the assemblage are the two-hand manos that have been shaped by flaking, pecking, or grinding. Over 50 percent of them have opposing ground surfaces and have lengthwise, widthwise, and length and widthwise striations on the surfaces. The ground surface area ranges between 77.0 sq cm and 198.0 sq cm with a mean of 146.7 sq cm. The one-hand mano assemblage is very small (n = 6). Fifty percent have been fully shaped by grinding, flaking, or pecking. All but one has opposing ground surfaces and exhibit widthwise and length and widthwise striations. The ground surface area ranges between 28.0 sq cm and 54.0 sq cm, giving a mean of 38.3 sq cm.

Trough and slab metates constitute this category on the site. Trough metates dominate the assemblage with 11 artifacts. They have all been shaped by methods of pecking, grinding, or flaking. The metate depth ranges from .4 cm to 11.0 cm and have lengthwise striations. The ground surface area falls between 187.0 sq cm and 873.0 sq cm with a mean area of 605.0 sq cm. The slab metates have been shaped by using the same methods as the trough metates. Their surfaces exhibit lengthwise, widthwise, or both length and widthwise striations and have a ground surface area ranging from 238.0 sq cm to 370.0 sq cm with a mean area of 272.5 sq cm. The basin metates were shaped by grinding and pecking. The depth of the circular depression measured 11.0 cm and exhibited circular striations.

It is evident that processing corn and other wild resources were being performed at the DZ site. The depth of the trough and basin metates would suggest that tool use was heavy. The presence of corn was found in Room 1 on the two trough metates and the associated two-hand manos and in Room 2 in a mortar.

Leaping Deer Ridge is multicomponent; however, the Late Pueblo period (A.D. 1200) portion contained all of the ground stone. The assemblage is very small consisting of a one-hand mano and a slab metate. The mano does not seem to have been shaped and exhibits lengthwise and widthwise striations on one surface. The slab metate has been shaped by grinding, flaking, and pecking, and the surface exhibits length and width striations. No ground surface area was monitored because a portion of the metate was missing.

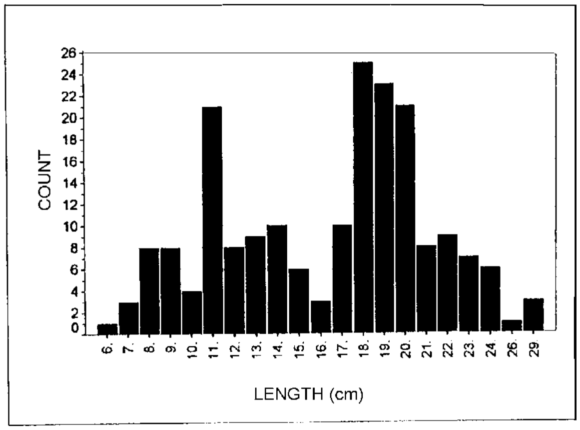

Figure 3.31. Mano lengths for the Luna project.

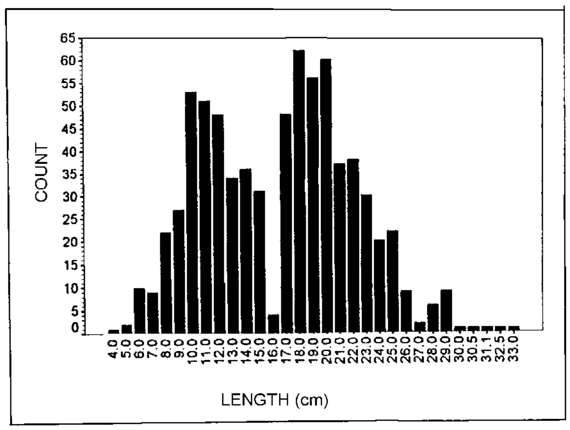

Figure 3.32. Mano lengths for the Mogollon Highlands.

Corn was found in the macrobotanical samples but not in the palynological samples. The presence of corn would suggest that it was being processed but it was not present on the ground stone artifacts; it was found within the small hearth.

Athabaskan

No whole manos were present on the Athabaskan sites of the Luna project; however one slab metate with a ground surface area of 350.0 sq cm was recovered from Apache Woods.

CHANGES THROUGH TIME

Everything changes through time and ground stone is no exception. In modern times it is called progress, and during the prehistoric period it is referred to as increasing dependence upon agriculture. Modern machinery has replaced physical labor to produce

Table 3.184. Ground Stone Data from the Mogollon Highlands, Excavated Sites

Site	Reference	Period
Winn Canyon	Fitting 1973	Early Pithouse
Mogollon Village	Gilman et al. 1991	Early Pithouse and Late Pueblo
Red Bow Cliff Dwellings	Gifford 1980	Late Pueblo
Tule Tubs Cave	Gifford 1980	Reserve
Pine FLat Cave	Gifford 1980	Late Pueblo
Tia Kii Ruin	Haury 1985b	Late Pueblo
Bear Ruin	Haury 1985c	Archaic
Bluff Site	Haury 1985c	Archaic
LA 6082	Kayser 1975	Pinelawn, Reserve, and Tularosa
LA 6082	Kayser 1975	Three Circle, Reserve, and Tularosa
Saige-McFarland Site	Lekson 1990	Three Circle and Reserve
Table Rock	Martin and Rinaldo 1960b	Late Pueblo
Wet Leggett	Martin and Rinaldo 1950a	Archaic
Promontory Site	Martin and Rinaldo 1950a	Pinelawn
Twin Bridges Site	Martin and Rinaldo 1950a	Three Circle
Oak Spring	Martin and Rinaldo 1950a	Reserve
Turkey Foot Ridge	Martin and Rinaldo 1950a	Three Circle
Apache Creek Pueblo	Martin et al. 1957	Tularosa
Valley View Pueblo	Martin et al. 1957	Tularosa
Higgins Flat Pueblo	Martin et al. 1956	Tularosa
Sawmill Site	Bluhm 1957	Reserve
Beach Site 30	Martin and Rinaldo 1960a	San Francisco
Beach Site 31	Martin and Rinaldo 1960a	Reserve
Little Ortega Lake Site	Martin and Rinaldo 1960a	Archaic
Laguna Salada Site	Martin and Rinaldo 1960a	Archaic
Foote Canyon	Rinaldo 1959	Tularosa
Wet Leggett Pueblo	Martin and Rinaldo 1950a	Reserve
Three Pines	Martin and Rinaldo 1950a	Reserve
South Leggett Pueblo	Martin and Rinaldo 1950a	Reserve
Cordova Cave	Martin et al. 1952	Archaic, Pinelawn, San Francisco, and Tularosa
Tularosa Cave	Martin et al. 1952	San Francisco
Crooked Ridge Village	Wheat 1954	Tularosa
SU	Wills 1994	Pinelawn

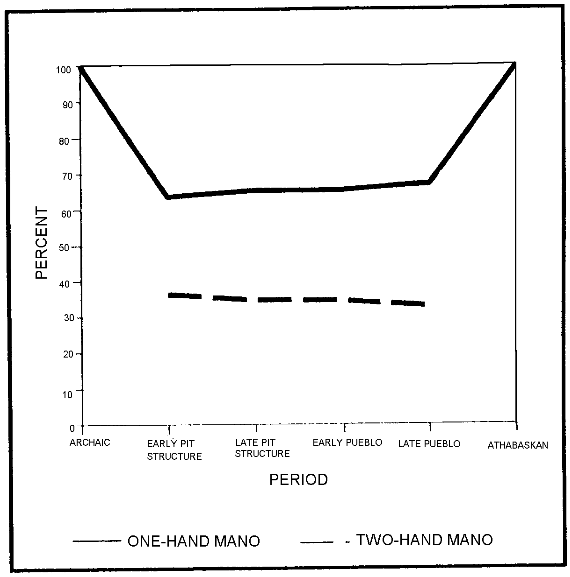

Figure 3.33. Manos through time on the Luna project.

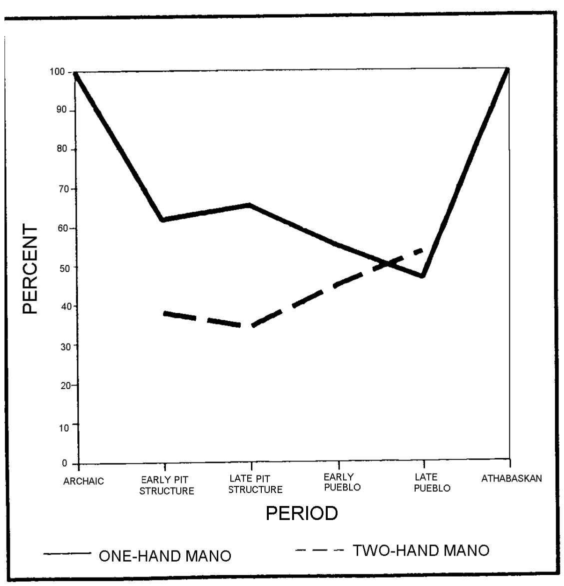

Figure 3.34. Mano types through time in the Mogollon Highlands.

larger quantities of goods, but prehistoric people had to find better ways of producing more food (for example, through improvements in grinding tools) to keep up with the growing population. The changes in manos and metates through time is one way that we can monitor that process.

There are many different classifications for manos. Many archaeologists like to categorize them into one-hand and two-hand types. However, Hard (1990) points out that these categories are somewhat of a misnomer, since both types are used with both hands. For our purposes, we have split the manos into one-hand and two-hand by size. One-hand manos are small with a comfortable fit for one hand. The two-hand manos are large enough to be held with two hands side by side. We have used Hard's method of using mano length for separating the two types of manos, with the one-hand types ranging from 2.4 cm to 15.99 cm and the two-hand ranging from 17.0 cm to 33.0 cm in length with the sizes determined by the bimodal distribution found in Figure 3.31. There is a low dip in the distribution at 16.0 cm, where it is difficult to place manos (n = 3) into either category. This same bimodal distribution can be seen in Figure 3.32, where ground stone data from all available sites in the Mogollon Highlands were tabulated (Table 3.184).

One-hand manos are present throughout all periods in the Mogollon Highlands (Figs. 3.33, 3.34). Use by Archaic and Athabaskan populations are indicated; however, the sample size for these periods is small and the amount of use is actually unknown. For the Mogollon area, in general, one-hand manos decrease in use by the Late Pueblo period while two-hand mano use increases. The two-hand manos are not present in the Mogollon Highlands until the Early Pithouse period; they are also not present during the Archaic period.

It is widely assumed that one-hand manos are primarily used for wild food processing, but in fact, this may not be true. Calamia (1990) has suggested they might be part of a portable tool kit and J. Adams (1988), in her use-wear analysis of hide processing stones, shows that what are sometimes assumed to be one-hand food processing manos may in fact be multipurpose tools, used in some cases to remove hair and flesh from hides, and in others to pack down and polish earthen floors. On the Luna project, at least six one-hand manos from temporally different sites contained some form of corn or corn starch.

Lancaster (1983) suggests that in the Mogollon culture, slab metates are functionally similar to basin metates, in that they are both primarily used for wild food processing. This is in contrast to the use suggested for slab metates in the Anasazi culture, which, as a relatively late development, replace the trough metate with a slab set into a mealing bin. The assumption that Lancaster (1983) makes about basin and slab metates being used primarily for wild food processing is not correct for the Luna project.

In Figure 3.35, basin metates are found during the Early Pithouse period; however, slab metates are found throughout each period, while trough metates do not evolve until the Late Pithouse period. The inverse uses of slab and trough metates during the same time periods is unexplained. It is commonly believed that basin metates are found only during the early periods and slab and trough metates are associated with the later periods. J. Adams (1996) believes that basin

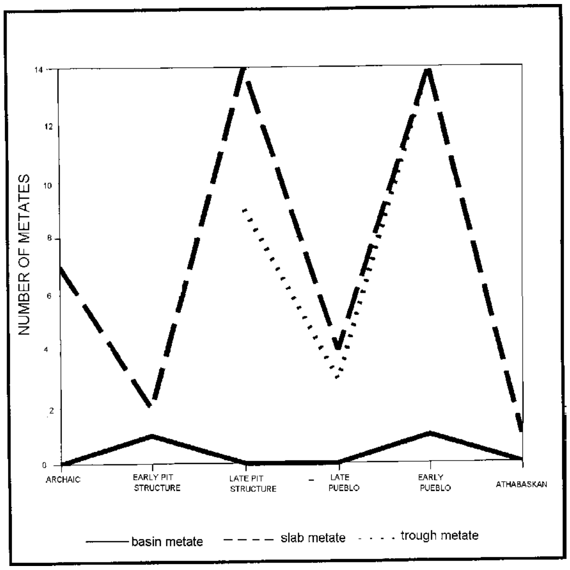

Figure 3.35. Metate types through time.

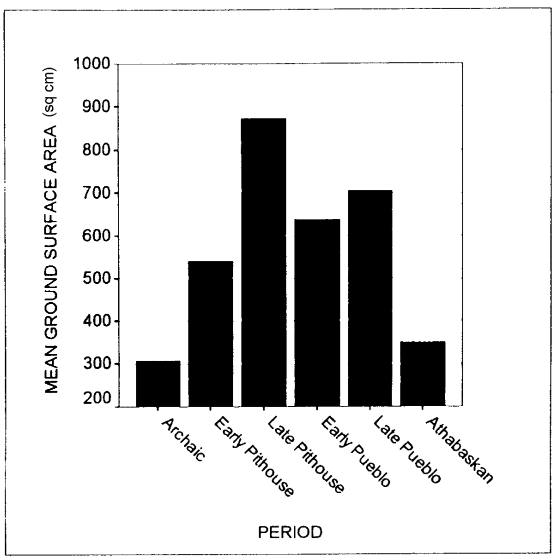

Figure 3.36. Metate mean ground surface area, Luna project.

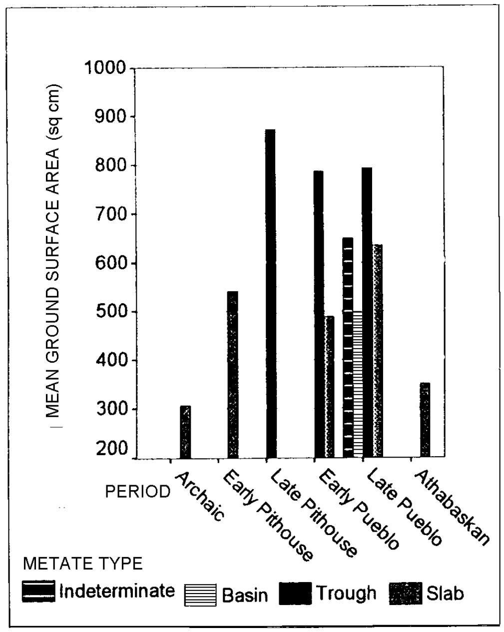

Figure 3.37. Mean metate ground surface area by type.

metates found on later period sites are obsolete tools. However, on the Luna project, basin metates are found only during the Early Pithouse and Late Pueblo periods represented by one each, suggesting minimal use by Mogollon peoples through time.

The ground surface areas of the metates from the Luna Project exhibit their biggest areal coverage during the Late Pithouse period (Figs. 3.36, 3.37), declining during the Pueblo period. This decline in area should not be expected if dependency on corn is increasing.

Evaluation of Several Functional Models

Hard (1990) and Mauldin (1993) produced models to measure dependency on agriculture through ground stone dimensional data. We have the opportunity to compare the data collected for the Mogollon Highlands and the Luna project to their data. If Hard's and Mauldin's models are correct, then there should be a correlation between their conclusions and ours and a demonstration of increasing size of ground stone milling tools through time.

Hard (1990) calculates mean mano length from a variety of manos in museum collections from earlier excavations in the Pine Lawn Valley, and determines that mano length can reasonably stand as an indicator of ground surface area, due to the fact that the width of these artifacts is constrained by the size of a normal handgrip (following Bartlett 1933). Based on their various work on grinding efficiency, the assumption by both Hard (1990) and Mauldin (1993) is that the ground surface area of manos increases with increased corn grinding, and thus correlates with agricultural dependence.

When comparing our data with Hard's (1990), they do not seem to actually correlate. The mean mano length of both one-hand and two-hand manos through time stays about the same, increasing only very slightly (Figs. 3.38, 3.39). Mean ground surface area of both types of manos does not generally increase through time either, with a slight decrease in frequency in the Late Pithouse period (Figs. 3.40, 3.41). When combining both one and two-hand mano lengths, Figures 3.42 and 3.43 indicate, again, only a slight increase in ground surface areas, except during the Late Pithouse period where average areas drop somewhat. Fewer two-hand manos were in use at this time, for reasons that are unknown. We would, therefore, expect to find that the ground surface area of the metates

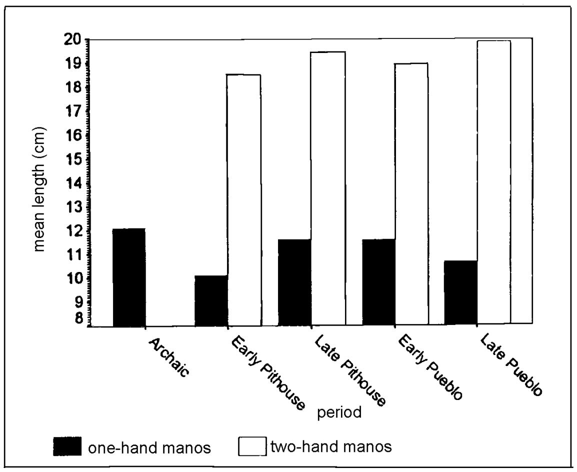

Figure 3.38. Luna project mean mano lengths by period.

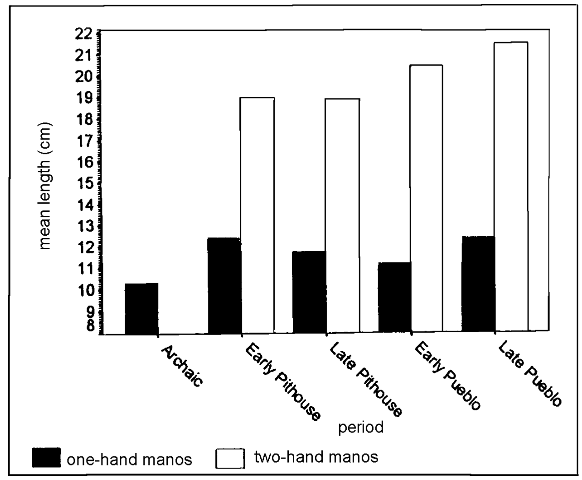

Figure 3.39. Mogollon Highlands mean mano lengths by period.

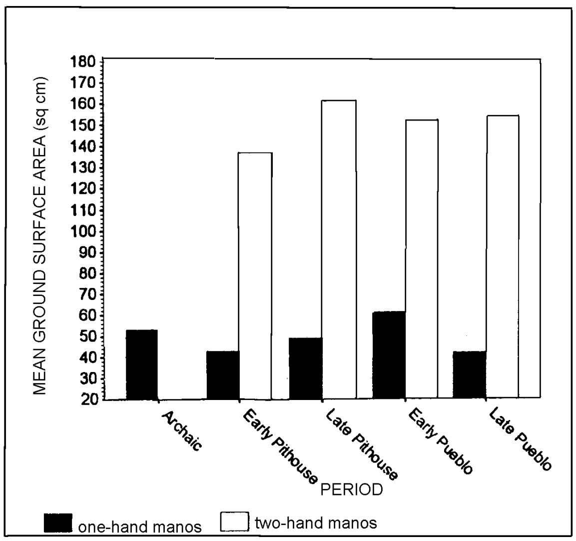

Figure 3.40. Luna project mano categories ground surface area.

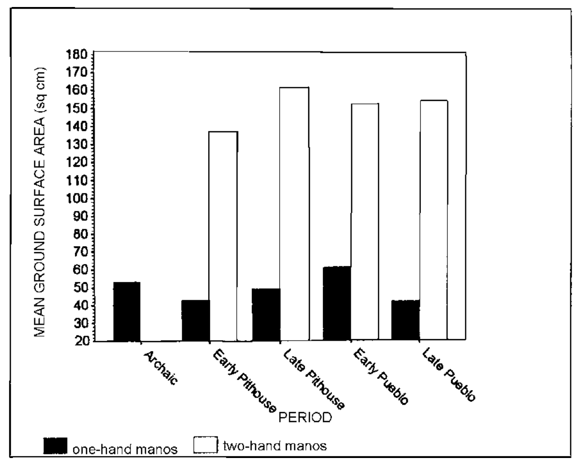

Figure 3.41. Mogollon Highlands mano categories mean ground surface area.

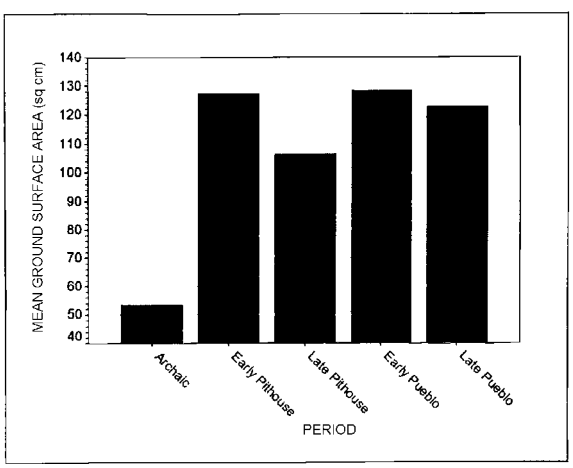

Figure 3.42. Luna project mano ground surface area.

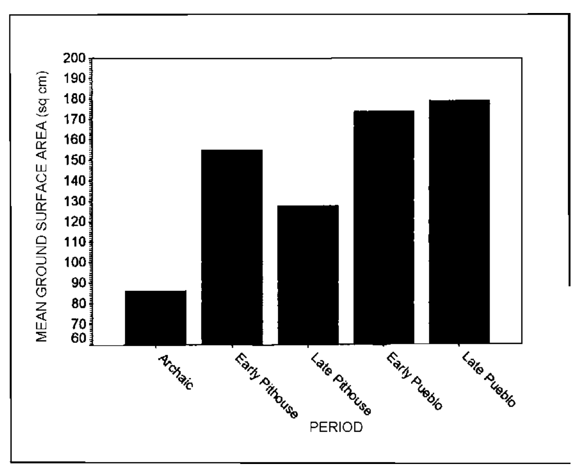

Figure 3.43. Mogollon Highlands mano ground surface area.

would also increase slightly through time along with the mano surface areas, if grinding intensity was a factor. This is not the case (see Fig. 3.36). The Late Pithouse period shows a large increase in metate surface area in contrast to a drop in mano area at the same time, again unexplainable at this point.

Mauldin (1993) expands Hard's (1990) study by looking at the mano ground surface area directly, rather than using length as an indicator. He concludes that during the Early Pithouse period there was limited reliance on agriculture. During the Late Pueblo period, however, he believes reliance on agriculture is extremely high.

The data from our study show that the ground surface area of the two-hand manos increases to a peak in the Early Pueblo period and decreases in the Late Pueblo period. This is in contrast to conclusions reached by Hard (1990) and Mauldin (1993).

Wills (1996) argues that determining dependency on corn production based on ground stone area is debatable since both Hard and Mauldin did not confirm their hypotheses with data on prehistoric corn use from the sites. He further states that if processing time was the critical factor for the size of manos, then smaller size ranges may mean only that grinding was not the primary step in preparing food. He agrees with Cutler (1956) and Snow (1990) that corn grown during the Archaic and Early Ceramic periods at high elevations was likely harvested green and roasted on the cob rather than prepared as flour, allowing for smaller-sized implements.

I agree with Wills (1996) that available ground stone data do not point to a limited or secondary economic significance for corn production because the data we collected do not correlate with either Hard's or Mauldin's data. Martin (1943) also believes that wild resources were extremely significant during the Pinelawn phase. The pollen from the Luna project produced small amounts of corn present on ground surfaces from a few manos and metates during this time. The flotation samples taken from the features produced corn, but not in large quantities, suggesting that although corn was part of prehistoric subsistence at this time, it was not the primary food resource of the prehistoric diet.

Conclusions

There remains the question of how dependent the people of the Mogollon Highlands were on corn. We applied Hard's and Mauldin's models in monitoring use-wear on ground surfaces and measuring the lengths and ground surface areas of the manos. We also measured the ground surface area of the whole metates in order to test their hypothesis that larger is better (J. Adams 1993). J. Adams (1996) argues that larger tools take more energy to operate than there is available if human strength is the source, making grinding efficiency inadequate. However, if tool efficiency is not enough to meet demands, the solution is grinding intensity (J. Adams 1993).

Diehl (1996) believes the shift to greater dependence on corn may possibly be attributed to the introduction of maiz de ocho during the late Georgetown and Early San Francisco phases and the increase in population from A.D. 200 through A.D. 1000. He also argues that corn dependence began much earlier than the Classic Mimbres (A.D. 1000 to 1150), as believed by Gilman (1987, 1988) and Mauldin (1991, 1993). We found corn present from the Archaic period to the Late Pueblo period in the Luna project sites. We would have to agree with Diehl that corn was being processed much earlier than A.D. 1000.

Wills (1996) also believes Archaic use of ground stone was the result of the introduction of possibly maiz de ocho. He further argues if there was a technological shift in ground stone attributable to specialized grain processing from the Late Archaic and Pinelawn phases, it may have been related to a new variety of more productive corn. He does not believe that the data point to a limited or secondary economic significance for corn production.

The flotation samples collected by Wills (1994) at SU and Oakes and Zamora (this report) from 11 sites on the Luna project in the Mogollon Highlands contained corn. At the SU site (Pinelawn phase), corn kernels and cobs fragments were common in the samples; on the Luna project, which identified sites that ranged from Archaic to Late Pueblo period, corn was not common. The fragments found were small and only a few were present. Not every sample contained corn. Only the Hough site contained a large amount of corn.

The pollen analysis was most successful in identifying corn or corn starch. The pollen washes from the surfaces of the ground stone produced even better results. Many pollen washes from ground stone had corn or corn starch present in contrast to the pollen samples taken from ground stone at the same proveniences.

Ground stone technology does change through time, although our data indicate it was not as notable as often thought. Hard (1990) and Mauldin (1993) have made an effort to explain this change through an analysis of mano length and ground surface area. However, the data from the Luna project and for the Mogollon Highlands, in general, do not correlate with their conclusions. If increase in mano length and ground surface area is the indicator of increasing corn dependence, then the ground surface area of the metates should correspond to the increasing mano size. The ground surface area of the metates decreases through time in the Mogollon Highlands and on the

Luna project sites specifically. As a measure of corn dependence, we believe Hard's (1990) and Mauldin's (1993) data are inconclusive because several data sets, including the Luna data, do not seem to support their conclusions.

The ground stone analysis from the Luna project excluded fragmented pieces for comparisons with the above-stated models. At the SU site and on the Luna project there was a large amount of discarded manos. These artifacts were worn and broken through heavy use, and they may signify intense food processing on sites. Perhaps these partial artifacts should have also had their surfaces checked for dietary resources. In most instances during the Luna Project, samples were taken from only the whole artifacts.

It is still unclear if ground stone can accurately measure the dependence on corn through time. Technology changes, but is it because of increasing agricultural dependence, population increase, shifts to sedentism, or could it be stylistic change like we find in ceramics and projectile points? Diehl (1996) suggests that the change in grinding tools over time may be due to increased corn consumption, increased trade, and a shift to nuclear families.

The ground stone data from the Luna project suggest that corn was used both as a dietary supplement and sometimes as a primary staple, but an overall dependence on corn as suggested by some researchers for the Mogollon Highlands is questionable. The ground surface area of the metates decreases during the Late Pueblo period when corn was thought to be consumed the most. However, the mano ground surface area increases during the Early Pithouse and Early Pueblo periods for the Luna project and for all the site in the Mogollon Highlands, creating a difficulty for interpreting agricultural dependency.

It may be that corn was harvested green as suggested by Cutler (1956) and Snow (1990); but there were very few corn remains in the majority of hearths and pits. Mauldin (1990) mentioned looking at vessels for boiling corn into hominy; however, once the corn is boiled the nutrients are lost and the residue is not necessarily left on the pots. The ceramics from the Luna project contained many wide neck jars with smudged interiors, but it is very difficult to say whether these were used for boiling corn (Dean Wilson, pers. comm. 1998). There is very little information in the literature on this subject, making it difficult to draw a conclusion.

Lancaster (1983), Gilman (1987), Hard (1990), Mauldin (1993), Diehl (1996), and Wills (1996) are several researchers that have provided us with issues to explore with the ground stone data. Zier (1981), J. Adams (1988, 1995, 1996), and Wright (1993), through experimentation, were able to reconstruct use-wear patterns using different ground stone material types on several different food and nonfood resources. Their experiments reveal that damage done by them to ground stone surfaces are similar to those found on prehistoric ground stone we find today. Even with this data available more research needs to be done before there can be a consensus on whether ground stone is actually a good measure for dependence on agriculture.

MISCELLANEOUS GROUND STONE TOOLS

Joy Beasley and Heather Bixler

The miscellaneous ground stone tool assemblage for the project derives from six sites: LA 39968, LA 39969, LA 39972, LA 39975, LA 45507, and LA 70185. One artifact was also analyzed from LA 87329, which was recorded during the survey (Oakes and Kimmelman 1995). The miscellaneous ground stone tool category refers to artifacts exhibiting some of the characteristics of ground stone but also possess other functional characteristics that require a separate analysis. Included in this analytical category are axes, grooved stones, mauls, and polishing stones (Table 3.185). However, due to the small size of this collection (N = 35), we were unable to make adequate comparisons with other site assemblages.

The miscellaneous ground stone tool analysis monitored several attributes that were adapted from the *Standardized Ground Stone Artifact Analysis* manual (Bullock et al. 1994), and the *Standardized Lithic Artifact Analysis* manual (OAS Staff 1994) used by the Office of Archaeological Studies. The analysis form was modified by additional categories, including provenience and grid, ground stone length, width, and type of striations. Three categories thought to be particularly useful in the analysis of axes were also added: edge angle, wear pattern, and bit reshaping. Hafting was monitored in the analysis of mauls and axes, and width and depth of groove was noted for shaft straighteners. Analysis of all the miscellaneous ground stone tools was performed using a binocular microscope, calipers, and a goniometer to measure edge angle on the axes. Select specimens were also examined by geologists from the New Mexico State Highway and Transportation Department, ERM/Golder Associates (contracting with Los Alamos National Laboratory), and the Santa Fe Community College.

AXES

Fourteen axes, three of which were complete, were found on three sites. The axes range in length from 14.7 to 20.1 cm and weigh between .9 and 1.6 kg. The most common material types are vesicular basalt and rhyolite. There was one hornblende specimen (Table 3.186).

Axes are defined as hand-sized cobbles with one or both ends sharpened into a bit, and whose production includes pecking and grinding to create a hafting element (Bullock et al. 1994). While the term axe implies a limited modern function of wood cutting, axes are in fact diverse in application (Morris 1939; P. Mills 1993). Generally, axe functions fall into two categories for the Luna collection: woodworking and ground-leveling work. Woodworking involves the cutting, splitting, or chopping of wood while ground-leveling work includes hoeing, clearing of brush, and in some instances, the sharpening of other stone tools (Kidder 1932).

Each category has its own set of distinguishing characteristics. Due to the small size and poor condition of this assemblage, qualifying elements were limited to wear patterns and the degree of polish present on the bit of the axes. Wear patterns created by woodworking are expressed through random striations running from the bit of an axe at each angle to the vertical axis and should occur as mirror images on each face of the bit (P. Mills 1993). Axes from Luna Village and an axe fragment from the DZ site both demonstrate this type of wear. Uniquely, both also possess a high degree of polish on their blade tips which has obliterated evidence of sharpening and reflects only that use for which the axe was last employed. In contrast, an axe from nearby site LA 87329 also indicates initial wood wear but has had most of its polish ground away by resharpening (see Table 3.186). Resharpening is distinguished by striations running parallel to the blade of the bit (P. Mills 1993). On top of these striations there are also several sets of random striations that appear perpendicular to the axe blade on both faces of the tool. These markings are consistent with wear caused by use in sediments. It would follow that due to the abrasive nature of soil, axes employed for ground-leveling work are not as polished as axes used for wood cutting.

An axe from the DZ site, although nearly complete, has lost a good portion of its original bit (Fig. 3.44b). It appears to have been broken during utilization and then reshaped through flaking. There is no visible use wear and nothing exists of the original bit to determine how it was being used. However, if design characteristics are used as indicators of function, it is more similar to axes used for ground-leveling work.

Luna Village contained the only full-grooved axe. It is also the only axe that does not have a ridge around the groove. The bit portion has a short cutting edge and the sides of the bit possess a distinct triangular shape (Fig. 3.44b). Axes from LA 87329 and LA 70185 are each ¾-grooved axes with ridges around the groove and facets distinguishing the four faces of the bit. Both axe bits slope into the groove at a narrow angle, making their shape more rectangular than triangular. The LA 87329 axe has a shorter cutting edge than the

Table 3.185. Miscellaneous Ground Stone Tool Frequency

Cells: Count Row Percent Column Percent	Function								Row Total
	Shaft Straightener	Polishing Stone	Palette	Maul	Axe	Stone Bowl	Cylindrical Tool	Medicine Stone	
3279					2 33.3% 14.3%	3 50.0% 100.0%		1 16.7% 100.0%	6 100.0% 17.1%
39968		1 10.0% 100.0%	2 20.0% 22.0%		6 60.0% 42.9%		1 10.0% 100.0%		10 100.0% 28.6%
39969	1 20.0% 33.3%		3 60.0% 33.3%		1 20.0% 7.1%				5 100.0% 14.3%
39972	1 33.3% 33.3%			2 66.7% 66.7%					3 100.0% 8.6%
39975				1 100.0% 33.3%					1 100.0% 2.9%
45507			4 80.0% 44.4%		1 20.0% 7.1%				5 100.0% 14.3%
70185	1 20.0% 33.3%				4 80.0% 28.6%				5 100.0% 14.3%
Column Total	3 8.6% 100.0%	1 2.9% 100.0%	9 25.7% 100.0%	3 8.6% 100.0%	14 40.0% 100.0%	3 8.6% 100.0%	1 2.9% 100.0%	1 2.9% 100.0%	35 100.0% 100.0%

Table 3.186. Axe Descriptions

Site	Field Specimen Number	Material Type	Complete	Reshaping	Polish	Weight (Kg)	Edge Angle (Degrees)
3279	353	Basalt	no	indeterminate	yes	.25	indeterminate
3279	2037	Basalt	no	indeterminate	yes	.22	indeterminate
39968	253	Serpentine	yes	no	yes	.85	66
39968	1053	Adesite	no	indeterminate	indeterminate	.10	indeterminate
39968	1812	Andesite	no	indeterminate	indeterminate	.10	indeterminate
39968	2099	Basalt	no	yes	yes	.7	60
39969	856	Quartizite	no	yes	no	.45	55
45507	207	Rhyolite	yes	yes	yes	.9	47
70185	415	Basalt	no	indterminate	yes	.35	90
70185	1323	Basalt	yes	yes	no	1.45	78
70185	1491	Hornblend	no	indeterminate	yes	.25	49
87329	1	Rhyolite	yes	yes	yes	1.6	46

one from the DZ site, but once again the original bit of the axe from LA 87329 is incomplete, and it is unknown if the original cutting edge was greater or smaller than its present dimensions. Luna Village produced the only axe recovered from a Three Circle phase site; the others were collected from later Reserve phase sites. The ¾- and full-grooved axe designs are contemporaneous for both Three Circle and Reserve phases (Wheat 1955).

Primitive axes were used for a multiplicity of tasks beyond the conventional function of chopping wood. Mills, in his 1993 article, states:

> In the greater Southwest and Mesoamerica, various uses have been proposed for prehistoric stone axes that include chopping brush (Hammond 1986:112), hoeing (Roberts 1940:120; Hughs 1977:147), and pick work (Holmes 1919:231; Reed 1951: 45) . . . The Hopi are reported to use axes as metate sharpeners, masonry tools, grooved-stone anchors for crow traps, and weapons of war (Stephan 1936:95-98; Woodbury 1954:41; Wright 1979:49).

The various functions can be identified through wear patterns and sometimes through design characteristics (Table 3.187). However, due to the small size and poor condition of the project collection it is difficult to observe any consistency in either set of characteristics.

An axe from Haury's site is missing a large portion of its bit, therefore original use wear is not identifiable (Fig. 3.46b). Secondary use wear, however, indicates that after the blade was broken, the tool was reshaped through flaking and then used as a chopper. Use wear is limited to the blade edge and no striations appear on the sides of the bit. The butt end has been battered extensively, indicating the tool has been used as a hammerstone or pestle. Spurgeon Draw axes are too fragmentary to observe any use-wear pattern.

The three complete axes show use striations consistent with a wood chopping function (Fig. 3.45c). All have striations that run from the bit at an angle to the vertical axis and occur as mirror images on each face of the bit (P. Mills 1993). Both also have a high degree of polish present on their bits indicating that they were not used in abrasive sediments during their last use. However, it is difficult to demonstrate that wood wear creates a heavier polish than ground-leveling work as no axe in the assemblage reflects wear patterns associated with ground-leveling work. Polish may also be more relative to material type than wear.

P. Mills (1993) discusses the possibility of design differences, as well as wear patterns, distinguishing between axes used for wood and those used for ground-leveling work. Among some of the characteristics are weight and edge angle or sharpness of bit (Table 3.187). Mills notes that the majority of axes recovered at Sand Canyon Pueblo demonstrating characteristic wood wear all weighed below .6 kg and were kept at relatively sharper edge angles than those used for ground-leveling work.

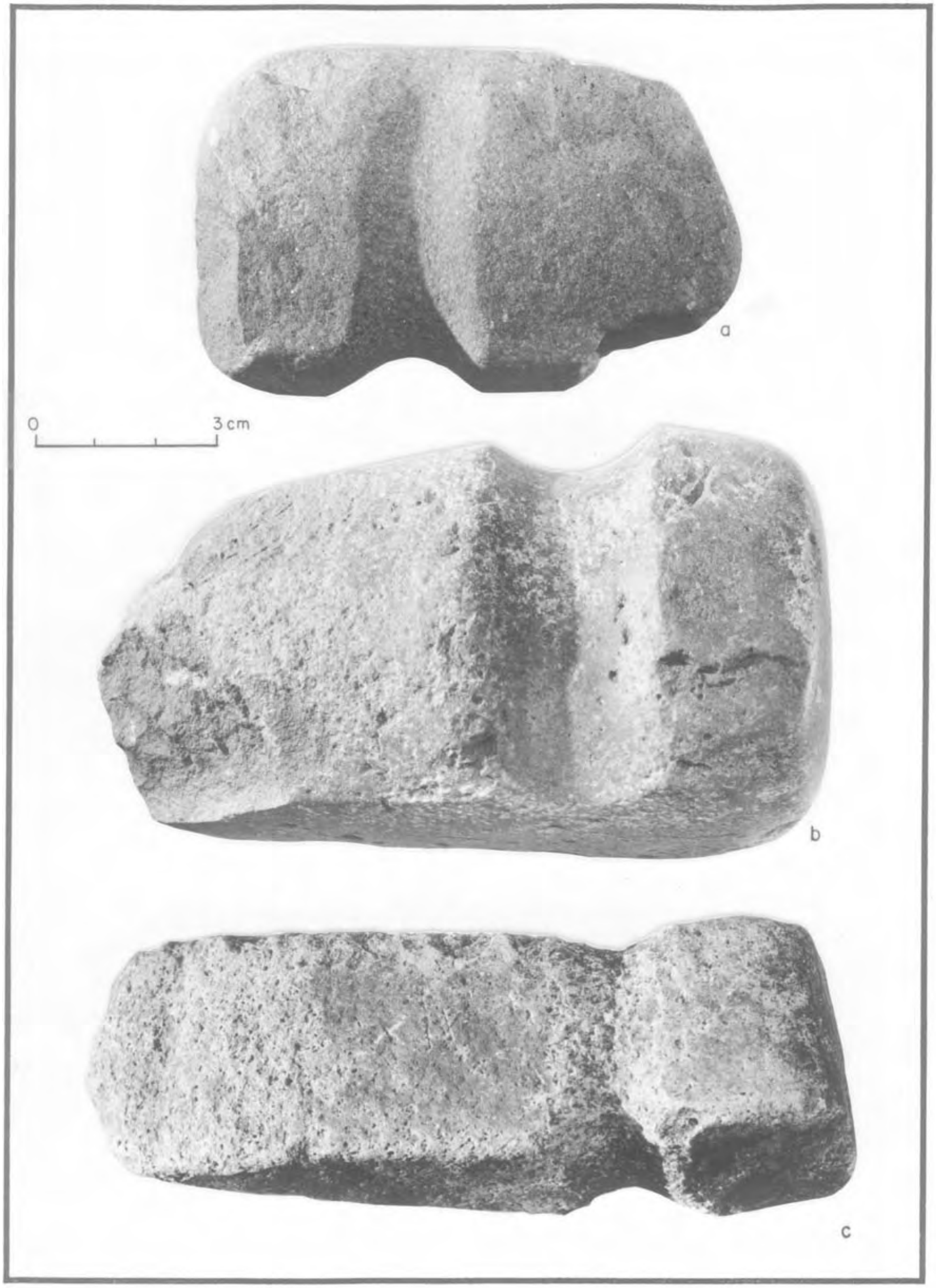

Figure 3.44. Axes: (a) LA 70185, (b) LA 45507, (c) complete ax indicating wood chopping, LA 3279.

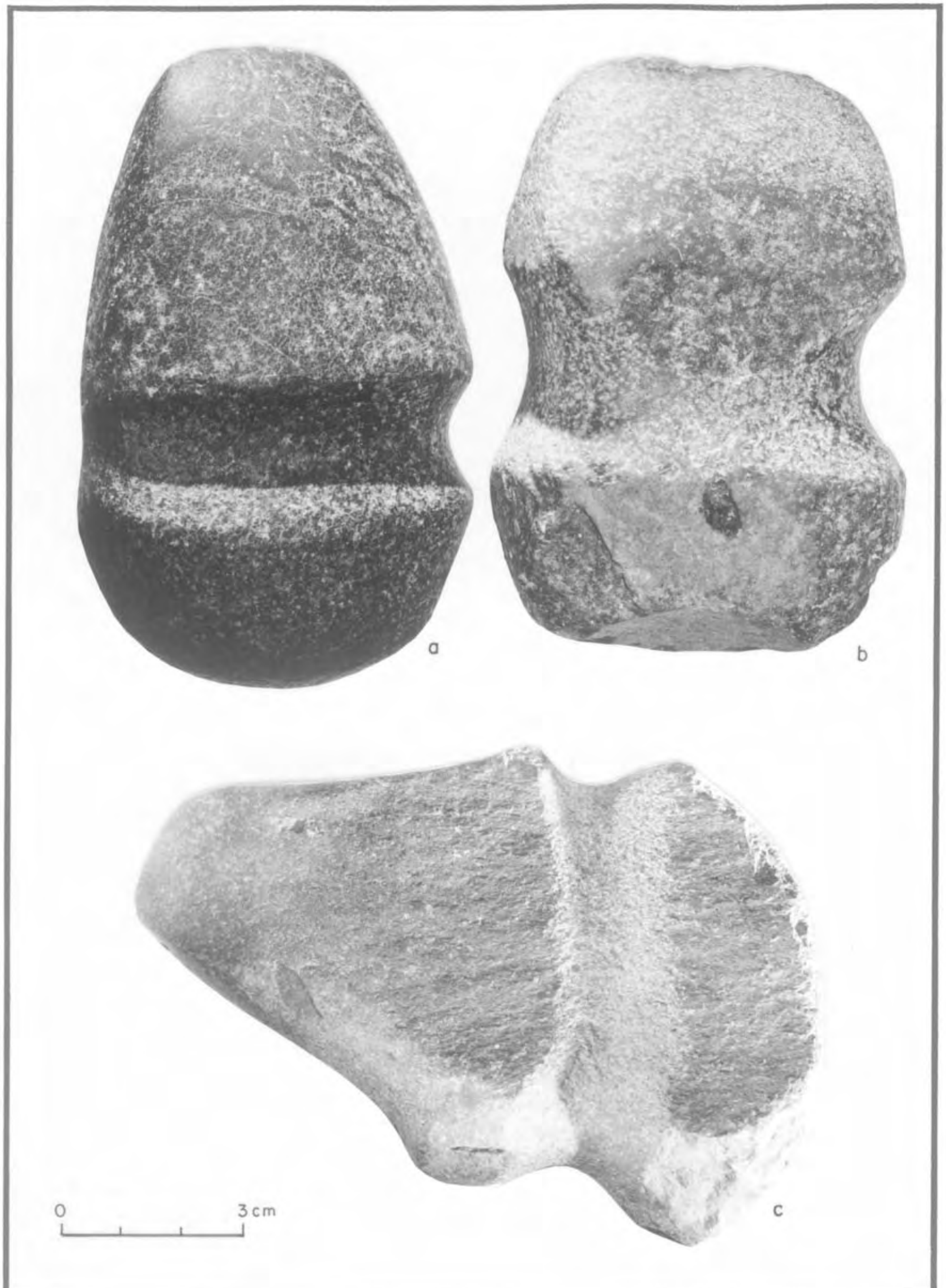

Figure 3.45. Axes: (a-b) LA 39968, (c) complete ax indicating wood chopping, LA 39969.

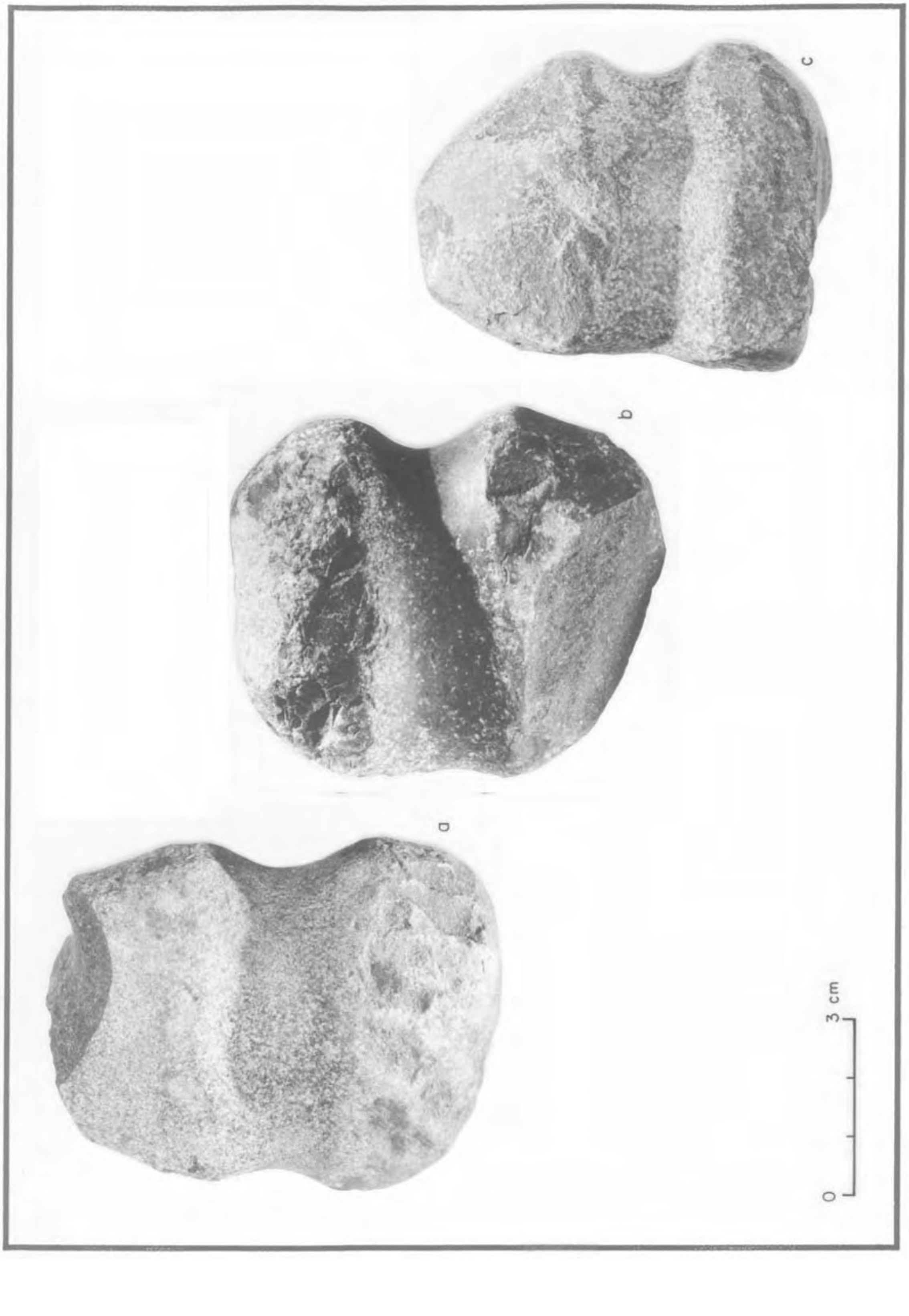

Figure 3.46. Axes: (a) LA 39968, (b) ax reused as a chopper, LA 39968, (c) ax with secondary use as a hammerstone, LA 3279.

Table 3.187. Design Characteristics

FS Number	Full Groove	3/4 Groove	Ridges on Groove	Faceted Bit
253		YES	YES	YES
856		YES	YES	
1053			YES	YES
1812			YES	YES
2099	YES		YES	YES

In his comparative experiment using axes replicated from collection specimens, P. Mills (1993) notes that heavier axes were more difficult to use when chopping perpendicular to the force of gravity, and duller axes did not cut as efficiently as the sharpest prehistoric model. Unfortunately Mills cites no clear method for qualifying sharpness versus dullness in prehistoric axes. His range was taken from the sharpest to the dullest axes found in the Sand Canyon Pueblo collection. Spurgeon Draw has the only axe in the assemblage that may be considered fully complete; therefore, there is no basis for comparison in measuring edge angles. It must be assumed that due to the nature of the wear patterns (i.e., striations; Fig. 3.45a), the edge angle was sufficient enough to chop wood efficiently.

Another axe from the same site shows wear patterns consistent with woodworking as well. It is also possible that it may have been used for ground-leveling work (Fig. 3.45b). The bit appears to have been broken at some point and then reshaped into its present form; the original length of the bit would have been considerably longer. The added weight to an axe already weighing .7 kg would have made it a better axe for ground-leveling work.

The reshaping of these axes would seem to demonstrate that they were used for many tasks even after breakage. Depending on the degree of damage, bits could be reformed into choppers or axes of differently intended functions (i.e., woodworking versus ground-leveling work) and butts could also be used as hafted or unhafted hammerstones (Figs. 3.46a, 3.46c). Weight appears to be the only limitation when considering what function an axe can perform. The three axes from the assemblage that demonstrate wood wear exceed the weight boundaries set by Mills in his test. However, this discrepancy in weight distribution may be due to the variation in material types available in each area and may also be influenced by cultural preferences.

Material types for the assemblage have been previously listed in Table 3.186 and all are believed to have been quarried from local sources. One axe from Spurgeon Draw is believed to be of serpentine containing the mineral pyroxene (Florie Caparuccio, ERM, Golder Associates, Los Alamos, New Mexico, pers. comm. 1995). This mineral is not native to New Mexico and would most likely have been imported from California or Mexico. A type of pyroxene called aegerite has been sourced in the Caballo Mountains in Sierra County, New Mexico, however, it is impossible to identify the specific type of mineral from the axe without taking a thin section. Due to the pristine condition of the axe, no such test was run. Several axes of what seem to be this same material have been found on sites in the Mimbres Valley and are considered locally available.

Design characteristics seem to vary as much as material and function. None of the axes fits neatly into any design plan. All axes were recovered from Late Pithouse or Reserve phase sites, and according to Wheat (1955), both full- and ¾-grooved axes were common stylistic elements for the area and period. Design characteristics such as ridges around the groove and faceted blades seem to reflect independent stylistic preferences. Axes with similar traits have been recovered from contemporaneous sites at Galaz Ruin (Lancaster 1983) and at OAS excavations at Luna.

Due to the small size of the Luna collection, it is difficult to effectively demonstrate stylistic change over time or dominance of one task or function over another. It must suffice to say that axes were used for a diversity of functions, in this particular assemblage for wood and ground-leveling work, and that both full-grooved and ¾-grooved axes were utilized in Pithouse and Pueblo periods.

Mauls

A large rhyolitic cobble with a rudimentary hafting groove was recovered from the Reserve phase portion of SU Tanks. It is 12 by 11 by 7.6 cm and has been extensively pecked around the perimeter, suggesting it may have been a maul preform. There is also a slight depression pecked in the center of one side, possibly from secondary use as an anvil or lapstone. Mauls are rounded cobbles grooved around all or part of the circumference of the stone whose general shape and use wear suggest that they have been used for hammering and pounding (Wheat 1955; McGimsey 1980). Three mauls were recovered from the Luna project: one of limestone from the Pinelawn phase site of Lazy Meadows, one of rhyolite from the Three Circle phase site at Luna Village, and a nonvesicular basalt specimen from the Tularosa phase DZ site.

Table 3.188. Maul Morphology

Site	Field Specimen Number	Haft	Material	Length (Cm)	Width (Cm)	Thick (Cm)	Wear
39975	497	Full grooved	Limestone	10.9	7.4	6.5	No
70185	1327	3/4 grooved	Basalt	11.3	7.3	3.7	No
45507	2000	3/4 grooved	Rhyolitic tuff	12.5	9.0	7.0	Yes

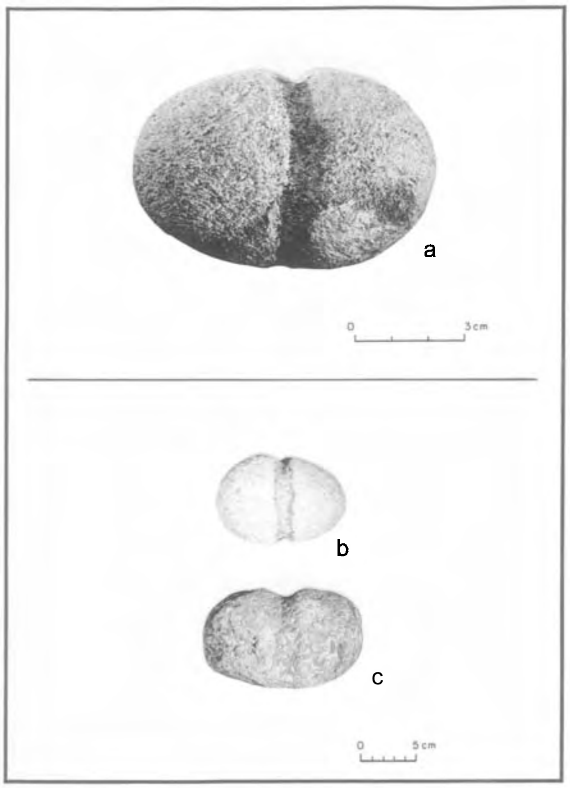

Figure 3.47. (a) Full-grooved maul from Lazy Meadows, LA 39975; (b-c) ¾-grooved mauls, LA 70185 and LA 45507.

The limestone specimen is an elongated round-ended hammerstone with a full hafting groove .6 cm in depth (Fig. 3.47a). Due to the roughness of the material it is difficult to tell if the cobble has been shaped by pecking and grinding or whether it was used in its natural form. The hafting groove is slightly off-center, and again the roughness of the material obscures any striations or polish in the groove, as well as any evidence of battering on either end.

The rhyolite specimen from Luna Village (Fig. 3.47c) is the largest of the three and has been roughly shaped by pecking and grinding, with extensive battering on both ends. It has a three-quarter hafting groove 1.1 cm in depth, but shows no evidence of polishing in the groove.

The nonvesicular basalt specimen from the DZ site (Fig. 3.47b) is an elongated flat-ended hammer with a three-quarter hafting groove .4 cm in depth. It is fully shaped by pecking and grinding and shows extensive damage on both ends, which may be related to battering wear. McGimsey (1980) has postulated that this type of hammer represented the "norm" for a general all-purpose hammer, but with such a small sample it is difficult to say if this sort of maul was the predominant type in the Luna area.

Wheat (1955) has noted that mauls occur in every period and every branch of the Mogollon. Thus it is not surprising that the mauls recovered from Luna are from sites of very different time periods. Since the three artifacts are similar in size (Table 3.188) and shape (with the exception of the haft), this may indicate that mauls did not change significantly over time among the Mogollon.

Shaft Straightener

Grooved stones are also known as shaft straighteners, shaft smoothers, and grooved abraders. They are characterized by a shallow groove or channel extending across the surface of the stone. There is some debate as to their function and the manner in which they wereused, but it is generally agreed that they were used to straighten the wooden or cane shafts of arrows (Anyon and LeBlanc 1984). They appear to be fairly common in Mogollon sites (Wheat 1955).

Only one shaft straightener was recovered in the Luna area from the Tularosa phase DZ site. It is a large (14.5 by 13 by 7 cm) slab of rhyolitic tuff with a groove .5 cm in width and .5 cm in depth extending the length of the stone. The groove shows lengthwise striations but no polishing, probably due to the roughness of the material, which would have been well-suited for abrading wooden arrow shafts (Wheat 1955). The dorsal surface has been ground extensively, suggesting it may have been manufactured from a broken metate or lapstone, which would also account for its large size.

Other grooved stones have been recovered by OAS from Reserve and Tularosa phase sites at Haury's site and Spurgeon Draw. Some were better suited for polishing arrow shafts than abrading them, and all were

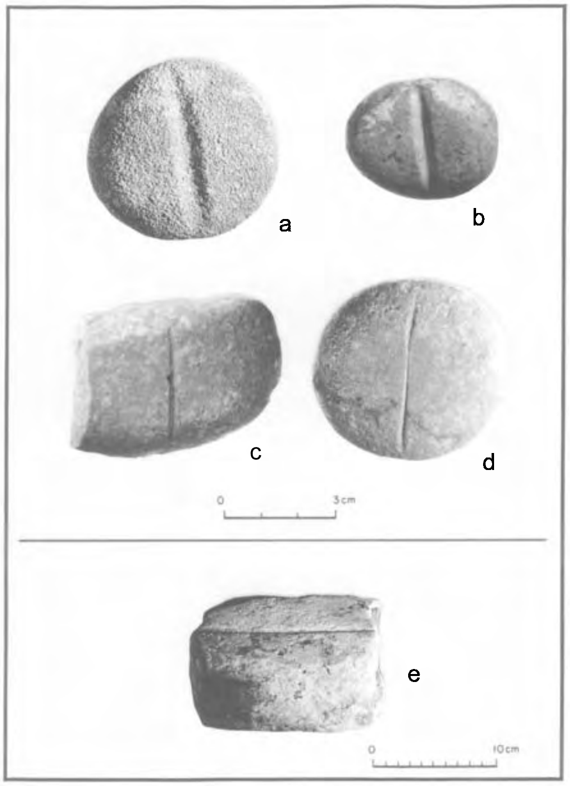

Figure 3.48. Shaft straighteners, (a-b) LA 39968; awl straighteners (c) irregular shaped limestone cobble from LA 39969, (d) oval quartzite cobble form LA 39968, (e) subrectangular sandstone from LA 70185.

significantly smaller than the shaft straightener recovered from the DZ site. As stated above, this is probably related to the artifact's previous function rather than a cultural selection for larger materials.

For the purpose of discussion, the four shaft straighteners recovered from post-A.D. 1000 sites near Reserve can be separated into two categories based on their general morphology. Two specimens are considered arrow shaft straighteners-abraders while the remaining two are identified as awl sharpeners-abraders. This distinction is based mainly on the width of the groove as well as the proposed function of the artifact (Table 3.189).

The shaft straighteners from the Reserve area consist of one of limestone from Haury's site and one of chert from Spurgeon Draw (Fig. 3.48a-b). These two specimens are similar in that both are flattish stones with a groove across the top and both show evidence of shaping in the form of pecking around the perimeter.

The chert specimen from Spurgeon Draw is a smooth, egg-shaped cobble with the groove on the short axis of the stone. The groove itself is .5 cm in width and .3 cm in depth showing lengthwise striations and high polish. This type of artifact was probably used to straighten the cane shafts of arrows (Kidder 1932).

The limestone specimen from Haury's site is round and biconvex in cross section with a groove 1 cm in width and .5 cm in depth. The ventral surface shows random striations, possibly from secondary use as an abrader. Because of the roughness of the material, no striations or polish are discernible in the groove. This sort of artifact may have been more suitable for shaft abrading than for shaft polishing (Wheat 1955).

The three awl sharpeners-abraders recovered from the Luna project are distinguished from the shaft straighteners by the width of the groove (Fig. 3.48c-e), which in all cases would have been too narrow for abrading arrow shafts but may have been useful for sharpening awls or similar implements (Wheat 1955). All specimens are a light gray quartzite with a shallow, narrow channel extending down the center of the artifact.

The first specimen (Fig. 3.48c) from a pit in Floor 1 of the pit structure at Spurgeon Draw is a round, flattish stone shaped by pecking around the perimeter. The groove is .1 cm in width and highly polished from use. An interesting attribute of this artifact is that it has random striations and grinding wear indicating that it has also been used as an abrader on both sides.

The quartzite specimen from the general fill at Haury's site appears to be part of a broken mano, as indicated by visible striations and polish on the same side as the groove (Fig. 3.48d). The edges have been shaped somewhat by pecking, including the side on which the break occurred. The fragment may have then been reused as an awl sharpener. The groove is highly polished and .2 cm in width.

Table 3.189. Shaft Straightener Morphology

Site	Field Specimen Number	Material	Groove Width (Cm)	Groove Depth (Cm)	Abraded	Polished Groove
39968	2081	Quartzite	.2	N/A	Yes	Yes
39968	2203	Quartzite	.1	N/A	Yes	Yes
39968	2235	Chert	.5	.3	No	No
39969	995	Limestone	1.0	.5	Yes	No

One other grooved stone was recovered from the DZ site (Fig. 3.48e). It is much larger than the other grooved stones (14.5 by 13 by 7 cm) and is made of roughly shaped rhyolitic tuff. The groove is .5 cm in width and .5 cm in depth with lengthwise striations. The abrasiveness of the material and the absence of polishing suggests that this tool was used for rasping arrow shafts. The grooved surface has also been ground smooth, indicating that this shaft straightener may have been manufactured from a broken metate or lap stone, which may also account for its large size. LA 70185 is a Tularosa phase site, roughly contemporary with LA 39968 and LA 39969.

POLISHING STONES

Polishing stones are small, naturally smooth pebbles used for scraping or polishing unfired pottery. They exhibit wear in the form of striations and polish on at least one face of each tool, often resulting in a flattened or concave use surface (McGimsey 1980). Six complete polishing stones were recovered near Reserve: four of quartz, one of chert, and one of hematite (Table 3.190). Only two polishing stones were recovered from the Luna area, one of chert and one of hematite.

What distinguishes these pebbles as tools is the presence of striations and polishing on at least one face of each implement (McGimsey 1980). The polished face is usually positioned along the long axis of each pebble, resulting in a flattened or slightly concave use surface. The location of the use surface was apparently determined by any natural flatness as well as ease in holding the pebble (Guthe 1925). Occasionally, polishing stones are used along the perimeter while being grasped by the two flat faces, resulting in increased maneuverability (Wening 1992).

A chert specimen from Luna Village, a Late Pithouse community, was small (see Table 3.190), with one slightly concave use surface showing random striations and polish. The hematite specimen from the Tularosa phase DZ site was larger and had been used on five surfaces, resulting in clearly defined facets, all of which had random striations and high polish. This faceting may be related to the relative softness of the material, suggesting this specimen may also have been a pigment source.

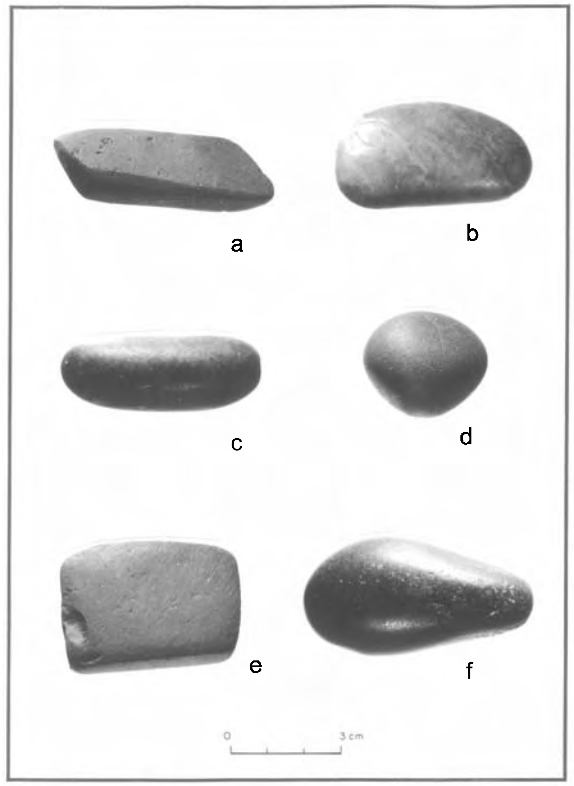

Figure 3.49. Polishing stones: (a-b, d) LA 39968, (c) LA 39972, (e) LA 39969, (f) LA 70185.

Table 3.190. Polishing Stone Attributes

Site	Field Specimen Number	Material	Length (Cm)	Width (Cm)	Thick (Cm)	Use Surfaces	Striations	Battering
39968	1584	Quartz	3.3	3.0	2.0	1	Random	No
39968	1699	Quartz	5.4	3.0	1.6	1	Random	No
39968	2006	Hematite	6.0	2.0	2.0	7	Random	No
39968	2203	Quartz	6.5	3.4	3.0	1	Random	Yes
39969	919	Quartz	7.7	3.6	2.4	1	Random	No
39972	130	Chert	5.5	2.1	1.5	1	Random	Yes
45507	1656	Chert	2.8	2.0	1.5	1	Random	No
70185	1499	Hematite	4.8	3.6	1.6	5	Random	No

Five specimens in our collection, four of quartz and one of chert, showed random striations and high polish, with one face flattened or slightly concave from use. One particularly fine quartz specimen from Spurgeon Draw was used along one face as well as along the perimeter. Two specimens, one of quartz from Spurgeon Draw and one of chert from SU Tanks, were battered on one end, possibly from secondary use as a pestle (Fig. 3.49).

The hematite specimen from Spurgeon Draw is significantly different from the rest of the collection. While it exhibits random striations and polishing, it also has seven use surfaces, resulting in clearly defined facets. These macroscopic facets may be a result of the relative softness of the material, the degree of use, or secondary use of the stone for pigment. The last option is particularly plausible for this specimen, as it is fairly soft and would have been well suited for use as pigment.

Although the polishing stones came from three different sites ranging from the Archaic to Tularosa phases, they are morphologically consistent with one another (with the exception of the hematite specimen discussed above). The mean size for this collection is 5 by 2.7 by 2 cm.

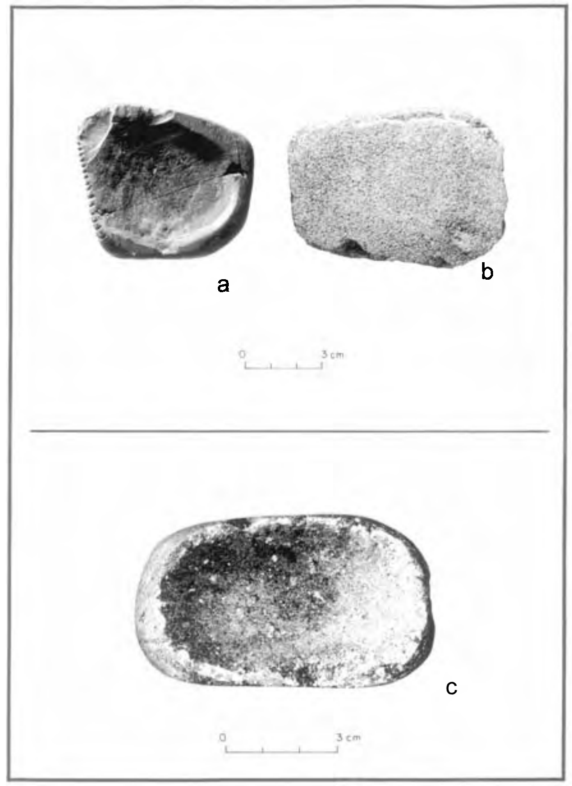

Figure 3.50. Palettes: (a) incised palette from LA 39968, (b) LA 39968, (c) paint palette from LA 3279, Room 10.

PALETTES

Palettes are perhaps the most interesting subgroup within the miscellaneous stone tool category. Their functions range from simple abraders to ornate ceremonial objects. The collection consists of three pieces, but within this small assemblage several functions have been identified. Material types for the three palettes, sandstone from Spurgeon Draw, an andesite specimen from Haury's site, and rhyolite from the Hough site, seem to be consistent with the most common materials used for this type of artifact in the Mogollon cultural area. Palettes of similar design and material types were recovered from a contemporaneous site at Galaz Ruin in the Mimbres Valley (Lancaster 1983).

Ornamentation occurs only on the andesite specimen recovered from Haury's site and consists of an incised edge (Fig. 3.50a). Borders are raised around what appears to be the palette surface but these borders may have more to do with function rather than decoration. The palette is subrectangular, 1.1 cm thick with a circular depression of .3 cm deep that is three-quarters enclosed. The open end is slightly raised and empties over the incised edge. The artifact is 7 cm long and 5.6 cm wide and striations appear on all surfaces; however, only four of seven possible surfaces demonstrate use wear.

Two of the palettes appear to have been originally in tabular form and then shaped into mortar form. Within the palette depression striations appear short and random indicating pigment grinding or possible bead grinding. A small piece of ground turquoise was recovered in the grid at the same level with the specimen from Haury's site, making bead manufacture a plausible function. The edges running the length of the artifact have developed a heavy polish, suggesting use as an abrader against a soft material, perhaps hides or fibers. The artifact has also been burned, which affected the sheen of the polish.

The design of the specimen from Haury's site is akin to the ceremonial palettes of the Hohokam, which according to E. Lowell (1990) were used as hallucinogenic snuff trays or in association with burials. While these are interesting possibilities that support the idea of palettes being a multipurpose tool, there is no evidence to conclude that this particular palette was used in either practice.

The palette from Spurgeon Draw is made from fine-grained sandstone and is less ornate. It is a tabular palette, .8 cm thick, with striations running the length and width on both faces. One is complete and unsharpened. The other has been pecked away at the edges and on the surface from resharpening. The artifact is 8.5 cm long by 6.5 cm wide (Fig. 3.50b).

The palette from LA 3279 is a fine-grained rhyolite that has been stained in the center with hematite, which was ground possibly for paint. The vessel is oval in shape and measures 8.3 cm by 4.9 cm and has a depression of .9 cm. Deep striations are present along the side of the palette. The back side of the artifact has been used for other purposes such as polishing or grinding. Some of the striations are also deep (Fig. 3.50c).

STONE BOWLS

J. Adams (1995:67) defines bowls as "artifacts that were shaped to be containers, but their use for mixing sometimes blurs the distinction between bowls and mortars."

Three stone bowls were recovered from the Spurgeon Draw Site and the Hough site in Rooms 7 and 10 and from the great kiva (Fig. 3.51). Two were complete; one was small in size, 8.10 cm by 4.7 cm with a depression of 7.3 cm, while the other is larger, measuring 27.60 cm by 19.0 cm; the central depression is 2.5 cm (Fig. 3.51a). The other was fragmented and resembled the larger bowl. Peckham (1963:52) recovered two stone bowls from the Luna Junction site, similar to the ones recovered at the Hough site. This is interesting because most of the stone bowls recovered are from Tularosa phase sites and the Luna Junction site dates to the Pinelawn phase.

Martin et al. (1957:63) recovered several stone bowls from Apache Creek Pueblo. Two were rectangular in shape and resembled the one that was recorded by Hough (1914:31) from Spur Ranch near Luna. Other bowls are decorated with carved or incised designs. Di Peso et al. (1974:206-218) found plain vessels at Casas Grande and both Haury (1976:289) at Snaketown and J. Adams (1995:67-68) at the Meddler Point site had some with elaborate designs.

Stone bowls are common, but as J. Adams (1996:18) points out if there is use-wear damage from using a pestle, the artifact is identified as a mortar. This type of artifact is common in Tularosa phase sites and Rinaldo (1956:55-128) suggests these objects are scarce in the upper San Francisco region and were probably traded in from the Hohokam area because they were plentiful on Classic Hohokam sites. Wheat (1954:181) also believes that stone bowls indicate trade relationships with the Hohokam.

CYLINDRICAL TOOLS

Cylindrical tools can be fragments of pestles, corn maidens, unfinished pipes, and unfinished mauls (Bullock et al.1994). The artifacts exhibit cylindrical morphology, but the function is unknown. One specimen was found at Spurgeon Draw that measured 3.5 cm long by 2.0 cm in diameter. The striations were along the length of the basalt artifact. It is possible that it may have served as a pestle; however the two ends were missing.

MEDICINE STONES

The one small medicine stone was found in a foot drum inside the great kiva at the Hough site. It is made of argillite, a soft reddish material that was highly polished and measured 2.40 cm long by .3 cm in diameter. One end tapered to a point. Kidder (1932) found several that were associated with graves and called them "medicine outfits." He believes that they were ceremonial objects. J. Adams (1996:24-25) describes the stones as looking like plummets, but have no obvious means of suspension. She further states they were primarily thought to have been ritual because of their association with burials and caches. One such artifact collected from Point of Pines contained fibers identified as agave, suggesting the possibility of use in straightening or cleaning fibers (J. Adams 1996:25).

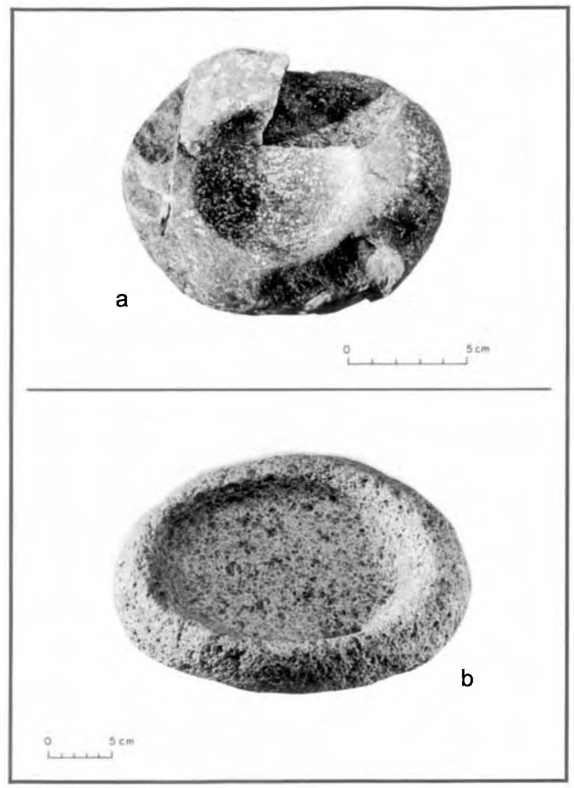

Figure 3.51. Stone bowls: (a) small stone bowl from LA 39968, (b) large basalt stone bowl from LA 3279, Room 10.

APPENDIX 3.1. AN ENERGY DISPERSIVE X-RAY FLUORESCENCE (EDXRF) ANALYSIS OF OBSIDIAN ARTIFACTS FROM 19 PREHISTORIC SITES IN CATRON COUNTY, NEW MEXICO

M. Steven Shackley[1]

The following report documents the EDXRF analysis of 101 obsidian artifacts recovered from 19 sites near Luna and Reserve in Catron County, New Mexico. All of the artifacts were produced from obsidian procured from sources in western New Mexico or eastern Arizona dominated by one or more of the chemical groups from the Mule Creek Regional Source in Grant County, New Mexico (Shackley 1995).

ANALYSIS AND INSTRUMENTATION

All samples were analyzed whole and were washed in distilled water before analysis. The results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least-squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data, through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984).

The trace element analyses were performed in the Department of Geology and Geophysics, University of California, Berkeley, using a Spectrace 400 (United Scientific Corporation) energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with a Rh x-ray tube, a 50 kV x-ray generator, with a Tracor x-ray (Spectrace) TX 6100 x-ray analyzer using an IBM PC based microprocessor and Tracor reduction software. The x-ray tube was operated at 30 kV, 0.20 mA, using a 0.127 mm Rh primary beam filter in a vacuum path at 250 seconds livetime to generate x-ray intensity K-alpha line data for elements titanium (Ti), manganese (Mn), iron (as Fe^T), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb). Weight percent iron ($Fe_2O_3^T$) can be derived by multiplying ppm estimates by $1.4297^{(10-4)}$. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1989). Further details concerning the petrological choice of these elements in Southwest obsidian is available in Shackley (1988, 1990, 1992, 1995; also Mahood and Stimac 1990; and Hughes and Smith 1993). Specific standards used for the best fit regression calibration for elements Ti through Nb include G-2 (basalt), AGV-1 (andesite), GSP-1 and SY-2 (syenite), BHVO-1 (hawaiite), STM-1 (syenite), QLM-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), all U.S. Geological Survey standards, and BR-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1989). In addition to the reported values here, Pb, Ni, Cu, Zn, Ga, and Th were measured, but these are rarely useful in discriminating glass sources and are not generally reported. These data are available on disk by request.

The data from the Tracor software were translated directly into Quattro Pro for Windows software for manipulation and on into SPSS for Windows for statistical analyses. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. Table A3.1.1 shows a comparison between values recommended for three international obsidian and rhyolite rock standards, RGM-1, NBS (SRM)-278, and JR-2. One of these standards is analyzed during each sample run to check machine calibration. The results shown in Table A3.1.1 indicate that the machine accuracy is quite high, particularly for the mid-Z elements, and other instruments with comparable precision should yield comparable results. Further information on the laboratory instrumentation can be found on the World Wide Web at:
<http://obsidian.pahma.berkeley.edu/xrflab.htm>.

Trace element data exhibited in Tables A3.1.1 and A3.1.2 are reported in parts per million (ppm), a quantitative measure by weight. Table A3.1.2 and Figure A3.1.1 exhibit the data for the archaeological samples. Questionable assignments are all due to small sample sizes (see Davis et al. 1996).

[1]X-Ray Fluorescence Spectrometry Laboratory, University of California, Berkeley

DISCUSSION

The dominance of obsidian procurement in the immediate region is expectable. The quality of the regional sources, particularly Mule Mountain at Mule Creek, Gwynn Canyon, and Red Hill, is as good as any in the Southwest (Shackley 1988, 1995). Nodule sizes are up to 10 cm in diameter, although the presence of bipolar reduction evident in this and other collections suggests that smaller diameter nodules were frequently used.

Three chemical groups from the Mule Creek regional source were evident in the assemblage (see Table A3.1.3 and Figure A3.1.1). Typically, as in this collection, material from the Antelope Creek locality dominates. Marekenites from this source are numerically dominant in the alluvium and Gila Conglomerate in the region, and this is reflected in the local assemblages.

As seems typical in western New Mexico, Gwynn Canyon appears to be numerically inferior, even though it is generally a better raw material than much of the Mule Creek-Antelope Creek locality material. This could be due to access issues in the Mogollon Highlands that may be social or environmental.

Finally, this is the largest sample of archaeological obsidian yet analyzed in western New Mexico. If the trends noted here continue, it appears that obsidian was typically procured from regional sources rather than any to the west, south, or north.

Table A3.1.1. X-Ray Fluorescence Concentrations for Selected Trace Elements of Three International Rock Standards

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba
RGM-1 (Govindaraju 1989)	1600	279	12998	14	108	25	219	8.9	807
RGM-1 (Glascock and Anderson 1993)	1079±120	323±7	863±210	145±3	120±10	n.r.[a]	150±7	n.r.	826±31
RGM-1 (this study)	1516±58	259±19	1399±143	152±3	108±2	24±1	266±4	10±1	806±12
SRM-278 (Govindaraju 1989)	1469	402	14256	127.5	63.5	41	295	n.r.	1140[b]
SRM-278 (Glascock and Anderson 1993)	875±162	428±8	9932±210	128±4	61±15	n.r.	208±20	n.r.	891±39
SRM-278 (this study)	1376±96	372±17	15229±399	129±2	68±2	42±2	290±3	17±2	1090±38
JR-2 (Govindaraju 1989)[b]	540	852	6015	297	8	51	98.5	19.2	39
JR-2 (this study)	343±51	680±17	7358±65	300±5	10±1	49±3	94±2	16±2	34±6

[a] n.r.= no report; n.m.= not measured
[b] values proposed not recommended
± values represent first standard deviation computation for the group of measurements.
All values are in parts per million (ppm) as reported in Govindaraju (1989) and this study.
RGM-1 is a U.S. Geological Survey rhyolite standard
NBS (SRM)-278 is a National Institute of Standards and Technology obsidian standard
JR-2 is a Geological Survey of Japan rhyolite standard
FE^T can be converted to $Fe_20_3{}^T$ with a multiplier of 1,4297(10-4) (see also Glascock 1991)

TableA3.1.2. X-ray Fluorescence Concentrations for the Archaeological Data All Measurements in Parts Per Million (ppm)

SAMPLE	Ti	Mn	Fe	Th	Rb	Sr	Y	Zr	Nb	SOURCE
Reserve Sites										
LA 78439										
222	656.82	382.81	9297.21	38.97	248.59	13.15	39.76	110.46	26.72	Mule Cr (Ant Cr)
133	614.63	375.80	8831.42	42.07	234.39	10.23	42.05	107.61	24.46	Mule Cr (Ant Cr)
142	1015.82	403.20	10794.88	43.91	261.70	13.69	44.83	114.77	19.97	Mule Cr (Ant Cr)
179	1193.82	462.98	7289.92	31.55	164.15	8.28	18.72	98.50	32.56	Mule Cr (Ant Cr)

SAMPLE	Ti	Mn	Fe	Th	Rb	Sr	Y	Zr	Nb	SOURCE
Reserve Sites										
232	882.63	361.04	9689.08	39.32	235.03	12.94	39.01	107.18	23.98	Mule Cr (Ant Cr)
LA 3563										
99	677.30	337.10	10174.46	33.56	238.65	11.9	43.49	110.18	22.88	Mule Cr (Ant Cr)
210	749.18	372.48	9545.86	38.82	234.63	10.27	40.89	114.59	23.52	Mule Cr (Ant Cr)
271	916.33	408.00	10262.43	35.82	210.26	14.87	33.88	104.31	21.10	Mule Cr (Ant Cr)
341	642.62	354.45	9097.45	36.80	246.69	13.70	42.56	119.30	30.94	Mule Cr (Ant Cr)
378	617.13	356.82	9305.46	43.08	241.37	14.89	38.59	110.89	29.85	Mule Cr (Ant Cr)
LA 37919										
3	711.90	390.77	9762.71	36.05	249.60	14.86	44.56	114.48	28.88	Mule Cr (Ant Cr)
40	670.04	677.72	8123.10	44.43	427.52	4.43	7049	111.66	111.65	Mule Cr (Ant Cr)
60	1301.94	416.73	9890.78	14.29	131.19	122.09	21.85	123.22	10.27	Cow Canyon
16	578.13	356.27	8499.12	33.28	225.52	11.69	40.87	106.80	25.43	Mul Cr (Ant Cr)
22	825.14	363.30	9433.19	44.29	238.31	20.71	36.61	113.10	25.54	Mule Cr (Ant Cr)
LA 45510										
13	693.76	362.39	9181.99	41.25	241.97	10.33	38.77	111.39	24.22	Mule Cr (Ant Cr)
26	767.62	382.08	9536.52	36.00	253.24	14.79	44.31	115.06	25.39	Mule Cr (Ant Cr)
42	922.11	333.71	9533.60	28.99	223.59	14.63	39.36	111.45	27.47	Mule Cr (Ant Cr)
117	619.72	371.95	9129.61	36.36	839.87	12.44	39.24	113.40	24.13	Mule Cr (Ant Cr)
149	650.68	402.07	9552.14	39.23	254.13	13.64	43.03	118.90	28.35	Mule Cr (Ant Cr)
LA 70189										
98	710.45	332.59	8772.68	37.58	232.68	13.20	38.75	102.71	30.68	Mule Cr (Mule Mts)
108	731.19	351.25	9483.98	26.20	239.21	8.16	39.48	114.37	28.50	Mule Cr (Ant Cr)
186	689.82	404.75	9513.69	41.24	245.74	11.40	38.82	112.71	25.67	Mule Cr (Ant Cr)
8	896.04	444.19	7112.14	11.57	138.69	75.09	25.13	77.35	13.47	Cow Canyon
179	901.37	400.65	7991.04	14.81	129.18	122.65	18.87	113.53	17.83	Cow Canyon
LA 75792										
132	813.04	354.03	922.42	28.94	240.67	15.37	4090	112.94	29.93	Mule Cr (Ant Cr)
403	828.12	346.33	9314.16	41.14	234.83	15.08	37.87	110.59	24.82	Mule Cr (Ant Cr)
520	951.45	305.69	8709.79	37.98	230.10	9.33	37.13	109.61	19.02	Mule Cr (Mule Mts)
565	1147.83	435.53	7107.63	12.06	126.51	70.07	23.04	69.73	11.66	Cow Canyon
447	561.89	343.75	8800.27	31.78	234.50	13.20	41.45	114.39	24.02	Mule Cr (Ant Cr)
LA75791										
152	910.12	418.81	8261.14	38.48	223.92	16.23	31.20	152.83	23.67	Gwynn Canyon
134	682.74	412.51	9931.16	36.99	247.17	14.12	43.80	119.68	30.07	Mule Cr (Ant Cr)
69	999.84	350.85	9392.90	18.63	147.29	3.55	37.85	148.56	44.35	Mule Cr (Mule Mts)
19	1712.52	171.48	6391.49	23.24	135.07	14.31	23.30	63.79	3.52	Red Hill
LA 70196										
87	1043.63	428.21	9184.50	38.40	235.80	15.09	31.89	151.64	21.13	Gwynn Canyon
313	652.00	852.79	9643.78	56.00	466.70	3.74	77.27	111.28	127.98	Mule Cr/N Sawmill
322	607.07	369.07	8973.03	29.69	234.04	12.83	37.20	110.61	24.85	Mule Cr (Ant Cr)
345-1	447.23	578.82	7105.39	19.03	165.56	8.03	36.40	67.78	47.22	Red Hill
345-2	740.54	553.84	7190.88	14.15	161.29	10.27	36.73	63.75	48.15	Red Hill
NODULE	7828.27	304.67	8856.64	31.73	218.82	11.94	40.83	108.14	23.59	Mule Cr (Mule Mts)
LA 70188										
1655	757.91	441.45	7430.92	9.41	143.12	81.55	23.70	83.32	13.18	Cow Canyon
1391	605.65	645.28	8297.05	51.15	437.75	2.98	68.41	106.38	119.33	Mule Cr/N Sawmill
1338	916.44	454.09	7353.31	38.48	168.90	10.26	25.47	113.21	26.83	Mule Cr (Mule Mts)
1121	570.01	375.54	8681.53	31.92	238.30	11.47	39.49	109.90	24.20	Mule Cr (Ant Cr)
1615	540.15	373.56	8701.79	31.78	243.71	12.03	38.16	112.29	23.02	Mule Cr (Ant Cr)
1605	729.36	352.18	9225.39	35.11	231.27	11.27	41.47	110.05	22.56	Mule Cr (Ant Cr)
1558	1795.82	219.19	6553.84	17.15	137.22	13.39	20.00	107.99	21.88	Mule Cr (Mule Mts)?
1345-452	683.74	356.88	9065.65	38.95	241.69	10.38	39.75	113.88	31.57	Mule Cr (Ant Cr)
1345-453	545.24	341.48	8917.56	38.45	229.83	13.01	39.74	111.83	27.17	Mule Cr (Ant Cr)
1345-454	491.35	344.20	8645.73	30.93	224.31	11.04	38.11	109.16	26.29	Mule Cr (Ant Cr)
1544	801.04	379.60	9053.09	4084	223.66	9.75	35.07	102.40	22.11	Mule Cr (Mule Mts)
1272	1078.89	379.82	8836.26	35.49	211.13	14.24	36.94	100.93	14.65	Mule Cr (Mule Mts)
1439	668.62	361.15	9081.79	37.75	239.95	11.99	42.96	115.90	27.28	Mule Cr (Ant Cr)
1150	1134.79	315.63	7983.12	19.95	200.47	8.44	27.38	91.21	15.74	Mule Cr (Ant Cr)
LA 37917										
338	1054.43	352.93	9017.38	35.62	218.04	8.93	31.99	95.93	19.94	Mule Cr (Mule Mts)
267	1980.93	546.87	12756.56	36.36	245.77	20.31	37.69	115.54	26.93	Mule Cr (Ant Cr)
540	965.13	413.27	10671.44	4076	235.80	16.17	36.83	103.74	28.14	Mule Cr (Mule Mts)
33	1175.27	348.07	8462.45	25.62	210.83	14.71	26.94	90.47	26.38	Mule Cr (Mule Mts)

SAMPLE	Ti	Mn	Fe	Th	Rb	Sr	Y	Zr	Nb	SOURCE
Reserve Sites										
266	1240.01	320.59	9282.20	37.66	210.94	13.34	37.72	93.64	16.04	Mule Cr (Mule Mts)
LA 39968										
1918	532.98	331.34	8607.96	34.89	226.26	10.36	40.80	98.53	24.13	Mule Cr (Mule Mts)
512	507.84	315.26	8784.36	30.56	224.00	12.47	37.29	106.51	23.18	Mule Cr (Mule Mts)
416	608.62	352.03	8789.23	37.98	233.07	16.54	39.48	108.73	23.29	Mule Cr (Mule Mts)
2173	1100.30	510.56	11566.52	38.58	245.48	17.38	38.83	120.64	28.13	Mule Cr (Ant Cr)
2440	843.91	259.76	8349.66	34.65	208.75	13.64	35.82	93.71	22.59	Mule Cr (Mule Mts)
LA 39969										
410	668.33	407.94	9562.50	33.15	237.77	14.01	37.72	112.90	28.27	Mule Cr (Ant Cr)
1182	619.91	365.03	8998.58	32.14	221.07	13.57	39.95	107.31	24.74	Mule Cr (Ant Cr).
1023	691.89	398.68	9204.79	38.61	250.67	13.00	43.02	116.92	27.96	Mule Cr Ant Cr)
839	820.09	355.57	8942.45	41.56	235.17	13.83	37.37	110.94	21.18	Mule Cr (Ant Cr)
1159	680.39	351.24	9410.35	38.89	249.44	14.41	36.38	115.06	23.92	Mule Cr (Ant Cr)
666	658.38	332.57	9119.20	29.02	228.52	19.11	40.77	121.82	28.42	Mule Cr (Ant Cr)
LA 43766										
458	1226.43	421.59	9056.41	33.84	210.50	16.49	30.01	152.08	19.74	Gwynn Canyon
57	921.16	365.05	8775.52	24.60	211.53	13.11	36.12	92.79	17.80	Mule Cr (Mule Mts)
392	1446.63	351.16	9335.18	33.09	222.87	13.14	35.55	93.26	16.64	Mule Cr (Mule Mts)
451	1425.28	490.81	10340.79	39.45	240.55	17.23	32.79	143.11	15.78	Gwynn Canyon
LA 39972										
568	1834.53	561.48	9829.98	40.40	236.85	15.65	34.74	137.57	20.83	Gwynn Canyon
599	541.29	540.21	6952.77	20.08	155.14	5.98	34.68	62.58	45.33	Red Hill
342	632.36	353.55	8420.57	32.38	225.63	12.83	40.90	108.62	27.01	Mule Cr (Ant Cr)
144	691.83	415.07	9653.30	35.23	249.91	10.22	42.73	116.04	27.61	Mule Cr (Ant Cr)
Luna Sites										
LA 39975										
44	794.63	402.78	9950.82	33.35	246.44	14.34	39.92	116.61	26.71	Mule Cr (Ant Cr)
677	722.72	374.84	9127.96	26.51	234.19	12.95	38.83	107.79	22.35	Mule Cr (Mule Mts)
501	821.37	511.83	10261.68	20.86	190.78	2.77	56.61	165.60	91.68	Gwynn Canyon
624	790.06	339.67	9525.83	40.17	222.18	13.43	31.38	107.61	24.72	Mule Cr (Ant Cr)
411	929.86	501.31	7573.60	13.72	136.35	78.06	19.55	82.01	16.51	Cow Canyon
LA 45508										
596	743.14	453.36	7291.85	35.42	178.19	5.01	27.45	109.39	28.57	Mule Cr (Mule Mts)
296	708.65	291.71	8709.95	40.68	226.47	14.50	38.90	109.39	26.43	Mule Cr (Ant Cr)
612-1	1032.60	327.44	8772.42	30.78	21793	10.48	36.43	98.65	21.03	Mule Cr (Mule Mts)
612-2	1116.92	469.83	9187.25	24.37	139.00	127.94	14.41	112.20	20.19	Cow Canyon
239	1907.03	383.93	7927.33	10.89	109.17	105.63	20.64	92.10	11.69	Cow Canyon
242	566.59	300.73	8675.00	33.61	218.66	15.99	36.85	113.94	21.84	Mule Cr (Ant Cr)
LA 70185										
456	985.39	411.87	8709.35	31.22	209.23	12.57	31.88	139.56	21.54	Gwynn Canyon
1018	578.54	320.89	8448.42	27.19	232.45	14.17	38.29	112.44	23.84	Mule Cr (Ant Cr)
486	1496.09	388.36	8920.87	41.62	212.94	8.83	32.82	92.12	26.24	Mule Cr (Mule Mts)
326	490.43	369.78	8997.66	33.12	231.61	11.33	37.36	114.79	26.07	Mule Cr (Ant Cr)
326	732.08	388.08	9238.14	43.89	242.83	12.92	42.34	112.09	33.93	Mule Cr (Ant Cr)
512	539.06	60.237	7449.19	18.65	132.83	5.73	31.92	57.91	37.46	Red Hill
LA 45507										
1713-23	504.41	844.04	8047.98	23.31	215.22	2.96	53.81	73.73	61.35	Red Hill
1713-24	593.05	301.84	8624.43	33.41	216.64	11.20	35.88	103.20	22.18	Mule Cr (Mule Mts)
2299	879.44	326.17	8959.65	29.72	200.02	13.94	35.29	95.52	15.47	Mule Cr (Mule Mts)
847	1046.11	476.89	9883.87	16.21	147.48	136.62	20.19	121.33	14.42	Cow Canyon
1854	705.25	463.65	7001.53	20.69	141.81	7.39	29.72	56.86	42.08	Red Hill
596	583.43	352.98	8618.83	31.25	226.04	12.02	43.96	105.62	28.34	Mule Cr (Mule Mts)

[1] Questionable sources assignments are generally due to small sample sizes, particularly samples less than 10 mm in smallest diameter and/or less than 3 mm thick (see Davis et al. 1996).

Table A3.1.3. Proportion of Source Provenience in the Assemblage

Source/Group	Number	Percent (rounded)
Mule Creek Source Region		
Mule Creek (Antelope Creek)	47	46.5
Mule Creek (Mule Mountains)	28	27.7 (includes questionables)
Mule Creek/North Sawmill Creek	3	0.03
Total Mule Creek All Groups	77	76.2
Cow Canyon	9	0.09
Gwynn Canyon	7	0.07
Red Hill	7	0.07
TOTAL	1201	100.0

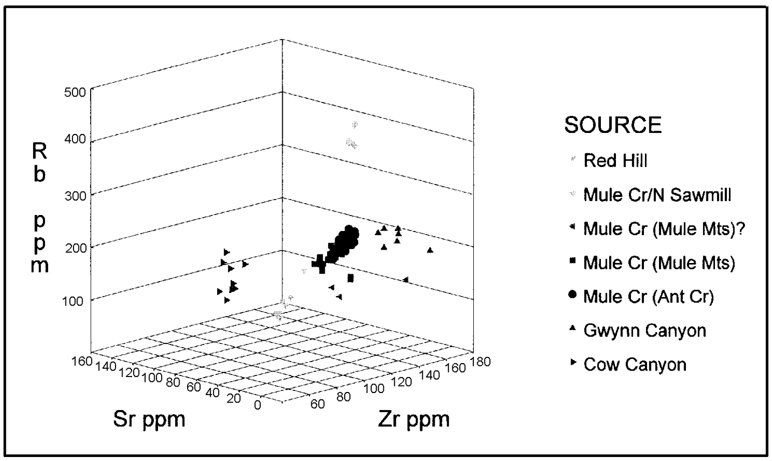

Figure A3.1.1. Rb, Sr, Zr three-dimensional plot of the archaeological samples.

APPENDIX 3.2. AN ENERGY DISPERSIVE X-RAY FLUORESCENCE (EDXRF) ANALYSIS OF OBSIDIAN ARTIFACTS FROM 11 PREHISTORIC SITES IN CATRON COUNTY, NEW MEXICO

M. Steven Shackley[2]

The following report documents the EDXRF analysis of 80 obsidian artifacts recovered from 11 sites in Catron County, New Mexico. All of the artifacts were produced from obsidian procured from sources in western and northern New Mexico or eastern Arizona dominated by one or more of the chemical groups from the Mule Creek Regional Source in Grant County, New Mexico (Shackley 1995). While the general distribution of obsidian source provenance is similar to the earlier study from the region with some of the same sites, this analysis indicates greater diversity and more complex procurement strategies (Shackley 1996a, 1996b).

ANALYSIS AND INSTRUMENTATION

All samples were analyzed whole and were washed in distilled water before analysis. The results presented here are quantitative in that they are dirived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least-squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984).

The trace element analyses were performed in the Department of Geology and Geophysics, University of California, Berkeley, using a Spectrace 400 (United Scientific Corporation) energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with a Rh x-ray tube, a 50 kV x-ray generator, with a Tracor X-ray (Spectrace) TX 6100 x-ray analyzer using an IBM PC based microporcessor and Tracor reduction software. The x-ray tube was operated at 30 kV, 0.20 mA, using a 0.127 mm Rh primary beam filter in a vacuum path at 250 seconds livetime to generate x-ray intensity K-alpha line data for elements titanium (Ti), manganese (Mn), iron (as Fe^T), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr). amd mopboi, (Nb). Weight percent iron ($Fe_2O_3^T$) can be derived by multiplying ppm estimates by 1.4297^{10-4}. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1989). Further details concerning the petrological choice of these elements in Southwest obsidians is available in Shackley (1988, 1990, 1992, 1995; also Mahood and Stimac 1991; and Hughes and Smith 1993). Specific standards used for the best fit regression calibration for elements Ti through Nb include G-2 (basalt), AGTV-1 (andesite), GSP-1 and SY-2 (syenite), BHVO-1 (hawaiite), STM-1 (syenite), QLM-1 (quartz latite), RGM-1 (obsidian), W-1 (diabase), BIR-1 (basalt), SDC-1 (mica schist), TLM-1 (tonalite), SCO-1 (shale), all U.S. Geological Survey standards, and BR-N (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1989). In addition to the reported values here, Pb, Ni, Cu, Zn, Ga, and Th were measured, but these are rarely useful in discriminating glass sources and are not generally reported. These data are available on disk by request.

The data from the Tracor software were translated directly into Quattro Pro for Windows software for manipulation and on into SPSS for Windows for statistical analyses. In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run. Table A3.2.1 shows a comparison between values recommended for three international obsidian and rhyolite rock standards, RGM-1, NBS (SRM)-278, and JR-2. One of these standards is analyzed during each sample run to check machine calibration. The results shown in Table A3.2.1 indicate that the machine accuracy is quite high, particularly for the mid-Z elements, and other instruments with comparable precision should yield comparable results. Further information on the laboratory instrumentation can be found on the World Web at:
<http://obsidian.pahma.berkeley.edu/xrflab.htm>.

Trace element data exhibited in Tables A3.2.1 and A3.2.2 are reported in parts per million (ppm), a quantitative measure by weight. Table A3.2.2 and

[2]X-Ray Fluorescence Spectrometry Laboratory, University of California, Berkeley

Figures A3.2.1-A3.2.4 exhibit the data for the archaeological samples.

DISCUSSION

A previous study in this region and in eight of the same sites indicated procurement in just the eastern Arizona and western New Mexico region (Shackley 1996a, 1996b). In this study, the acquisition of obsidian now includes obsidian from the Cerro Toledo Rhyolite formation in the Jemez Mountains recovered from Early Pithouse period contexts at LA 39975 (Table A3.2.3). This source is also available in secondary contexts in the Rio Grande alluvium to the east. It is impossible to determine which area was exploited for raw material in this analysis. Additionally, the Mule Creek-North Sawmill Creek locality glass found in the earlier analysis was not recovered from these sites. Most likely, these differences are due to sampling issues (see Shackley 1997).

The dominance of obsidian procurement in the immediate region is expectable. The quality of the regional sources, particularly Mule Mountain at Mule Creek, Gwynn Canyon, and Red Hill, is as good as any in the Southwest (Shackley 1988, 1995). Nodule sizes are up to 10 cm in diameter, although the presence of bipolar reduction evident in this and other collections suggests that smaller diameter nodules were frequently used.

Three chemical groups from the Mule Creek regional source were probable in the assemblage (Mule Creek-Antelope Creek; Mule Creek/Mule Mountains; and Mule Creek-SF River Alluvium). Typically, as in this collection, material from the Antelope Creek locality dominates. Marekenites from this source are numerically dominant in the alluvium and Gila Conglomerate in the region, and this is reflected in the local assemblages. Due to this phenomenon, the Antelope Creek and Mule Mountain localities were pooled for source assignment, while the San Francisco River alluvial samples were separated due to more extreme chemical differences (see Shackley 1995, 1997).

As seems typical in western New Mexico, Gwynn Canyon appears to be numerically inferior, even though it is generally a better raw material than much of the Mule Creek-Antelope Creek locality material. This could be due to access issues in the Mogollon Highlands that may be social or environmental.

With this analysis, this study becomes the largest sample of archaeological obsidian yet analyzed in western New Mexico. As discussed elsewhere, as the sample size increases, the knowledge of procurement also increases (see Shackley 1995, 1997). It now appears the sources throughout New Mexico and eastern Arizona were exploited.

Table A3.2.1. X-Ray Fluorescence Concentrations for Selected Trace Elements of Three International Rock Standards

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba
RGM-1 (Govindaraju 1989)	1600	279	12998	149	108	25	219	8.9	807
RGM-1 (Glascock and Anderson 1993)	1800±200	323±7	12400±300	145±3	120±10	n.r.[a]	150±7	n.r.	826±31
RGM-1 (this study)	1516±58	259±19	13991±143	152±3	108±2	24±1	266±4	10±1	806±12
SRM-278 (Govindaraju 1989)	1469	402	14256	127.5	63.5	41	295	n.r.	1140
SRM-278 (Glascock and Anderson 1993)	1460±270	428±8	14200±300	128±4	61±15	n.r.	208±20	n.r.	891±39
SRM-278 (this study)	1376±96	372±17	15229±399	129±2	68±2	42±2	290±3	17±2	1090±38
JR-2 (Govindaraju 1989)[b]	540	852	6015	297	8	51	98.5	19.2	39
JR-2 (this study)	343±51	680±17	7358±65	300±5	10±1	49±3	94±2	16±2	34±6

[a] n.r.= no report; n.m.= not measured
[b] values proposed not recommended
± values represent first standard deviation computation for the group of measurements
All values are in parts per million (ppm) as reported in Govindaraju (1989) and this study; RGM-1 is a U.S. Geological Survey rhyolite standard; NBS (SRM)-278 is a National Institute of Standards and Technology obsidian standard; JR-2 is a Geological Survey of Japan rhyolite standard
FE^T can be converted to $Fe_20_3{}^T$ with a multiplier of 1,4297(10-4) (see also Glascock 1991)

Table A3.2.2. X-ray Fluorescence Concentrations for the Archaeological Data
All Measurements in Parts Per Million (ppm)

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	SOURCE
LA 45507									
552	736.15	615.26	7590.77	169.84	11.47	40.62	61.98	41.39	Red Hill
2018	1386.88	341.01	10028.37	226.72	11.51	40.46	94.41	13.03	Mule Creek[1]
1684	1084.09	563.76	7152.40	152.64	12.72	31.01	65.89	39.71	Red Hill
LA 39975									
150	725.26	349.17	9650.70	236.63	13.54	38.19	111.90	28.20	Mule Creek
156	1050.43	331.79	9620.02	236.39	13.16	38.27	110.09	20.95	Mule Creek
242	1078.37	301.20	9094.07	209.67	9.95	40.09	114.17	18.58	Mule Creek
364	954.35	395.04	9928.43	253.56	14.85	38.68	112.45	27.66	Mule Creek
375	1020.30	273.35	8597.84	230.81	13.69	41.33	101.78	29.01	Mule Creek
572	1106.57	319.49	9111.74	219.71	12.86	41.26	100.28	21.36	Mule Creek
579	798.10	494.64	9969.38	199.24	0.03	58.01	165.66	88.21	Cerro Toledo Rhy.[2]
584	830.43	388.80	8836.03	171.34	0.49	49.09	146.81	83.19	Cerro Toledo Rhy[2]
654	756.42	377.86	9771.95	252.19	10.74	46.28	118.33	25.46	Mule Creek
746	764.94	353.19	9782.79	250.44	14.18	38.56	116.44	27.78	Mule Creek
765	945.42	267.76	8394.56	193.20	11.39	33.99	97.51	18.29	Mule Creek
10395	794.90	361.79	9636.81	239.90	11.69	42.06	110.90	26.80	Mule Creek
10409	942.61	334.52	9429.23	226.41	12.91	40.03	104.25	17.40	Mule Creek
LA 70188									
1021	902.35	386.78	8022.63	207.53	14.23	31.21	139.28	23.79	Gwynn Canyon
1073	1292.14	478.00	8499.97	124.43	92.65	21.98	118.28	12.06	Cow Canyon
1368	819.91	354.82	9125.18	227.60	12.96	39.81	107.05	26.19	Mule Creek
LA 39969									
147	815.57	383.86	9828.53	252.09	16.09	44.53	117.27	26.18	Mule Creek
626	1056.26	364.98	8338.07	204.90	12.41	32.49	130.38	20.46	Mule Creek
835	725.73	376.30	9701.46	236.87	11.57	43.07	112.72	27.42	Mule Creek
879	717.19	379.09	9597.05	245.75	11.54	42.72	119.62	28.24	Mule Creek
928	956.64	392.92	8484.00	218.64	11.14	27.83	143.09	24.28	Gwynn Canyon
989	1094.95	419.27	8446.84	210.24	11.79	30.38	144.93	15.55	Gwynn Canyon
992	1058.11	357.00	9967.76	250.29	7.85	43.69	106.72	26.87	Mule Creek
1019	719.63	349.58	9001.66	329.38	12.56	43.24	118.23	29.45	Mule Creek
1085	845.86	393.24	10203.81	258.66	12.20	41.03	114.37	24.60	Mule Creek
1103	665.72	365.50	9544.27	241.34	11.47	40.75	118.39	24.53	Mule Creek
LA 45508									
101	790.83	310.49	8421.14	209.48	14.81	41.74	101.14	23.71	Mule Creek
553	702.60	383.10	9408.79	236.87	11.67	42.83	107.36	28.43	Mule Creek
629	946.90	362.36	10187.00	256.72	11.71	40.23	116.27	25.60	Mule Creek
LA 37919									
73	1528.85	553.23	9372.96	144.76	103.54	18.74	124.51	19.08	Cow Canyon
75	1606.45	471.70	8697.57	130.63	88.29	12.13	110.66	8.01	Cow Canyon
90	914.76	308.70	9056.16	211.46	8.24	33.89	96.36	26.45	Mule Creek
97	1631.77	532.36	9709.49	137.63	124.03	25.00	104.48	14.32	Cow Canyon
106	754.12	334.61	9160.00	234.81	10.68	39.22	108.70	21.34	Mule Creek
LA 70196									
77	772.83	561.89	7941.13	170.41	8.35	37.67	65.95	48.89	Red Hill
160	1247.68	400.96	10194.93	239.97	12.10	35.31	106.78	25.03	Mule Creek
186	959.36	567.44	8530.79	154.43	84.22	19.19	86.37	12.15	Cow Canyon
253	2777.29	494.81	17742.93	230.86	14.83	40.69	125.47	29.69	Mule Creek
LA 3279									
103	1016.87	428.62	10524.29	257.31	15.79	46.96	118.45	32.89	Mule Creek
216-440	1036.27	384.78	8593.54	221.33	12.68	27.30	151.88	28.03	Gwynn Canyon
216-407	846.82	454.81	7840.97	147.52	80.87	20.89	87.11	11.29	Cow Canyon
251	535.07	611.17	7500.94	179.37	7.99	38.62	65.55	52.34	Red Hill
290	1241.91	404.71	8836.32	139.42	127.20	17.78	122.82	13.31	Cow Canyon
323	738.23	336.99	9362.22	232.79	15.98	43.36	109.31	24.80	Mule Creek
352	673.21	376.65	9395.58	247.78	10.04	43.39	111.60	28.73	Mule Creek
399-192	1347.89	495.12	9990.21	151.62	137.03	22.56	125.13	13.89	Cow Canyon

SAMPLE	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	SOURCE
399-690	994.57	340.49	10741.45	235.22	15.56	39.50	113.35	30.44	Mule Creek
399-704	981.59	323.89	9291.06	175.77	14.23	28.24	92.79	8.53	Mule Creek (SFR)[1]
454	637.61	352.17	9380.60	244.48	14.53	44.18	110.48	25.47	Mule Creek
518	883.15	357.03	10073.36	250.76	12.06	42.01	106.42	20.69	Mule Creek
519	857.06	374.77	9479.16	250.68	13.01	38.68	116.82	26.76	Mule Creek
578	1160.77	454.80	9200.14	142.56	129.34	20.55	127.81	15.28	Cow Canyon
632	865.10	330.84	9316.50	234.07	12.25	39.01	106.51	25.61	Mule Creek
674	1559.02	433.00	9013.30	211.55	13.44	26.82	139.43	11.62	Gwynn Canyon
LA 37917									
27	1025.20	323.32	9255.43	223.50	12.92	25.04	98.66	23.19	Mule Creek (SFR)
37	890.02	337.46	9844.67	2421.32	14.87	36.18	104.17	24.92	Mule Creek
115	889.73	319.49	9800.04	263.01	10.62	44.00	109.57	28.02	Mule Creek
173	1307.77	322.98	9146.05	211.77	15.02	36.28	94.02	20.84	Mule Creek (SFR)
205	919.90	367.28	9890.74	236.32	11.83	36.88	105.04	23.61	Mule Creek
240	1429.69	338.09	9176.17	203.80	9.69	28.31	95.50	12.43	Mule Creek (SFR)
248	887.23	400.57	10003.40	246.19	11.27	39.70	115.60	24.03	Mule Creek
253	863.13	378.64	9362.31	228.51	13.69	34.05	105.95	19.40	Mule Creek
275-8	853.97	333.66	9330.52	238.76	14.08	39.00	112.11	22.77	Mule Creek
275-9	1327.13	442.94	9747.17	224.34	17.25	27.80	99.26	14.73	Mule Creek (SFR)
279	712.76	381.96	9463.84	239.02	12.69	37.16	111.78	27.31	Mule Creek
342	1210.20	326.16	9163.47	215.95	11.64	33.60	94.42	17.72	Mule Creek (SFR)
343	941.07	334.49	9051.26	235.40	10.16	40.74	105.45	22.61	Mule Creek
LA 39972									
123	1157.33	337.13	10954.74	249.94	15.62	43.96	115.69	23.42	Mule Creek
338	1820.00	341.07	9098.72	204.04	10.01	23.38	94.55	16.15	Mule Creek (SFR)
340	114.72	517.57	8257.61	152.88	9.18	36.21	61.68	42.50	Red Hill
350	2199.01	288.59	8644.35	175.90	6.01	26.26	71.07	20.57	Red Hill
612	679.98	320.29	8764.83	221.71	10.05	39.41	102.69	16.69	Mule Creek
614	1421.34	432.70	9824.50	136.67	122.75	16.66	111.72	15.46	Cow Canyon
627	942.10	315.96	9293.81	230.58	14.44	34.51	99.33	22013	Mule Creek
641	1424.47	318.21	9633.94	218.86	8.20	32.00	123.78	22.87	Mule Creek
LA 3279									
674	850.67	366.60	9495.27	225.54	14.42	38.70	110.51	26.94	Mule Creek
1716	809.51	478.29	7762.44	146.20	79.81	19.90	79.97	23.91	Cow Canyon

[1] The “Mule Creek” designation here includes the Antelope Creek and Mule Mountain Localities that cannot be compositionally discriminated with these elements only (see Shackley 1995).

[2] The Cerro Toledo Rhyolite designation applies to the silica flows that produced artifact quality glass from a number of domes in the Tewa Group in the Jemez Mountains, New Mexico region including Obsidian Ridge, and Almo, Chapulin, Cochiti,, and Bland Canyons (see Baugh and Nelson 1987).

[3] The “SFR” designation includes the elemental data for samples recovered only from the San Francisco River alluvium at Clifton, Arizona that must be derived from the lower San Francisco River drainage, but the source locality has not yet been discovered (see Shackley 1995).

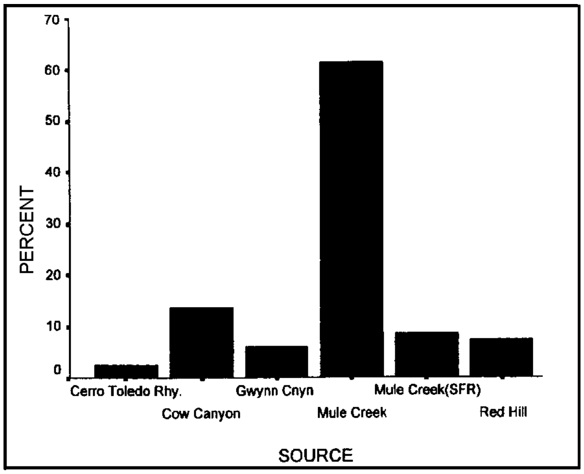

Figure A3.2.1.Proportion of obsidian source provenance overall.

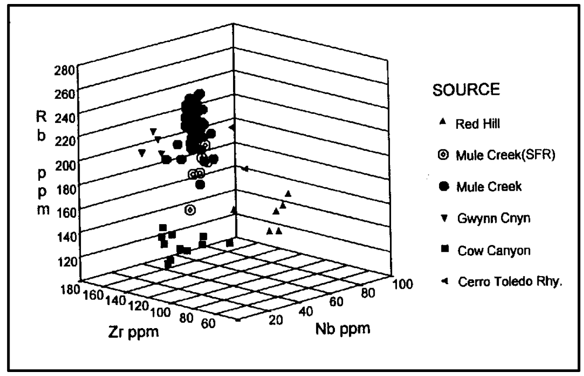

Figure A3.2.2. Rb, Zr, Nb three-dimensional plot of archaeological specimens.

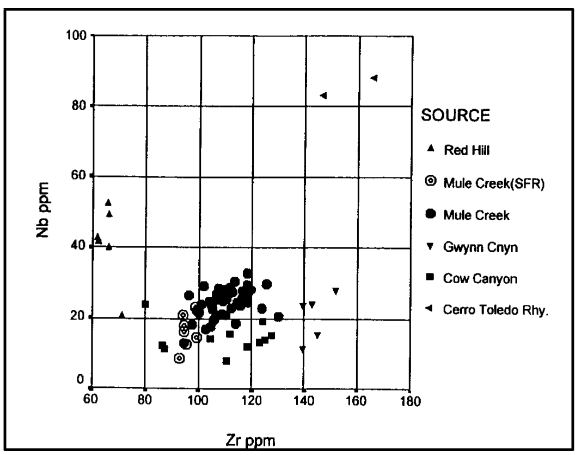

Figure A3.2.3. Nb versus Zr plot of archaeological specimens.

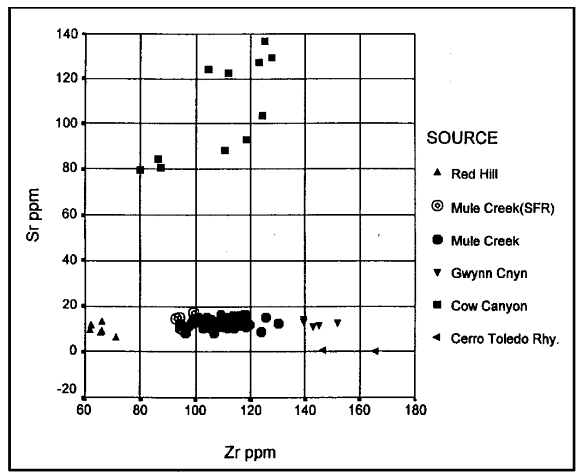

Figure A3.2.4. Sr versus Zr plot of archaeological specimens.

Table A3.2.3. Cross Tabulation of Sites by Obsidian Source Provenience

SITE		SOURCE					Total
		Mule Creek (all)	Red Hill	Cerro Toledo Rhyolite	Gwynn Canyon	Cow Canyon	
45507	COUNT	1	2				3
	Percent within SITE	33.3	66.7				100.0
	Percent within SOURCE	1.8	33.3				3.8
	Percent of Total	1.3	2.5				3.8
39975	COUNT	11		2			13
	Percent within SITE	84.6		15.4			100.0
	Percent within SOURCE	19.6		100.0			16.3
	Percent of Total	13.8		2.5			16.3
70188	COUNT	1			1	1	3
	Percent within SITE	33.3			33.3	33.3	100.0
	Percent within SOURCE	1.8			20.0	9.1	3.8
	Percent of Total	1.3			1.3	1.3	3.8

		Mule Creek (all)	Red Hill	Cerro Toledo Rhyolite	Gwynn Canyon	Cow Canyon	
39969	COUNT	8			2		10
	Percent within SITE	100.0			20.2		100.0
	Percent within SOURCE	14.3			40.0		12.5
	Percent of Total	3.8			2.5		12.5
45508	COUNT	3					3
	Percent within SITE	80.0					100.0
	Percent within SOURCE	5.4					3.8
	Percent of Total	3.8					3.8
37919	COUNT	2				3	5
	Percent within SITE	40.0				60.0	100.0
	Percent within SOURCE	3.6				27.3	6.3
	Percent of Total	2.5				3.8	6.3
70196	COUNT	2	1			1	4
	Percent within SITE	50.0	25.0			25.0	100.0
	Percent within SOURCE	3.6	16.7			9.1	5.0
	Percent of Total	2.5	1.3			1.3	5.0
3279	COUNT	9	1		2	4	16
	Percent within SITE	56.3	6.3		12.5	25.0	100.0
	Percent within SOURCE	16.1	16.7		40.0	36.4	20.0
	Percent of Total	11.3	1.3		2.5	5.0	20.0
37917	COUNT	13					13
	Percent within SITE	100.0					100.0
	Percent within SOURCE	23.2					16.3
	Percent of Total	16.3					16.3
39972	COUNT	5	2			1	8
	Percent within SITE	62.5	25.0			12.5	100.0
	Percent within SOURCE	8.9	33.3			9.1	10.0
	Percent of Total	6.3	2.5			1.3	10.0
3279	COUNT	1				1	2
	Percent within SITE	50.0				50.0	100.0
	Percent within SOURCE	1.8				9.1	2.5
	Percent of Total	1.3				1.3	2.5
TOTAL	COUNT	56	6	2	5	11	80
	Percent within SITE	70.0	7.5	2.5	6.3	13.8	100.0
	Percent within SOURCE	100.0	100.0	100.0	100.0	100.0	100.0
	Percent of Total	70.0	7.5	2.5	6.3	13.8	100.0

APPENDIX 3.3. AN ENERGY DISPERSIVE X-RAY FLUORESCENCE (EDXRF) ANALYSIS OF OBSIDIAN ARTIFACTS FROM FOUR SITES IN THE LUNA-RESERVE REGION, NEW MEXICO

M. Steven Shackley[3]

I am sending a letter report due to the small sample size. The source provenance is shown in Table A3.3.1. Source assignment was made with data in the Berkeley EDXRF library (Shackley 1995), and data in Baugh and Nelson (1987). Instrument methodology is discussed in Shackley (1992, 1994, 1995). The assemblage is dominated by Mule Creek glass, not unusual for the sites. Sample 70196-130, however, is produced from obsidian procured from the Cerro del Medio chemical group in the Valles Caldera region of northern New Mexico, *or* from Rio Grande gravels south to Chihuahua (see Baugh and Nelson 1987).

Table A3.3.1. EDXRF Concentrations for the Archaeological Sample
All Measurements in Parts Per Million (ppm)

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
LA 3279									
216	575.50	331.93	9615.93	244.73	14.54	40.68	110.52	25.83	Mule Creek
298	574.01	309.46	9205.78	241.24	12.18	40.36	111.30	23.01	Mule Creek
674	525.35	317.59	9230.40	232.41	12.25	40.60	110.20	30.05	Mule Creek
LA 45507									
1879	468.17	308.80	9052.68	225.67	12.81	39.77	111.77	29.61	Mule Creek
LA 39968									
750	670.44	326.46	10063.10	250.59	13.61	44.10	111.95	23.76	Mule Creek
942	566.28	289.98	9223.19	236.56	13.17	41.03	109.37	25.08	Mule Creek
938	505.12	278.13	8728.15	224.40	13.85	41.92	106.79	23.22	Mule Creek
LA 70196									
130	686.72	287.30	9202.60	144.33	7.68	42.67	152.80	45.29	Cerro del Medio

[3] X-Ray Fluorescence Spectrometry Laboratory, University of California, Berkeley