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**The development of prehistoric grinding technology in the Point
of Pines area, east-central Arizona**

Adams, Jenny Lou, Ph.D.

The University of Arizona, 1994

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THE DEVELOPMENT OF PREHISTORIC GRINDING TECHNOLOGY
IN THE
POINT OF PINES AREA, EAST-CENTRAL ARIZONA

by
Jenny Lou Adams

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A Dissertation Submitted to the Faculty of the
DEPARTMENT OF ANTHROPOLOGY
In Partial Fulfillment of the Requirements
For the Degree of
DOCTOR OF PHILOSOPHY
In the Graduate College
THE UNIVERSITY OF ARIZONA

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THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

As members of the Final Examination Committee, we certify that we have
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ABSTRACT

The development of grinding technology is a topic that has not received much attention from archaeologists in the American Southwest. Presented here is a technological approach to ground stone analysis capitalizing on the methods of ethnoarchaeology, experimentation, and use-wear analysis. These methods are applied to an existing collection of ground stone artifacts amassed by the University of Arizona field school's excavation of the Point of Pines sites in east-central Arizona. The heart of the technological approach is the recognition that technological behavior is social behavior and as such is culturally distinct. Both puebloan and nonpuebloan ethnographies provide models for understanding how ground stone tools were used by different cultural groups in daily activities and for making inferences about gender-specific behaviors. Culturally distinct behaviors are sustained through technological traditions, defined as the transmitted knowledge and behaviors with which people learn how to do things.

A technological approach is applied to the ground stone assemblages from nine Point of Pines sites that date within eight phases, from A.D. 400 to A.D. 1425-1450. The assemblages are compared and assessed in terms of variation that might reflect developments in grinding technology. Developments may have derived from local innovations or from introduced technological traditions. Assemblage variation is evaluated in light of major events in Point of Pines prehistory, particularly the change from pit house villages to pueblo villages and the immigration of Tusayan Anasazi.

Point of Pines grinding technology continued relatively unchanged until late in the occupation. Around the mid-1200s, an Anasazi group immigrated to the Point of Pines area and took up residence in the largest Point of Pines pueblo. Foreign technology was introduced but not immediately adopted by the resident Mogollon. Food grinding equipment of two different designs coexisted for about 100 years, until around A.D. 1400 when there is evidence of a change in the social organization of food grinding. It is this change that signals the blending of Mogollon and Anasazi into Western Pueblo.

CHAPTER 1

INTRODUCTION

We must not be satisfied with a single classification of a group of artifacts or of a cultural development, for that way lies dogma and defeat. Brew 1946:65.

There is no better way to learn about the behavior of prehistoric people than to look at the tools they used on a daily basis. Most tools that have survived long enough to be recovered by archaeologists were manufactured out of stone. Those manufactured through abrasive techniques or that function through abrasion have been called "ground stone." The study of ground stone artifacts has long been an important part of archaeological research. It is the use of ground stone tools, after all, that distinguishes the Neolithic. In the American Southwest, ground stone tools have been routinely classified and sorted using a form-function typology that has not been updated since the mid-1950s. In contrast, since the 1960s, archaeologists have been fascinated by flaked stone tools and many have become expert flint-knappers. The classification of flaked tools is so internally focused that even the detritus from tool manufacture is categorized (Amick et al. 1988:199-234; Mauldin and Amick 1989:83-85; Patterson 1982:50-58, 1990:550-558; Shott 1994:69-110). Experiments are conducted with flaked tools, and use-wear studies flourish.

Ground stone tools have never evoked the same level of interest. Some would argue that it is because they are the tools of women's work, a much neglected subject of prehistory (Conkey and Gero 1991:3; Jackson 1991:300). Some might claim we already know all that can be learned about ground stone tools through

ethnographic documentation, and it is these archaeologists who leave ground stone artifacts in the field. The reasons for the neglect are really unimportant. What is important is the realization that new questions are being asked and it is imperative that the artifacts be available for research.

Old World archaeologists studying the rise of agriculture in the Levant area of Southwest Asia are interested in ground stone tools that might have been designed to process cultivated resources. This interest is summarized in a recent article by Wright (1994:238-263). In another article, Wright (1992:53-81) standardizes the way ground stone artifacts from the Levant are described, measured, and analyzed. Such a standardized approach will facilitate comparisons between sites and allow for a regional perspective on the development of grinding technology.

New World archaeologists working in the American southwest have shown similar interest in relating ground stone tools to subsistence patterns. Studies of food processing tool design and tool efficiency have been included in discussions of changes in food resources from gathered to cultivated (Hard 1990:135-149; Lancaster 1984:247-262; Mauldin 1993:317-330), and differences in settlement function, occupation strategies, and abandonment (Nelson and Lippmeier 1993:286-305; Schlanger 1991:460-474). These studies have focused primarily on food processing tools, and given little consideration to other aspects of grinding technology and other types of processing activities.

Presented here is a technological approach to ground stone analysis capitalizing on the methods of ethnoarchaeology, experimentation, and use-wear

analysis. These methods are applied to an existing collection of ground stone artifacts amassed by the University of Arizona Field School excavations in the Point of Pines region, east-central Arizona. I suggest that a technological approach to understanding all ground stone artifacts can lead to an understanding of the larger social context in which they functioned.

The ethnoarchaeological method incorporates information about Puebloan groups, specifically Hopi and Zuni, and about non-Puebloan groups, such as Papago (Tohono O'odham), Pima, Walapai, Maricopa and other Yuman tribes. Their technological knowledge, after all, derived from preceding technological traditions. Various written ethnographies are utilized, as well as personal experience with the Hopi, to develop models of grinding behavior. Recognizing that technology continued to develop along varying trajectories, an understanding of how grinding technology is incorporated into the social context of historic groups will aid in the formulation of correlates applicable to the archaeological record. Correlates may be artifactual in terms of artifact design, use and reuse, situational in terms of activity location, or they may be gender related in terms of who used the artifacts.

The experimental method draws from a series of experiments I have conducted with various artifact types (Adams 1988:307-315, 1989a:261-271, 1989b:259-276, 1994:119, in press). These experiments were designed to study the manufacture of tools, the motor habits of use, and use-wear damage patterns. The result is a better understanding of morphological variation. Differences in tool morphology are the result of more than one process. Some differences are related to tool design, for

example, basin, trough, and flat metates are all different tool designs. Other differences are related to motor habits, for example, manos with two opposing worn surfaces were moved against the metate with a different motor habit than those with two adjacent worn surfaces.

Use-wear analysis makes it possible to determine if an artifact was utilized in the activity for which it was designed. Both macroscopic and microscopic assessments provide evidence about the nature of the use activity. For example, a macroscopic analysis of a mano, designed as a food processing tool, might recognize a U-shaped groove on a non-use surface as evidence of redesign for a nonfood processing activity. Similarly, microscopic analysis of a mano might detect remnants of pigment as evidence of reuse, without redesign, in a nonfood processing activity. Microscopic use-wear analyses can also reveal damage patterns created through contact with various surfaces. For example, the damage patterns on the bit of a wood chopping axe are distinct from those on the bit of an axe reused for shaping stone or gardening.

These three methods applied to the classification of an archaeological assemblage strengthen inferential statements about prehistoric behavior. Within such a classification, artifact definitions encompass not only morphological attributes, but also technological attributes of design and manufacture, and use and reuse. When added to information about where the artifacts were found in the archaeological record, the life history of each artifact becomes clear. The accumulation of all artifact life histories allows for the recognition of patterns of behavior meaningful

for inferences about technological traditions.

The heart of the technological approach is the recognition that technological behavior is social behavior and that these behaviors may be culturally distinct (Dobres and Hoffman 1994:221; Lemonnier 1992:5, 17). These culturally distinct behaviors are sustained through technological traditions. Technological traditions are the transmitted knowledge and behaviors with which people learn how to do things. In this sense technological tradition incorporates technological knowledge as defined by Schiffer and Skibo (1987:597-598) to include recipes for action, teaching frameworks, and techno-science.

Briefly, recipes for action are the parameters within which raw materials are turned into working tools for use in particular activities. A recipe for action is a summary of the materials, tools, and behaviors needed to accomplish an activity. Teaching frameworks facilitate the intergenerational transmission of the recipes for action. While these transmissions may be either verbal or nonverbal, nonverbal transmissions may be the most common and, for example, may take the form of demonstrations, apprenticeships, and imitation. Techno-science is the implicit understanding of the how and why things respond to the application of recipes for action. Techno-scientific understanding may become explicit through the application of scientific methods of observation and experimentation. These are analytical constructs that may or may not be recognized by technology practitioners.

A refinement suggested to the definition of technological knowledge as presented by Schiffer and Skibo (1987:597-598) is that teaching frameworks are not

solely intergenerational transmissions. Practitioners of one technological tradition may become aware of an alternative tradition. At some point they may make a decision to adopt the alternative, creating intertraditional transmission of knowledge. This, as well as the decision not to adopt an alternative tradition, may have been socially driven choices, and may or may not be recognizable in the archaeological record. Lemonnier (1992:19) concludes that a "study of the relations between technology and society must necessarily start from the study of differences, of variations in technological actions." Following this logic, the best way to assess whether archaeological material provides the necessary information for studying the relations of technology and society is to assess assemblage variation.

This is the approach taken with the ground stone assemblages from nine Point of Pines sites that date within eight phases (these sites and phase assignments are described in Chapter 3). The assemblages are compared and assessed in terms of variation that might reflect developments in grinding technology. Developments may have derived from local innovations or from introduced technological traditions. Assemblage variation is evaluated in light of some major events in Point of Pines prehistory, such as the change from pit house villages to pueblo villages and the immigration of Anasazi from the north.

Thus, the goals of this research are: (1) to shift the direction of ground stone analysis away from the treatment of these artifacts exclusively as things and toward their consideration as technological conduits of social development; (2) to demonstrate that use-wear damage patterns created on experimental stones can be

recognized on prehistoric artifacts; and (3) to demonstrate that new research problems can be answered even when collections were made under other research designs.

Although it did not start out as a goal of this research, one of the benefits has been the development of an understanding of the growth of knowledge. What I know about ground stone artifacts has grown tremendously. The result is that the questions asked in the beginning and the data gathered to answer them were much less useful than the questions and data collection toward the end of the research. This research did not start in a vacuum. Many of the questions I had were those asked by others who previously worked with ground stone artifacts and by those who worked in the Point of Pines area. The answers they came up with in many ways have been corroborated. However, by taking a technological approach, the answers to my questions emphasize the behavior of the people who used the artifacts. Evidence that the first goal has been met will be a clearer understanding of what grinding technology is, how it was used by the prehistoric inhabitants of the Point of Pines area, and an evaluation of changes in grinding technology through time.

Evidence that the second goal has been met will be a clearer understanding of how individual artifacts were used. Experimental use-wear research refines the definitions of existing ground stone artifact types. The results are more understandable type definitions and the recognition that many artifacts were used in more than one activity. The Point of Pines assemblage of ground stone is perfect

for recognizing developmental changes in technology because it is from both pit house and pueblo sites occupied sequentially over a long period of time.

Evidence that the third goal has been reached will be an understanding of how excavation and information recording strategies have impacted what is available for analysis. Excavation reports, analysis reports, published and unpublished documents provide information about how the archaeological record was uncovered and initially interpreted; including insights the excavators had into prehistoric behaviors that created the record.

The next chapter (Grinding Technology) discusses the concept of life history. How artifacts were designed, manufactured, used, reused, and discarded must be considered in order to understand prehistoric grinding behavior in the larger picture. Schiffer (1987:13-15) suggests that life history is a useful concept for understanding the archaeological record. A similar concept, *chaîne opératoire*, is common to both French archaeology and the study of flaked stone for reconstructing the techniques and decision making processes of prehistoric flint-knappers (Lemonnier 1992:25-27; Sellet 1993:106-112). For ground stone artifacts the life history concept allows for the consideration of behavior at various stages in the life of a tool. Both experimental and ethnographic data are compiled to discuss whether a tool was strategically designed or expediently designed. Experimental data help evaluate whether a tool was used in a single activity or more than one. Excavation records were consulted to assess whether an artifact was found where it was used, stored or discarded.

The third chapter (Analytical Strategy) presents an analytical strategy specifically developed for evaluating a museum artifact collection. The artifacts from Point of Pines were collected during several summers of excavation. The project research design and the artifact recovery strategies were different than if the work had been designed for this analysis of grinding technology. This evaluation provides an objective way of assessing how useful the collection from each site is for understanding the development of grinding technology in a prehistoric setting.

Background information for the Point of Pines field school and the modern environment is in Chapter 4 (The Point of Pines Field School). The life history approach discussed in the second chapter makes it possible to recognize not only the activity for which an artifact was designed, but also if it was used in more than one activity. In Chapter 5 (Ground Stone Artifacts), the ground stone artifacts are grouped according to the activity for which they were designed. Each artifact type is defined and distinctive attributes are described, including use-wear damage patterns. Artifacts used in more than one activity are discussed in terms of sequential and concomitant use. Ethnographic data from various Native American groups provide not only an understanding of how prehistoric artifacts might have been used, but also the recognition of technological variation between groups, and within each group the actualization of technological behavior as social behavior.

Chapter 6 (Grinding Technology at the Pit House Villages) summarizes the analysis of ground stone artifacts from each of four pit house villages. The seventh chapter (Grinding Technology at the Pueblo Villages) does the same for four

pueblos and two phases of occupation at a fifth pueblo.

Comparisons between pit house and pueblo assemblages highlight variations in the number of ground stone artifact types, and morphological variation within each artifact type. Some variations are attributable to the coexistence of immigrant technological traditions while others are the result of local innovations. These variations are discussed in the eighth chapter (Grinding Technology in the Point of Pines Area). This chapter also draws the entire analysis together in a historical reconstruction of grinding technology in the Point of Pines area. Opinions are offered on how developments in grinding technology reflect social development, particularly in the social organization of food processing.

CHAPTER 2

GRINDING TECHNOLOGY

What are ground stone artifacts and how do they operate as components of grinding technology? As utilized here, the term technology encompasses not only the tools but the knowledge and behaviors associated with their manufacture and use (Lemonnier 1986; Schiffer 1992; Schiffer and Skibo 1987; Kingery 1989; Adams 1993). Implicit in this study is the belief that "distinctive cultural predilections are expressed through technologies and technological choices" (Dobres and Hoffman 1994:221). Changes in technology co-occur with changes in the social conditions within which technology operates.

How was grinding technology employed in the past? Prehistoric people were well aware of the effects of rubbing stones together to reduce a substance to finer texture, and of rubbing stones against other materials to alter their shape or texture. Thus, two-piece tool kits were designed and manufactured to grind (manos and metates) or to crush (pestles and mortars) intermediate substances--either food or nonfood. One-piece tools were designed and manufactured to make other tools (axes, awls, pots, and arrows) from a variety of materials, or to make items that are not tools (figurines, beads, and pendants). The ways in which tools were manufactured and used leave distinctive morphological attributes that when viewed macroscopically reflect motor habits (Adams 1993; Bartlett 1933; Morris 1990), and when viewed microscopically reflect the damage created by use-wear (Adams 1988, 1989a, 1989b, 1993b, in press; Mills 1993; Flenniken and Ozbun 1988).

Life History

The concept of artifact life history is integral to this analysis of ground stone tools. Life history is a framework for understanding how artifact manufacture, and subsequent use and reuse leave damage patterns that can be correlated with a specific sequence of behaviors (Schiffer 1987:13-14, 1992:8 called life cycle; Sullivan 1978:194-210). An artifact may enter the archaeological record at any point within its life history. It may have been manufactured and then discarded, used lightly and discarded, or it may have been used for a long period of time in one activity and then redesigned for another activity. An artifact discarded early in its life history has a certain, perhaps measurable, amount of remnant use-life. Each behavior (manufacture, use, reuse) creates distinctive damage patterns on the tool. A recognition of these patterns coupled with a consideration of where the artifact was found strengthens inferences about prehistoric behaviors.

Design and Manufacture

Design and manufacture are the first stages in the life-history of a tool (Schiffer 1987:13-15; Kingery 1989:2-5). Decisions made at the design stage begin with raw material acquisition and involve selection on the basis of formal properties, such as texture or size (Horsfall 1987:340). For example, a polishing stone is manufactured from rock of appropriate texture, for a stone too rough will abrade not polish. Selection of the proper size stone is important in mano design, as mano length is dependent on metate width. Additionally, mano design is dependent on metate design; the stone selected cannot be larger than the grinding surface of the

metate, especially one manipulated in a trough metate. The design of the metate itself may be dictated by the size of the raw material. Because manos and metates are essentially two components of grinding equipment, one component is not functional without the other, and they work best if their configurations are compatible (Adams 1993:339, Lightfoot 1992:3). A mano designed and manufactured longer than the width of the metate trough is not a compatible component, and together they do not make a functional tool.

For some artifacts, once a stone was selected there was no further manufacture. Tools used without modification of the naturally shaped stone were expediently designed. Those that were modified for grasping or to create a specific shape were strategically designed. Expediently designed tools required no additional manufacture time beyond what it took to choose the raw material. Strategically designed tools required more manufacture time and, therefore, if time and effort are relative measures of cost, are more expensive than expediently designed tools.

Other design factors might also impact the cost of tools. For example, metates designed with a trough were more expensive to make than flat metates. Manos designed with finger grooves and shaped to fit the hand are more expensive to make than unmodified cobbles. These cost factors might be important in the decisions made about tool treatment, such as storing tools, managing wear, and taking tools during moves from one village to another. Discussions about these decisions abound in the literature (Bamforth 1986, Binford 1978, 1979 and Shott 1986, 1989 for curation behavior with flaked lithics; Nelson and Lippmeier 1993 for ground stone

design; Cameron and Tomka 1993 and Schiffer 1987:89-96 for abandonment processes).

The relationship between tool manufacturer and tool user may also have influenced decisions about ground stone tool treatment. If the manufacturer and user were the same person, or closely related, replacing tools would not have been as large a problem as if the manufacturer were located in one village and the user in another. Horsfall (1987), using the Guatemalan Maya as a model, discusses constraints on household metate inventories due to the social and economic costs of metate procurement. In her study, a man specialized in the manufacture of metates for trade with the locals or for sale at the more distant marketplace. Communication between the user and the manufacturer was sporadic, so it may have been hard for the user to ask for design changes. In the American Southwest, Hopi women who needed metates or other tools were joined by husbands, sons, or brothers in the procurement of raw material, but manufactured the tools themselves or with some help from the men (Stephen 1936:134; Titiev 1972:219, 243, 271). Communication was easy between the manufacturers and the users and design changes would have been easy to make.

Some tools, such as manos and metates, were designed to be activity-specific, to process food; although they may have also ground nonfood substances. Other activity-specific tools include polishing stones and abraders for processing nonfood resources. Some tools may not have attributes to identify them with specific activities and these are considered of ambiguous use. For example, handstones and

netherstones do not have mano or metate attributes, yet they may have served as needed in food or nonfood processing activities. While tool design may indicate intended use, other evidence, such as use-wear damage patterns, reflect actual tool use.

Use

The next stage in the life history of an artifact is use. Artifact use may be inferred from various sources of evidence including ethnographic information, experimentation, use-wear analysis, and archaeological context. The assumption in this analysis is that the artifacts recovered from the Point of Pines sites were used at those villages. It is also assumed that many artifacts were removed when the villages were abandoned or later scavenged. Assumptions about whether artifacts found on structure floors were left in use positions, storage positions, ritual positions, or were discarded vary by structure and site. Refer to Chapter 3 (The Nature of the Assemblage) for a discussion of the methods involved in assessing whether the assemblages from each site reflect use, discard, or abandonment behaviors. Archaeological context is discussed later in this chapter; this section presents experimental and use-wear analysis techniques for inferring artifact use.

Artifact use may either obliterate the damage patterns created through manufacture, or add distinctive damage patterns of wear. Through experimentation, microscopic and macroscopic examination, and application of tribological research, it is possible to understand the mechanisms of wear.

Tribology is the study of friction, lubrication, and wear, and has many

industrial and scientific applications (Blau 1989; Arnell et al. 1991; Czichos 1978; Dowson 1979; Kragelsky et al. 1982; Quinn 1971; Szeri 1980; Teer and Arnell 1975). Four mechanisms recognized by tribologists seem most appropriate for describing and understanding the formation of specific damage patterns on ground stone artifacts: adhesive wear, abrasive wear, surface fatigue, and tribochemical wear. They are not mutually exclusive in their operation on a tool's surface, nor is each the result of a single independent event. Rather, the four mechanisms interact, with one dominant over the others, depending on the characteristics of the contacting surfaces and the nature of any intermediate substances. An important surface characteristic is asperity; a combination of material granularity and surface roughness, influenced by material hardness. An asperity is a single grain or a single projection from a surface.

Adhesive wear begins the moment two surfaces come into contact; even if there is no movement, there are molecular interactions. These interactions create bonds that are broken when there is movement of one surface across or away from the other surface (Kragelsky and others 1982:6; Czichos 1978:119-123). The movement and subsequent breaking of bonds releases energy in the form of frictional heat and loosens material from one or both surfaces that can remain loose between the surfaces, or can become attached to the opposite surface or at another location on the original surface. In the early stages of wear, the damage may not be visible except at very high power magnification. However, as wear progresses the damage builds up and interacts with the other mechanisms.

Surface fatigue begins as pressure, or the alternating stress of movement is applied to contacting surfaces; the highest elevations bear the load. If the load is more than is bearable then there is collapse and crushing of the elevations until the weight of the load can be withstood (Czichos 1978:105; Teer and Arnell 1975:95). This crushing of the elevations is the result of surface fatigue. Damage is visible, both macroscopically and at low power magnification, as cracks, step fractures, and pits. The effect is similar to that seen on frosted window glass. Surface fatigue might destroy damage patterns created by adhesive wear, but at the same time it opens up fresh surface area upon which new adhesive bonds can be created.

Abrasive wear can be caused by particles loosened through adhesive wear and surface fatigue that remain between surfaces, becoming abrasive agents in the wear process. These abrasive agents create scratches across the stone's surface. Material gouged out by the agents also becomes involved in the abrasive wear process. Abrasive wear is also caused by the movement of a more asperite surface across a less asperite surface. The harder, rougher grains of one surface dig into the softer, smoother material of the other surface. Movement displaces the softer material, creating abrasive scratches in the direction of the movement (Czichos 1978:126, Teer and Arnell 1975:106).

As surfaces move against each other, the alternating stresses of movement and pressure instigate the mechanisms of adhesive wear, abrasive wear, and surface fatigue. These mechanisms create surficial cracks on both contacting surfaces. Once a crack has formed, crack propagation results in the release of energy in the

form of frictional heat (Czichos 1978:105-112). The release of heat is only one of the factors important in the "environment" surrounding the contacting surfaces.

Other factors include any intermediate substances that are between surfaces. In the industrial world, intermediate substances might be lubricants or abrasives. In terms of traditional societies using ground stone tools, these might be grain, meat, clay or anything processed between two stones; or it might be properties of one of the surfaces such as the oils in hides or bone, or the silicates in vegetal remains. Other truly environmental factors are also important, including whether the surfaces are contacting in a wet or dry atmosphere or in clean or dirty surroundings.

In essence, what happens is an interactive process. Adhesive wear, abrasive wear, and surface fatigue create an environment for the chemical interactions of the **tribochemical** mechanism. These chemical interactions produce reaction products, which are the films and oxides that build up on surfaces (Czichos 1978:123). These reaction products are visible on stone surfaces as sheen, sometimes referred to as polish by technologists studying flaked stone tools. Tribochemical interactions are constantly occurring and are enhanced by frictional energy and mechanical activation. However, unless the reaction products are allowed to build up, they cannot be seen. While the other three mechanisms are constantly exposing fresh surfaces upon which interactions can occur, they are concomitantly removing any build-up of reaction products. Such removal continues until the higher elevations of the contacting surfaces have been crushed to the point that surface fatigue is no longer a factor, and the asperities of the two surfaces are no longer gouging each

other. Thus, a reduction in surface topography allows reaction products to build up enough to be visible macroscopically.

It is impossible to discuss what happens to the surfaces of ground stone tools without using the term wear. Wear is the progressive loss of substance from the operating surface of a body as a result of relative motion (Adams 1988:310; Arnell et al. 1991:66; Czichos 1978:98; Szeri 1980:35; Teer and Arnell 1975:94). It is easy to see that the mechanisms of adhesive wear, abrasive wear, and surface fatigue are reductive processes. Tribochemical wear, however, adds reaction products. The reaction products cannot build up until the other mechanisms have reduced the microtopography of the contacting surfaces to the point that there is no more crushing or gouging. Thus it is possible, by looking at damage patterns, to determine which wear mechanisms were in operation most recently on the surface (Adams 1988, 1989a, 1989b).

Ground stone tools are manipulated against a variety of surfaces. Manos and metates, mortars and pestles, grinding slabs and handstones have contact of stone-against-stone with an intermediate substance adding to the contact environment. Abraders, especially grooved abraders, have contact of stone-against-wood or stone-against-bone. These contacts are more pliable than stone, and create damage patterns very different than those of stone-against-stone contact. Stone surfaces worked against soft surfaces, such as hide processing stones, have yet another very distinctive damage pattern.

It is toward understanding how these distinctive patterns are formed and what

role intermediate substances play that experiments were conducted using replicated artifacts of sandstone and vesicular basalt (Adams 1989b, in press). Grooved abraders were used to fashion awls out of sheep metapodials and arrowshafts out of willow. Flat abraders were employed for shaping greasewood digging sticks, bone gaming pieces, and shell beads (Adams 1989b, in press). Through these experiments it was learned that a functional awl can be made in less than half an hour, a digging stick can be made in less than one hour, and one olivella shell bead can be readied for stringing in 10 minutes (Adams 1989a: 263-266, in press).

Experimental manos and metates were made for grinding corn, sunflower seeds, amaranth, clay, and sherds. The sunflower seeds were much more difficult to grind than any other substance because of their oily nature. Future experiments will compare these results with the results of grinding roasted seeds. With all the other substances it was possible to grind one cup of seeds to a flour consistency in 15 to 20 minutes. The less surface asperity the grinding tools had, the longer it took to grind a cup of anything. Material was more quickly processed after the surface was pecked with another stone, making the surface rougher. More detailed accounts of these experiments are presented elsewhere (Adams 1988, 1989a, 1989b).

Stone-Against-Stone

Using the experimental manos and metates as a baseline for description, is it possible to identify the damage caused when two stone surfaces are worked against each other. The first points of contact are on the highest elevations of the stone. At the macroscopic level this would be an uneven bump or ridge. At the microscopic

level this would be the tops of the grains or a high point in the crystalline structure of the stone. The rigid stone does not flow into the elevational lows, the interstices between the grains, or the insides of the vesicles.

The experiments were specifically designed to determine how different intermediate substances affect the wear process. The questions asked are: Do corn, sunflower seeds, amaranth seeds, clay, and sherds differentially interact with the wear mechanisms as two stone surfaces grind together? And is it possible to distinguish damage patterns left on the stones' surfaces after the different substances have been ground? Each substance was ground on a freshly manufactured mano/metate equipment. After six to ten hours of grinding each substance it is possible to make some very preliminary observations about the different wear patterns.

The effects of abrasive wear and surface fatigue wear mechanisms are the easiest and quickest to observe at a macroscopic or low-power microscopic level. Crushed grains and scratches happen immediately. As grinding proceeds, the fine powder or meal created through grinding fills up the interstices or vesicles of the stone material, slowing down the crushing effects of surface fatigue. Essentially this makes the surface less rough and reduces grinding efficiency. Once the surface is cleaned the efficiency improves.

A comparison of the experimentally used surfaces suggests that the most distinctive wear pattern is a result of the tribochemical mechanism. No matter what is ground, the stones' surfaces all have evidence of abrasive and surface fatigue wear

mechanisms. The difference lies mainly in a sheen that is created most obviously when oily substances are ground. The sheen is most likely the result of the oils interacting with the properties of the stone that are made available through a combination of frictional heat and the exposing of fresh surfaces for tribochemical interactions.

Sherds and clay have no oil. Thus, the damage patterns on the stones' surfaces after grinding these substances are primarily of abrasive and surface fatigue wear mechanisms. Sunflower seeds have more oil than amaranth or corn. It is after grinding sunflower seeds that the relationship between oil and a shiny surface becomes obvious. The sheen on the surfaces used to grind sunflower seeds accumulates on the highest and lowest elevations of the stones surfaces (Figure 2.1). This contrasts with surfaces used to grind amaranth or corn where the sheen is visible only after long periods of grinding have leveled the stone so that the reaction products can build up without being worn away by abrasion or surface fatigue. In fact, on surfaces that remain rough it is not possible to distinguish those used to grind corn or amaranth from those used to grind clay or sherds (Figure 2.2). The conclusion seems to be that the concomitant operation of wear mechanisms makes it difficult to see some distinctive patterns until a point is reached in the wear process where tribochemical wear mechanisms are more dominant than abrasive and surface fatigue mechanisms.

Stone-Against-Wood or Bone

The experimental tools used to make arrow shafts, digging sticks, and bone

Figure 2.1. Photomicrograph of experimental sunflower-seed grinding stone. Compare with the two photomicrographs in Figure 2.2.

Figure 2.2. Photomicrographs of experimental stones used to grind corn (A) and sherds (B). The tops of the grains are frosted with impact fractures and the interstices are filled with corn or sherd dust.

awls provide a baseline for describing damage created between stone and a resilient or pliable surface (Adams 1989a, 1989b). When wood and bone come into contact with an asperite stone surface, there is an area of greater surface contact than there is when stone comes into contact with stone. Because they are more pliable, wood and bone push into the topographic lows and the interstices between grains. Wood and bone are not as hard or asperite as stone so there is less opportunity for abrasive wear. The movement of softer material against the grains rounds off the sharp edges. For this reason it is important to know what unused material looks like, so that naturally round grains are not confused with grains rounded through use-wear. All exposed edges of the grains are much more involved in the wear process than in stone-against-stone wear.

As green wood is worked against the stone, it will leave a sticky residue over the grains and in the interstices. Further rubbing will remove the residue from the grains, but the interstices will remain clogged. Dry wood will leave drier dust on the stone surface but this dust will not interfere with the abrasion process as much as the residue from the green wood. The resultant wear patterns from green and dry wood are at this point indistinguishable. It must be pointed out, however, that there has been no high-power microscopy, nor enough experimentation to determine if it is possible to differentiate these wear patterns.

Green and dry bone, on the other hand, do seem to leave distinctive wear patterns. The difference is probably a result of the oils that remain in the green bone. There is noticeably more sheen on the surface of the tool used to abrade

green bone. It is somewhat discouraging to find that there is very little difference in wear patterns produced by abrading dry bone or any kind of wood (Figure 2.3).

Stone-Against-Hide

An experimental stone used to process a dried deer hide provides the baseline for describing the damage created on a stone used against a soft surface (Adams 1988). The use-wear created by rubbing a hide is unlike the damage created through stone-on-stone contact or any other contact situation. The hide pushes against the stone surface, completely filling the topographic lows and the interstices between the grains. There is nothing abrasive in the hide, so the only chance for abrasive wear is when a grain from the stone surface is dislodged, or a particle from the environment is trapped between the surfaces.

Pressure, triggering surface fatigue, is a factor depending on how the stone is used. Adhesive wear and tribological wear are most dominant. Frictional heat, although not as obvious as with stone-against-stone contact, helps to change the contact environment. The resulting residues build up and become visible as a sheen on the tops of grains, down the sides of the grains, and in the interstitial spaces between the grains (Figure 2.4).

How the handstone moves across the hide depends on the amount of connective tissue and moisture on the hide. Until the connective tissue is removed and the hide is drier, the handstone becomes clogged and not very abrasive. Washing the stone surface removes the clogging material and restores abrasiveness. An abrasive stone can work a nap into the hide, creating a soft, suede-like surface.

A.

B.

Figure 2.3. Photomicrographs of experimental wood (A) and bone (B) working tools.

Figure 2.4. Photomicrograph of experimental hide processing stone.

Damage Pattern Assessment

Many things can be discerned about damage patterns by looking at the surface of a ground stone tool without magnification. Striations, crushed grains, leveled areas, and sheen are all damage patterns visible macroscopically and are indications that the wear mechanisms were active on the surface. The location of these damage patterns is important to note for assessing contact situations. For example, if the topography of a handstone's surface has many elevational differences and the damage patterns are visible only on the highest elevations, it is most likely that the stone was in contact with another stone or very rigid surface. If the damage extends into the lower elevations as well, then the opposing surface had to have been pliable enough to reach into the lower areas.

In order to fully understand damage patterns, however, one must examine the surfaces under low power (10 to 40x) magnification. Magnification reveals the microtopography of a ground stone tool, with grains in high relief and the interstices or gaps between the grains in low relief. Before judging the microtopography for evidence of damage, it is first important to know what undamaged material looks like. An undamaged area of the tool should be examined to determine the nature of the lithic material. Is it granular or vesicular? Are the grains angular or rounded? Do they have naturally occurring step fractures or a natural sheen? Are the vesicle margins rounded or sharp? What do the interstices or the insides of the vesicles look like? Once the nature of the stone is assessed, it is possible to isolate damage caused by contact with an opposing surface.

In the study of Point of Pines ground stone, a use-wear analysis was conducted on all tools at a macroscopic level, with those from two sites analyzed using a zoom stereomicroscope to scan at 18x to 40x. The artifacts were assessed both macroscopically and microscopically for evidence of damage patterns created during manufacture, use, and for the possibility of secondary use.

Secondary Use

A tool designed or selected for a particular use in practice may have served in multiple activities, been reused, or recycled. Single-purpose artifacts were designed and used in one activity. Reused artifacts were single-purpose artifacts used in another activity without an alteration in artifact design. Tool reuse may be indicated only by the presence of a residue, such as pigment left on a mano that ground paint. Other secondarily used artifacts were redesigned and remanufactured to produce attributes needed in the second activity, such as a handstone grooved for use as a shaftsmoother.

Two concepts, concomitant use and sequential use, are introduced here to further understanding of when in the life cycle a second use might have occurred. In some cases the attributes created through the second use destroy the attributes of the first so that the artifact could no longer have served as originally designed. This is sequential use and the tools are redesigned tools. An example of sequential use is a mano redesigned with a grooved placed across the grinding surface for use as a shaftsmoother. This tool was no longer usable as originally designed. The original designer and the redesigner may have been different people, with a scavenged or

recycled tool serving as raw material (Schiffer 1987:29-30; Schlanger 1991:463).

With some artifacts this step occurs after provisional discard (Deal 1985:253-259; Hayden and Cannon 1983:133).

In other cases, the attributes created through the second use did not destroy those of the original design, and the artifact could have served in either task. This is concomitant use and the tools are multiple-use tools. An example of concomitant use is a mano redesigned as a shaftsmoother, but the groove was placed on a surface not manipulated against the metate. The tool could have served as both a mano and a shaftsmoother. The original designer and the redesigner may have been the same person, who was trying to broaden the range of accomplishable activities without expanding the number of tools.

The secondary use of some artifacts might be discovered only through their archaeological context, such as metates recycled as building stones or roasting rocks. Adhering mortar or plaster, smoke stains, or fragmentation may be the only physical indications of recycling. The distinguishing characteristic is that they were no longer processing tools, but were recycled into some other role.

The artifacts available for analysis from Point of Pines sites were assessed for evidence of secondary use. Stone catalogue cards also recorded this information for some artifacts left at the sites, but because microscopic analysis is needed to identify some secondary uses, it is possible that many escaped notice. With this caveat, it is interesting to note that anywhere from 12 percent to 33 percent of each site assemblage had secondary use (Table 2.1). Understanding how artifacts were used

TABLE 2.1

Summary of secondary use from each site

SITE	SECOND ACTIVITY percent
CROOKED RIDGE	15
STOVE CANYON	21
LUNT	12
NANTACK	15
W:10:37	24
TURKEY CREEK	25
W:10:50 MAV MTN	33
W:10:50 CAN CRK	25
W:10:51	27
W:1050B	29

secondarily is important for understanding the role of ground stone tools as components of technology in general.

Archaeological Context

As part of understanding the life history of ground stone artifacts, consideration is given to where the artifacts were found. This is also discussed in the third chapter (Analytical Strategy). Many researchers have studied how artifacts are deposited (Deal 1985; Hayden and Cannon 1983; Schiffer 1987:47-98; Schlanger 1991). For this analysis it is possible to consider whether artifacts were found on

floors, in fill, or for some sites, in features. The artifacts from all sites were combined, and those from fill, floor, and feature assemblages were compared. Floors have fewer artifact types (n=19) than fill (n=22) and features have fewer types (n=14) than either floors or fill. Differing distributions may have something to do with where the artifacts were used, where they were stored, the way they were abandoned, or how they were discarded.

In this analysis, floor assemblages are appropriate for inferring that certain activities occurred at the village. The tools may have been used in the structures or only stored there, and the difference was not always easy to determine from the records. The only inferences about specific activities occurring within structures are made about food grinding activities. Free-standing metates found with support rocks that propped them at an angle or the presence of mealing receptacles or bins were interpreted as locations of food processing activities.

Processing Activity

The activity in which a tool was used can be determined through a combination of macroscopic and microscopic techniques. The design or the way a tool is structured during manufacture may indicate its intended function. This fact is the basis of most form/function analyses done with ground stone tools. Ethnographic comparisons provide the most useful information for identifying artifact type (Adams 1979; Bartlett 1933; Castteter and Bell 1937, 1942, 1951; Euler and Dobyns 1983; Spier 1933; Woodbury 1954). Most typological definitions of ground stone artifacts were made many years ago, and the present analysis, for the

most part, does not change these definitions, but it does refine them on the basis of experimental and ethnographic research.

By combining an assessment of design and manufacture with use-wear analysis, one can categorize artifacts by the activity in which they were used. For example, manos and metates were designed and manufactured as equipment made up of moving parts, and used during food processing activities. Manipulation of a mano against a metate leaves distinctive damage patterns. If close examination discovers pigment, then the mano was also reused in a nonfood processing activity.

Nonfood processing tools shape or alter the surfaces of other artifacts, or alter the texture of nonfood substances. For example, abraders and polishing stones shape and smooth the surfaces of other items; palettes and lapstones are surfaces upon which substances are ground or mixed. Distinctive damage patterns are also left on the surfaces of nonfood processing tools. These damage patterns reflect the nature of the contact surface permitting inferences about tool use.

Some tools are generic enough in design to have served in either food or nonfood processing activities. Broken or unidentifiable artifacts are included in the ambiguous category if distinguishing attributes are missing.

Tools used in procurement activities include axes and fire-drill hearths (all tool types are defined in Chapter 5). Axes were designed for wood procurement, and fire-drill hearths were designed to create fire from a friction-generated spark.

Construction activities involve tools to build or maintain structures. Examples include floor polishers for applying and burnishing plaster, and digging tools for

excavating house pits, post holes, and other features.

Some artifacts were shaped by abrasion or polishing but were either ancillary to processing activities or not used in processing activities at all; balls and pipes are examples of such items. Also included in this category are artifacts shaped to be containers or container parts, such as bowls, caps, and plugs. While containers may have been used in processing activities, they were not doing the processing, and so are considered nonprocessing tools.

Because a variety of artifacts, with grinding applied at various stages in their life histories, are included in the category of ground stone artifacts, the discussion of grinding technology at Point of Pines is organized by activity: food processing, processing of nonfood items, ambiguous activities, procurement activities, construction activities, and nonprocessing activities (Table 2.2). In order to group the artifacts into these activity categories, it is still necessary to categorize them by formal types. A discussion of the ground stone types involved in this analysis is presented in Chapter 5 (Ground Stone Artifacts).

TABLE 2.2

Summary of activities in which ground stone artifacts were used

SITE	FOOD PROCESS	NONFOOD PROCESS	CONSTRUCT	AMBIG	PROCURE	NONPROS	TOTAL
	# %	# %	# %	# %	# %	# %	
CROOKED RIDGE	173 50.4	72 21.0	12 3.5	73 21.3	1 .3	12 3.5	343
STOVE CANYON	81 65.3	12 9.7	0 0	29 23.4	1 .8	1 .8	124
LUNT	33 49.3	13 19.4	0 0	18 26.9	1 1.5	2 3.0	67
NANTACK	74 47.7	28 18.1	0 0	44 28.4	3 1.9	6 3.9	155
W:10:37	132 38.3	70 20.3	5 1.4	114 33.0	21 6.1	2 .9	345
TURKEY CREEK	140 24.2	205 35.5	1 .2	35 6.1	125 21.6	72 12.5	578
W:10:50 MAVERICK MNT	118 52.9	53 23.8	3 1.3	23 10.3	21 9.4	5 2.2	223
W:10:50 CANYON CREEK	131 36.2	118 32.6	2 .6	60 16.6	43 11.9	8 2.2	362
W:10:51	383 60.9	95 15.1	0 0	72 11.4	70 11.1	9 1.4	629
W:10:50B	86 41.6	52 25.1	0 0	40 19.4	29 14.0	0 0	207
TOTAL	1351 44.5	718 23.7	23 .8	508 16.7	318 10.5	115 3.8	3033

CHAPTER 3

ANALYTICAL STRATEGY

The analysis of grinding technology in the Point of Pines area focuses on nine sites dating within eight phases: Crooked Ridge village, Circle Prairie phase; Stove Canyon and Lunt villages, Stove Canyon phase; Nantack village, Nantack phase; Pueblo AZ W:10:37, Reserve phase; Turkey Creek pueblo, Tularosa phase; Pueblo AZ W:10:50, Maverick Mountain occupation; Pueblo AZ W:10:50, Canyon Creek phase; and pueblos AZ W:10:51 and AZ W:10:50B, Point of Pines phase (Table 3.1). Those sites with more than one component were analyzed in such a manner as to exclude artifacts from the less dominant component. In essence the component is the unit of analysis in this study. For example, artifacts from the masonry component at the pit house village of Nantack were not included, nor were artifacts from the pit house component under the masonry structures at Point of Pines Pueblo (AZ W:10:50). The result is that each site represents a case study from a different segment of time. For each of these cases, grinding technology provides the framework for discussing differences, similarities, and change.

Each site has been documented through either a published site description or a dissertation/thesis and these provide background information on site location, environment, excavation results, and conclusions made by the field school project. The collections of ground stone artifacts available from the above sites are housed in the Collections Division of the Arizona State Museum (ASM). The artifacts and their catalogue cards are easily accessible, as are cards called "stone catalogue cards" (filled

TABLE 3.1

Chronological sequence of Point of Pines sites

SITE	DATES OF OCCUPATION	PHASE
W:10:50B	1400-1450	POINT OF PINES
W:10:51	1400-1450	POINT OF PINES
CANYON CREEK	1300-1350	CANYON CREEK
MAVERICK MTN	1265-1300	MAVERICK MTN
TURKEY CREEK	1225-1290	TULAROSA
W:10:37	1100-1200	RESERVE/TULAROSA
NANTACK	900-1000	NANTACK
LUNT	800-900	STOVE CANYON
STOVE CANYON	650-900	STOVE CANYON
CROOKED RIDGE	400-600	CIRCLE PRAIRIE

out for each stone artifact left in the field) and room records written during the fieldwork. These four sources of information (artifacts, catalogue cards, stone catalogue cards, and room records) were all employed to reconstruct the ground stone assemblages from each site. Previous ground stone analyses presented in the published descriptions of some sites (see especially Breternitz 1959 for Nantack, Wendorf 1950 for AZ W:10:51, and Wheat 1954 for Crooked Ridge) are another source of information.

In this study of grinding technology, information about the artifacts was organized by level of analysis. If the artifact is at ASM, it was analyzed and

recorded as such. If the artifact was not brought back to ASM it was recorded as inventoried. Some basic information is available from the stone catalogue cards, such as material type and sometimes number of used surfaces, but most of what we can learn about grinding technology comes from the artifacts now housed at ASM. Whenever possible, information from the inventoried artifacts or from published site reports is included to make the data base more robust.

The nine sites identified above provide glimpses of technology used during specific periods. As a start toward understanding how the site assemblages vary from each other, a diversity analysis was conducted to compare the property of assemblage richness (Kintigh 1992). This assessment essentially identified those sites that had more or fewer artifact types than expected on the basis of assemblage size. Five sites were plotted that had fewer artifact types than expected (Table 3.2). What this assessment does not tell us is why these assemblages are different. To get at the why, comparisons of assemblage similarities and differences were made. These comparisons (described below) provide the vehicles for discussing the development of grinding technology.

As important as it is to understand the differing prehistoric behaviors at each site, it is equally important to understand the differing excavation and artifact recovery strategies at each site. Both the prehistoric and historic behaviors contribute to the nature of the ground stone assemblage.

TABLE 3.2

Diversity plot of richness value for artifact types analyzed from each site (TQA Statistical Package, Kintigh 1992).

The Nature of the Ground Stone Assemblage

The ground stone assemblage recovered from the Point of Pines sites is a product of both human and natural forces, called formation processes (Schiffer 1987). It is also a product of excavation and recovery strategies. Prehistorically, people used and discarded artifacts. Upon abandonment of structures or villages, they may have left some items and taken others. Ground stone tools left at some villages may have been differentially scavenged, or sealed from potential scavenging (Schlanger 1991:470). Some of the earlier structures at villages with later

components may have served as trash receptacles. All of these behaviors affect the nature of the recovered assemblage.

Other researchers have also grappled with understanding how fill and floor assemblages reflect prehistoric behavior (Montgomery 1992b:126; Reid 1973:115-118; Reid and Shimada 1982:14-15; Schiffer 1987:323-338; 1989:37-58). Using pottery data from Grasshopper pueblo, Reid (1973:115-118) constructed values of artifact density by dividing the total number of sherds in the fill by room area. These values were assessed by whether or not rooms had pottery vessels on their floors. The conclusions were that rooms with high sherd densities and no vessel assemblages on the floors were abandoned before the entire pueblo and were filled with trash by the remaining occupants. Rooms with vessel assemblages on the floors and low sherd densities were abandoned and no one remained to fill them with trash. The values obtained through these comparisons were called "abandonment measures" (Montgomery 1992b:126; Reid 1973:117; Reid and Shimada 1982:15).

Schiffer (1987:323-338, 1989:37-58) expands on the abandonment measure with diversity plots that compare pottery types in fill and floor deposits from Broken K pueblo as a way of recognizing rooms with restorable pots. Rooms with low diversity in design styles probably have many sherds from a single pot and were impacted less by abandonment strategies than rooms with higher diversity, which were probably trash filled.

Montgomery (1992a, 1992b:126) used the abandonment measure to identify a

prehistoric behavior of purposefully burying a pueblo upon abandonment. At Chodistaas pueblo she identified rooms with multiple pots on the floors and high sherd densities in the fill. Her conclusion is that the occupants filled the rooms with trash to close the pueblo. Rooms could not be reoccupied and their contents were sealed from scavengers.

While it is exciting to be able to recognize prehistoric behaviors such as those identified above, some consideration must also be given to historical behaviors. Excavation and recovery strategies also affect the nature of the ground stone assemblage. The excavation and data recording techniques of the field school have been described several times (Breternitz 1959:4; Neely 1974:96-121). Most structure fill was not screened, except for the floor-fill level, extending to approximately 10 cm above a floor. Ground stone artifacts visible in the upper fill were retrieved, with more attention paid to whole artifacts than to broken ones. Not all of the retrieved artifacts were brought to ASM. There were biases. For example, manos and metates were less apt to have been brought to ASM than any other artifact type. Records kept during the excavations indicate that strategies varied at each site, and that at some sites not even stone catalogue cards were filled out for each artifact retrieved. The room records, filled out by the excavator of each room, give some idea of what was kept and what was discarded, as well as the interpretations of the excavators.

The nine sites involved in this study also received differing amounts of excavation. For example, every room in AZ W:10:51 was partially to completely

excavated, while at Crooked Ridge, 22 out of a possible 100 pit houses were excavated. Excavation strategy for each site is discussed in more detail in Chapters 6 and 7.

The purposes of this section are to evaluate each site in terms of the recognizable prehistoric behaviors of discard and abandonment, and to evaluate excavation and artifact recovery strategies. These behaviors are described in more detail in Chapters 6 and 7. The result of this evaluation is a rating for how confident I feel that the assemblage from each site reflects prehistoric use. A confidence rating was configured by computing values for four room and assemblage assessments (deposit similarity value, deposit variety value, floor artifact value, and floor assemblage value), and three assessments of excavation and recovery strategies (excavation value, analysis value, and records value). Explanations for how these values were computed are presented below.

Deposit Similarity Value

A deposit similarity value was computed, using the Brainerd-Robinson statistic (Cowgill 1990:512-521), comparing the assemblage recovered from the combined fill of all structures to the assemblage recovered from the combined floors of all structures (Table 3.3). This was done to determine if the same artifact types were found in each deposit in the same percentages. The assumption is that if the assemblages from the floors and fill are similar (Brainerd-Robinson statistic of more than 140 or greater than 70% similar), then at least some of the floor artifacts may have been deposited as trash. If the assemblages from the floors and fill are less

similar (Brainerd-Robinson statistic of less than 140 or less than 70% similar) then there are probably floor assemblages that reflect certain behaviors.

Seventy percent similarity was chosen as a limit for considering assemblages similar in a rather arbitrary manner, but it fits when coupled with the room assemblage value. Most of the sites with more than 70% similarity (Stove Canyon, Turkey Creek, AZ W:1050, Canyon Creek phase) had ground stone floor assemblages in fewer than 20% of the excavated rooms. Sites with less similar assemblages (less than 70%) had higher percentages (greater than 26%) of rooms with floor assemblages (Crooked Ridge, Lunt, Nantack, AZ W:10:50, Maverick Mountain occupation, AZ W:10:51, and AZ W:10:50B). Thus, trash deposition has a homogenizing effect in the variety of artifact types in both fill and floor assemblages. The one exception to this pattern is AZ W:10:37, which had the highest deposit similarity value, and floor assemblages in 38.1% of the rooms. Deposit similarity values were used to rank the sites from least similar to most similar.

Deposit Variety Value

To compute the deposit variety value, the number of artifact types found in the fill and the number found on floors was divided by the total number of artifact types. The resulting percentages from each deposit type were subtracted from each other, resulting in a difference value (Table 3.3). This difference value reflects the fact that one of the deposits has more artifact types than the other.

TABLE 3.3

Values computed to assess the nature of the assemblage

SITE	DEPOSIT SIMILRITY	DEPOSIT VARIETY	FLOOR ARTIFACT	FLOOR ASSEMBL.	EXCAVAT	ANALYSIS	RECORD KEEPING	AVERAGE RANK	CONFID RANK
CROOKED RDG	57.9	7.7	32.7	29.1	26.0	37.0	1	4.3	1
STOVE CAN	84.0	63.7	19.4	18.8	94.1	11.3	1	8.0	2
LUNT	61.6	28.6	38.8	21.4	90.0	35.8	1	5.1	2
NANTACK	50.0	56.3	37.4	41.7	100.0	34.2	1	3.7	1
W:10:37	90.8	26.7	30.7	38.1	39.6	20.9	2	6.7	2
TURKEY CRK	70.2	15.8	14.2	3.9	92.8	76.7	3	6.0	3
W:10:50 MAVERICK MT	64.5	17.6*	68.6	60.0	66.7	30.9	2	4.5	1
W:10:50 CANYON CREEK	72.3	47.4	19.9	14.3	?	28.2	3	8.2	3
W:10:51	68.6	11.8*	61.0	76.2	100.0	23.4	1	3.2	1
W:10:50B	50.5	30.0	31.0	33.3	54.5	25.1	1	5.5	1

* Greater variation in floor assemblage

In most cases the fill deposits had more variety than the floor deposits. This is interpreted as reflecting the filling of abandoned rooms with trash. At two sites, the floor assemblages had more variety than the fill. One of these is the AZ W:10:50, Maverick Mountain occupation assemblage that had good floor assemblages and was sealed by fire and immediately reoccupied before trash was deposited. The other site is one of the last occupied, which also had good floor assemblages, and no trash from later occupations. Artifact variety values were used to rank the sites from smallest difference in variation to largest difference.

Floor Artifact Value

A floor artifact value was determined by dividing the number of artifacts found on all floors by the total number of artifacts recovered from the rooms. This resulted in a percentage of floor artifacts (Table 3.3). The sites were ranked from highest percent of floor artifacts to lowest. The assumption is that artifacts found on a floor were probably either used or stored in that structure. However, to account for the possibility that individual ground stone artifacts may have gotten onto floors through trash deposition, a possibly more informative floor assemblage value was also computed.

Floor Assemblage Value

A floor assemblage value was determined by dividing the number of rooms with ground stone floor assemblages (determined with the aid of excavation room records when possible, or by the occurrence of multiple, whole ground stone artifacts on floors), by the total number of rooms from which ground stone artifacts

were recovered. This resulted in a percentage of rooms with floor assemblages (Table 3.3). Room assemblage values were used to rank the sites from highest percentage of rooms with floor assemblages to lowest. This value and the floor artifact value rank the sites in almost identical order, but they are both used in this analysis because they measure slightly different distributions. One measures individual floor artifacts and the other measures floor assemblages.

Excavation Value

An excavation value was computed by dividing the number of rooms excavated by the number of rooms estimated to be at each site. This value serves as an estimate of how much is known about the site (Table 3.3). Each site was ranked from the highest percentage of excavated rooms to the lowest. Four sites (Lunt, Nantack, AZ W:10:51, and Turkey Creek) were virtually completely excavated. Conversely, Crooked Ridge had only 26% of the structures excavated. At AZ W:10:50, Canyon Creek phase it was not possible to compute an excavation value because the extent of this occupation is unknown. Therefore, it was assigned a high rank number because of uncertainty about how much information it provides about the pueblo during this phase.

Analysis Value

An analysis value was computed for each site by dividing the number of artifacts available for analysis by the total number of artifacts documented (Table 3.3). This value must be considered tenuous because excavation records indicate that for some artifacts no information was recorded. (This tenuousness is tempered

/by assigning a record keeping value.) Analysis values were used to rank the sites from highest to lowest. Except for Stove Canyon (11.3% analyzed), at least 20% of the artifacts were analyzed from each site. Most sites had 25%-35% analyzed. Turkey Creek has an unusually large percentage (76.7%) analyzed but the record keeping value indicates that a large number of artifacts were not inventoried.

Record Keeping Score

This score was assigned to each site based on the quality of records about the inventoried artifacts (Table 3.3). If the records were good, and I was confident that good information was recorded about the artifacts not brought back to the ASM, then a "1" was assigned. If I was uncertain about the quality of the record keeping, then a "2" was assigned. If there were many unrecorded artifacts, or if the quality of the information was poor, then a "3" was assigned.

Confidence Rating

The confidence rating is an assessment of all the values. The average of all the values for each of the above categories was computed and ranked from lowest average to highest average (Table 3.3). The lowest rank most clearly reflects prehistoric use behavior and the highest rank is most affected by other factors. Each site was then compared to the record keeping value. Based on the averaged rank and the record keeping value, a decision was made about how confident I felt the assemblage from each site reflects prehistoric use, as opposed to prehistoric abandonment or post-abandonment behaviors, or even excavation and artifact recovery strategies.

Crooked Ridge, Lunt, Nantack, AZ W:10:50, Maverick Mountain occupation, AZ W:10:51, and AZ W:10:50B were all assigned a confidence rating of 1 (Table 3.3). These sites were thoroughly excavated, had reasonable records, and had a good sample of artifacts available for analysis. They also had fill and floor assemblages that were not very similar, and floor assemblages in greater than 27% of the excavated rooms. The ground stone assemblages from these sites are excellent sources of information about prehistoric behavior.

Stove Canyon and AZ W:10:37 were assigned a confidence rating of 2. Stove Canyon was thoroughly excavated, but it had a low percentage of artifacts available for analysis. It also had low values for floor artifacts and room assemblages while having similar fill and floor deposits. Therefore, I am confident that the assemblage recovered from Stove Canyon is of good quality, but prehistoric use context cannot be confidently determined because most of the artifacts came from trash deposits. It seems that most of the rooms at Stove Canyon were cleaned out prior to abandonment and then filled with trash. The same conclusion is reached for AZ W:10:37. While AZ W:10:37 had high values for floor artifacts and floor assemblages, the assemblages from the fill and floor were very similar (as noted earlier) which probably means that trash fill introduced most of the artifacts onto the floor. Even though 20.9% of the artifacts were available for analysis, the record keeping made it difficult to reconcile analyzed categories with inventoried categories. Thus, I am not as confident of this assemblage as I am of others for inferring prehistoric use behavior.

The assemblages from Turkey Creek and AZ W:10:50, Canyon Creek phase were assigned confidence values of 3 (Table 3.3). While a large percentage of the assemblage was available for analysis, there is very little confidence in the record keeping for artifacts at Turkey Creek. Room records indicate that many artifacts were found but not inventoried. Field photographs show many more manos and metates than are accounted for on stone catalogue cards. Therefore, it is hard to make any determination of the prehistoric use context of these artifacts.

For very different reasons, there is little confidence that the artifacts recovered from AZ W:10:50 Canyon Creek phase accurately reflect prehistoric use contexts. The rooms used in this analysis, as well as Canyon Creek phase rooms excavated elsewhere in AZ W:10:50 had very few floor assemblages. Movement and reorganization within the large pueblo may have provided an opportunity for the inhabitants to remove completely the artifacts that were originally used or stored on these floors. Similar prehistoric behavior was noted at Grasshopper pueblo where the later occupied rooms had abundant floor assemblages and earlier occupied rooms had relatively clean floors (Reid 1973; Reid and Shimada 1982:15). Thus, what is available for analysis from AZ W:10:50, Canyon Creek phase may not be representative of all prehistoric uses of grinding technology during this period.

This exercise in confidence building has allowed for consistent assessment of the nature of the ground stone assemblage from each site. The behaviors of prehistoric people, as well as those of the excavators, have influenced what is available for analysis. The assigned confidence rates will be useful in later

discussions about grinding technology at each site in Chapters 6 and 7.

Interpretations can be made only by using the available evidence; their strength is dependent on the quality and variety of the evidence.

CHAPTER 4

THE POINT OF PINES FIELD SCHOOL

As a place for training archaeologists, there is probably no better spot in the greater Southwest than the area that has become known as Point of Pines (Figure 4.1). The Point of Pines area was selected by Emil W. Haury and E.B. Sayles after a reconnaissance in 1945 showed that there were many sites whose sequential occupations might span a thousand years or more. Haury (1989) documents the establishment and operation of the field school from 1946 until 1960. The location of the field school camp, about one mile south of the small Apache ranch community of Point of Pines, was approved by the San Carlos Apache tribal government, which permitted the construction of permanent structures and the drilling of a well so that the Point of Pines Field School became a settlement. The large, nearby ruin is called Point of Pines pueblo and the area that encompasses all the sites excavated by the field school is called the Point of Pines area.

Emil Haury actively directed the field school for most of its 15 years, except for a hiatus in 1954 when Edward Danson directed, and when directorship was turned over to Raymond Thompson in 1957. Some 33 sites were partially or completely excavated. Many archaeologists were trained at the Point of Pines field school, and many people learned that they did not want to be archaeologists.

In his history of the field school, Haury (1989) recounts some of the reasons why each site was chosen for excavation. Usually the main reason was for improving knowledge about a time period. This is why the Point of Pines area is a

Figure 4.1. Map of Point of Pines area.

good place to study the development of grinding technology. Within a fairly small area, roughly 32 square miles, there is a series of sites occupied by people who were related, at least by the fact that they shared the same cultural community and were adapted to the same biological community. There were developments--social, economic, and material--related to the pueblification of these people, and to interactions with other cultural groups. By understanding these developments in terms of grinding technology, it is possible to see how the daily lives of the prehistoric Point of Pines inhabitants changed through time.

The Point of Pines Environment

Anyone visiting the Point of Pines area today would not be surprised to find that it was inhabited prehistorically. A broad expanse of grassland, called Circle Prairie, is vegetated by grama grasses and associated plants and herbs, and surrounded by a Northern Mesic Evergreen forest. This combination of grassland and forest provided a rich resource area for generations of prehistoric people. Occasional springs and seeps are replenished by 18-19 inches of moisture a year, coming predominantly in mid-winter and mid-summer. Prehistoric tanks or cisterns located in drainages took advantage of a high water table. Linear borders, check dams, and terraces directed runoff and delimited fields (Woodbury 1961:11-15). Whatever was grown in these fields had a growing season of 165-170 days or less. It has been postulated that there has been no noticeable change in climate or vegetation since A.D. 1000 (Olson 1959:4; Martin et al. 1961:66).

Neely (1974:34) identified the Point of Pines area as a transition or

intermediate zone between the Colorado Plateau and the Basin and Range province. The area has an average elevation of 6200 ft. Most Point of Pines sites are in the transition between the grassland and the forests. A study of the plant ecology around the Point of Pines pueblo was conducted by Bohrer (1973:423-437). She collected and catalogued 199 species of plants (Neely 1974:79), many of which have nutritional value and could have been prehistorically exploited. Neely (1974:15-89) details the Point of Pines natural environment, which is summarized here.

Herbs growing in the park-like grasslands must have been important prehistorically, including small lupine (Lupinus kingii), lupine (Lupinus lemonii), prickly pear (Opuntia sp.), yellow phlox (Linanthus aureus), Tansy mustard (Descurainia obtusa), and horsemint (Mondarda pectinata). Forests provided valuable construction and fire wood, including ponderosa pine (Pinus ponderosa), alligator juniper (Juniperus deppeana), evergreen gray oak (Quercus grisea), Emory oak (Quercus emoryi), Silverleaf Oak (Quercus hypoleucoides), and pinyon pines (Pinus edulis) (Neely 1974:82). In shadier, cooler locations are big-tooth maple (Acer grandidentatum), southern white pine (Pinus reflexa), some bracken fern (Pteridium aquilinum), and wild rose (Rosa sp.). Near Lunt and Stove Canyon in the intermittent drainages are New Mexican locus, birchleaf buckthorn (Rhamnus betulifolia), walnut (Juglans major), gambel oak, and pine thermopsis (Thermopsis pinctorum) (Neely 1974:83).

The southern part of the Point of Pines area is dominated by Nantack Ridge, with elevations of 7000-7200 ft. The southern face of Nantack Ridge provides a

different vegetation community, with catclaw (Acacia sp.), manzanita (Arctostaphylos sp.), mesquite (Prosopis juliflora), prickly pear (Opuntia sp.), cholla (Opuntia sp.), agave (Agave sp.), yucca (Yucca sp.), and bear grass (Nolina sp.) (Neely 1974:78). Caves located within the escarpment of Nantack Ridge were used prehistorically, and protected a data-rich, collection of perishable artifacts.

Prehistoric use of fauna included various deer, elk, big horn sheep, antelope, bison, several rabbits, javelina, bear, mountain lion, skunk, fox, porcupines, badgers, turkey, hawks, quail, owls, crows, ravens, and geese (Neely 1974:86, Stein 1963). Thus, by all accounts, the Point of Pines area provided a rich natural environment, the productiveness of which was enhanced with agricultural fields probably planted with corn, beans, and squash (Woodbury 1961:35).

The prehistoric inhabitants utilized these biotic communities in a variety of ways. The tools they made to exploit the resources provide a wealth of information about how this was done. The following chapter categorizes the ground stone tools and provides a context for making inferences about the Point of Pines inhabitants.

CHAPTER 5

GROUND STONE ARTIFACTS

The classification of ground stone artifacts presented here is the result of applying ethnographic, experimental, use-wear, and contextual data to the assemblage from ten components at nine Point of Pines villages. The purposes are to define tools as technological components, and to establish a descriptive baseline of prehistoric grinding technology used in different activities. Variation through time in tool design and tool use reflect changes in technological traditions. The changes in technological tradition for the Point of Pines villages are outlined in Chapters 6 and 7, building on the understanding of tool types and their uses developed in this chapter. The last two chapters interpret the possible social changes reflected in the technological changes.

Lithic Material

Before proceeding with the classification of ground stone artifacts, one must understand the material composition of these tools. In the Point of Pines area there is a variety of material available from igneous, metamorphic and sedimentary deposits (Brown 1989). Materials were identified for each artifact in the field. Specific material identification is important for addressing questions of artifact origin. However, identification of material sources requires petrographic analysis, which is beyond the scope of this dissertation. Such a study would add much to the analysis of grinding technology by identifying whether tools or just technological knowledge was brought to the Point of Pines villages. Summaries of each artifact type are presented by

material (Table 5.1) and texture (Table 5.2).

The important feature for studying grinding technology is not so much the proper assignment of material type, but the recognition of surface texture. Lithic material has a natural granularity that was exploited by prehistoric tool makers to either smooth or roughen the surfaces of other items, or to alter the texture of a substance worked between two stones. The identification of material granularity was standardized by a chart with grain sizes marked as coarse, medium, and fine. Some material has a combination of grain sizes and this was noted. Vesicular basalt was categorized by large and small vesicles, and some material was smooth enough to categorize as having no texture.

Natural granularity can be changed through use and maintenance of tools. The surface of a tool made from a medium-grain material may have been worn to a smooth texture. If the tool was designed to abrade, the smooth surface would have to be roughened. Similarly the texture of a tool made from fine-grain material may have been made rougher by pecking the surface with a hammerstone. Thus, material granularity may not be as informative about the use of ground stone artifacts as surface texture.

In tribology, the term *asperity* describes a combination of surface texture and hardness (Adams, in press). *Asperity* is a combination of material granularity and surface roughness and is influenced by material hardness. The surfaces of tools made from coarse-grain material will have more asperity, or be more asperite, than the surfaces of tools made from fine-grain material. But the surface of a fine-grain tool can

TABLE 5.1

Summary of material types at each site

MATERIAL TYPE	CROOK RIDGE	STOVE CAN	LUNT	NANTK	W:10:37	TURK CRK	W:10:50 MAV MT	W:10:50 CAN CR	W:10:51	W:10:50B	TOTAL # %
ANDEST/DIORT	8	0	4	0	6	16	5	13	28	12	92 4.0
BASALT	103	27	20	51	137	126	62	85	98	65	774 33.5
CHERT/CHALCED	0	0	0	0	1	49	0	2	1	0	53 2.3
GRANITE	8	0	0	1	8	2	1	2	0	1	23 1.0
FELSITE/BIOT	2	0	1	1	2	1	3	1	11	0	22 .9
IGNEOUS	1	1	1	4	6	4	6	7	3	1	34 1.5
LIMESTONE	0	0	2	0	2	17	3	3	9	1	37 1.6
METAMORPHIC	0	0	0	0	1	1	0	1	0	0	3 .1
PUMIC/TUFF	19	0	0	0	4	62	25	55	8	10	259 11.2
QUARTZ	0	0	0	0	0	0	0	0	1	0	1 0
QUARTZITE	9	10	3	10	32	36	14	23	29	19	185 8.0
SANDSTONE	17	1	5	16	19	29	22	20	6	4	139 6.0
SCHIST	9	1	1	1	1	7	6	2	1	0	29 1.3
SILT/MUDSTONE	4	0	0	2	6	1	0	5	1	0	19 .8
SLATE/SHALE	1	0	0	1	1	9	1	1	0	0	14 .6
STEATITE	0	0	0	0	0	2	0	1	0	0	3 .1
VESIC BASALT	52	84	29	26	84	119	71	105	24	29	623 27.0
TOTAL	276	124	67	129	226	481	219	326	220	142	2310*

* 993 pieces not identified by material

TABLE 5.2

Summary of material texture at each site.

MATERIAL TEXTURE	CROOK RIDGE	STOVE CAN	LUNT	NANTK	W:10:37	TURK CR	W:10:50 MAV MT	W:10:50 CAN CR	W:10:51	W:10:50B	ASSEMB TOTAL # %
CONGLOMERATE	0	0	0	0	0	1	0	0	0	0	1 0.1
COARSE/MEDIUM	2	0	0	0	0	3	0	0	0	0	5 0.5
COARSE/FINE	2	0	0	1	1	35	0	0	0	0	39 3.5
MEDIUM/FINE	28	0	0	9	5	12	0	6	1	0	61 5.5
MEDIUM	1	0	1	1	0	3	0	0	0	0	6 0.5
FINE	75	6	12	24	57	178	41	55	64	31	543 49.1
LRGE VESICLES	11	1	3	6	2	24	2	3	5	0	57 5.2
SML VESICLES	8	3	4	2	7	75	5	9	0	2	115 10.4
SMOOTH	0	4	5	10	0	112	22	26	73	19	271 24.5
UNRECORDED	0	0	0	0	0	0	0	3	4	0	7 0.6
TOTAL	127	14	25	53	72	443	70	102	147	52	1105

be made more asperite by roughening the surface with a hammerstone. Asperity is an important concept for understanding how use-wear damage patterns are created (see Use, Chapter 2). Throughout the following discussion on typology reference is made to surface texture or asperity as they relate to artifact use.

Typology

In his classic analysis of stone implements of northeastern Arizona, Woodbury (1954:12) discusses how he used classification and the concept of types to structure the data specifically to address concerns of temporal and cultural variation. He concluded, as did Brew (1946:44) before him, that the classification of assemblages into types should be done for specific purposes, resulting in different classification schemes for different projects. This attitude towards classification is lauded today (Adams and Adams 1991:157) and is continued here to define ground stone artifact types and to sort them into activity categories.

Woodbury (1954:13) organized the ground stone assemblage by function; if function could not be determined, then descriptive attributes were used. Artifact function was determined through ethnographic analogy and descriptive terms highlighted unusual characteristics about the artifacts (cupped stone or notched disk). Woodbury (1954) summarized the culture-specific attributes of artifacts and noted artifact distributions through time and across space. For the Colorado Plateau area, not much new has been added to Woodbury's classification scheme in the succeeding decades.

However, Rinaldo analyzed the stone artifacts from Casas Grandes with a similar

form-function approach and expanded on some temporal and cultural variations identified by Woodbury (Di Peso et al. 1974). Rinaldo attempted to standardize the identification process by presenting charts and tables showing morphological variation and assigning computer codes to keep track of artifact attributes (Di Peso et al. 1974:2-16). The contribution of both Woodbury and Rinaldo is that their classification schemes are clearly spelled out so others can use them.

The descriptions of artifact types presented for the Point of Pines artifacts follows the lead of Woodbury and Rinaldo. The types are primarily functional; however, use-wear attributes are emphasized. An artifact that was served in more than one activity is identified first by the type of artifact it was designed to be and then by how it was secondarily used. Within the type definitions, ethnographic examples are provided to emphasize who used the tools and how they were used. The classification of the Point of Pines ground stone artifacts is presented differently than previous studies because the goal here is to consider these items parts of technological traditions employed by prehistoric people to carry out certain daily activities.

Food Processing Activities

The purpose of using stone tools to process food resources is either to change the physical form of the food, remove undesirable parts, or begin detoxification processes (Stahl 1989:172). Grinding changes the physical form of grain by loosening fiber and reducing the size of particles. This has implications for the digestibility of vegetal resources: smaller particles improve digestibility, increase the rate of digestion, and alter the effects of fiber on the digestive system (Stahl

1989:173-174).

Food resources other than grain might have been processed using manos and metates, or mortars and pestles, including dried meat, whole rodents, and turtles (Adams 1979:25-26; Euler and Dobyns 1983:256; McGee 1898:236-237; O'Brien 1994; Yohe et al. 1991:659-666). Two types of tool kits were used in food processing activities at the Point of Pines villages: manos and metates, and mortars and pestles.

Manos and Metates

Manos and metates are two components of food processing equipment. The metate is the netherstone; the upper stone or mano is the smaller, hand-held component. Because manos and metates were used together, the use-wear on the surface of one tool reflects the use-wear on the surface of the other. Metates have been variously typed by archaeologists according to surface configuration, but the lack of attention to the way in which metates were worn makes classification problematic. The surface configuration of some metates is dependent on the length of the mano manipulated against it. Metates with borders, such as basin and trough metates, were designed and manufactured to a particular shape, and subsequent use and maintenance determined the final configuration of both the mano and metate surfaces. Flat metates used with manos shorter than their width developed concave surfaces that, if deep enough, confined the meal in the same way as trough or basin metates (Euler and Dobyns 1983:264).

Reciprocal and circular strokes alter both mano and metate surfaces in

distinctive ways. In this analysis, metates were typed as basin if the surface was an elliptical shape worn through the manipulation of a mano in some combination of circular and reciprocal strokes (Adams 1993:336-338; Dick 1965:110; Euler and Dobyns 1983:254; Haury 1950:315-316; Woodbury 1954:50-51). Manos used in basin metates develop use-wear facets on the edges and ends and curvilinear abrasive scratches on the surfaces (Adams 1993:336-338; Haury 1950:315; Morris 1990:181-186).

Trough metates have intentionally shaped depressions and were worn through the manipulation of a mano in reciprocal strokes. They can be subtyped by the configuration of the surface and the confining borders. Open troughs have borders only along the sides so that both ends are open (some are typed as through troughs). Three-quarter troughs (some are typed as "scoop metates") have borders on both sides and one end (Utah metates have a special flat surface, or mano rest, on the closed end), and closed troughs have borders on both sides and both ends. Closed troughs are distinguished from basin metates by the strictly reciprocal stroke used with the mano.

Flat metates may start out as flat or unshaped surfaces, but they remain flat only if a mano of the same length as the width of the surface is used. If a mano shorter than the width of the metate is used, then eventually a concave surface is worn in the metate surface and a convex surface on the mano. The difference between a trough metate and a concave metate is in the intentional shaping of the trough. The difference between a basin metate and a concave metate is in the depth

of the grinding surface and the size of the compatible mano. A concave metate has been used with a longer mano, primarily with a reciprocal stroke.

Most archaeologists classify manos as either one-hand or two-hand, not distinguishing by the type of companion metate. Most manipulated in basin metates would be considered one-hand manos with this method; however, so would a lot of small manos manipulated in trough, concave, or flat metates. Euler and Dobyns (1983:256) show Walapai women using basin and flat equipment with both hands working manos that previously would have been classified as one-hand manos. For this reason, and for increased accuracy, manos are classified here according to the type of metate in which they were used rather than hand size.

The type of stroke used in a basin metate determines the type of damage pattern visible on the mano (Adams 1993:337-338, Haury 1950:315; Morris 1990:181-182). Basin manos manipulated with a circular stroke have wear facets on parts of the ends and edges (Figure 5.1). Those manipulated in a reciprocal stroke have wear facets only on the edges (Figure 5.2). If both strokes are used, wear facets will be visible on all ends and edges.

Only a reciprocal stroke is used with a trough mano and metate. The mano shows distinctive use-wear damage patterns where the metate borders come in contact with the ends of the mano. Manos manipulated in concave metates have convex surfaces but the ends do not rub against the metate and no use-wear damage is created. Manos manipulated against flat metates have flat surfaces and also have no use-wear damage on the ends.

Figure 5.1. Circular stroke in a basin metate. a. Pressure is greatest under the palm. b. Pressure is transferred to the fingers. c. Pressure moves toward the thumb (Adams 1993;fig. 3, drawing by Doug Gann).

Figure 5.2. Reciprocal stroke in a basin metate. On the away stroke, pressure is exerted by the palm. On the return stroke only the fingers exert pressure (Adams 1993;fig. 4, drawing by Doug Gann).

Archaeologists often associate manos and metates with processing agricultural products. Differences in tool configurations have been equated by some with differences in the nature of subsistence strategies; the implication being that larger tools developed in response to increased reliance on cultigens, specifically corn (Bartlett 1933:27-29; Hard 1990:135-149; Martin 1972:56-57; Mauldin 1993:317-330; Plog 1974:141; Woodbury 1954:8). It also has been suggested that variation in material make-up of manos and metates is related to the processing of different seeds. Small seeds, such as cactus and amaranth, could have been ground on tools

of fine-grain material while larger seeds, such as corn, were ground on coarser grain or vesicular material (Greenwald 1990; 1993:438-439). However, pollen evidence gathered from specific trough metates by Lancaster (1984:257) and Greenwald (1993:438-439), suggests that a variety of both domestic and wild seeds were ground with the same equipment. The experimental and ethnographic information presented in this chapter should demonstrate that single attributes such as tool size and material make-up are not sufficient evidence for making inferences about such complicated matters as subsistence strategy.

Motor Habits

Experiments conducted with grinding feed corn in basin, trough, and flat mano/metate equipment showed that the motor habits used with each design are quite different (Adams 1993:336-340). The motor habits involved with basin equipment are more stressful on the shoulders and elbows than those with either trough or flat equipment. However, the ability to vary the stroke was less tiring than with the strictly reciprocal stroke dictated by the trough design. The advantage to the trough design was improved grinding efficiency due to larger grinding surface area (Adams 1993:338; Hard:1990:137, Lancaster:1984:256; Plog 1974:140). However, the repetitiveness of the stroke is stressful to the back, shoulders, and elbows. The flat design seems to have encompassed the best of the other two designs (Adams 1993:339). Surface area is large for efficiency, and the lack of sides allows the grinder to vary the stroke enough to relieve fatigue without stopping. Flat equipment could have been manipulated for longer grinding sessions than

trough equipment, if the limiting factor is human strength and endurance. Efficiency is discernible between basin and trough designs, but less so between trough and flat. A cup of corn took an hour to grind to the consistency of a fine flour with a basin mano/metate equipment; while two cups were ground in a hour with either the trough or flat equipment (Adams 1993:338).

Thus, the distinctive mano/metate equipment designs have interesting implications for technological choices, and the flow of information between the designers and users. A grinder would opt for more efficient trough equipment over basin equipment in order to either save time or grind more grain. Free time could be spent at other activities, and more grain could make up a larger portion of the diet or feed more people. The choice of a flat design over a trough would have facilitated more intense grinding. The grinder using flat equipment could sustain longer hours of grinding because of the ability to relieve muscular stress without interrupting work.

Intensity, Efficiency and Wear Management

Analyses of mano design and mano surfaces make it possible to discuss grinding intensity. Grinding intensity has implications for specialization and the social networks of food processing (Adams 1993) which will be discussed later. A distinction should be made here between improving grinding efficiency and increasing grinding intensity.

(1) Improved efficiency means **less time** spent grinding to feed the **same number of people the same amount of grain**. This implies that the grinder would

have more free time to participate in other activities.

(2) Improved efficiency means the **same amount** of time spent grinding to **feed more people**, or to **increase the amount of grain** in the diet.

(3) Increased **intensity** means **more time** spent at the grinding task either to **feed more people** or to **increase the amount of grain** in the diet.

Efficiency is measured by output of grain product per unit of time. If improved grinding efficiency (a definite technological advantage) results from designing and manufacturing larger tools, then the grinder will have to expend more energy to manipulate the equipment. Such a design is limited by human strength and endurance, and has implications for the acquisition of the appropriately sized raw materials for making the tools.

Intensity is measured by the amount of time spent at each grinding task. For example, equipment manipulated four hours a day has been more intensely used than that manipulated one hour a day for four days. Increased intensity does not require larger tools, but the limitations of human strength and endurance and material resistance to wear might govern tool design. Knowing these limitations, designers could select wear-resistant material or develop techniques to manage wear. The use of wear-management techniques leaves distinctive morphological traits (discussed below) that can be used to signal intense grinding activities.

Based on her observations of Hopi women, Bartlett (1933:15) provides a fairly detailed discussion of two types of grinding strokes using a two-hand mano against a flat metate. Both strokes are used against a metate that is tilted down and

away from the grinder. With the first stroke, the grinder exerts pressure on the proximal edge of the mano on the downward part of the stroke while holding the distal edge of the mano away from the metate surface. On the upward stroke the grinder rocks the mano forward so that the distal edge is held against the metate and the proximal edge is lifted up carrying grain back to the top of the metate (Figure 5.3). This movement creates more pressure, and thus more wear, on the proximal edge which eventually becomes thinner than the distal edge. To counteract this uneven wearing the grinder rotates the mano so that the distal edge becomes the proximal edge. Eventually two adjacent surfaces are created. A triangular profile provides the grinder a raised edge that keeps the fingers from coming into contact with the metate surface as the mano becomes thinner.

The second type of stroke maintains the mano flat against the metate surface. Because the mano is not rocked, the pressure exerted by the back of the hand wears down the proximal part of the mano only, creating a wedge-shaped profile. By rotating the mano so that the distal edge becomes proximal the wear becomes balanced and a single flat surface is maintained. Eventually the mano becomes thin enough that the fingers are subject to grinding, and the mano is essentially "worn out".

What is important in Bartlett's (1933) description of grinding motor habits is the awareness the grinder has of the effects of wear and the development of a wear-management technique to prolong mano use-life. However, even if the grinder did not use the strokes described by Bartlett, wear management might have been

Figure 5.3. Schematic of reciprocal grinding with flat equipment. a-e. Pressure is exerted on the proximal edge on the away stroke. f-g. A lighter pressure on the distal edge during the return stroke brings meal back to the top of the metate (Adams 1993;fig.1, redrawn by Ron Beckwith).

practiced simply by flipping the mano over and using the opposite side, creating two opposite grinding surfaces. Flipping the opposite surfaces would necessarily have been done regularly to maintain surface compatibility with the metate. While this would not counter the thinning of the mano as does the creation of two adjacent surfaces, it does provide a second surface to use when the first one has become smooth and needs roughening. Wright (1993:345-355) describes the effects of

roughening on wear rates.

A grinder might want to manage wear for several reasons. A particular mano might be more comfortable to hold, or raw materials might be scarce. It might be more desirable to prolong mano use-life rather than expend the energy to procure new material, manufacture a new tool, and break in that tool until it is compatible with an existing metate.

Equipment Set Up

The location of food processing activities and equipment set-up are important factors for understanding food grinding technology. Some mano/metate equipment was free-standing with rocks underneath to support the metate and allow for adjusting the height and angle of the grinding surface. This equipment could have been dismantled and moved to another location or into storage if the space was needed for other activities. Other mano/metate equipment was more permanently fixed, either with adobe ridges creating catchment areas for the ground meal (called mealing receptacle), or with stone slabs creating a bin (called mealing bin) to confine both the metate and the meal.

Ethnographic Comparisons

Ethnographic accounts of pueblo and non-pueblo groups provide interesting comparisons for studying technological traditions. Accounts of non-pueblo groups, such as the Pima and Papago, illustrate women using free-standing mano/metate equipment outside their houses (Fontana 1983;fig. 6; Spier 1933:pl. III). In each account, one woman did the grinding; if another woman was involved, she was

attending to some other preparation task. Women who prepared foods together took turns grinding with the same equipment (Underhill 1979:67). Illustrations of Hopi and Zuni habitation rooms show multiple, slab-lined bins as permanent fixtures (Bartlett 1933;fig. 7; Ladd 1979;fig. 3; Mindeleff 1891;figs. 101, 105). Pueblo women frequently ground in groups of two or three, and often worked in rhythm to singing or flute music supplied by a male visitor (Hough 1915:62-63; Kidder 1932:67, quoting Castañeda; Stephen 1936:153-154,882).

Food preparation was the responsibility of women, with a few exceptions, such as Maricopa men who cooked the small game and fish they procured (Spier 1933:77, 80). Such foods, however, did not involve grinding, and according to a Papago account--it looks bad for a man to grind food (Underhill 1979:64). Thus, the pattern is consistent among both pueblo and non-pueblo groups, grinding was the main responsibility of women. Young girls learn the art of grinding from their mothers and they must demonstrate their expertise to prospective husbands and mothers-in-law (Hough 1915:62-63; Spier 1933:79; Underhill 1979:35). In preparation for marriage, Hopi women perform a grinding ceremony as part of the courtship ritual (Simpson 1953:39).

It should also be noted that there is a difference between pueblo and non-pueblo groups in the network of ground food distribution. In non-pueblo groups the women grind on a daily basis for their households and any visitors. Small amounts of stored meal may have filled an extra pot or two (Spier 1933:52), and extra meal may have been taken to festivals or large gatherings (Underhill 1979:82), but this

extra was mostly for personal consumption. Pueblo women, on the other hand, grind massive amounts of meal, beyond their daily household needs, for consumption by a large network of people (Hough 1915:70). Large quantities of food are consumed at various occasions: (1) feasting activities accompanying marriages and ceremonies (Hough 1915:95; Simpson 1953:39), (2) the feeding of public performers, such as Katsinas, or social dancers (Stephen 1936:134, 589), and (3) given away to those watching the public performances (Stephen 1936:17-19, 369, 505; Titiev 1972:216).

Secondary uses of food grinding tools also must be considered in order to understand their entire life histories. Archaeological work at a historic Tohono O'odham (Papago) house found grinding tools, originally used to grind food, were ultimately reused to grind pottery clay (Doelle 1983:97). Euler and Dobyns (1983:256) mention that Walapai women process pottery temper with their food grinding tools. Hopi women have explained (personal communications) that *manos* are still occasionally taken to the roof to apply and smooth mud. Mindeleff (1891:155, fig. 43) discusses the recycling of discarded grinding tools into walls and wall features. Thus, the expropriation of food grinding tools for nonfood processing activities is not unusual.

All of the behaviors identified by ethnographic accounts provide models for prehistoric behavior. This is not to suggest that either pueblo or non-pueblo people are descendants of the Point of Pines Mogollon, but rather to demonstrate that technological traditions can be associated with different ethnic groups.

Point of Pines Manos and Metates

The manos and metates from Point of Pines are described on the basis of the information that can be gleaned from the stone catalogue cards, room records and published reports. However, the excavators did not consistently record the number of used surfaces on manos, the types of metates they were manipulated against, and evidence of secondary use. In fact, most (56.3%) of the 1015 manos are not identified by the type of metate in which they were used (Table 5.3). For example, the percentage of basin manos (1.6%) is probably not representative because many were considered handstones by those who recorded them in the field.

While there is a sizable percentage (11.2%) of manos identified as manipulated against flat metates, the large percentage of unidentified manos (88.4%) at AZ W:10:51 and AZ W:10:50B (91.0%) probably includes many more flat manos to go with the predominately flat metates (60.4% at AZ W:10:51; 64.7% at AZ W:10:50B). The combined metate assemblage from all the villages is 15.7 percent flat metates. Thus, in general, basin mano/metate equipment is less than 10 percent of the assemblage, flat mano/metate equipment is less than 20 percent, and the rest are either 3/4- or open-trough equipment. It is impossible to determine if a mano was manipulated in a 3/4-trough or open-trough, but based on the metate evidence, the highest percentage of mano/metate equipment (43.7%) is of open-trough design. Mano/metate designs vary by village. Basin mano/metate equipment occurs in low percentages at all villages except the two latest pueblos, AZ W:10:51 and AZ W:10:50B, where there were none. Three quarter-trough metates are the highest

TABLE 5.3

Summary of mano designs from each site

SITE	BASIN # %	TROUGH # %	FLAT # %	INDETER # %	TOTAL #
CROOKED RDG *	@	25 20.3	1 .8	97 78.9	123
STOVE CAN *	@	1 2.0	0 0	50 98.0	51
LUNT *	3 12.0	17 68.0	2 8.0	3 12.0	25
NANTACK *	6 11.3	38 71.7	5 9.4	4 7.5	53
W:10:37	1 .9	54 47.0	3 2.6	57 49.6	115
TURKEY CREEK	4 12.5	22 68.8	3 9.4	3 9.4	32
W:10 50 MAVERICK MTN	2 2.0	71 69.6	29 28.4	0 0	102
W:10:50 CANYON CREEK	0 0	84 75.0	28 25.0	0 0	112
W:10:51 *	@	@	39 11.6	296 88.4	335
W:10:50B	0 0	2 3.0	4 6.0	61 91.0	67
TOTAL	16 1.6	314 30.9	114 11.2	571 56.3	1015

- * Published descriptions of manos combine those used in basin and trough metates, thus counts may be skewed for some sites. Some handstones may have been used in basin or small trough metates.

@ There may have been manos of this type; however, no counts are available.

percentage (Table 5.4) in all the pit house villages (Crooked Ridge, Stove Canyon, Lunt, Nantack). The metates at Stove Canyon and Lunt, however, are not as consistently identified by type as those from the other pit house villages, and it is assumed that the large number of unidentified trough metates were 3/4-troughs based on photographs, drawings, and a few metate fragments. Open-trough metates are not described at any of the pit house villages; but at AZ W:10:37, the earliest pueblo village, open-trough metates make up more than half (56.3%) of the metate assemblage. Open-trough metates are also the largest part of the assemblage at Turkey Creek (98.1%), AZ W:10:50, Maverick Mountain occupation (50.0%), and at AZ W:10:50, Canyon Creek phase (42.1%). No 3/4-trough metates were identified in the records from Turkey Creek; however, a photograph taken in the field illustrates a couple of 3/4-trough metates (Figure 5.4). No 3/4-trough mano/metate equipment was identified at AZ W:10:50, Maverick Mountain occupation, but was found at AZ W:10:50, Canyon Creek phase, AZ W:10:51, and AZ W:10:50B. The implications of this distribution are discussed later.

The managing of mano wear was always important to some extent in that at every village there were manos with two opposing surfaces (Table 5.5). The flipping technique used to make two opposing surfaces allowed a grinder to interrupt grinding less frequently to roughen a smooth surface. At all but the earliest pit house villages (Crooked Ridge, Stove Canyon, and Lunt), some grinders lifted one edge of the mano, and rotated it so that two adjacent surfaces were created on a side (Adams 1993:332-336; Bartlett 1933:15). This technique was used more commonly

TABLE 5.4
Summary of metate designs from each site.

SITE	BASIN		3/4 TROUGH		OPEN TROUGH		INDTR TROUGH		FLAT		CONCAV		INDTR		TOT #
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
CROOKED RDG	6	12.8	27	57.4	0	0	0	0	0	0	0	0	14	29.8	47
STOVE CANYON	2	6.7	2	6.7	0	0	26	86.7	0	0	0	0	0	0	30
LUNT	0	0	2	25.0	0	0	6	75.0	0	0	0	0	0	0	8
NANTACK	2	9.5	18	85.7	0	0	0	0	1	4.8	0	0	0	0	21
W:10.37	3	18.8	3	18.8	9	56.3	0	0	1	6.3	0	0	0	0	16
TURKEY CRK *	0	0	0	0	101	98.1	0	0	2	1.9	0	0	0	0	103
W:10.50 MAVERICK MTN	4	25.0	0	0	8	50.0	1	6.3	2	12.5	0	0	1	6.3	16
W:10.50 CANYON CRK	2	10.5	3	15.8	8	42.1	0	0	5	26.3	0	0	1	5.3	19
W:10.51	0	0	1	2.1	15	31.3	0	0	29	60.4	3	6.3	0	0	48
W:10.50B	0	0	3	17.6	1	5.9	0	0	11	64.7	0	0	2	11.8	17
TOTAL	19	5.8	59	18.2	142	43.7	33	10.2	51	15.7	3	1.0	18	5.5	325

* May have been some basin and 3/4-trough metates, but counts not available.

Figure 5.4. Field photograph of the variety of metates found at Turkey Creek. Note the two bottom right are 3/4-trough.

TABLE 5.5

Summary of the number of used surfaces on manos from each site

SITE	ONE SURF		2 OPPOS SURFS		2 ADJACN SURFS		THREE SURFS		UNIDENT		TOT #
	#	%	#	%	#	%	#	%	#	%	
CROOKED RDG	67	54.5	19	15.4	0	0	0	0	37	30.1	123
STOVE CANYON	15	29.4	36	70.6	0	0	0	0	0	0	51
LUNT	16	64.0	9	36.0	0	0	0	0	0	0	25
NANTACK	33	62.3	19	35.8	1	1.9	0	0	0	0	53
W:10:37	63	54.8	41	35.7	6	5.2	5	4.3	0	0	115
TURKEY CRK	25	78.1	6	18.8	0	0	1	3.1	0	0	32
W:10:50 MAVERICK MTN	29	28.4	12	11.8	0	0	0	0	61	59.8	102
W:10:50 CANYON CRK	33	29.5	17	15.2	1	.9	0	0	61	54.5	112
W:10:51	199	59.4	97	28.9	34	10.3	5	1.5	0	0	335
W:10:50B	33	49.3	28	41.8	1	1.5	0	0	5	7.5	67
TOTAL	513	50.5	284	28.0	43	4.2	11	1.1	164	16.2	1015

at AZ W:10:37 (5.2%) and at AZ W:10:51 (10.3%) than at the other villages (Table 5.5).

Based on the floor assemblages found at Point of Pine's pit house villages, most free-standing mano/metate equipment was situated so that the grinder faced more or less toward the center of the structure. In two pit houses (1, 2) at Crooked Ridge and two at Stove Canyon (4, 7), multiple free-standing metates were found, suggesting the possibility that more than one grinder could have worked within each structure. Three pit houses at Nantack (1, 5, 6) had multiple free-standing metates,

but it is unclear if they were in use or storage positions. Individual free-standing metates were found in at least one pit house at each pit house village, some still contained manos. Metates were also found in storage positions, either near walls or near post holes. Those found lying over post holes were probably propped against posts for storage and came to rest over the holes after the posts rotted away.

In addition to free-standing metates, mealing receptacles were found in five rooms at Turkey Creek pueblo (Johnson 1965:36). One receptacle had an open-trough metate in place; metate identification for the rest is not available, either because the metates were removed, or the information was not recorded. A photograph of an adjacent pair of receptacles shows one flat and one open-trough metate in place (Figure 5.5). No metates were found in these receptacles so it is unclear if these were found nearby and thought to have been used with the receptacles, or merely metates randomly selected to illustrate the set-up. Other receptacles occurred singly or in multiples up to as many as three. Mealing receptacles were found only at Turkey Creek the Tularosa phase occupations at AZ W:10:50.

Mealing bins were found at AZ W:10:50, Maverick Mountain phase, AZ W:10:50, Canyon Creek phase, AZ W:10:51, and AZ W:10:50B. These were created out of slabs, sometimes incorporating the structure wall as one side of the bin (Figure 5.6). A large sherd was sometimes used as part of the opposite side. The metate was set at an angle and cemented into place; usually with room for a container to catch the meal. As with a receptacle, a bin more permanently affixes

Figure 5.5. Adjacent grinding receptacles at Turkey Creek. Metates found in the same room (256) but not in place. Upper is a flat design, lower is open-trough.

Figure 5.6. Multiple grinding bins in Room 13, AZ W:10:51. Note the co-occurrence of both flat and open-trough metates, and the baffle sherds used in bin construction.

the location of grinding than the use of free-standing equipment. Most of the metates had been removed prehistorically from the bins; the few found in place were mostly flat with one or two open-trough. Bins occur singly or in multiples up to as many as four.

While a higher percentage of metates were found in floor assemblages (58.7%) than manos (49.0%), some floors had manos but no metates, and most bins and receptacles lacked metates. This is good evidence that metates were either removed at abandonment of the structure or were scavenged later. Manos and metates are the only artifact types found in higher percentages on floors than in fill (Table 5.6). This may be because food grinding was primarily an inside activity with tools used and stored inside.

Mortars and Pestles

Pestles are handstones used for crushing, or crushing and grinding substances. They may have been used in stone or wood mortars or on the ground to crush food or nonfood substances. Use-wear damage patterns include impact fractures and abrasive scratches. Pestles having evidence of use in mortars (age extending up the sides of the tool) are considered food processing tools unless the presence of pigment or other substance suggests otherwise.

Food processing mortars are identified by Hopi as used to pound dried meat to soften it for those who had no teeth (Adams 1979:25). They have been used by the Walapai, Maricopa, Pima and other non-pueblo groups to crush the pods of mesquite beans (Euler and Dobyns 1983:259; Spier 1933:51; Castetter and Bell

TABLE 5.6

Artifact types analyzed from fill, features and floors

ARTIFACT TYPE	FILL		FEATURES		FLOOR	
	#	%	#	%	#	%
ABRADER	228	13.9	3	3.2	77	7.0
AWL	2	.1	0	0	1	.1
AXE	188	11.5	10	10.5	107	9.7
BALL	8	.5	0	0	6	.5
BOBBIN	0	0	0	0	0	0
BOWL	34	2.1	2	2.1	11	1.0
DISK	12	.7	1	1.1	4	.4
FIRE HEARTH	4	.2	0	0	0	0
GRINDING SLAB	8	.5	0	0	8	.7
HANDSTONE	235	14.3	18	18.9	135	12.3
LAPSTONE	25	1.5	1	1.1	21	1.9
MANO	475	29.0	27	28.4	483	43.8
MAUL	36	2.2	7	7.4	14	1.3
METATE	84	5.1	2	2.1	122	11.1
MORTAR	70	4.3	6	6.3	16	1.5
NETHERSTONE	29	1.8	0	0	11	1.0
PALETTE	20	1.2	1	1.1	4	.4
PESTLE	24	1.5	12	12.6	14	1.3
PIPE/TUBE	11	.7	0	0	3	.3
PLUG/CAP	33	2.0	0	0	3	.3
PLUMMET	12	.7	0	0	0	0
POLISHING STN	100	6.1	4	4.2	62	5.6
SPINDLE BASE	2	.1	1	1.1	0	0
TOTAL *	1640		95		1102	

* 196 artifacts from various other contexts.

1937). Once the pods were broken apart with mortars and pestles they were processed further with a mano and metate (Spier 1933:51). As with the mano and metate, ethnographic accounts of non-pueblo mortar-and-pestle use describe women as the tool users (Castetter and Bell 1951:96, Euler and Dobyns 1983:259, Fontana 1983;fig 6; Spier 1933:57, 96; Webb 1959:12). Chemical analyses have been conducted that recognize the presence of animal immunoglobins on mortars and pestles in California (Yohe et al. 1991:663). Sayles and Sayles (1948:29) illustrate a Maricopa Indian woman using a stone pestle to crush chunks of clay on a blanket.

These varied food and nonfood processing activities may or may not leave distinctive damage patterns; however, the use of a pestle in a mortar damages both the end of the pestle and some distance up its side depending on mortar basin depth. Use on the ground concentrates use-wear damage on the distal end of the tool and the damage would be seen as impact fractures, chips, and abrasion, depending on the hardness of the clay chunks and the hardness of the surface beneath the blanket. Thus, unlike manos, some pestles were damaged through use without a lower counterpart and it may be this that distinguishes nonfood processing pestles from those involved in food processing.

A mortar has a basin to confine the substance being crushed and ground. A downward stroke brings the pestle forcefully into contact with the mortar, crushing any intermediate substance, and creating impact fractures on the surfaces where the mortar and pestle come into contact. Additional circular or reciprocal movements of the pestle in the mortar basin grinds the intermediate substance and causes abrasive

damage to the surfaces of the mortar and pestle.

Research at the historic Hopi village of Walpi (Adams 1979:25-26) helped identify attributes of mortars used in food processing activities and those of mortar-like tools employed in other activities. Some artifacts typed by archaeologists as mortars were identified by Hopi as eagle watering bowls. The distinctive attributes of a watering bowl are a flat bottom, a square rim, and a broad, deep basin damaged only through manufacture techniques (impact fractures and only minor abrasive scratches). Mortars used in food processing have rounded bottoms, variously shaped rims, and deep, conical basins with both impact fractures and numerous abrasive scratches caused by the pestle. Additional descriptions of food processing mortars can be found in Euler and Dobyns (1983:259-262).

No watering bowls were recognized at the Point of Pines villages, but six mortars and one pestle were found and assumed to have been used in food processing. In order to understand the use of all mortars and pestles at the Point of Pines villages it is necessary to read the discussions in both food and nonfood processing activities.

Nonfood Processing Activities

The purpose of using ground stone tools in nonfood processing activities is to change the physical properties of another item or intermediate substances. Tools of medium or coarse texture were used to alter something through abrasion; those of fine texture or of a material with no texture altered something by polishing it. Some tools were hand-held (i.e., some abraders, awls, mauls, pestles, and polishing stones)

and worked against another surface in an active motion, while others remained stationary (i.e. some abraders, fire-drill hearths, lapstones, mortars, palettes, and spindle bases) and provided work surfaces. Some manos, metates, mortars and pestles, which were designed for food processing, may have had secondary uses as nonfood processing tools, possibly to grind pigments, clay, or temper.

Abraders

Abraders are handstones that have an asperite surface useful in tool manufacture or for abrading the surfaces of other items. Woodbury (1954:98-100) discusses the typological difficulties of defining flat abraders and their distribution in the Southwest, and recognizes that artifacts of different materials were shaped with flat abraders. For example, wooden weaving tools or ceremonial altar pieces, stone axes, figurines, and personal ornaments might all have been worked against a flat abrader at some point in their manufacture. The ultimate shape of an abrader is dependent on its use. The surfaces of flat abraders may have remained flat or become convex or concave depending on what they were used against.

Abraders with U-shaped grooves were employed for shaping cylindrical objects, such as wooden or reed shafts for arrows, wooden spindles for spinning fiber or for drills, prayer sticks, stone awls, or strings of stone beads (Jernigan 1978;fig. 95). Rinaldo (Di Peso et al. 1974:136-138) identified some grooved abraders as having been used to straighten and smooth yarn, or to knock the rough spines off bear grass or other basket weaving material.

Abraders with V-shaped grooves were used to shape or sharpen awls or

needles, or possibly to dull the edges of lithic tools. Some grooved "abraders" were made from a lithic material with little or no asperity, and were used to straighten or polish, rather than abrade (Woodbury 1954:101-111; Haury 1976:285-286; see Flenniken and Ozburn 1988:37-52 for ethnographic and experimental research on grooved abraders), and might be termed shaft straighteners or shaftsmoothers in some reports (Woodbury 1954:101; Di Peso et al. 1974:86).

A total of 319 abraders was recovered from the Point of Pines villages (Appendix A, Table 1). Flat abraders are the most numerous (45.6%) with a slightly smaller percentage of abraders with U-shaped grooves (40.6%). Few (7.5%) abraders have V-shaped grooves. Two types of abraders were recognized among the Point of Pines tools that have not been described in the literature previously: faceted abraders and wedge abraders.

The facets on faceted abraders were created through use against smooth, hard surfaces. The use-wear damage patterns are similar to those on experimental tools used against other stone surfaces (Adams 1989a:264; 1989b:267). It is suggested that axes were shaped or resharpened with these tools and that similarly faceted stones of smoother texture put the finish on the bits (see description of polishing stones). Faceted abraders were not found at any of the pit house villages, and were found only at the pueblos of Turkey Creek and AZ W:10:50, Canyon Creek phase.

Wedge abraders are flat abraders used in such a way as to create a wedge-shape profile with the convergence of two flat surfaces toward one edge. The surfaces against which these stones were used were broad, flat, and pliable. The

use-wear damage patterns are most similar to experimental tools used to shape wood (Adams 1989a:267, 1989b:268, in press). These wedge abraders may have been used like modern sanding blocks to alter the surfaces of broad pieces of wood. Wedge abraders were found among the tools from AZ W:10:50, Maverick Mountain occupation, and AZ W:10:50, Canyon Creek phase. They may have been found at AZ W:10:51 and AZ W:10:50B; however, most flat abraders are not available for analysis and the information on stone catalogue cards is inadequate for identifying wedge abraders.

Seventy-one grooved abraders are also other artifacts: 42 are also handstones, 19 are polishing stones, 7 are lapstones, and 2 are manos. Most of the different tool uses were concomitant (Figure 5.7). One grooved abrader was made from a broken axe bit and another was made in a polishing stone; the different uses were sequential (Figure 5.8).

There is some patterning to the placement of grooves on 116 grooved abraders. The largest percentage (41.4%) have one or more grooves placed across the width of the stone; 37.9 percent were placed lengthwise. A small percentage (6.0%) were grooved diagonally; and 3.4 percent had two grooves, one placed lengthwise and the other widthwise, so they intersect at right angles. It is interesting that the design of so many of these abraders did not always optimize possible groove length. Groove length might have some as yet-unrecognized functional or behavioral implication.

Figure 5.7. Example of concomitant use tool. Abrader/polishing stone with grooves on one side and use as a polishing stone on the opposite side.

Figure 5.8. Example of sequential use tool. Groove was placed over the polishing stone surface.

Measurements were taken on 134 grooves (Table 5.7) from seven villages. No grooved abraders were found at Stove Canyon, Lunt, or Nantack. Crooked Ridge is the only pit house village where grooved abraders were recovered; groove widths range from 0.3 cm to 3.5 cm. The measurements of wooden artifacts from the nearby cave sites of Red Bow Cliff Dwelling, Ash Flat Cliff Dwelling, Tule Tubs Cave, and Pine Flat Cave (Gifford 1980) were compared to see if some correlation could be made between artifact diameter and groove width. The larger groove widths of 2.5 cm and 3.5 cm are equal to the diameters of digging sticks. The smaller groove widths, 0.4 cm, 0.5 cm, and 0.8 cm, are equal to the diameters of wooden awls. The pahos (prayer sticks)

TABLE 5.7

Abrader groove widths.

SITE	NUMBER MEASURD	NARROWST CM	WIDEST CM	MODE CM	MEDIAN CM
CROOKED RIDGE	16	.5	1.2	.7	.7
STOVE CANYON	0	-	-	-	-
LUNT	0	-	-	-	-
NANTACK	0	-	-	-	-
W:10:37	9	.6	2.5	.7/.8	1.2
TURKEY CRK	60	.3	3.5	1.0	1.2
W:10:50 MAVERICK MTN	6	.8	1.4	1.2	1.2
W:10:50 CANYON CRK	10	.2	1.2	.7	.7
W:10:51	15	.8	1.1	1.0	.9
W:10:50B	18	.7	1.3	-	.9

found in these caves ranged in diameter from 0.4 cm to 1.1 cm, easily within the groove widths of some abraders. Weaving tools measured 1.3 cm in diameter, a flute 1.1 cm, and arrows 0.6 cm to 0.8 cm. Thus, variation in groove widths probably reflects the variety of wooden artifacts shaped by grooved abraders. It is interesting to note that arrows found in the nearby caves were made of reed and were the only shaft tools not shaped by an abrader (Gifford 1980:94). These were probably ritual arrows, not used in either hunting or warfare.

Some wooden shafts could not have been shaped with these grooved

abraders. The groove widths on axe heads indicate the size of handle needed for hafting. Most of the abrader grooves are too small to have shaped most of the axe handles. Only 31.2 percent of the axe heads have grooves narrow enough to accommodate a handle that could have been shaped by any of the grooved abraders. Clearly, another tool must have been used to shape axe handles.

Not all of the grooved abraders were used to shape wooden items. One found at AZ W:10:51 has use-wear damage patterns consistent with use against a stone surface. These may have been used to shape stone awls, three of which were found at Point of Pines villages, or strings of stone beads (Jernigan 1978;fig. 95). Not all grooved abraders were analyzed using a microscope, and it is possible that others used to shape stone surfaces were not recognized during macroscopic analysis.

The use-wear damage patterns on most of the flat abraders are consistent with contact with pliable, probably wooden surfaces. Castetter and Bell (1951:94) note that the Papago shaped digging sticks with a flat rough stone. The Maricopa shaped their arrows with flat abraders and used their teeth to straighten the shafts (Spier 1933:134). On one Point of Pines tool the use-wear damage patterns are most similar to those on experimental tools employed to fashion shell beads. Haury (1976:284) defines a similarly shaped tool as a reamer used to manufacture shell bracelets.

Abraders are a higher percentage of the fill assemblage (13.9%) than either the floor assemblage (7.0%) or the feature assemblage (3.2%; Table 5.6). This may

be a factor of where they were used. If abraders were more commonly used outside structures, they might have made it into fill deposits more often than onto floors or into feature deposits. Alternatively, abraders might not have been valuable enough to warrant storing inside a structure or feature, or they were so valuable that they were removed upon abandonment.

Awls

Stone awls are small conical pieces of stone sharpened to a blunt point. Damage patterns include abrasive scratches, perhaps a remnant from tool manufacture, and rounding of the asperities from use of the tool against a soft surface. Stone awls may have been used in much the same way as bone or wooden awls, for stringing corn cobs, for poking holes in leather or basketry, or for use in weaving textiles (Adams 1980:3-8).

Three awls were recovered from Point of Pines villages: 1 from AZ W:10:50 Maverick Mountain phase, one from AZ W:10:50 Canyon Creek phase, and one from AZ W:10:51 (Appendix A, Table 1). The diameter of these tools ranges from 0.6 cm to 0.8 cm, which is compatible with groove widths on abraders having damage patterns consistent with the shaping of stone. Only one awl was found on a floor, the rest were found in fill deposits.

Bobbins

Bobbins may have been used prehistorically in the same way as modern bobbins; to store thread for use in textile production. Most prehistoric bobbins were probably made of perishable material; however, some shaped pieces of stone would

have served just as well. One stone from AZ W:10:51 had been notched on all edges and has use-wear damage patterns consistent with contact against a soft surface--all edges and grain tops are rounded. There may have been many uses for such a piece, but it is suggested here that it was used as a bobbin with the notches functioning to hold thread in place as it was wound. Sharp edges were rounded to keep from cutting the thread and the movement of the thread against the stone rounded the individual grains tops.

Disks

Disks are tabular circles of stone. Some are perforated with a centrally located hole that probably fit over a spindle shaft. Wilcox (1987:145-162) and Greenwald (1988:150) discuss perforated stone disks and the possibility that differences in whorl sizes relate to the types of fibers processed. Teague (1991:68) questions the possibility of a direct relationship between whorl size and the types of fibers spun, and it seems unwise at this point to infer the precise use of Point of Pines whorls. The disk/spindle whorl configuration may also have been used by jewelry makers in hand drills or even pump drills (Judd 1954:pl. 20; Ladd 1979;fig. 5). Perforated disks on short spindles were used as toy tops by the Hopi (Culin 1907:743).

Another type of perforated disk included in this category has been called a stone ring by Haury (1976:290-291) and described as doughnut shaped (Di Peso et al. 1974:32,307). Suggestions regarding their possible uses include shelling corn, as weights on digging sticks, or as chunky stones in a hoop-and-pole game (Haury

1976:290). Nothing similar is identified in any historic assemblage in the American Southwest. I suggest that some doughnut stones may have served as a type of abrader or shaftsmoother. Use-wear damage patterns in the holes indicate contact with wooden surfaces. Archaeological context does not provide much information for inferring how these disks were used, except for the association of one of the doughnut stones with an axe and other axe-shaping tools on the floor of a Maverick Mountain structure. The doughnut stone hole is 2.6 cm in diameter, and the groove width on the axe is 2.2 cm. The hole could have served as an abrader to smooth and possibly bend a handle for the axe. Use-wear damage patterns on this particular doughnut stone are consistent with such a use; however, the damage patterns on all doughnut stones are not the same.

No disks of any type were found at the pit house villages (Appendix A, Table 1); but 18 were found in four of the six pueblos (AZ W:10:37, Turkey Creek, AZ W:10:50, Maverick Mountain occupation, and AZ W:10:50, Canyon Creek phase). Disks are almost equally small percentages of the fill (0.7%), floor (0.4%) and feature (1.1%) assemblages (Table 5.6).

Lapstones

Lapstones are small, hand-held netherstones. Most have small areas on their surfaces where something was worked. Use-wear damage patterns include abrasive scratches and sometimes sheen, depending on the texture of the opposing surface. Stones too large to be hand-held are categorized more generically as netherstones. Lapstones are distinguished from palettes by their simplicity. Palettes have borders

while lapstones do not.

Thirty-nine lapstones were found at the Point of Pines villages, coming from every village except Stove Canyon and AZ W:10:37 (Appendix A, Table 1).

Twenty-seven lapstones were available for analysis. Most (18) were used to process pigment: seven had remnants of pigment, and 11 had similar shapes with identical use-wear damage patterns but lacked pigment. Four lapstones have use-wear damage patterns consistent with use against soft stone or shell, and they might have been used in the production of personal ornaments. One lapstone had impact fractures on its surface from having something crushed against it. Four lapstones had abrasive scratches from contact with a more asperite surface.

Lapstones are almost an equal percentage of the floor (1.9%), fill (1.5%) and feature (1.1%) assemblages (Table 5.6). However, over half (53.2%) the lapstones were found in the fill. The archaeological context does not help with the interpretation of their uses.

Mauls

Mauls are large rocks grooved to accommodate a wooden handle and used for heavy pounding. It has been suggested that they were used for pounding stakes, driving wedges, and may be in the early stages of processing some food resources (Di Peso et al. 1974:154). Mauls with both 3/4-grooves and full-grooves were identified at Casas Grandes (Di Peso et al. 1974:154-162), but few mauls were reported from Snaketown (Gladwin et al. 1938:104 called them "grooved hammerstones"). Mauls with various groove configurations occur in Mogollon

assemblages from the earliest to the latest periods (Wheat 1955:122), and in Anasazi and Hopi assemblages (Adams 1979:115; Woodbury 1954:43-49 calls them hammers). Wheat (1955:122) identifies a groove technique that encircles seven-eighths of the tool's circumference. He calls this technique most typical (Wheat 1955:122) of Mogollon, but does not discuss if it is common to all branches of the Mogollon, or is specific to Point of Pines where he first recognized it (Wheat 1954:127, 140). Nothing similar is illustrated by Woodbury (1954), Di Peso et al. (1974), Gladwin et al. (1938) or Haury (1976); and in Martin's Mogollon reports, only one from a Tularosa phase site is described (Martin et al. 1957:68) .

Mauls were recovered from all Point of Pines villages except Stove Canyon (Appendix A, Table 1). The largest percentage (42.1%) are full grooved, making full-groove mauls seem most typical of Mogollon. However, a large percentage (31.6%) have 7/8 grooves. Both of these groove techniques occur at Crooked Ridge, the earliest pit house village, and at the latest pueblos, AZ W:10:50 and AZ W:10:50B. However, the only 7/8-groove maul from these late pueblos was not used and has no use-wear damage in the groove suggesting it was not hafted.

Some Crooked Ridge mauls are 3/4 groove, but none occur at the pueblos later than Turkey Creek; 21.1 percent of all Point of Pines mauls have 3/4 grooves. One maul from Nantack is unusual with the 3/4 groove oriented so that one broad side is ungrooved, suggesting use with a different motor habit.

Use-wear damage patterns were assessed on 37 of the 57 mauls. Most (73.0%) mauls are damaged by angular, deep impact fractures and occasional chips.

These were probably used against hard--probably stone surfaces. Other mauls (21.6%) are damaged by rounded, shallow impact fractures. These were probably used against pliable, possibly wooden surfaces. Most (75.0%) of the mauls possibly used against wood surfaces were found at Crooked Ridge; the rest were found at the latest pueblos (AZ W:10:51 and AZ W:10:50B). One Crooked Ridge maul was covered with clay and was interpreted to have been used in clay processing either for pottery (Wheat 1954:66) or possibly for clay plaster.

Mauls are a slightly higher percentage of the feature assemblage (7.4%) than the fill (2.2%) or floor (0.9%) assemblages (Table 5.6). The slightly higher percentage in the feature assemblage may indicate that some mauls were stored for future use; however, well over half (63.2%) of the mauls were found in the fill, suggesting most were abandoned without concern for future use.

Mortars

The mortars considered nonfood processing tools are of a size and configuration useful only for processing small amounts of a substance. Herbs, spices, or medicines may have been ground in them, but many have pigment in their basins. Use-wear damage patterns include abrasive scratches more often than impact fractures, suggesting something granular was mixed and not crushed in the basins. Therefore, it is assumed they were used either to mix or grind pigment (or some other powdery substance).

Some small mortars, created from pebbles, were altered only by the manufacture of a shallow basin; these are called pebble mortars (Wheat 1955:118)

and were probably used for processing pigments or resin. This assumption is substantiated by remnants of pigments and possibly resin identified through a microscopic examination of the basins. Another type of mortar was manufactured out of other tools. The basin configuration is similar to pebble mortars; however, the basins were pecked into handstones (Figure 5.9). For convenience these are called here mortar/handstones. Several have remnant pigment and it is suggested that they were used concomitantly as handstones and mortars for grinding and mixing paint. Two or three others have more than one basin, either adjacent to each other or on opposing sides, in which case use as a mortar was probably sequential after use as a handstone.

Mortars are slightly more common in feature assemblages (6.3%) than in either the fill (4.3%) or floor (1.5%) assemblages (Table 5.6). Some mortars may have been stored for future use; however, 76.1 percent were found in the fill, suggesting they were discarded without concern for future use.

Palettes

Palettes are thin tabular pieces of stone, most frequently associated with Hohokam mortuary rituals (Haury 1976:288). Most are embellished with border decorations, some have evidence of having been used with censers, others have various minerals burned on them (Haury 1976:288; Hawley 1938; Appendix IV; Schroeder 1990). Haury (1976:286) developed a chronological sequence for palettes indicating that the elaborateness of decoration reached a florescence in the Colonial and Sedentary periods. Dean's (1991:82-83) reassessment of Hohokam dating

Figure 5.9. Mortar/handstone. Concomitant use with a mortar basin on one side and a handstone on the other side.

would place this sequence during the Gila Butte and Santa Cruz phases. These Hohokam phases roughly coincide with the occupations of Stove Canyon, Lunt and Nantack. Palettes are distinguished from lapstones by borders that are either raised or indicated by an incised line.

Twenty-six palettes were recovered from the Point of Pines villages; 10 are whole. Five broken palettes may have been fractured from heat, reminiscent of palettes used in Hohokam mortuary rituals. A petrographic analysis of the lithic material would be useful for understanding if the Hohokam-like palettes were locally manufactured or imported. The design on at least seven palettes is similar to Hohokam palettes; the rest are less elaborate and were probably of local origin.

One palette from AZ W:10:50, Canyon Creek phase is burned, but it may have been reclaimed from the burned Maverick Mountain deposits, rather than having been burned from use. Another palette from AZ W:10:50, Canyon Creek phase had been used to grind and mix powdery substances. A depression worn into the surface ultimately had a hole knocked into it, effectively "killing" the tool.

Three broken palettes each had a smooth edge and were probably used as polishing tools. No palettes were found at Crooked Ridge, the earliest pit house village, or at AZ W:10:51 and AZ W:10:50B, the latest pueblos.

Palettes are represented in almost equally small percentages in the fill (1.2%), and feature assemblages (1.1%), and in a smaller percentage in the floor (0.4%) assemblage. The archaeological context does little to help with the interpretation of prehistoric use of these items. Most (80.0%) were found in the fill, suggesting no

concern for future use. Only four palettes were found on floors; two are palette fragments--one is whole, the other is broken but reconstructibly whole.

Polishing Stones

Polishing stones are defined here as handstones of smooth texture (made from fine-grain or cryptocrystalline stone) used in the final stages of the manufacture of other items. The smooth texture alters the surface of the manufactured item through tribological processes that create a smooth and often shiny surface (Adams 1989a). Polishing stones have been identified with the manufacture of pottery, wood, bone, or stone items, and the application of plaster to walls and floors (Adams 1979:51; Woodbury 1954:93). The latter are described in the section on construction activities.

Ethnographic accounts of puebloan (Dillingham 1992:10; Simpson 1953:75; Stanislawski 1978:217) and non-puebloan (Spier 1933:107) groups document the fact that pottery production is women's work. The teaching frameworks employed may have varied slightly, but generally, women teach their relatives and maybe their neighbors how to make pottery (Stanislawski 1978:219). The recipes for action passed through the teaching frameworks include the proper selection of raw material to make the pottery, as well as the proper use of tools for finishing the pottery. Pottery-polishing stones are generally made from pebbles selected for their smooth texture; therefore, there is no manufacture stage in their life history. River pebbles are commonly chosen because of their roundness and lack of surface asperity that would cause abrasive scratches on the pottery (Adams 1979:49-51). However,

things other than pottery might also have been polished with river pebbles.

Experiments conducted with river pebbles (Adams 1994:119) indicate that polishing of wood and bone surfaces produces use-wear patterns distinctive from those produced polishing stone and pottery surfaces.

Pebbles used as polishing stones (n=110) were found at each of the Point of Pines villages (Appendix A, Table 1). A small sample (n=23) were examined with the microscope and use-wear damage patterns for most (60.9%) were consistent with use as pottery-polishers; 30.4 percent were probably used to polish stone, and 8.7 percent were used to polish wood or bone.

Another type of polishing stone has been identified among the tools from the Point of Pines villages. These are called faceted polishing stones, and are reminiscent of the faceted abraders described above. The difference between the faceted polishing stones and the faceted abraders is that the latter has a coarser-texture lithic material. Perhaps both were used in the manufacture of axes at different stages in the shaping of bits. The abraders may have been used to shape the bits and to form the bit edges, and the polishers to remove the abrasive scratches caused by the abraders and to hone the edge. The fact that there were no abrasive scratches on the polishing stone facets indicates they were used against stone surfaces of similar asperity (Adams, in press).

Twenty-three faceted polishing stones were recovered from Point of Pines villages. None were found in pit house villages, but at least one was found in each of the pueblos. Polishing stones are represented almost equally in the fill (6.1%),

floor (5.6%), and feature (4.2%) assemblages (Table 5.6). Where they were found does little to help understand the prehistoric use of polishing stones. The 60.2 percent found in the fill were abandoned without concern for future use.

Spindle Bases

Spindle bases are the netherstones used with spindle whorls (Di Peso et al. 1974:138). They provide a firm surface and confine, but do not restrict, the movement of rotating spindles. Three spindle bases were recovered from Point of Pines villages, but only at pit house villages: one at Lunt and two at Nantack (Appendix A, Table 1). Some of the pebble mortars identified in the pueblos may have been used as spindle bases if their identification as having been used with a wooden pestle is incorrect. Spindle bases have small, shallow depressions, most similar to unfinished mortar basins. The use-wear damage patterns in the depressions are most similar to wood contact, which could have been created by spinning spindles. Two bases were found in fill and one was found in a feature.

Artifacts of Ambiguous Use

Some artifacts have a less specific design than others, and it is difficult to determine their intended use; others are fragmentary and use is indeterminable. Use-wear damage patterns may provide some clues to artifact use, but frequently these patterns could have been made in more than one way, or use was too light to create distinctive damage patterns. Any tool not identifiable with a specific activity was included in this category of ambiguous use.

Grinding Slabs

Grinding slabs are large pieces of stone either ground to shape or chosen for their naturally tabular shape. The broad surface is used as a grinding surface, but often the grinding area is smaller than the total surface area. Grinding slabs, which rest on a surface, are generally smaller than metates, but larger than hand-held abraders or lapstones. Grinding slabs are easily distinguished from trough and basin metates because they have flat surfaces. Distinguishing flat metates and grinding slabs is more difficult, but is based on how much of the surface is abraded. Metate surfaces are totally involved in the grinding, while grinding slabs have small areas of grinding resulting from use of smaller handstones.

Sixteen grinding slabs were recovered from the Point of Pines villages, but only two are available for analysis (Appendix A, Table 1). One is a small corner fragment, and the other has a small area of use where something pliable was worked against it. No grinding slabs were found in features, but they are almost equally represented in the fill (0.5%) and floor (0.7%) assemblages (Table 5.6).

Handstones

The category of handstones is reserved for tools lacking the specific attributes of manos, polishing stones, or pestles. Their use is ambiguous in the sense that nothing in how they were designed or used created distinctive attributes. The attributes created through use against a metate, combined with those created by manufacture techniques are useful for distinguishing manos and handstones. In addition to having use-wear damage from rubbing against metates, some manos were

designed with features that make them easier to hold. Mano edges may have been roughened or grooves pecked to provide a more secure grip. The side of the mano that fits in the hand may have been pecked or abraded to make the tool more comfortable to hold. Handstones have none of these designed attributes. Thus, it is a combination of designed attributes and attributes created through use-wear that distinguish manos from handstones.

A total of 411 handstones, some of which might have been used in metates, were identified from the Point of Pines villages. A microscopic use-wear analysis of the 31 brought to ASM indicates that most were used against stone surfaces; they may have been the tools used with grinding slabs. Eleven had been used against more than one surface. Two had use-wear damage patterns most similar to experimental stones used to process hides (Adams 1988; 1989a:269). Spier (1933:125) notes that the Maricopa pounded hides with stones. Another handstone has use-wear damage patterns similar to those found on pottery anvils. Anvils of both pottery and stone were used by Maricopa (Spier 1933:107). None of these tools was typed as hide processing stones or pottery anvils because they did not have formal attributes indicating they were designed tools.

Next to manos, handstones are the highest percentage of the floor (12.3%), fill (14.3%) and feature (18.9%) assemblages (Table 5.6). The slightly higher percentage in the feature assemblage may reflect the storing of some handstones for future use. However, well over half (60.6%) were found in the fill, suggesting they were discarded without concern for future use.

Netherstones

Netherstones are the bottom stones against which something is worked. The general category of netherstones includes artifacts not having the specific attributes of metates or grinding slabs. Larger than lapstones, they are damaged by abrasion and impact fractures. Netherstones provide a working surface upon which a variety of activities could have taken place. Ladd (1979:495) illustrates a Zuni man shaping a string of beads against a flat netherstone.

Thirty-nine netherstones were identified from the Point of Pines villages and 14 are available for analysis (Appendix A, Table 1). Use-wear analyses indicate that the surfaces were used in a variety of ways. Some were used with hard stones, others with pliable or soft items; one had both abrasive scratches and impact fractures indicating crushing and grinding motions; five had concave surfaces worn into them. No netherstones were found in features, and almost equally low percentages were in the fill (1.8%) and floor (1.0%) assemblages (Table 5.6).

Construction Activities

Two types of ground stone artifacts from the Point of Pines villages are identified as used in construction activities: pestles and polishing stones. These tools, especially the pestles, are distinguished from food or nonfood processing tools through use-wear analysis, and through inference based on association. Construction tools were manufactured using grinding techniques, but only the polishing stones employed grinding techniques as part of their tasks. The pestles were not used to grind or crush material, and they were not all used in the same way.

Pestles

Seventeen pestles are thought to have been used in construction activities. They are considered pestles because they are long, roughly cylindrical, and are damaged through abrasion or impact fractures. Their identification as construction implements is inferred through association of 11 pestles within a feature, and a use-wear analysis indicating each one had been used in different, but probably related, tasks. Similar tools found at other villages were then classed the same and inferred to have been used in the same type of construction activity.

Five pestles were probably used as digging tools (Wheat 1954:117; 1955:120). The distal ends are blade-like and have abrasive scratches that might have been produced through contact with the soil. The digging tool found with the stored tools was interpreted as used for digging house pits, storage pits, or post holes (Wheat 1954:137). The other stored tools had use-wear damage patterns consistent with mallets used to pound pliable, probably wooden surfaces. They may have served to split planks or pound beams into place. One of the stored tools might have smoothed large beams in the superstructures of pit houses; it had a concave surface damaged by use against a pliable surface. Each of the stored tools had use-wear damage patterns on the proximal end, probably the result of being held in the hand. A couple were notched to provide grips.

The stored tools were the only items found in a pit house at Crooked Ridge and they may have been the components of a construction specialist's tool kit. Pestles possibly used in construction activities were not found at any other pit house

village, but did occur at AZ W:10:37, AZ W:10:50, Maverick Mountain occupation, and AZ W:10:50, Canyon Creek phase. However, at none of these pueblos was there a similar collection of tools. If they had not been found at Crooked Ridge it is unlikely that the use of these tools in construction activities would have been inferred.

Polishing Stones

Polishing stones inferred as having been used in construction activities are floor polishers. Floor polishers are distinguishable from other polishing stones by their size and shape. They are defined as generally discoidal pieces of stone with opposing, flat surfaces (Adams 1979: 51; Kidder 1932:64; Woodbury 1954:90) and are larger than pottery-polishing stones. Artifacts specifically identified as floor polishers by Hopi were distinguished by a pecked area in the center of the flat polishing surface (Adams 1979:51). These stones were used in the application and finishing of plaster to both walls and floors in Hopi structures (Adams 1979:52). If a naturally shaped stone was suitable for use as a floor polisher, no manufacturing was done; otherwise, the perimeters were pecked and ground.

Six floor polishers were identified from the Point of Pines villages. Only one was found at a pit house village (Crooked Ridge); the rest were at pueblos (AZ W:10:37, Turkey Creek, and AZ W:10:50, Canyon Creek phase). All were found in the fill except one from Crooked Ridge which was on the floor, and one in a feature at AZ W:10:50, Canyon Creek phase.

Procurement Activities

The tools identified here as procurement tools (axes and fire-drill hearths) are a part of grinding technology because grinding was used in their manufacture. Axes were used to procure wood for the manufacture of wood artifacts, for architectural components, or for fires with which to cook and keep warm. Hearths were used to "procure" fire for warmth, cooking, and ritual (Hough 1890:531-587; Spier 1933:129). Thus, they are indirectly related to food and nonfood processing activities.

Axes

Axes are composite tools combining a stone head and a wooden handle, and are designed for chopping wood (Woodbury 1954:25; Haury 1976:291; Di Peso and others 1974:58-59). There are many ways to haft an axe head, and the technique selected seems to have been a factor of technological tradition. It is axiomatic that axe heads designed with 3/4 grooves were made by Mogollon and Hohokam and axes designed with full grooves were made by Anasazi (Reed 1951:45; Woodbury 1954:36). The presence of an axe head with a groove design differing from the cultural norm is interpreted as evidence for the movement of either commodities or people. What actually happened may have been a little more complex than the above axiom implies.

If axes were designed with the intention of cutting down trees, their actual uses were quite a bit more varied. Ethnographic accounts of axe use indicate that, historically, stone axes were collected from prehistoric sites and ultimately used for

shaping metates (Hough 1918:270-271; Russell 1908:110; Woodbury 1954:40-42). Axes collected from prehistoric sites are also a component of ritual alters at Hopi (Hough 1918:271; Woodbury 1954:41). Haury (1945:132) found Hohokam axes covered with clay that he interpreted as used in clay procurement or processing at Los Muertos. Mills (1993:393-413) postulates through experimentation and microscopic use-wear analyses that some axes found in southwest Colorado were used to grub out bushes in clearing agricultural fields. Recent research in the Four Corners area suggests that axe heads were commonly collected and stored for potential future use (Larralde and Schlanger 1994:10).

The collection of axes from the Point of Pines villages provides an opportunity to discuss artifact life history from artifact design and manufacture, to use and reuse, and finally disposal. Four categories of attributes were analyzed: groove design, groove width, evidence of resharpening, and bit edge configuration. The two basic groove designs used by prehistoric people in the greater Southwest have already been noted. How an axe head was grooved or regrooved reflects technological knowledge and knowledge transmission about axe design, manufacture, and maintenance. Groove widths provide information on the size of the axe handles and reflect technological knowledge about design and manufacture. Resharpening evidence indicates an effort to maintain usefulness as a wood chopping tool. Additionally, bit edge configuration--sharp, dull, or rounded--indicates the stage at which an axe head was abandoned or discarded.

Not all of the axes found at the Point of Pines villages were brought back to

ASM. There is information on 305, with 264 available for analysis. Some of the information recorded on stone catalogue cards is usable in the following analyses, so the total number of axes varies. Eleven axes not included in this analysis are described in the section on artifacts not used for processing.

Groove design was assessed on 305 axes. Most (79.0%) were hafted with a 3/4-groove technique (Figure 5.10a), 9.5 percent with a full-groove technique (Figure 5.10b), 0.9 percent with a notched technique, 8.5 percent were regrooved with either a full groove or a 3/4 groove, and a small percentage (1.9%) were not identifiable by hafting technique (Table 5.8). Of those designed with a 3/4 groove, one has ridges on both the poll and bit side of the groove, which is a technique commonly attributed to Hohokam artisans. Other axes have a ridge on either the poll or the bit side of the groove that may have been a spontaneous attempt to improve the seating for the handle. The assumption is that 3/4- and full-grooving techniques allow for equally functional hafts. This is something that needs to be experimentally tested. No full-grooved axes were found at pit house villages, but 3/4-groove designs and full-groove designs co-occurred at every pueblo (note Table 5.8 indicates no full-grooved axes at AZ W:10:50B, but Table 5.9 records one 3/4-groove axe regrooved with a full groove). Most of the regrooved axes were found at Turkey Creek and AZ W:10:51, but one or more occurred at each pueblo (Table 5.9).

Figure 5.10. Grooved axe heads. A. 3/4-groove axe head. B. Full-groove axe head.

TABLE 5.8

Summary of axe haft designs by site

SITE	3/4 GROOVE		FULL GROOVE		NOTCH		REGRVE		UNIDNT		TOT #
	#	%	#	%	#	%	#	%	#	%	
CROOKED RDG	1	100.0	0	0	0	0	0	0	0	0	1
STOVE CANYON	0	0	0	0	0	0	0	0	1	100.0	1
LUNT	0	0	0	0	0	0	0	0	1	100.0	1
NANTACK	2	66.7	0	0	0	0	0	0	1	33.3	3
W:10:37	18	85.7	2	9.5	0	0	1	4.8	0	0	21
TURKEY CRK	88	74.6	17	14.4	2	1.7	8	6.8	3	2.5	118
W:10:50 MAVERICK MTN	14	66.7	5	23.8	0	0	2	9.5	0	0	21
W:10:50 CANYON CRK	36	90.0	2	5.0	1	2.5	1	2.5	0	0	40
W:10:51	56	80.0	3	4.3	0	0	11	15.7	0	0	70
W:10:50B	26	99.7	0	0	0	0	3	10.3	0	0	29
TOTAL	241	79.0	2	9.5	3	1.0	26	8.5	6	2.0	305

TABLE 5.9

Groove configuration of regrooved axes

SITE	3/4-3/4 REGRV	3/4-FULL REGRV	FULL-3/4 REGRV	3/4-NTCH	TOTAL
CROOKED RDG	0	0	0	0	0
STOVE CANYON	0	0	0	0	0
LUNT	0	0	0	0	0
NANTACK	0	0	0	0	0
W:10:37	0	0	0	1	1
TURKEY CREEK	1	6	1	0	8
W:10:50 MAVERICK MTN	0	1	0	1	2
W:10:50 CANYON CREEK	0	1	0	0	1
W:10:51	9	1	1	0	11
W:10:50B	2	1	0	0	3
TOTAL	12	10	2	2	26

The small assemblage of regrooved axes (n=26) is important for information about technological knowledge. Four regrooving strategies were identified: twelve 3/4-groove axes were regrooved with a second 3/4 groove; ten 3/4-groove axes were regrooved with full grooves (Figure 5.11a); two full-groove axes were regrooved with a 3/4 groove (Figure 5.11b); and two 3/4-groove axes were redesigned with notches. An axe would need regrooving for one of two reasons: (1) the axe head was unbalanced and the groove needed to be relocated, or (2) a different hafting technique was to be applied. Those 3/4-groove axes regrooved with 3/4-grooves

Figure 5.11. Regrooved axe heads. A. 3/4-groove axe head regrooved with a full groove, at arrow. B. Full-groove axe head regrooved with a 3/4 groove, at arrow.

were probably adjusted for balance or for handle replacement. I suggest that those regrooved with a different groove technique were altered by an artisan who learned a particular recipe for action (*sensu* Schiffer and Skibo 1987:597) and continued to use that recipe even when confronted with an alternative technique.

Also included in the technological knowledge an axe maker must have about grooving is how wide to make the groove. Groove widths were measured to determine axe handle size, and there may have been some standardization. Widths range from 1.2 cm to 6.0 cm; however, the median and mode figures from each village are within 0.4 cm, ranging from 2.6 cm to 3.0 cm (Table 5.10). The coefficients of variance for each village are low, indicating there is little variation around the central tendency of axe groove width (Table 5.10). The technological knowledge used to make axe heads may have included a design preference for the size of the axe handle. This preference may have been structured by a knowledge of available wood sources for handles, or some other axe performance characteristic.

A sample of axes (N=145) was examined microscopically to determine if axes were similarly used. Most (66.9%) had use-wear damage patterns consistent with chopping trees (Mills 1993:405). Smaller percentages were used against hard, probably stone surfaces (8.9%), and against a variety of surfaces (11.7%), probably both wood and stone. The use-wear patterns on 7.6 percent of the axes are similar to those described by Mills (1993:407) as resulting from their use in grubbing bushes from agricultural fields. One axe (0.7%) had use-wear damage patterns

TABLE 5.10

Axe groove widths

SITE	TOTAL MESRD	SMLST CM	LRGST CM	MODE CM	MEDIAN CM	VARIANCE COEFFCNT
CROOKED RDG	1	2.0	-	2.0	2.0	-
STOVE CANYON	0	-	-	-	-	-
LUNT	0	-	-	-	-	-
NANTACK	2	2.8	3.2	-	-	.094
W:10:37	14	2.2	3.6	3.0	3.0	.155
TURKEY CRK	121	1.7	4.9	3.0	2.9	.192
W:10:50 MAVERICK MTN	17	1.6	3.3	2.8	2.8	.152
W:10:50 CANYON CRK	20	1.2	4.3	2.6/2.7	2.7	.274
W:10:51	72	1.5	6.0	2.7/2.8	2.8	.196
W:10:50B	29	2.0	3.7	2.8	2.8	.176

consistent with use against a smooth, pliable surface. A few (2.8%) had no indications of use-wear damage patterns. The implication is that axes were multipurpose tools. They may have been designed for use in chopping trees, but they were used opportunistically in a variety of activities.

In order to assess how much axes were used and maintained several attribute combinations were recorded. If an axe had not been resharpened and it was sharp, it was considered usable. If an axe had been resharpened and was sharp, it was considered maintained usable. If an axe had not been resharpened and was dull, it was considered as needing maintenance. If an axe had been resharpened and was

dull, it was considered in need of more maintenance. If there was no remaining bit edge, the axe had been reused as a maul and was considered used in a second activity. If the axe was broken, it was considered not usable.

These attribute combinations were then recorded for axes found on floors (Table 5.11) and those found in fill (Table 5.12). When considered with the grooving and regrooving techniques discussed above some interesting patterns emerge. Of the artifacts originally designed as axes, 20.2 percent had no remnant use-life because they were no longer used or usable as axes. Slightly more than one-third (35.5%) had a lot of remnant use-life and are usable without resharpener; including 5.5 percent essentially new axes never resharpener or used enough to dull the bit edge. The rest (39.6%) had some remnant use-life as axes, but needed resharpener before they could have been used for chopping wood.

Most of the axe assemblage (63.0%) was found in fill deposits. While 27.5 percent were not usable as axes, 35.6 percent could have been used without resharpener. The remaining 37.0 percent needed more maintenance before they were usable as axes. Thus, it seems there was not much selectivity in which axes were discarded into fill deposits. Axes with lots of remnant use-life were only slightly less abundant in fill deposits (8.1%) than axes with no remaining axe-use life.

Using only the axes found on floors, a couple of villages stand out with different patterns. Half (50.0%) of the axes from AZ W:10:37 were ultimately used as mauls; only 1 axe (12.5%) was usable without further resharpener. This

TABLE 5.11

Maintenance and use of axes found on floors*

SITE	USABLE		MAINTAIN USABLE		NEEDS MAINTENC		NEEDS MORE MAINTEN		SECOND USE		NOT USABLE		TOTAL FLOOR
	#	%	#	%	#	%	#	%	#	%	#	%	
CROOKED RDG	0		1	100.0	0		0		0		0		1
STOVE CANYON	0		0		0		0		0		0		0
LUNT	0		0		0		0		0		0		0
NANTACK	0		0		0		0		0		0		0
W:10:37	0		1	12.5	0		¹ 3	37.5	4	50.0	0		8
TURKEY CRK	0		2	15.4	¹ 3	23.1	¹ 3	23.1	5	38.5	0		13
W:10:50 MAVERICK MTN	1	8.3	¹ 4	33.3	³ 3	25.0	3	25.0	0		1	8.3	12
W:10:50 CANYON CRK	1	100	0		0		0		0		0		1
W:10:51	0		20	44.4	2	4.4	18	40.0	² 5	11.1	0		45
W:10:50B	1	12.5	0		0		4	50.0	3	37.5	0		8
TOTAL	3	3.6	28	31.8	8	9.1	31	35.2	17	19.3	1	1.1	88

* Axes are 3/4 groove design unless otherwise designated.

1 1 full-groove design.

2 2 full-groove design; 1 double-bit.

3 1 full-groove design, 1 3/4-groove design regrooved with full groove

TABLE 5.12

Maintenance and use of axes found in fill*

SITE	USABLE		MAINTAIN USABLE		NEEDS MAINTNC		NEEDS MORE MAINTNC		SECOND USE		NOT USABLE		TOTAL FILL
	#	%	#	%	#	%	#	%	#	%	#	%	
CROOKED RDG	0		0		0		0		0		0		0
STOVE CANYON	0		0		0		0		0		1	100.0	1
LUNT	0		0		0		0		0		1	100.0	1
NANTACK	2	100.0	0		0		0		0		0		2
W:10:37	0		1	25.0	1	25.0	1	25.0	0		² 1	25.0	4
TURKEY CRK	5	5.4	¹ 26	28.0	² 7	7.5	¹ 25	26.9	³ 25	26.9	⁵ 5	5.4	93
W:10:50 MAVERICK MTN	1	25.0	0		1	25.0	1	25.0	0		² 1	25.0	4
W:10:50 CANYON CRK	0		4	40.0	1	10.0	2	20.0	⁴ 3	30.0	0		10
W:10:51	0		7	46.7	0		7	46.7	1	6.7	0		15
W:10:50B	2	10.5	5	26.3	2	10.5	7	36.8	2	10.5	1	5.3	19
TOTAL	10	6.7	43	28.9	12	8.1	43	28.9	31	20.8	10	6.7	149

* Axes are 3/4-groove design unless otherwise indicated.

¹ 4 full-groove design.² 1 full-groove design.³ 2 full-groove design.⁴ 3 full-groove design.⁵ 1 blank.

contrasts with the floor assemblages from AZ W:10:51 and AZ W:10:50, Maverick Mountain occupation. At AZ W:10:51, 44.4 percent of the axes were usable without further resharpening, and only 11.1 percent no longer functioned as axes. Clearly, different artifact abandonment strategies occurred at AZ W:10:37 and AZ W:10:51. The AZ W:10:50, Maverick Mountain floor assemblage has a pattern more similar to AZ W:10:51. None of the Maverick Mountain axes were used other than as axes, and 33.3 percent were usable without resharpening. Similarly, double-bitted axes were found only at AZ W:10:50, Maverick Mountain phase and at AZ W:10:51. The Maverick Mountain deposits were sealed so that there was little potential for scavenging. The deposits of AZ W:10:51 may also have been left undisturbed after abandonment, as the whole Point of Pines area was abandoned.

A comparison of axes found on floor and in fill shows 89.7 percent similarity, with the biggest difference being in the higher percentage of axes in need of maintenance on floors (45.1%) than in fill (37.1%). The percentages of usable axes are identical (35.4%) for fill and floor with resharpened axes occurring in slightly higher percentages on floors (31.8%) than in fill (28.9%). Thus, axes in need of maintenance, or maintained but not subsequently used were more commonly stored on floors than discarded into fill deposits.

Only manos, metates, handstones, and abraders were found in larger numbers than axes. However, there were few axes at the pit house villages. Only axe fragments were found at Lunt and Stove Canyon, one axe at Crooked Ridge, and three axes at Nantack. The axe found at Crooked Ridge is of Hohokam design, as

were the three at Nantack. The sparse number of axes at pit house villages is intriguing. Axe technology was obviously known to these people. Even if they did not have the knowledge for making axes, they knew from where axes could be obtained. They certainly had a need for axes to fell the trees for their pit house superstructures. Why are there so few axes in the pit house villages? Perhaps the axe heads from the pit house villages were consistently removed so that they are inaccurately represented in the archaeological record. The axe assemblage from pueblos is much larger and is quite varied. The implications for these differing distributions will be discussed in the concluding chapter.

Fire-drill Hearths

A fire-drill hearth is the netherstone part of a fire starting kit. Small, notched cupules serve to contain the spark created by friction from a rotating fire drill. A hearth may have a single basin or multiple basins. Grooves cut into the cupules allow flammable pieces of material to come into contact with the spark, thereby generating a flame. Ethnographic accounts of puebloan and non-puebloan fire starting describe men as the tool users (Hough 1890:531-532, 1915:164; Spier 1933:79).

Four fire-drill hearths were found at Point of Pines villages. All are broken. Three were found at Turkey Creek, each with a single cupule. One is embellished with an incised zig-zag line. The only fire-drill hearth found at AZ W:10:50, Canyon Creek phase has three cupules, two are worn out. Most of the fire-drill hearths are wood (Hough 1890:531-532) and perhaps stone fire-drill hearths were

experiments in using different material. Stone fire-drill hearths were found at Casas Grandes and one or two other sites in the southwest (Di Peso 1974:205); however, wood fire-drill hearths may have had a different distribution than those of stone. Archaeological context does little to help interpret how these were used at the Point of Pines villages as all were found in fill deposits.

Nonprocessing Activities

Many artifacts were shaped by grinding for use in activities unrelated to processing resources; however, some containers or parts to containers, included here, are related to storing resources before or after processing. Other items, such as axes, balls, or pipes/tubes, not used in processing were used in games or rituals.

Axes

Eleven axes were not used, not hafted, made of material inappropriate for an axe, and are considered symbolic axes. Stephen (1936:43) describes a Hopi altar with an old stone axe. Such an axe may have been part of the ritual paraphernalia since prehistoric times, or it may have been procured from a prehistoric site. Six symbolic axes made of tuff were found at AZ W:10:50, Maverick Mountain occupation, AZ W:10:50, Canyon Creek phase, and AZ W:10:51. Five made of scoria were found at AZ W:10:50, Canyon Creek phase and at Turkey Creek pueblo. Those found at Turkey Creek were in fill; four at AZ W:10:50, Canyon Creek phase were in fill, two on floors; one at AZ W:10:50, Maverick Mountain phase was on the floor; and two at AZ W:10:51 were on floors. While none of the axes had been hafted, they did have differing groove designs. Three found at AZ W:10:50, Canyon

Creek phase had full grooves. Another is unusual in that the groove design is reminiscent of the 7/8-groove on some mauls, and it is double-bitted. The rest of the symbolic axes have 3/4 grooves and single bits.

Balls

Balls are roughly spherical pieces of stone either ground, or chosen for their natural shape. Stone balls are most commonly identified through ethnographic studies of the Pueblo and Papago as gaming pieces, club heads, noise-making stones (thunderstones), or racing stones (Adams 1979:90; Russell 1908:172-173,179; Stephen 1936:271-280; Underhill 1939:146-150; Woodbury 1954:173). Russell (1908:172-173,179) notes that the Papago prepared racing tracks at Sacaton Flats and Casa Blanca. Races were run on both tracks and through open country kicking stone balls, some covered with pitch or gum (Bahr 1983;fig. 8; Russell 1908;fig. 88).

Racing stones, also called kickballs, are identifiable by impact fractures. Some have flattened surfaces or slightly concave sides where pitch was applied to make the stone adhere to the foot and allow the racer to heft the all into the air for more distance (Adams 1979:90). Stone balls are also rolled across wooden covered pits to simulate the sound of thunder (Woodbury 1954:172). Balls used as thunder stones are generally more spherical than kickballs and use-wear damage patterns are less obvious impact fractures and asperities rounded from being rolled across a wooden surface.

Sixteen balls were recovered from Point of Pines villages. Of the twelve

available for analysis, most (75.0%) were probably used as racing balls. Impact fractures and abrasive scratches damage the surfaces. The other balls were either made of material unsuitable for racing balls, or they were not damaged by impact fractures. No balls were found in features, and they are equally low percentages (0.5%) of the fill and floor assemblages (Table 5.6). However, over half (57.1%) of the balls were found in the fill, discarded without concern for future needs.

Bowls

Bowls are shaped to be containers; however the occasional stirring, or scooping of the contents creates abrasive scratches that sometimes blur the distinction between bowls and mortars. Bowls may be plain, or decorated with carved or incised designs (Di Peso et al. 1974:206-218; Haury 1976:289).

Forty-seven bowls were identified at the Point of Pines villages; all but one is available for analysis. Three are embellished with incised designs. One was selected for its natural shape and natural depression and is, therefore, considered expediently designed. The rest were pecked and ground on the exterior, but for some the bottoms do not rest flat, and others the basins do not sit level. Three have knobs or notches by which they could have been suspended.

One bowl is unusual and deserves special attention. The craftsmanship is of unusually high-quality, and it was designed to resemble a melon (Wheat 1954:138). There is a red stain on the interior and perhaps it was used in a processing activity. However, because it is one-of-a-kind it is included with the other containers. This was found on the floor of a pit house at Crooked Ridge that has other artifacts

attributed to Hohokam design (Wheat 1954:138). While there were other bowls found on floors, most (72.3%) were found in the fill. Bowls are almost equally small percentages of the fill assemblage (2.1%) and the floor assemblage (1.1%), and none were in features (Table 5.6).

Pipes/Tubes

Pipes or tubes are cylindrical or conical shapes probably used for smoking tobacco (Woodbury 1954:174-175). Tubes do not have smoke-blackening in the bore, and they may have been used for something else, but for the most part they are of the same size and configuration as those that do have smoke-blackening.

Ethnographic accounts of pipe smoking describe men socially sharing the pipe or blowing smoke over objects or people in ritual observances (Stephen 1936:683).

Pipes are also components of certain Hopi altars (Hough 1915:137).

Fourteen pipe/tubes were recovered from the Point of Pines villages. Ten are tubes, most of which were probably intended to have been used as pipes. Four were blackened inside from use; one still contains an organic substance, possibly tobacco. One tube is embellished with incised lines. This one was found on the floor of a pit house at Crooked Ridge along with the bowl described above, and other artifacts of Hohokam design. Pipes/tubes are both low percentages in the fill (0.7%) and floor assemblages (0.3%), none were found in features (Table 5.6). However, most pipe/tubes (78.6%) were found in fill and archaeological context does little to help with the interpretation of how these were used at the Point of Pines villages.

Plugs/Caps

Plugs and caps are pieces of stone designed to seal the narrow opening of containers, such as canteens, or gourd "bottles". Plugs are more or less cylindrical and fit wholly within the diameter of the container's neck. Caps are plugs with wide tops that rest on the rim of the container's neck.

Nine caps and 27 plugs were recovered from the Point of Pines villages. All had been ground to shape; some more than others. Only one cap/plug was found at a pit house villages (Nantack). There was a sparse distribution of caps/plugs at the pueblos except for Turkey Creek where 86.1 percent of all the caps/plugs were found. Caps/plugs are a higher percentage of the fill assemblage (2.0%) than the floor assemblage (0.3%), and none were found in features (Table 5.6); however, almost all (91.6%) were found in fill deposits.

Discussion

The purpose of organizing the ground stone artifacts into activity categories is to show how grinding technology pervades all aspects of prehistoric life. The knowledge of what happens when a stone surface contacts another surface is used over and over to accomplish many vital tasks. Grinding technology is a basic, daily technology. Artifacts, as components of grinding technology, are concomitantly components in many other technologies. Food preparation is a technology that encompasses the knowledge, tools, and behavior needed for the procurement, processing, storing, cooking, consumption, and disposal of nutritional resources. Ground stone tools are used in the procurement, processing, storing, and cooking stages

of food preparation technology.

Examples abound for the use of ground stone tools as components of other technologies. In weaving technology, ground stone tools are used to shape weaving tools and to wrap yard or thread. In pottery technology, ground stone tools are used to process clay, temper, and pigments, and to smooth and polish vessel surfaces. In architectural technology, ground stone artifacts are used to procure and shape structural elements, to apply and smooth plaster, and to dig house foundations, storage pits, and post holes. Clearly, if we can understand grinding technology, we can gain an understanding of what prehistoric people were doing on a daily basis. If we can understand their technological behavior perhaps then we can gain some insight into their social behavior.

In the next section of this study, the ground stone artifacts from individual villages are organized into the activity categories outlined above. Once we know the nature of the grinding technology used at each village, it will be possible to compare technological systems from villages dating to different time periods. This will give us an understanding of how grinding technology changed through time. If, as is asserted here, technological action is social action, then technological change is social change. The final chapter discusses these technological and social changes.

CHAPTER 6

GRINDING TECHNOLOGY AT THE PIT HOUSE VILLAGES

Four pit house sites were excavated, each with the intention of answering specific questions about chronology and cultural affiliation. Most of the Point of Pines sites were not datable by absolute techniques; there were few datable tree-ring specimens and no archeomagnetic samples. All were dated using relative seriation and cross dating techniques for house and pottery types. Collectively, the pit house villages provide information for the period from about A.D. 400 to A.D. 1000. A summary of grinding technology and the identification of technological traditions follows. More detailed descriptions of specific artifact types are in Appendix A.

Crooked Ridge Village

Crooked Ridge village (AZ W:10:15) is located approximately three miles south and east of Point of Pines (Figure 4.1) in a thin stand of evergreen trees. It was excavated during the summers of 1948 and 1949, and the summary publication was written by Joe Ben Wheat (1954). Crooked Ridge is primarily a pit house village, but there is a small masonry unit superimposed over two pit houses, indicating a later reoccupation of the site area (Wheat 1954:64). This analysis of grinding technology includes only the artifacts from the pit house occupation. The confidence value computed for this site is 1 (Table 3.3). Even though only about 25 percent of the site was excavated, the record keeping was good, and there were several pit houses with floor assemblages.

Twenty-four out of a possible 100 pit structures were excavated. Although

temporal control is minimal, the village seems to have been occupied during a single phase, the Circle Prairie Phase, A.D. 400-600. Superpositioning of some pit houses indicates that they were not all occupied contemporaneously, and Wheat (1954:170-171) speculates that building began in the north and spread south. More of the site was not excavated because it was thought that to do so would only duplicate what was already learned (Wheat 1954:17).

Ground stone artifacts were found in 22 pit houses. Several pit houses (1-5,7,9,11,14,16,21-23) had ground stone artifacts on their floors, either in use contexts or stored against walls or posts. Metates were identified as in use contexts if rocks were positioned under them to provide support and create an angled grinding surface. Those identified as stored were positioned upside down, or so near walls and posts that there was no room to work. Other stored tools were found in pits. There is information on 343 ground stone artifacts; 127 are available for analysis and 216 are described on stone catalogue cards, in room reports, or in Wheat's report (1954). Many of the types described here are different than Wheat's, primarily because of the technological orientation of this analysis.

The assemblage was classified into 14 artifact types and sorted into activity categories; most (50.4%) were involved in food processing activities (Table 6.1). Fifteen percent were used in more than one activity (Table 2.1). The fill and floor assemblages are 57.9 percent similar, with a slightly greater variety of artifact types in the fill (n=12) than on the floor (n=11). Manos and metates are a higher percentage (70.7%) of the floor assemblage than the fill (30.2%), and abraders and

TABLE 6.1
Artifacts from Crooked Ridge Village

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Grind Sls*	2	2.7	.6
	Handstn*	66	90.4	19.2
	Pestle	5	6.8	1.5
	Subtotal	73	99.9	21.3
FOOD	Mano*	123	71.1	36.9
	Metate*	47	27.2	13.7
	Mortar	2	1.2	.6
	Pestle	1	.6	.3
	Subtotal	173	100.1	50.4
NONFOOD	Abrader	28	38.9	8.2
	Lapstone	4	5.6	1.2
	Maul*	19	26.4	5.5
	Mortar	9	12.5	2.6
	Polish Stn	12	16.7	3.5
	Subtotal	72	100.1	21.0
PROCUREMENT	Axe	1	100.0	.3
CONSTRUCTION	Pestles	11	91.7	3.2
	Polish Stn	1	8.3	.3
	Subtotal	12	100.0	3.5
NONPROCESSING	Ball	1	8.3	.3
	Bowl	3	25.0	.9
	Pipe/Tube	8	66.7	2.3
	Subtotal	12	100.0	3.5
	TOTAL	343		100.0

- * These categories include artifacts not available for analysis. Pertinent information was obtained from stone cards, room reports, and Wheat (1954).

handstones are a higher percentage of the fill (41.6%) assemblage than the floor (15.8%). A small collection of ground stone artifacts was found in features; the most interesting of which is a group of 11 pestles found in a depression on the bench of Pit house 8 (see below).

Grinding Technology at Crooked Ridge Village

Crooked Ridge village provides an excellent opportunity for understanding the state of grinding technology as it was first employed by the Mogollon living in the Point of Pines area. The founders of Crooked Ridge had technological knowledge that they brought with them from somewhere else. While there were Archaic people present in the Point of Pines area, as indicated at the Cienega site (Haury 1957), there is no archaeological evidence of any occupation between A.D. 1 and A.D. 400 (Haury 1989:115). Thus, the technological knowledge brought to the Crooked Ridge Village probably was developed in another setting.

Food grinding strategies at Crooked Ridge relied primarily on 3/4-trough mano/metate equipment. Basin mano/metate equipment was scarce as were mortars and pestles. Six pit houses (1,2,4,5,7,9) are of particular interest for this analysis because they had free-standing metates, some propped in use-positions on their floors. Pit house 1 had three propped metates and Pit house 2 had two. The multiple metates were spaced far enough apart that it would not have been easy for one woman to coarse grind on one and then to transfer meal to another for fine grinding; therefore, it seems reasonable to assume that they were set up for two or three women to grind simultaneously.

Food grinders usually kept one mano surface compatible with the metate, but a few manos were flipped so that two surfaces were created. This technique may have allowed a grinder to manage mano wear, making it unnecessary to stop grinding to resharpen the mano surface during a grinding session. Such attempts at wear management might also indicate a desire to prolong the use-life of a comfortable or "good" mano.

Many pit houses had manos left in them but no metates. While it is possible that the metates were stored elsewhere or were used and left outside, it seems most probable that because metates were more expensive to make than manos they were more apt to have been removed upon abandonment or through subsequent scavenging.

Nonfood processing activities involved ground stone tools to shape and finish a variety of items. Abraders of various types shaped wood and bone items; most were grooved, some with more than one U-shaped groove. Groove widths range from 0.5 cm to 1.2 cm wide and could have straightened or smoothed spindles, arrows, flutes, or weaving tools. Mauls were employed in a variety of tasks to pound on wooden or stone surfaces, and to process clay. Pigments or small amounts of other substances were pulverized in pebble mortars. Polishing stones polished pottery and burnished plaster on floors and walls.

Grinding technology was also involved in the manufacture of bowls, balls, pipes, and tubes, for use in activities other than processing. The balls and pipes may have functioned in both secular and ritual activities. Similarly, bowls may have

served in rituals at times and as containers in mundane activities at other times.

Only a single axe was recovered from the pit house occupation at Crooked Ridge, and it was probably a Hohokam product. This axe has raised ridges bordering the 3/4 groove, which along with the wedge groove on the fourth side is a hafting technique common to Hohokam axes (Haury 1976:291). According to the trait lists developed for Mogollon culture, axes were not part of the Mogollon tool repertoire during the pit house occupation (Wheat 1955:207). Obviously, they were familiar with Hohokam axe technology.

There are several artifacts in addition to the axe that do not seem to be of local manufacture. A bowl, an incised tube, and a "medicine stone" (the medicine stone was not included in this analysis), all have been identified as Hohokam (Wheat 1954:138). The incised tube may have been an unsmoked pipe. The bowl had red pigment and might have been part of a nonfood processing activity. These possibly foreign artifacts were manufactured with a quality of craftsmanship not found in the locally manufactured items (Wheat 1954:138). Additionally, the material seems to be different than what is available locally; however, it would take a petrographic analysis to confirm this hypothesis. Wheat (1954:181) interprets the presence of these tools as an indication of trade. What is interesting is that they were all found on the floor of the same pit house (2), and nowhere else at the site were ground stone artifacts of Hohokam origin found.

The presence of these Hohokam tools on the floor of this pit house is intriguing. The pit house is of typical Mogollon design. Also on the floor were

two, free-standing, 3/4-trough metates. Nearby, there were Alma Plain pots. No Hohokam or Hohokam-style pots were found, nor were there any Hohokam designed, open-trough metates; nothing that would have been identified as Hohokam women's tools. The Hohokam-design items, axe, bowl, incised tube, and medicine stone are all small and easily transported. They also may have been tools more common to male use than female use. How did they come to this Mogollon home, and why were no other Hohokam ground stone artifacts found at Crooked Ridge? Were these items brought into this house by a Mogollon man who went to Hohokam country and traded for personal items, or are these the tools of a Hohokam man who came to reside in this house?

The 11 tools recovered from Pit house 8 give another opportunity for insight into the behavior of Crooked Ridge inhabitants. These tools were found together in a depression on the interior bench of the pit house. There is a variety of tools; Wheat (1954:117) calls them pestles and digging tools. All are long, pestle-like tools, but were manipulated with different motor habits. Three mallet-like tools had grips on the narrow, proximal ends. One was used like a two-handed plane. Two were digging tools, and the rest were either broken or had been used in multiple ways. The fact that they were stored together on the shelf of a pit house suggests that something binds them together. They might have been used by the pit house occupants to perform several tasks, been part of a specialist's tool kit, or part of the ritual leaving of the structure (see Walker, in press, for a discussion of ritual abandonment of structures). No other artifacts were associated with the use of this

structure.

Because there were no other examples of these types of tools found at the village, it is tempting to speculate that this was a specialist's tool kit. If this was a tool kit, it might have been involved in the construction of pit house superstructures. Two tools could have been used for digging the house pit, storage pits and post holes. The mallets could have split slats for wall construction and pounded the secondary beams into place (see Wheat 1954:65-69 for roof and wall reconstructions). Beams or slats could have been smoothed with the two-handed plane. If, for some reason, the specialist could not take the tools, they might have been left in the pit house as a sacrifice, with everything else removed from the house.

In summary, the analysis of ground stone tools from Crooked Ridge has identified technological traditions that were brought into the area from somewhere else. As early as A.D. 400-600, grinding technology was a part of all aspects of prehistoric life including subsistence, tool making, house building, and ritual. There was an established technological tradition of food grinding that utilized 3/4-trough, mano/metate equipment. Food grinding was mostly an individual chore. The two examples where two or three women could have ground simultaneously may represent teaching frames in operation as one woman taught a daughter how to grind, or may be a daughter-in-law came to grind at the house of a mother-in-law. Technological traditions are not as easily identified for other tool types. There was no tradition for axe production at Crooked Ridge, even though their wooden houses

required the felling of many trees and splitting of many planks. The presence of one Hohokam axe suggests that the Crooked Ridge inhabitants were familiar with axe technology; however, they may not have possessed the recipes for making them. Instead they imported axes and then took them when they left.

Stove Canyon Village

Both Stove Canyon (AZ W:9:10) and Lunt (AZ W:9:83) villages were excavated in the summer of 1960. James A. Neely participated in their excavation and wrote a dissertation (1974) reporting on the findings. The sites have both a pit house and a masonry component. The Stove Canyon phase, A.D. 600-900, was defined by the excavation of the pit house components and based on house types and the pottery found in the pit houses. Stove Canyon was a small pit house community evidently occupied slightly earlier than Lunt (Neely 1974:963). It is the farthest north and west of all the sites excavated by the field school and is located on a gently sloping hill that is part of the larger grassland park (Neely 1974:122). Stove Canyon has long been considered an unusual site by having ritual structures identified as belonging to different cultural groups; one a Hohokam ball court and the other a Mogollon great kiva.

Identifying the cultural affiliation and developing a culture history of the people living at Stove Canyon village was of primary importance to the Point of Pines Field School (Johnson 1961). Other research interests included the relationship between settlement patterns and the environment, pit house architecture, comparisons with other Mogollon sites, and analysis of ball court and great kiva

architecture (Neely 1974:xxxii). It was believed that there was a close relationship of some sort between what was identified as the Black River Branch of the Mogollon at Point of Pines and the Pine Lawn Branch in Reserve, New Mexico (Neely 1974:xxxii; Wheat 1954:181-182). The presence of a ball court was used to postulate a Hohokam presence in the area. However, does the presence of a ball court mean that people of differing cultural origins were living together in the Stove Canyon community? Or were the ritual structures and possibly the ritual behaviors of one group being exploited somehow by the local residents? Neely (1974:978) postulates the presence of a small resident Hohokam group because Pit houses 6 and 16 are similar to Hohokam houses built during the same period (Neely 1974:312).

Neely (1974) laments the fact that stone artifacts were often left in the field making it impossible to answer many of his questions. As much as possible, this analysis incorporates room notes, stone catalogue cards, catalogue cards, and the artifacts available for analysis to develop an understanding of grinding technology at Stove Canyon. The confidence value assigned to this site is 2 (Table 3.3). Even though the excavation and recording strategies were good, there were not enough floor assemblages to be able to make interpretations about the use contexts of most of the artifacts. A few floor assemblages were found, but according to the excavation records most of the rooms were cleaned out upon abandonment, or shortly thereafter. While the cleaning out of rooms gives us some information about prehistoric behavior, it does not provide much evidence about how the inhabitants used their ground stone artifacts.

Sixteen of seventeen pit houses were excavated along with parts of the ball court and great kiva. Four pit houses (1,4,7,15) are of particular interest for this analysis because they had trough metates (probably 3/4-trough) left in possible use positions. Pit house 4 had three metates, Pit house 7 had two, and the other two had a single metate. Four other pit houses had manos but no metates.

Of the 124 ground stone artifacts recorded from the pit house component, 110 (88.7%) were inventoried, and 14 (11.3%) are available for analysis. Eleven artifact types were identified and these types were sorted into activity categories; most (65.3%) were used in food processing activities (Table 6.2). A small but noticeable percentage (21.0%) was involved in more than one activity (Table 2.1). This is the largest percentage of secondarily used artifacts from any pit house village. The fill and floor assemblages from Stove Canyon are 84.0% similar, with a much greater variety of artifact types in the fill (n=11) than on the floor (n=4). Higher percentages of manos and metates were found on floors (85.0%) than in fill (63.0%) and higher percentages of everything else were in the fill.

Grinding Technology at Stove Canyon

The ground stone assemblage from Stove Canyon seems meager compared to that at most other sites. More than half (65.3%) of the assemblage was involved in processing food resources, but what is known about food processing tools is limited by their fragmentary nature. Four pit houses had metates in use positions, indicating that food grinding activities were conducted inside. As postulated for Crooked Ridge, the presence of more than one metate in two pit houses may represent the

TABLE 6.2
Artifacts from Stove Canyon Village

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Grind Slb*	3	10.3	2.4
	Handstn*	24	82.8	19.4
	Netherstn	2	6.9	1.6
	Subtotal	29	100.0	23.4
FOOD	Mano*	51	63.0	41.1
	Metate*	30	37.0	24.2
	Subtotal	81	100.0	65.3
NONFOOD	Abrader*	3	25.0	2.4
	Palette	2	16.7	1.6
	Plummet	1	8.3	.8
	Polish St*	6	50.0	4.8
	Subtotal	12	100.0	9.7
PROCUREMENT	Axe	1	100.0	.8
NONPROCESSING	Pipe/Tube	1	100.0	.8
	TOTAL	124		100.0

- * These categories include artifacts not available for analysis. Pertinent information was obtained from stone cards, room reports, and Neely (1974).

functioning of teaching frames where mothers were teaching daughters to grind or daughters-in-law were grinding for mothers-in-law. The metate locations were not suitable for one woman to have employed both in multiple stages of grinding. That manos but not metates were found in at least four other houses suggests that some metates were removed. It is always possible that manos were stored in some houses for use with metates located elsewhere.

The manufacturers of manos and metates designed equipment that was

troughed, and although trough configuration was not recorded for most, the few identified were all 3/4-trough. Most Stove Canyon manos (71%) had two opposite surfaces, suggesting that the grinders were concerned with managing mano wear and maintaining more than one surface compatible with the metates (Table 5.5).

The tools involved in nonfood processing activities indicate that pottery was manufactured at the site, some possibly with a stone anvil in the paddle-and-anvil technique. The pots were finished with pebble polishing stones. One palette may have been burned in a Hohokam-like ritual; the other was used to process a fine powder, possibly pigment.

The use of a small portion of the ground stone tool assemblage (23.4%) was ambiguous in that they could have been part of either food or nonfood processing activities.

What can be said about grinding technology at Stove Canyon is limited by the small size and fragmentary condition of the assemblage. The size of the assemblage was somewhat affected by the field school recovery strategy, but primarily it is a factor of prehistoric behavior. Either few tools were used at this village, most were removed upon abandonment, or the village sat open with artifacts available to scavengers. The fact that there were manos but no metates in some pit houses suggests that abandonment strategies or scavenging depleted the archaeological record at Stove Canyon.

No ground stone artifacts were found on the floors of the two pit houses thought to have been Hohokam, and only a metate fragment was found in the center

of the ball court. The only artifacts that suggest the presence of a Hohokam population are a probable pottery anvil and a Hohokam-like palette. The palette was destroyed by fire, possibly in a cremation ritual; however, no cremations were found at Stove Canyon (Merbs 1967). Thus, if Neely (1974) is correct about there being a resident Hohokam population, their tools were cleared out of their houses, leaving little evidence of their presence in the ground stone assemblage.

Lunt Village

Lunt village (AZ W:10:83) is near Stove Canyon (about an hour walking distance), on a small hill in a similar park-like setting (Neely 1974:224). Also like Stove Canyon village, Lunt has a pit house and a masonry component. However, occupation did not begin at Lunt until A.D. 800; 150 years after the initial occupation of Stove Canyon (Table 3.1). Fourteen pit houses were found and excavated. Neely (1974:229) estimates that 90 percent of the early component was excavated, so there may have been one or two unexcavated pit houses. Only three pit houses (1,4,10) had ground stone assemblages. Only Pit house 1 had a metate on the floor that might have been in a use position (Neely 1974:233). As with Stove Canyon, artifacts may have been removed from Lunt upon abandonment or shortly thereafter. Unlike Stove Canyon, some features at Lunt were identified as Hohokam.

The ground stone assemblage from Lunt is small (n=67), yet 15 artifact types are represented--five more than found in the larger Stove Canyon assemblage. Many artifact categories from Lunt have only one example. Perhaps Lunt villagers and

Stove Canyon villagers made the same artifact types; but those from Stove Canyon are under-represented in the archaeological record because of abandonment strategies or scavenging. The confidence rating given to the collection from Lunt is 2 (Table 3.3). While all of the known pit houses were excavated and the record keeping was adequate, there were good floor assemblages in only a few rooms.

Of the 67 artifacts recorded at Lunt, 43 (64.2%) were inventoried, and 24 (35.8%) are available for analysis. The types were sorted into activity categories with the largest percentage (49.2%) involved in food processing activities (Table 6.3). A small percentage (12.0%) of the ground stone artifacts was used in more than one activity (Table 2.1); this is the smallest from any Point of Pine's village. The fill and floor assemblages are 61.6 percent similar, with more variety in the fill (n=13) than on the floors (n=9). Manos and metates occur in only slightly higher percentages in floor assemblages (50.0%) than in fill (47.6%). An axe, a ball, a bowl, and a spindle base were found only in fill. The only abrader was found on the floor, which is opposite of the distribution at most villages; however, assemblage size is probably impacting these distributions more than prehistoric behavior.

Grinding Technology at Lunt

The ground stone assemblage only hints at the nature of the technological traditions at Lunt Village. The food processing assemblage is small, but it suggests that mano/metate equipment was primarily of trough design, probably all 3/4-trough. The use-wear damage patterns on one mano suggest that things oiler than corn or amaranth were processed (Adams, in press). Most manos (64.0%) have only one

TABLE 6.3

Artifacts from Lunt Village

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Grind Slb*	4	22.2	6.0
	Handstn*	11	61.1	16.4
	Netherstn*	3	16.7	4.5
	Subtotal	18	100.0	26.9
FOOD	Mano*	25	75.8	37.3
	Metate*	8	24.2	11.9
	Subtotal	33	100.0	49.3
NONFOOD	Abrader*	1	7.7	1.5
	Lapstone	2	15.4	3.0
	Maul	1	7.7	1.5
	Palette	3	23.1	4.5
	Plummet	1	7.7	1.5
	Polish Stn	4	30.8	6.0
	Spindle Bs	1	7.7	1.5
	Subtotal	13	100.1	19.4
PROCUREMENT	Axe	1	100.0	1.5
NONPROCESSING	Ball	1	50.0	1.5
	Bowl	1	50.0	1.5
	Subtotal	2	100.0	3.0
	TOTAL	67		100.0

- * These categories include artifacts not available for analysis. Pertinent information was obtained from stone cards, room reports, and Neely (1974).

surface suggesting that the grinders had little concern for managing wear or maintaining more than one surface compatible with the metate (Table 5.5). Besides food processing, ground stone artifacts were involved in many other activities. The spindle base suggests that there was spinning, and possibly weaving. A ball and three broken palettes may have been part of both secular and religious aspects of village life. Pigments may have been processed on palettes, but burning on one suggests a possible participation in Hohokam-like mortuary rituals; although no cremations were found at Lunt (Merbs 1967). These broken palettes and a bowl fragment are the only ground stone artifacts that suggest a connection with Hohokam.

The assemblage from Lunt is small. The assumption is that the recovered artifacts were not all that were used during the occupation of the village. There probably were axes (an axe fragment was found), metates, and other artifacts removed from the village. If the inhabitants of Lunt moved to another, nearby village they would have taken tools with them, or returned at their leisure to retrieve tools.

Nantack Village

Nantack village (AZ W:10:111) was excavated by the field school during the summers of 1954 and 1955 (Haury 1989). Daniel Scheams supervised the project in 1954; David A. Breternitz took over in 1955 and wrote the descriptive report (Breternitz 1959). The village has both a pit house component and a masonry component. The pit house component was of particular interest to the field school

as it would provide information for a time period about which little was known. Based on pottery and house types, the Nantack phase was defined and dated to A.D. 900-1000.

Nantack Village is located approximately one mile south of Point of Pines in a modern stand of trees. The sediments accumulated in the pit houses provide a perfect medium for the growth of Western Yellow Pine, Alligator juniper, and Live oak. Nine pit structures were completely excavated and two were test-excavated; one is a Great Kiva and another a possible ceremonial structure. The rest are domestic structures. The confidence rating assigned to this collection is 1 (Table 3.3), because all of the site was excavated, there were good floor assemblages, and the record keeping was good.

Only the artifacts from the pit house component are considered in this analysis of grinding technology. Fifty-three artifacts (34.2%) are available for analysis, but when information was incorporated from the stone cards, room records, and published reports (Breternitz 1959), 155 artifacts were classified into 17 types (Appendix A, Table 1). The largest percentage (47.7%) were involved in food processing activities (Table 6.4). Fifteen percent were used in more than one activity (Table 2.1). The fill and floor assemblages are 50.0 percent similar with much more variety in the fill ($n=15$) than on floors ($n=6$). Manos and metates are a higher percentage of the floor assemblage (81.0%) than the fill (31.2%) and abraders and handstones are a higher percentage of the fill (31.2%) assemblage than the floor (12.1%).

TABLE 6.4

Artifacts from Nantack Village

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Grind Slb*	1	2.3	.6
	Handstn*	39	88.6	25.2
	Netherstn	1	2.3	.6
	Pestle*	3	6.8	1.9
	Subtotal	44	100.0	28.4
FOOD	Mano*	53	71.6	44.2
	Metate*	21	28.4	13.5
	Subtotal	74	100.0	47.7
NONFOOD	Abrader*	5	17.9	3.2
	Lapstn	2	7.1	1.3
	Maul	4	14.3	2.6
	Mortar	4	14.3	2.6
	Palette	3	10.7	1.9
	Polish St*	8	28.6	5.2
	Spindle Bs	2	7.1	1.3
	Subtotal	28	100.0	18.1
PROCUREMENT	Axe*	3	100.0	1.9
NONPROCESSING	Ball	4	66.7	2.6
	Bowl	1	16.7	.6
	Cap	1	16.7	.6
	Subtotal	6	100.1	3.9
	TOTAL	155		100.0

- * These categories include artifacts not available for analysis. Pertinent information was obtained from stone cards, room reports, and Breternitz (1959).

Seven pit houses (1,3,5,6,7,8,10) and the great kiva are of particular interest for this analysis because of the ground stone assemblages on their floors or in pits. Three pit houses (1,2,5) had multiple metates, some of which may have been propped for use; the rest had metates in storage positions or in pits.

Grinding Technology at Nantack

While one or two basin and flat metates were found, most metates (85.7%) were designed with 3/4 troughs (Table 5.4); most manos (62.3%) have a single surface (Table 5.5). A few grinders flipped their manos to create two opposing surfaces, and one rotated the mano to create two adjoining surfaces, allowing her to continue with a thinning mano.

Several nonfood processing tools have been identified (Table 6.4). While no grooved abraders were found at Nantack, spindle bases were, suggesting that spindles were shaped with some other tool, possibly one of several flat abraders. The only flat abrader available for analysis had been used to shape a pliable, probably wooden surface. Polishing stones polished pottery more than anything else; one is a large handstone that was worked against a hard, smooth surface.

Two axes were found in fill deposits, both are sharp enough to be usable, and have abrasive damage on their bit edges to suggest they were used for felling trees. One is more damaged with several chips removed. The more damaged axe is also more massive (1942 grams) than the axe damaged only by abrasion (451 grams) and may have been used in felling larger trees with a more forceful motion than the smaller axe. Both axes are of a design common to the Hohokam at about the same

time period (Haury 1976:291; adjusting the chronology according to Dean [1991:91]). Their Hohokam-like design and the fact that no tools were identified at Nantack that could have been used in their manufacture may mean they were traded into the Point of Pines area.

Balls found at Nantack may have served in either mundane or more ritual activities; palettes also suggest a ritualized aspect to life at Nantack. Palettes were either imported from Hohokam localities or locally manufactured in imitation of Hohokam palettes, possibly for use in rituals borrowed from Hohokam. If this in fact occurred, it was not a widespread borrowing, with two Hohokam palette fragments (Breternitz 1959:42) and one whole, possibly imitation Hohokam palette. With no cremations found at Nantack (Merbs 1967), there may not have been a ritual use for this palette and the palette fragments may have been imported already broken.

The grinding technology at Nantack provides evidence for a variety of daily activities. Most tools were designed to function in specific activities. Although there were a few pit houses with good floor assemblages, it is difficult to know all that was taken when the village was abandoned. For example, the frequency of axes and grooved abraders is probably not adequately represented by what was left at Nantack.

Summary

Haury (1989:116) suggested that with the Nantack phase, pure Mogollon occupation of the highlands ends. After A.D. 1000 there is an influx of new ideas,

and possibly people, that changes the local life-style enough to be considered a new ethnic or cultural group, called Western Pueblo by some archaeologists (Johnson 1965:14; Lowell 1991:16; Reed 1950:120-138). In order to assess Haury's interpretation it would be useful to summarize what is known about the state of grinding technology based on evidence from the pit house villages: Crooked Ridge, Stove Canyon, Lunt, and Nantack. This evidence forms a baseline of technological traditions against which the evidence from later pueblo assemblages can be compared.

Food grinding was accomplished primarily with mano/metate equipment. Mortars and pestles may have been used occasionally at Crooked Ridge, but there is little evidence of them at other pit house villages. Basin mano/metate equipment may have occurred at each village, but clearly the preferred design was 3/4 trough. Some 3/4-trough metates were designed with a mano rest or shelf on the closed end. The abundance of manos and metates and the paucity of mortars and pestles may or may not be indicative of what was being ground. Others have suggested that mortars and pestles, and probably basin mano/metate equipment ground wild resources, and trough mano/metate equipment ground agricultural resources (Bartlett 1933:27-29; Hard 1990:135-149; Martin 1972:56-57; Mauldin 1993:317-330; Plog 1974:141). At Lunt, the use-wear damage patterns on a trough mano indicates it ground an oily substance, possibly oily seeds, such as sunflower seeds or pinon nuts (Adams, in press). If more manos had been available for analysis it might have been possible to find others similarly damaged. For now, it is presumed that both

domesticated and wild foods were processed on the same equipment.

Metates and associated manos were found on pit house floors at all four villages. Some metates were clearly propped for grinding, others were stored near or against walls, or against posts. Four pit houses, two at Crooked Ridge and two at Stove Canyon, had multiple propped metates. Manos without associated metates were found on floors in a few houses. This may have been the result of differing abandonment strategies, or subsequent scavenging activities.

Some grinders managed wear on their manos by flipping them to maintain two surfaces compatible with the metate. Such management might have delayed the need for resharpening the surface, and prolonged the mano's use-life. Food grinding technology appears to have changed very little during the 600 or so years of pit house occupation in the Point of Pines area. This conservative technological tradition was probably maintained through teaching frames that passed along recipes for action varying little from one grinder to the next.

There is more variation in the technological traditions associated with nonfood processing activities. For example, grooved abraders were found only at Crooked Ridge. Could it be that Crooked Ridge had an abrader tradition that was unknown at the other villages? Spindle bases occurred at Lunt and Nantack villages suggesting that spindles were used, so if grooved abraders were not part of the technological knowledge of these villagers how were the spindles shaped? The apparent lack of grooved abrader technology at the other villages may be a factor of abandonment or scavenging strategies.

Whole axes were found at Crooked Ridge and at Nantack, while only broken bits were found at Stove Canyon and Lunt. The axe found at Crooked Ridge was undoubtedly of Hohokam origin; those from Nantack might have been Hohokam. Even if the axes were manufactured at Nantack, the technological knowledge probably originated with the Hohokam. Axe fragments were found at Stove Canyon and Lunt, suggesting that along with many other artifact types, they were removed upon abandonment or shortly thereafter. It has been asserted that the Mogollon did not use hafted axes (Wheat 1950:207). I suggest that axe technology was known among the Point of Pines Mogollon, and if they did not make their own axes, they at least acquired them from the Hohokam. Such traded items might have been so valued that they were taken upon abandonment of a village, leaving little evidence in the archaeological record.

Pebble mortars have a similar site distribution as the whole axes. No pebble mortars were found at Stove Canyon or Lunt. These mortars may have been worked with small wooden pestles to crush and mix small amounts of some substance, probably pigments. The distribution of pebble mortars may be accounted for by the abandonment or scavenging strategies mentioned previously for other artifact types. It seems strange that a technology employed at both earlier and later villages would not have been at either Stove Canyon or Lunt.

The pigments processed with pebble mortars may have painted pottery, among other things, and the presence of pottery-polishing stones at all four villages provides additional evidence that pottery production was an activity for which grinding

technology supplied raw material and tools. One handstone at Stove Canyon might have been an anvil for the production of pottery, but if it was, either some Mogollon pottery was made using paddle-and-anvil techniques, or a Hohokam potter was present.

A noticeable percentage of tools from all pit house villages was involved in more than one activity (from 12% to 21%), most were used sequentially. Tools designed for one purpose were reused, redesigned, or recycled, and possibly scavenged from abandoned rooms, trash deposits, or selected from tools stored for future use.

Some ground stone artifacts provide additional evidence that the Hohokam were occasional residents. At Crooked Ridge the presence of several Hohokam artifacts suggests an unusual connection between this household and the Hohokam; either a trade relationship or the presence of a Hohokam individual. At Stove Canyon, there are no ground stone tools as evidence of Hohokam residents, but there is architectural evidence that cannot be ignored. The fact that the Hohokam structures contained no artifacts suggests that they were abandoned, possibly before the rest of the village, and either their tools went with them or they were scavenged by those who remained. Bits of Hohokam palettes were found at Stove Canyon, Lunt, and Nantack and a whole palette found at Nantack is a possible local imitation of a Hohokam palette. The Hohokam palette fragments may have been all that remained of mortuary rituals conducted at the villages; however, no cremated human remains were found at any of the pit house villages (Robinson and Sprague

1965:444). It is intriguing that stone bowls recovered from Crooked Ridge, Lunt, and Nantack were probably Hohokam in origin. A few locally manufactured bowls were recovered, but they are not as well crafted, or embellished.

In summary, between A.D. 400-1000, the Mogollon utilized grinding technology in a wide variety of activities. In some respects their grinding traditions can be considered conservative, especially their food grinding traditions. This conservativeness is manifest in tool design, equipment set-up, and activity location, all of which remained unchanged for centuries. There was a preferred 3/4-trough design, a preferred arrangement of free-standing equipment with metates tilted so that the open end was down, and a preference for grinding inside pit houses.

Some technology was borrowed from the Hohokam. The presence of Hohokam designed tools (axes, bowls, palettes) suggests either that Hohokam residents were present and manufacturing items within their own technological tradition, or that exchange with Hohokam brought in foreign technology. Alternative designs and manufacturing techniques could have been learned and applied by the Mogollon or ignored. For the most part, during the pit house occupation at least, Hohokam technology was ignored, especially in food processing activities.

CHAPTER 7

GRINDING TECHNOLOGY AT THE PUEBLO VILLAGES

The ground stone artifacts from four pueblo villages; Pueblo AZ W:10:37, Turkey Creek pueblo, Pueblo AZ W:10:50, and Pueblo AZ W:10:51 were involved in this analysis. The Point of Pines pueblo, AZ W:10:50, had three components: (1) the Maverick Mountain occupation; (2) the Canyon Creek phase occupation; and (3) AZ W:10:50B, a small pueblo rebuilt during the Point of Pines phase within the ruins of the older Point of Pines pueblo. The artifacts from these phases at AZ W:10:50 and the other three pueblos listed above are important to the discussion of the development of grinding technology. The sites and site components were dated by the same relative techniques of structure and pottery type seriation and cross dating as used with the pit house villages; however, the Maverick Mountain occupation was well dated by tree-rings (Haury 1989:117). A summary of grinding technology from each pueblo follows; more detailed descriptions of artifact types are in Appendix A.

Pueblo AZ W:10:37

The pueblo designated AZ W:10:37 is approximately one-third mile southwest of Point of Pines. It is located on a low ridge in an open ponderosa pine forest (Olson 1959:5). In 1952 the field school began excavations at this site to better understand the time when the first pueblos were built. Alan P. Olson supervised the excavation and wrote up the results as his dissertation (Olson 1959). Twenty-one, single-story rooms and five kivas were excavated and thought to have been about

half of the existing rooms with the possibility of one more kiva (Olson 1959:21). The confidence rating assigned AZ W:10:37 is 2 (Table 3.3). While a sizable percentage of the site was excavated (39.6%), and there were good floor assemblages, the record keeping was incomplete, and it is unclear whether the floor artifacts were a result of trash deposition or prehistoric behavior.

Construction of the pueblo probably began in the north end and grew south (Olson 1959:71-79). During the early part of the occupation the kivas were more-or-less circular, subterranean structures located some distance from the masonry rooms. As the pueblo grew these kivas were abandoned and rooms were constructed over them. New construction incorporated kivas into the masonry room block.

This pueblo is the earliest above-ground, masonry construction in the Point of Pines area, occupied during the late Reserve, early Tularosa phases, probably between A.D. 1100 and 1200. It is quite obvious that the architecture is different from earlier pit house architecture, but were the artifacts involved in daily activities also different? The artifacts from this early pueblo provide an opportunity to assess the pueblification of the indigenous Mogollon.

Of the 345 artifacts included in this analysis, 273 (79.1%) were inventoried and 72 (20.9%) were analyzed (Appendix A, Table 1). Artifact descriptions provided by Olson (1959) and information from stone cards and room records supplement the inventoried artifacts. Olson's classifications, however, are different than those used here--making comparisons difficult.

Sixteen artifact types from AZ W:10:37 are incorporated into the discussion of

grinding technology. Artifact types were sorted into activity categories with the largest percentage (38.3%) involved in food processing (Table 7.1). This is a lower percentage than at any pit house village (47.7% at Nantack, the lowest of any pit house village). Twenty-four percent of the assemblage was used in more than one activity (Table 2.1). The fill and floor assemblages are 90.8 percent similar with more variety in the fill (n=15) than on floors (n=11). Higher percentages of every artifact type were found in the fill than on floors. Several rooms are of interest to this analysis because they had ground stone assemblages on the floors (rooms 2,3,5,7,10, and kivas 1,3). It is unclear, however, how many had metates in use or storage positions.

Grinding Technology at AZ W:10:37

As the earliest pueblo in the area, AZ W:10:37 is important for understanding the effects of pueblofication on daily life. In contrast to the radical change in architectural style, there were only minor design changes in some ground stone tools. These changes, however, reflect interesting technological and sociological choices made by the inhabitants. For example, while a few grinders may have continued to use 3/4-trough mano/metate equipment, most began to use metates designed with open-troughs. The location of food grinding was not altered, as free-standing, open-trough metates were found in habitation rooms, near hearths, much as they were in pit houses. Thus, within the framework of the food grinding tradition there was only a change in equipment design.

TABLE 7.1

Artifacts from Pueblo AZ W:10:37

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Grind Slb*	3	2.6	.9
	Handstn*	98	85.9	28.4
	Mortar*	8	7.0	2.3
	Netherstn*	1	.9	.3
	Pestle*	4	3.5	1.2
	Subtotal	114	99.9	33.0
FOOD	Mano*	115	87.1	33.3
	Metate*	16	12.1	4.6
	Mortar	1	.8	.3
	Subtotal	132	100.0	38.3
NONFOOD	Abrader*	31	44.3	9.0
	Disk	2	2.9	.6
	Maul*	10	14.3	2.9
	Mortar*	2	2.9	.6
	Palette*	1	1.4	.3
	Plummet	1	1.4	.3
	Polish st	23	32.9	6.7
	Subtotal	70	100.1	20.3
PROCUREMENT	Axe*	21	100.0	6.1
CONSTRUCTION	Pestle*	2	40.0	.6
	Polish St*	3	60.0	.9
	Subtotal	5	100.0	1.4
NONPROCESSING	Ball*	1	33.3	.3
	Bowl	2	66.7	.6
	Subtotal	3	100.0	.9
	TOTAL	345		100.0

- * These categories include artifacts not available for analysis. Pertinent information was obtained from stone cards, room reports, and Olson (1959).

This new design was not a local innovation. Open-trough metates were a part of food grinding traditions during the same time period, if not earlier, at eastern Mogollon villages (Martin and Rinaldo 1950a:452; 1950b:304; Martin et al. 1949:136; Wheat 1955:115), at Mimbres villages (Lancaster 1984:fig. 17.4), and at Hohokam villages (Haury 1976:281). The technological knowledge needed to make open-trough metates could have come to the Point of Pines area in one or more of several ways: (1) Point of Pines residents traveled to other areas, acquiring tools or knowledge of how to make them; (2) Traders brought in tools or knowledge; (3) Immigrants settled in the Point of Pines area and taught their designs to the local residents; or (4) Women who married in from an area where the open-trough design was common. A few traditional, 3/4-trough metates were found at AZ W:10:37, possibly the remnants of an abandoned design, or the tools of women who refused to give up the traditional design.

One food processing tool may be the result of a local innovation. A mortar was designed with a notch and probably worked with a wooden pestle to extract liquids from an unidentified food product. The notch would have facilitated pouring the liquid from the mortar basin. No other, similarly designed stone tool has been identified from Point of Pines. Such an innovation may have been needed for processing a new food resource, or wooden or pottery vessels may have normally served in the extraction process and this tool was an experiment in alternative materials.

Nonfood processing traditions also have minor but interesting developments.

Abraders had always served in a variety of tasks, including shaping shell or soft stone, and making wooden shafts. New developments involved the designing of tools useful in more than one way. These tools were either used in more than one activity, or in an activity with multiple processing stages. For example, some abraders with U-shaped grooves on one side are handstones or polishing stones on the opposite side. Abrader/polishing stones were probably involved in different activities; while abrader/handstones may have been used in different stages of processing in the same activity. The abrader may have been for shaping shafts and the handstone for grinding pigment to color the shafts.

Other developments in polishing technology were perhaps related to the production of axes with the advent of a faceted polishing stone. Use-wear damage patterns on the faceted polishing stones are similar to those on experimental stones used to polish other stones (Adams 1994:119). Faceted polishing stones may have been used in the final stages of axe production. If these were so used, they are the first evidence of axe production in the Point of Pines area. The few axes from pit house villages were Hohokam-like and may have been imports. The two from Nantack were of identical design to those from AZ W:10:37, but no possible manufacturing tools were found at Nantack. Perhaps the presence of axe manufacturing tools as AZ W:10:37 is a result of the acquisition of Hohokam technological knowledge.

Axe technology shows some other developments in hafting techniques, as well. For the first time, some axes (n=2) are designed with full grooves. These full-

grooved axes, or the technological knowledge needed for their manufacture, may have originated somewhere other than with the Hohokam, or the Point of Pines Mogollon; this is discussed in more detail in the next section on Turkey Creek pueblo.

Unlike the pit house assemblages, no artifacts from AZ W:10:37 resemble Hohokam artifacts. The only palette found at AZ W:10:37 was probably locally produced. The trend at this time seems to be the continuation of the baseline traditions that were brought into the area by the pit house occupation Mogollones, with the addition of a new metate design and the knowledge of how to make axes. Alternatively, a few puebloan foreigners may have been in residence, sharing their knowledge about architecture and making tools within their own technological tradition.

Turkey Creek Pueblo

Turkey Creek pueblo (AZ W:9:123) is located three miles northwest of Point of Pines, on the edge of Circle Prairie where the trees become sparse and the grassland begins. The pueblo was constructed to be one story with 335 rooms eventually occupied. Three small kivas, one great kiva, and two plazas stand out in the site plan. The small pit house component identified below the pueblo is not considered in this analysis.

The field school conducted work at Turkey Creek during the summers of 1958, 1959, and 1960. Almost the entire pueblo was excavated during the first two

summers and trash mounds were trenched during the third (Lowell 1991:9). The excavation of the rooms was supervised by Alfred E. Johnson, and he wrote a summary of the site for his dissertation (1965); twenty-five years later Julie Lowell (1991) wrote her dissertation on Turkey Creek households.

The earliest occupation probably began in the northwest part of Turkey Creek pueblo (Lowell 1991:32). Various clusters of rooms were constructed over time, eventually filling in space and moving so that the most recently constructed rooms were to the southeast. For this analysis Turkey Creek will be considered a single-component site occupied during the Tularosa phase, between A.D. 1225 and 1290.

This large pueblo was excavated by the field school to gain an overall understanding of the architecture. Recovery of artifacts was not a high priority. Artifact summaries were made in the field and examples of artifacts were removed for storage at ASM. Thus, what is known about some categories of artifacts, such as manos and metates, is based on summary information. Other artifact categories, such as axes, are well represented in ASM collections and are available for analysis. The confidence rating assigned the collection from Turkey Creek is 3 (Table 3.3). While most of the site was excavated (92.8%), floor artifacts and floor assemblages were few.

The excavators of Turkey Creek postulated that the pueblo was abandoned, and most of the artifacts and some of the building stone removed to other, nearby villages--particularly the Point of Pines pueblo. While this may indeed have happened, it will be difficult to evaluate the possibility using the ground stone

assemblage. Records for some artifacts do not exist if the photographs showing rows of stacked manos and metates are indications of the numbers recovered (Figures 5.4, 7.1). Thus, the low occurrence of floor assemblages may be related to prehistoric behavior, or to poor record keeping.

Of the 578 artifacts for which there is information, 443 (77%) are available for analysis (Appendix A, Table 1). Twenty-one artifact types are incorporated into the discussion of grinding technology from Turkey Creek pueblo. The largest percentage (35.5%) were used in nonfood processing activities (Table 7.2). Some (25.0%) tools were involved in more than one activity (Table 2.1); most could have been used concomitantly. The fill and floor assemblages are 70.2 percent similar with more variety in the fill (n=19) than on the floors (n=16). Manos and metates are a higher percentage of the floor assemblage (21.6%) than the fill (4.5%); abraders and axes are a higher percentage of the fill (46.1%) than the floor assemblage (28.1%).

Five rooms at this pueblo are of particular interest for this analysis because they contain mealing receptacles. Descriptions of only three rooms (6,65,256) are available. A receptacle is formed by clay ridges that serve to confine ground meal around the metate. The single receptacle in Room 65 has a slab placed behind the proximal end of an open-trough metate, which sits at an unknown angle. The metates were missing from the two receptacles in Room 256 and the three receptacles in Room 6. An excavation photograph shows a flat metate and an open-trough metate restored to use positions in adjacent receptacles in Room 256

Figure 7.1. Field photograph of manos recovered from Room 123, Turkey Creek pueblo.

TABLE 7.2
Artifacts from Turkey Creek

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Handstn	14	40.0	2.4
	Mortar	5	14.3	.9
	Netherstn	9	25.7	1.6
	Pestle*	7	20.0	1.2
	Subtotal	35	100.0	6.1
FOOD	Mano *	32	22.8	5.5
	Metate *	103	73.6	17.8
	Mortar	1	.7	.2
	Netherstn	4	2.9	.7
	Subtotal	140	100.0	24.2
NONFOOD	Abrader	86	42.0	14.9
	Disk	8	3.9	1.4
	Lapstn	9	4.4	1.6
	Maul	17	8.3	2.9
	Mortar	49	23.9	8.5
	Palette	13	6.3	2.2
	Plummet*	8	3.9	1.4
	Polish Stn	15	7.3	2.6
	Subtotal	205	100.0	35.5
PROCUREMENT	Axe	122	97.6	21.1
	Hearth	3	2.4	.5
	Subtotal	125	100.0	21.6
CONSTRUCTION	Polish Stn	1	100.0	.2
NONPROCESSING	Ball	4	5.6	.7
	Bowl*	35	48.6	6.1
	Pipe/Tube	2	2.8	.3
	Plug/Cap	23	31.9	4.0
	Subtotal	72	100.0	12.5
	TOTAL	578		100.1

- * These categories include artifacts not available for analysis. Pertinent information was obtained from stone cards, room reports, and Johnson (1965).

(Figure 5.5). It is unclear if these metates were found in this room and might have been the ones removed prehistorically; if so, then food grinders at Turkey Creek worked both flat and open-trough metates interchangeably. The presence of receptacles at Turkey Creek may be more evidence that knowledge about food grinding traditions came from the eastern Mogollon. Similar grinding receptacles were found in eastern Mogollon villages dated to about the same time, or perhaps even earlier (Martin et al. 1956:38, 1957:24-25).

Grinding Technology at Turkey Creek

Even though the information from Turkey Creek pueblo is incomplete, it is possible to put together a picture of food grinding technology. Most of the food grinding was done with individual, free-standing, open-trough mano/metate equipment, the same strategy employed by grinders living in the pit house villages, except for a change in metate design from 3/4-trough. A few grinders at Turkey Creek pueblo used mealing receptacles; two sets of multiple receptacles were positioned so that more than one grinder could work at a time. Some manos were designed with finger grips; a feature that would make them easier to hold during long grinding sessions. The presence of a few permanent, multiple grinding features, the predominance of open-trough metates, and strategically designed manos (those with finger grips) suggest a change in food grinding strategy (Adams 1993:341). The change may have been to a strategy that employed more efficient tools, but also required more intense tool-use during longer grinding sessions. Instead of grinding alone during these longer grinding session, a few women may

have chosen to work together. Most women, however, continued to grind with individual, free-standing mano/metate equipment.

The relative efficiency of various metate designs is discussed in Chapter 5 (Ground Stone Artifacts). In essence, open-trough mano/ metate equipment was more efficient and allowed a woman to produce more meal in the same amount of time as with 3/4 trough equipment. The presence of tools designed for more efficient use at Turkey Creek suggests that social changes in the production of ground food resources were occurring. The women who lived in this pueblo may have been required to produce more ground food per unit of time than the women who inhabited the earlier pit house villages (Crooked Ridge, Stove Canyon, Lunt, Nantack), or even the earliest pueblo village (AZ W:10:37). This may have been necessary to feed an expanding population, or to increase the amount of ground food in a stable population. Alternatively, fewer grinders may have been needed to feed the same number of people a constant amount of ground food.

While open-trough metates became the most common design at Turkey Creek pueblo, the 3/4-trough design employed throughout the pit house occupation continued. There is no information recorded about 3/4 trough metates at Turkey Creek pueblo (Table 5.4); however, a field photograph (Figure 5.4) shows that some were found. Some grinders may have preferred the traditional 3/4-trough design.

Other tools were identified that might have been involved in processing food at Turkey Creek, including one mortar and several netherstones possibly used for extracting liquids from juicy or pulpy foods. These tools had spouts or holes that

would have served to drain liquids. The mortar also had a handle useful for pouring.

Tool designs first noted in the AZ W:10:37 assemblage continued in use at Turkey Creek. For example, several abraders with U-shaped grooves were also handstones, lapstones, or polishing stones. The grooves on Turkey Creek abraders have a greater width range (0.3 cm to 3.5 cm) than those from any other village (Table 5.7). Some are wide enough to have shaped axe handles or digging sticks, but most are of a size useful for spindles, weaving tools, prayer sticks, or flutes.

New tool designs were developed at Turkey Creek, such as a faceted abrader, similar in design to the faceted polishing stones in the AZ W:10:37 assemblage. The use-wear damage patterns on the abraders are similar to those on the faceted polishing stones; the difference is in the texture of the lithic material. The abraders, being rougher, may have been part of an earlier stage of manufacture than the polishing stones, which would have put on the finish. Both faceted tool types may have been used in axe manufacture or maintenance.

The "doughnut stone" may be another tool associated with axe production, possibly having been used in the manufacture of axe handles (see Disks, Chapter 5). Doughnut stones have been identified in the Hohokam area, but they have not previously been viewed as associated with axe production. Both the faceted abraders mentioned previously and doughnut stones show up in the archaeological record at Point of Pines at the same time. I propose that this co-occurrence is related to the local production of axes using a technology borrowed from the

Hohokam.

Axe technology provides some interesting evidence about coexisting technological traditions. Axes found at Turkey Creek were hafted with two different hafting designs: 3/4 groove and full groove. These designs are from technological traditions that originated with different cultural groups. The 3/4-groove axe was a design common to a Hohokam tradition and was probably acquired by craftsman living at AZ W:10:37. The full-groove axe, part of an Anasazi tradition, was also first found among the axes from AZ W:10:37 (Table 5.8). The manufacturers of these two different designs maintained their differences even to the point of changing the groove configuration on existing tools. For example, six axes from Turkey Creek pueblo were originally manufactured with 3/4 grooves and regrooved with full grooves (Table 5.9). This suggests that the practitioners of the full-groove axe tradition were in the pueblo, scavenging or being given tools made in the local tradition and redesigning them according to their own tradition. The seventeen full-grooved axes found at Turkey Creek (Table 5.8) appear to be of local material, although, only a petrographic analysis could determine this for certain.

The presence of full-groove axes may not mean there were Anasazi living in the pueblo. Full-grooved axes, and open-trough metates were recovered from eastern Mogollon villages that were perhaps contemporary with or slightly earlier than AZ W:10:37 and Turkey Creek (Martin et al. 1949:138; Martin and Rinaldo 1950a:451; 1950b:305). Full-groove axes and open-trough metates may have been introduced into the Point of Pines area by eastern Mogollon.

Palettes found at Turkey Creek seem different than the palettes found in earlier contexts. While they have either raised borders or borders indicated by an encircling line similar to Hohokam palettes, they appear to be more imitation than the real thing. These locally produced palettes have more use-wear on them than earlier palettes and may not have been part of mortuary rituals. Petrographic analyses should be conducted to determine the source of the lithic material.

Caps, plugs, bowls, and mortars were more frequently used at Turkey Creek than at other Point of Pines villages (Appendix A, Table 1). More than half (65.4%) of the 55 mortars at Turkey Creek had been designed for concomitant use in a second activity. Seventeen mortars designed in handstones had pigment in the basins to suggest their involvement in the production or application of paint. Two of the 35 bowls are embellished; one with pecked dimples, the other with nested Vs encircling the outside. One plain bowl must have been a container for the yellow pigment remnant in the interstices of the stone. The caps (n=8) and plugs (n=23) have been shaped by grinding, but there is little other evidence to suggest how they were used. Appendix A provides more detailed descriptions of all the artifacts analyzed from Turkey Creek.

Turkey Creek is viewed as a Point of Pines' example of population aggregation which was occurring all over the Southwest (Lowell 1991:62-63). The coming together of different people is evident through increased village size and variation in pottery types. The ground stone assemblage, as well, reflects this aggregation. New types of ground stone tools were designed and manufactured,

with different technological designs coexisting both in food processing activities and in procurement activities.

AZ W:10:50, Maverick Mountain Occupation

Point of Pines pueblo (AZ W:10:50) is the largest pueblo in the area, with more than 800 ground-floor rooms, two plazas, and a great kiva (Haury 1989:117). The site was occupied from A.D. 1150 to 1450, with several components dating from the Tularosa, Pinedale, Canyon Creek, and Point of Pines phases (Lindsay 1987:191). A time of rapid expansion began in the late 1200s; at the end of the 1300s, however, some of the pueblo's inhabitants began moving away. Those who stayed behind built new units around and over the old pueblo (AZ W:10:50A,C; AZ W:10:51; AZ W:10:47) or remodeled existing rooms (AZ W:10:50B).

The field school began work at the Point of Pines pueblo in 1947, and continued there until the final year in 1960. In the south-central part of the large pueblo is a group of 70 rooms, some of which were discovered to have been destroyed by fire. These burned rooms were the focus of the field school beginning in 1950 and continuing into 1952. The prehistoric people who occupied this part of the large pueblo were decidedly different from the rest of the occupants, and it has been postulated that 50 or 60 Anasazi families migrated to Point of Pines (Haury 1958:421, 1986:416; Lindsay 1987:193 speculates 60 to 100 people). A model for the immigration of these Anasazi has been described by Lindsay (1987:190-198).

Lindsay (1987:193-194), building on Haury's hypothesis of migration, postulates that a group of Tusayan Anasazi joined the local population at the Point

of Pines pueblo around A.D. 1265 and occupied a portion of the pueblo for approximately 20 years until the rooms were destroyed by fire (Haury 1958:421). Haury (1958:421) suggests the fire was set by hostile neighbors who knew the store rooms were full from recent harvests. After the fire, the Anasazi either immediately moved on, or they became invisible archaeologically if they remained in the Point of Pines pueblo. The evidence considered so far, mainly pottery, is inconclusive.

Twenty-eight of the Maverick Mountain rooms (50-52,61,62,64-73,78,81,84-87,89,90,95,96,98,99,110) were selected for the analysis of grinding technology. These rooms were chosen because they had floor assemblages, and because most had evidence of being reoccupied after the fire. The lower floors were those occupied by Maverick Mountain people, and the upper floors by either Maverick Mountain or indigenous Point of Pines people who reoccupied the rooms.

Most of the rooms thought to have been occupied by Maverick Mountain people were excavated, and good floor assemblages were found. The excavators of these rooms noted evidence for a hot fire that was probably intentionally set, and that the reoccupants scavenged a few artifacts from the burned deposits. Many stored goods contributed to the hot quick fire that ripped through the pueblo, including corn, textiles, mats, as well as the roofing material (Lindsay 1987:194). This archaeological context might reflect one of three prehistoric behaviors: (1) the rooms were destroyed by Point of Pines people who wanted to remove the Maverick Mountain people from their pueblo; (2) departing Maverick Mountain people burned their own rooms to prevent others from using them or their contents; or (3) the

burning was accidental. The fact that some of the burned rooms were reoccupied and their contents scavenged suggests that Maverick Mountain people reoccupied rooms from which they knew items could be retrieved (Lindsay 1987:195). The confidence rating assigned to this collection is 1 (Table 3.3). Most of the rooms had good floor assemblages, a large number of artifacts available for analysis and the record keeping is good.

The 223 artifacts from the Maverick Mountain occupation were classified into 16 types (Appendix A, Table 1). Most (68.6%) are known only through stone catalogue cards or room records. The artifact types were sorted into activity categories with most (52.9%) involved in food processing activities (Table 7.3). A use-wear analysis using a microscope was conducted on those artifacts housed at the ASM. This analysis aided not only type identification but also the identification of tools used in more than one activity.

The fill and floor assemblages are 64.5 percent similar, with more variety in the floor assemblage (n=16) than in the fill (n=13). The opposite distribution was found at all other sites except AZ W:10:51. The Maverick Mountain occupation distribution supports the assumptions: (1) many rooms were destroyed with their contents still in place, and (2) rooms were immediately reoccupied before any trash could be added to the burned deposits. This distribution also contributed to the high confidence value assigned to the assemblage. The artifacts found on the floors reflect where they were used or stored, probably more than at any other Point of Pines village except AZ W:10:51.

TABLE 7.3

Artifacts from AZ W:10:50, Maverick Mountain occupation

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Grind Slab	2	8.7	.9
	Handstn*	16	69.6	7.2
	Netherstn*	3	13.0	1.3
	Pestle	2	8.7	.9
	Subtotal	23	100.0	10.3
FOOD	Mano*	102	86.4	45.7
	Metate*	16	13.6	7.2
	Subtotal	118	100.0	52.9
NONFOOD	Abrader	31	58.5	13.9
	Awl	1	1.9	.5
	Disk	5	9.4	2.2
	Lapstn	2	3.8	.9
	Maul*	2	3.8	.9
	Palette	2	3.8	.9
	Polish Stn	10	18.9	4.5
	Subtotal	53	100.1	23.8
PROCUREMENT	Axe*	21	100.0	9.4
CONSTRUCTION	Pestle	3	100.0	1.3
NONPROCESSING	Axe	1	20.0	.5
	Ball*	1	20.0	.5
	Bowl	1	20.0	.5
	Pipe/Tube	1	20.0	.5
	Plug/Cap*	1	20.0	.5
	Subtotal	5	100.0	2.2
	TOTAL	223		99.9

- * These categories include artifacts not available for analysis. Pertinent information was obtained from stone cards and rooms reports.

Five rooms (Rooms 71,81,86,96,100) are of particular interest for this analysis because they had evidence of mealing bins. Room 86 had two bins that were remodeled into a single bin, but the metate had been removed. Room 96 had one bin remodeled by adding a second bin and a coating of plaster over both bins. The metates had been removed from these bins, as had those from the double bins in Room 71 and the single bin in Room 100. The trough metate removed from the bin in Room 100 was noted by the excavators as having been found in the room fill. In Room 81 the slabs to a possible mealing bin were found in what was probably the fill of the second story room. The mealing bins found in the Maverick Mountain rooms differ from the mealing receptacles found at Turkey Creek by having slabs and sherds that create a box around the metate; receptacles have adobe ridges creating a catchment at the distal end of the metate.

Grinding Technology of the Maverick Mountain Immigrants

The Anasazi who were incorporated into the Point of Pines Pueblo brought with them technological knowledge acquired in a different cultural setting. They may have brought some tools with them, but most of their material culture had to be newly manufactured. A higher percentage (33.0%) of Maverick Mountain tools were involved in more than one activity than at any of the other Point of Pines villages (Table 2.1), maybe because locally manufactured tools were scavenged or gifted and then altered for use by the Maverick Mountain people.

Trough metates made by the resident population were incorporated into the bin technology brought by the immigrants. If new metates were manufactured by the

immigrants they were made using the traditional flat design. Axe heads with 3/4 grooves, probably made by the resident population, may have been redesigned with full grooves by the immigrants. If new axes were manufactured they were made using their traditional full-groove technique. Axes, as well as metates, may have been traded or given to the immigrants.

The way in which the Maverick Mountain deposits were sealed by fire and immediately reoccupied preserved the ground stone assemblage with minimal post-occupational disturbance or contamination from trash deposition. There is little difference in the rest of the ground stone assemblage from the Maverick Mountain occupants and the occupants of earlier Point of Pines villages. Grooved and flat abraders, polishing stones, palettes, and other items involved in nonfood processing activities, items of ambiguous use, and items part of nonprocessing activities all seem to have been used in the same way. Thus, the grinding technology of the immigrant Anasazi is distinctive in only a few activities.

AZ W:10:50, Canyon Creek Phase

The Canyon Creek phase occupation of the Point of Pines pueblo (AZ W:10:50) involves many more rooms than are discussed here. This analysis includes only those rooms previously occupied by Maverick Mountain people. The Maverick Mountain occupation was terminated by a fire that destroyed a large number of rooms (Lindsay 1987:194). Shortly after the fire, the rooms were reoccupied. This reoccupation has been identified as part of the Canyon Creek phase, but whether the reoccupants were Maverick Mountain people or indigenous Point of Pines people is

unclear. The reoccupation of the burned rooms was accomplished by placing new floors directly on top of the burned material. Lindsay (1987:195) postulates a short reoccupation by Maverick Mountain people, who left the burned rooms after less than a year and were assimilated into the surrounding Point of Pines population or moved on.

The field school excavators noted several instances where burned deposits were disturbed, possibly by people retrieving artifacts left on burned floors. In Room 100, a metate bin was raided through the burned deposits and the scavenged metate was found in the fill. The excavators did not indicate how or why the metate was abandoned. The removal of tools may indicate scavengers knew there were tools, and possibly even where the tools were located. Such knowledge would be common to those who originally occupied the burned rooms, suggesting that reoccupation was by the original Maverick Mountain inhabitants.

It is unclear what percentage of the Canyon Creek occupation is represented by the rooms excavated. More Canyon Creek phase rooms were excavated; however, according to the excavators the floors were clean. Records kept on the artifacts inventoried from the Canyon Creek occupation are limited. Thus, between prehistoric abandonment behavior and historic excavator behavior, the ground stone assemblage probably does not well reflect how ground stone artifacts were used during the Canyon Creek phase. The confidence rating assigned to this occupation is 3 (Table 3.3).

Of the 362 artifacts assigned to the Canyon Creek phase occupation of the

Maverick Mountain rooms, 260 (71.8%) were inventoried and 102 (28.2%) were analyzed (Appendix A, Table 1). The assemblage was sorted into 19 types. These artifact types were sorted into activity categories with the highest percentage (36.2%) involved in food processing activities (Table 7.4). However, a nearly equal percentage (32.6%) was used in nonfood processing activities. Twenty-five percent of the artifacts were used in more than one activity (Table 2.1).

The floor and fill assemblages are 72.3 percent similar, with more variety in the fill (n=19) than on the floors (n=10). A higher percentage of manos and metates (57.0%) was in floor assemblages than in fill (32.1%), while abraders, handstones, and polishing stones were found in higher percentages in the fill (43.8%) than the floor assemblages (33.3%).

Grinding Technology of the Canyon Creek Phase Reoccupation

The Canyon Creek occupants of the Point of Pines pueblo used grinding technology in several ways. Food grinding was accomplished primarily with open-trough mano/metate equipment, some of which may have been scavenged during this short-term occupation. One metate bin was associated with a Canyon Creek floor. In general, the food processing strategy was no different than that of the Maverick Mountain people with a combination of open-trough and flat mano/metate equipment.

Nonfood processing activities included axe manufacture if the faceted polishing stones and faceted abraders are correctly associated with this task. Other

TABLE 7.4

Artifacts from AZ W:10:50, Canyon Creek Phase

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Handstn*	46	76.7	12.7
	Netherstn*	8	13.3	2.2
	Mortar*	4	6.7	1.1
	Pestle*	2	3.3	.6
	Subtotal	60	100.0	16.6
FOOD	Mano*	112	85.5	30.9
	Metate*	19	14.5	5.2
	Subtotal	131	100.0	36.2
NONFOOD	Abrader*	71	60.2	19.6
	Awl	1	.8	.3
	Disk*	3	2.5	.8
	Lapstn	8	6.8	2.2
	Maul	2	1.7	.6
	Mortar	4	3.4	1.1
	Palette	2	1.7	.6
	Polish Stn	27	22.9	7.7
	Subtotal	118	100.0	32.6
PROCUREMENT	Axe*	42	97.6	11.6
	Firehearth	1	2.3	.3
	Subtotal	43	99.9	11.9
CONSTRUCTION	Pestle	1	50.0	.3
	Polish St*	1	50.0	.3
	Subtotal	2	100.0	.6
NONPROCESSING	Axe*	2	25.0	.3
	Ball	1	12.5	.3
	Bowl	1	12.5	.3
	Pipe/Tube	2	25.0	.6
	Plug/Cap	2	25.0	.6
	Subtotal	8	100.0	2.2
	TOTAL	362		100.1

- * These categories include artifacts not available for analysis. Pertinent information was obtained from stone cards and room reports.

polishing stones polished pottery. Abraders were involved in the manufacture of various flat and shaft wooden items. Several with U-shaped grooves had been redesigned for concomitant use in handstones and polishing stones. Groove widths range from 0.2 cm to 1.2 cm, suggesting that only narrow shaft tools were shaped. Small mortars and a couple of palettes may have been used in the production of pigments. One of the palettes was perhaps "killed" with a small hole knocked through the bottom. One of the mortars was designed for concomitant use in a handstone. A stone awl was identified with use-wear damage patterns suggesting contact with a soft, probably hide, surface. The nonfood processing tools recovered from the Canyon Creek phase deposits indicate a wide variety of things were made and decorated with paint.

Although some axes were newly manufactured, many were regrooved and may have been scavenged from the older deposits or from storage elsewhere in the pueblo. All axes were designed with 3/4 grooves (Table 5.8) except for two full-groove axes which were not functional because of their material. Perhaps they were designed for ritual purposes; one was possibly scavenged from the burned Maverick Mountain deposits. One 3/4-groove axe was redesigned with a full-groove, but its ultimate use was not to chop trees. The use-wear damage patterns on the bit edge of this axe and on two 3/4-groove axes suggest they were worked in gardening activities (Mills 1993:407).

The people who reoccupied the burned Maverick Mountain rooms essentially employed the same grinding technology as the people who occupied the rooms

before the burning. Similarities include basic tool designs, and a strategy of scavenging and reusing artifacts. Twenty-five percent of the Canyon Creek artifacts and 33 percent of the Maverick Mountain artifacts were involved in more than one activity. This evidence supports the idea of Maverick Mountain people reoccupying their burned rooms, scavenging the artifacts they knew were left in the rooms, and continuing the food and nonfood processing activities much as they did before the fire.

Pueblo AZ W:10:51

Pueblo AZ W:10:51 was the first site excavated by the field school, with work conducted during the summers of 1946 and 1947. It is situated in the transitional zone where the pine trees become sparse and the grasslands begin. The largest pueblo, Point of Pines (AZ W:10:50), is less than 20 meters to the east of AZ W:10:51 (Wendorf 1950:19), and was in its final phase of occupation when AZ W:10:51 was built.

AZ W:10:51 was a single-story pueblo of 21 rooms built over a pit house occupation (Wendorf 1950:21). Wendorf's architectural reconstruction indicates that not all of the pueblo rooms were occupied contemporaneously, and that rooms were added and remodeled over some period of time. Construction started with a suite of four rooms and grew to the north and south with addition of other suites of rooms. Building material--and it can be assumed other artifacts as well--were removed from older, nearby pueblo. The pueblo component of the AZ W:10:51 was occupied during the Point of Pines phase and perhaps was one of the last villages occupied in

the Point of Pines area.

If the people moved a long distance away, they may have left most of their tools behind. Haury (1989:16) recalls the impression of hastily abandoned rooms because of so much material left on the floors. With no one else around to scavenge them, this might be the most complete assemblage we have for assessing prehistoric use of ground stone artifacts. The site was completely excavated, there were large numbers of floor assemblages, and the record keeping was good. The confidence rating for this collection is 1 (Table 3.3).

In his summary of AZ W:10:51, Wendorf (1950:53-68) provides an accounting of the ground stone with summary descriptions of artifact types. These descriptions include information about artifacts not available for analysis; mostly manos and metates. All of the artifacts included in this analysis of AZ W:10:51 are summarized in Appendix A, Table 1. Of the 629 ground stone artifacts involved in the discussion of grinding technology, 482 (76.6%) were inventoried, and 147 (23.4%) were available for analysis.

Eighteen artifact types were identified, and classified by the activity in which they were used. Most (60.9%) were involved in food processing activities (Table 7.5). Twenty-seven percent were used in more than one activity (Table 2.1). The fill and floor assemblages are 68.6 percent similar, with more variety in the floor assemblage (n=13) than in the fill (n=11). This is different than the floor and fill distributions for other Point of Pines sites except AZ W:10:50, Maverick Mountain occupation. This collection is also different from other sites in that manos and

TABLE 7.5
Artifacts from Pueblo AZ W:10:51

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Grind Slb*	1	1.4	.2
	Handstn*	57	79.2	9.1
	Mortar*	1	1.4	.2
	Netherstn*	8	11.1	1.3
	Pestle*	5	6.8	.8
	Subtotal	72	100.0	11.4
FOOD	Mano*	335	87.5	53.3
	Metate*	48	12.5	7.6
	Subtotal	383	100.0	60.9
NONFOOD	Abrader*	32	33.7	5.1
	Awl	1	1.1	.2
	Handstn	2	2.1	.3
	Lapstn*	10	10.5	1.6
	Maul	1	1.1	.2
	Bobbin	1	1.1	.2
	Polish St*	48	50.5	7.6
	Subtotal	95	100.0	15.1
PROCUREMENT	Axe	70	100.0	11.1
NONPROCESSING	Axe	2	22.2	.3
	Ball	3	33.3	.5
	Bowl	3	33.3	.5
	Plug/Cap	1	11.1	.2
	Subtotal	9	99.9	1.4
	TOTAL	629		99.9

* These categories include artifacts not available for analysis. Pertinent information was obtained from stone cards, room reports, and Wendorf (1950).

metates are a larger percentage of the fill assemblage (75.5%) than of the floor assemblage (46.6%). Some of these manos and metates may have been stored or used on roofs that collapsed into the structures and were excavated as fill. Abraders, axes, metates, and polishing stones were found in higher percentages on floors (29.7%) than in fill (13.0%).

Of special interest to this analysis are the many rooms at AZ W:10:51 that had mealing bins (1-3,7,9,13-15,17,20,21) (Wendorf 1950:29). Four rooms (2,3,9,14) had one mealing bin; five rooms (1,7,17, 20,21) had two mealing bins next to one another; one room (15) had two mealing bins facing each other and a single bin in another part of the room; and one (13) had four bins set in a row. Fifteen flat metates were still in place in the bins. One of the set of four in Room 13 was missing a metate, as was the only bin in Room 14, and one of the set of two in Rooms 1 and 20. In addition to bins, Rooms 13-15,17,20 and 21 also had free-standing metates on the floors; many were found in possible use positions, but most were in storage positions. Rooms 18 and 16, although lacking bins, each had a free-standing metate on the floor. All rooms with bins or free-standing metates also had several manos, except Room 9 which had one bin with a metate still in it but no associated manos. Thus, 13 of the 21 rooms at AZ W:10:51 were clearly associated with food processing activities and half of these could accommodate more than one grinder at a time. At no other Point of Pines village was there such a concentration of food grinding equipment.

Grinding Technology at AZ W:10:51

The ground stone artifacts analyzed from AZ W:10:51 were employed in a variety of activities. Many, such as abraders, handstones, and lapstones, were used for processing or applying pigments. Grinding technology was also involved in the alteration of the surfaces of pottery, wood, bone, and stone objects. Polishing stones and handstones were redesigned with U-shaped grooves for concomitant use as abraders, or shaftsmoothers. Wood or reed, and stone shafts were smoothed with the grooves. Abraders with V-shaped grooves were used to sharpen points on wood or bone tools. Abraders with U-shaped grooves shaped shafts ranging in diameter from 0.8 cm to 1.1 cm (Table 5.7).

Most axes were designed with 3/4 grooves (Table 5.8); one was redesigned with a full groove (Table 5.9). Two full-groove axes and four 3/4-groove axes were ultimately used either to garden or to shape stone. Faceted polishing stones were recovered that may have been part of the manufacture or maintenance of axes. Some artifacts, such as balls and pipes, were shaped for ritual purposes. One maul was shaped but never used.

Probably most informative about technological development at AZ W:10:51 is the food grinding technology. The 13 rooms where mealing bins, or in situ metates, were found indicate that a large portion (61.9%) of this pueblo was devoted to grinding food. The positioning of multiple bins, and bin and free-standing metates, indicates that in most rooms more than one grinder could work at a time. The permanent bins, and the multiple grinding "stations", are very different than the food

grinding strategy (moveable, free-standing metates) of the pit house villages or the early pueblos.

Manos, as well, are distinctive. Ten percent of the manos had two adjacent surfaces and two percent had three surfaces (Table 5.5), evidence of wear management techniques not found on earlier manos. These mano and metate characteristics suggest that, at least for some grinders, food grinding was efficient and intense. By this I mean an individual grinder was responsible for producing large quantities of ground resources. If this were the case, time would pass more pleasantly with groups of women working together to grind the needed resources. Ethnographic accounts tell of Hopi women singing grinding songs, joking and telling stories as they worked over the grinding bins (Hough 1915:63; Judd 1954:133 citing Castaneda; Stephen 1936:153-154). Groups of grinders would have produced more meal than needed for daily consumption. This means ground resources were probably stored, redistributed, used ritually, and possibly traded.

The use of food grinding technology at AZ W:10:51 shows a development not represented at any of the other villages in this analysis. The fact that so many rooms (13) were designed for grinding food resources, and so many of these (7) were designed for more than one grinder, indicates a certain level of specialization, possibly even centralization in food production not before achieved in the Point of Pines area. I propose that late in the pueblo occupation there was a change in food distribution. Resources ground by the women at AZ W:10:51 may have been accumulated for redistribution within the community, much as is done in modern

pueblo society (see Chapter 5). At the pit house villages, and probably at the first pueblo village (AZ W:10:37), where grinding was done with free-standing mano/metate equipment, the grinder may have been required to produce only enough for consumption by her own household. But when permanent locations for grinding activities were installed, perhaps women were spending longer hours at the grinding task, and grinding became more of a social event. Their meal may have been stored and eventually consumed by a group larger than a household.

AZ W:10:51 is unusual in other ways as well, in that none of the rooms was specifically designed for ritual or ceremonial purposes. One storage room (Room 1) contained artifacts, such as two painted slabs, that might have been involved in rituals. One slab was painted with a katsina face (Di Peso 1950:57-65; Wendorf 1950:75-76). The inhabitants of AZ W:10:51 must have conducted celebrations elsewhere--possibly at AZ W:10:50B, at the great kiva or the smaller kivas still functioning in the deteriorating Point of Pines pueblo. The food grinding technology employed by the inhabitants must reflect some organization of labor that fits into a larger social picture of cooperation.

Pueblo AZ W:10:50B

The pueblo of AZ W:10:50B is a remnant of the final stages of occupation at the Point of Pines pueblo, and probably of the whole Point of Pines area. It was built upon the remains of earlier occupations and is within the physical limits of the Point of Pines ruin AZ W:10:50. The Point of Pines ruin is on a ridge that today has a few scattered pines, and borders an open expanse of grassland called Circle

Prairie. AZ W:10:50B and AZ W:10:51 (which was built just beyond the western limits of AZ W:10:50) probably were occupied contemporaneously. Perhaps these two villages were occupied by people who abandoned the main Point of Pines pueblo (Haury 1989:118).

Elizabeth Morris, in her master's thesis (1957), described the excavations at AZ W:10:50B, and the remains uncovered below the pueblo. Altogether a time period from A.D. 1250 to 1450 is represented. For this analysis of grinding technology, only those remains associated with the occupation of the pueblo are included. AZ W:10:50B was constructed beginning around A.D. 1300. Parts of the pueblo were abandoned around A.D. 1400, but other parts continued to be occupied for maybe another 50 years (Morris 1957:54). Twelve rooms were excavated in the pueblo, which is estimated to have 20-25 rooms.

This pueblo and pueblo AZ W:10:51 were the latest occupied in the Point of Pines area, and perhaps both were abandoned in the same fashion. If the people moved a long distance away, they may have left most of their tools behind; with no one else around to scavenge artifacts, what remained might reflect use or storage behaviors. The confidence value given to this collection is 1 (Table 3.3).

Morris (1957) presents a summary of ground stone found during the excavations; however, she does not separately discuss those found in the pueblo and those found in the occupation below. Room records help identify which artifacts came from the pueblo component. Of the 207 ground stone artifacts from the pueblo occupation, 155 (74.9%) were inventoried, and 52 (25.1%) were analyzed

(Appendix A, Table 1).

The artifacts were sorted into 10 types, and the types were sorted into activity categories. The highest percentage (41.5%) was involved in processing food activities (Table 7.6). The fill and floor assemblages are 50.5 percent similar with more variety in the fill (n=9) than on floors (n=7). Metates, axes, and handstones are higher percentages of the floor assemblage than the fill, while only manos are a higher percentage of the fill assemblage. Twenty-nine percent of the assemblage was used in more than one activity (Table 2.1).

The rooms most interesting for this analysis are Rooms 7 and 11, which had mealing bins. Room 11 had two mealing bins, one of which still had a flat metate in position. At least 5 manos were also found on the floor, two in proximity to the mealing bins. Room 7 had a row of three bins with all of the metates removed. The unspecified number of manos found on the floor of Room 7 were thought to have been introduced as trash. Thus, this room was abandoned as a functioning mealing room before the pueblo was abandoned. Only one room (1) had a free-standing trough metate in what was perhaps either a use or storage position. From the rooms excavated at AZ W:10:50B it seems that food grinding might not have been as centralized or specialized as it was at AZ W:10:51.

TABLE 7.6

Artifacts from Pueblo AZ W:10:50B

PROCESS TYPE	ARTIFACT	COUNT	PERCENT CATEGORY	PERCENT TOTAL
AMBIGUOUS	Handstn*	38	95.0	18.4
	Pestle*	2	5.0	1.0
	Subtotal	40	100.0	19.4
FOOD	Mano*	67	78.0	32.4
	Metate*	17	19.8	8.2
	Mortar*	2	2.3	1.0
	Subtotal	86	100.0	41.5
NONFOOD	Abrader*	31	59.6	15.0
	Lapstn*	3	5.8	1.4
	Maul	1	1.9	.5
	Mortar*	2	3.8	1.0
	Pestle*	4	7.7	1.9
	Polish St*	11	21.2	5.3
	Subtotal	52	100.0	25.1
PROCUREMENT	Axe	29	100.0	14.0
	TOTAL	207		100.0

- * These categories include artifacts not available for analysis; pertinent information was obtained from stone cards, room records, and Morris (1957).

Grinding Technology at AZ W:10:50B

Although not all rooms were excavated, and not all artifacts from those that were excavated were brought out of the field, much has been learned about the grinding technology employed by the inhabitants of AZ W:10:50B. Food grinding activities, for the most part, involved flat mano/metate equipment (Table 5.4) set up in specialized areas within habitation rooms. Two rooms were identified with multiple grinding bins, and while there may have been similar rooms in the unexcavated portion of the site, compared to contemporaneous AZ W:10:51, very little space and few tools were devoted to food grinding activities. Perhaps food grinding was not as social as at AZ W:10:51.

Two mortars were identified as part of food processing activities. The only one available for analysis is similar to those ethnographically identified as used to crush mesquite pods (Euler and Dobyms 1983:259). All of the pestles recovered from AZ W:10:50B had pigment on them and so were considered employed in non-food processing activities. None were available to determine if they had been involved in more than one activity. Other tools covered with pigment include abraders, lapstones, mortars, and polishing stones.

Nothing specific was learned about tools used to polish pottery because they are unavailable for analysis; however, based on the information on stone catalogue cards and room records, not many pottery-polishing stones were found at AZ W:10:50B. The only polishing stone available for analysis was faceted and may have been involved in the manufacture of axes. It was redesigned with a V-shaped

groove for sharpening wooden or bone points, and was usable concomitantly in either polishing or sharpening activities.

Some grooved abraders were manipulated to shape and straighten wood or reed shafts while others shaped stone beads or stone awls. Groove widths range from 0.7 cm to 1.3 cm (Table 5.7). One was designed for concomitant use as an abrader with multiple U-shaped grooves and a handstone. Pigment on the handstone surface and in one groove may have been from processing paint for application on a shaft tool. There were other tools involved in more than one activity. A few were redesigned into new tool types, such as mano redesigned into a hoe. Many were used concomitantly in more than one activity. All axes were designed with 3/4 grooves; three had been regrooved (Table 5.8), one with a full groove (Table 5.9). Five axes were ultimately used for activities other than chopping wood, such as gardening or shaping stone.

It is interesting that there are fewer artifact types from this site than from earlier sites; this may be the only one with no artifacts shaped for use in nonprocessing activities. No bowls, pipes, or tubes were identified as coming from the Point of Pines phase occupation of AZ W:10:50B. As with AZ W:10:51 it is possible that the people living at AZ W:10:50B were part of a larger community within which they fulfilled the parts of their daily activities not provided within the immediate pueblo.

Summary

The pueblo occupation of the Point of Pines area began sometime around A.D. 1000-1100 and continued until A.D. 1425-1450. This period is interesting for assessing technological developments and what happens when different traditions are introduced through immigrations. Developments are easiest to see in comparisons between food grinding strategies from the earliest (AZ W:10:37, Turkey Creek) and latest (AZ W:10:51) pueblos. At the earliest pueblos, food grinding was accomplished with free-standing, open-trough mano/metate equipment. Some women continued to grind on the traditional 3/4-trough design, but open-trough designs predominated. Along with the aggregation of population into Turkey Creek pueblo, there were some minor changes in the positioning of food grinding activities. In a few rooms more than one woman could have worked simultaneously on two or three adjacent open-trough metates permanently affixed with grinding receptacles. In the latest pueblo (AZ W:10:51), food grinding was done on flat metates permanently installed in multiple bins located in most of the pueblo rooms. The difference between grinding strategies used in the earliest and latest pueblos may relate to different social strategies of food distribution. Perhaps grinders in the earlier villages supplied a smaller network than grinders in the later villages. This possibility will be explored further in the final chapter.

The effects on grinding technology by immigration are evident in the assemblage from AZ W:10:50, Maverick Mountain occupation. When the Anasazi arrived in the Point of Pines area, they may have brought some tools, but most were

acquired or manufactured upon arrival. That tools were scavenged from local discards, or given by welcoming residents is evident in the positioning of locally designed, open-trough metates in Anasazi designed bins.

There is other evidence of coexisting technological traditions in the axe assemblage. This coexistence became visible with the introduction of full-grooved axes into the assemblage from the earliest pueblo (AZ W:10:37) and with their continuance at all but the latest pueblo (AZ W:10:51). The introduction of full-groove axe designs did not supplant the local 3/4-groove design; some 3/4-groove axes were redesigned with full grooves, and one or two full-groove axes were redesigned with 3/4 grooves. This means that those who were confronted with alternative technological traditions maintained their own techniques, even if it meant redesigning an already functional feature. The reasons for the occurrence of different but equally functional techniques is a topic of some interest to those who seek to find the ways in which artifacts transmit information (see for example Hodder 1982; Lemonnier 1992; Wiessner 1983; Wobst 1977).

A final technological development is seen in the designing of tools usable in more than one activity. Concomitant use may have been a way of conserving resources or energy, or perhaps a convenient way of using a tool in separate stages of a manufacturing process. For example, a grooved abrader designed in a handstone may have been used to smooth a shaft tool and to grind the pigment for coloring the shaft. Materials for making grinding tools is not scarce in the Point of Pines area, so resource conservation was probably not a concern.

This discussion of technological developments has highlighted some of the changes that occurred during the pueblo occupation. The next chapter combines the data from both the pit house and pueblo occupations, summarizing the developments of grinding technology within each previously define activity category.

CHAPTER 8

GRINDING TECHNOLOGY IN THE POINT OF PINES AREA

Sometime around A.D. 1000-1100 there was a dramatic change in the design of Point of Pines villages. Above-ground, contiguous masonry structures were built to accommodate most of the mundane cooking and storing activities previously associated with pit houses and extramural pits. Subterranean structures continued in use, but the activities that occurred within them changed. Haury (1958:38; 1989:116-117) attributed the changes to Anasazi immigrants, who built according to their traditional pueblo village design. Using pottery and architectural evidence, Haury postulates that the indigenous Mogollon and the immigrant Anasazi created a new group not considerable as either Mogollon or Anasazi. Others (Johnson 1965:14; Lowell 1991:16; Reed 1950:120-138) have labeled these pueblo people, Western Pueblo. However, an assessment of grinding technology brings to light conservative technological traditions not changed until late in the occupation of the Point of Pines area.

Wheat (1955) details the variation in village layout, domestic and ceremonial architecture, pottery types, and various stone artifact types for the Mogollon prior to A.D. 1000. He defines the Black River Branch Mogollon with the Point of Pines pit house villages. Based on the reconstruction of variation through time in architecture and pottery for the Black River Branch, the distinctions between the early pit house villages (Wheat's Mogollon I and II include Circle Prairie phase) and the late pit house villages (Wheat's Mogollon IV includes Nantack phase) are

quite obvious. Houses get larger and deeper and roof strategies change (Wheat 1955:55-56), certain pottery shapes are made earlier that are not made later, and frequencies of plain pottery decrease while textured, smudged, and painted pottery increase (Wheat 1955:109, table 10). Based on the analysis described here, the same can not be said about the ground stone assemblage.

The technological traditions of grinding brought into the Point of Pines area at about A.D. 400 established a conservative baseline of tools, knowledge, and behaviors that remained essentially unchanged for 600 years. However, beginning with pueblification and over the ensuing 350 years, the baseline traditions were altered with the addition of new tool types and design modifications that improved productivity. The most dramatic and socially significant, are developments in the design of food processing tools and strategies that occurred during the last 50 to 100 years of occupation. These changes are more significant than any that occurred during the previous 900 to 1000 years, creating a greater difference between the late pueblo occupation (W:10:51, W:10:50B) and the early pueblo occupation (W:10:37, Turkey Creek pueblo) as there was between the early pueblo occupation and the pit house occupation. These will be detailed below.

Pit house and pueblo assemblages are 78.1 percent similar in occurrence of artifact types. Every artifact type associated with pit house villages was also associated with pueblos (Table 8.1), with the exception of spindle bases (but refer to the discussion on spindle bases in Chapter 5). Woodbury (1954:208-210) noted a similar trend in ground stone artifacts on the Colorado Plateau.

TABLE 8.1

Summary percentages of artifact types
from pit house and pueblo villages

ARTIFACT TYPE	PIT HOUSE VILLAGES	PUEBLO VILLAGES
ABRADER	5.4	12.0
AWL	0	.1
AXE	.9	13.2
BALL	.9	.4
BOBBIN	0	.1
BOWL	.7	1.8
DISK	0	.8
FIRE HEARTH	0	.2
GRINDING SLAB	1.5	.3
HANDSTONE	20.3	11.6
LAPSTONE	1.1	1.4
MANO	36.6	32.6
MAUL	3.5	1.4
METATE	15.4	9.3
MORTAR	2.2	3.4
NETHERSTONE	.9	1.4
PALETTE	1.2	.8
PESTLE	2.9	1.4
PIPE/TUBE	1.3	.2
PLUG/CAP	.1	1.5
PLUMMET	.2	.4
POLISHING STN	4.5	5.9
SPINDLE BASE	.4	0

Generally, there are only minor, time specific differences in the application of grinding technology to particular activities. For example, all but one of the pueblos (W:10:51) have higher percentages of nonfood processing tools than the pit house villages, and all pueblos have higher percentages of procurement tools than the pit house villages (Table 8.2). Food grinding equipment is not an increasingly larger part of the ground stone tool assemblage (Table 8.1); something that might be expected if agricultural products were increasingly important in the diet as suggested by some (Hard 1990:135-149; Mauldin 1993:317-330; Plog 1974:141). Nor can these distributions be attributed to site function, because all those included in this analysis were villages. If the differing distributions reflect anything, it is probably differences in abandonment strategies, and possibly differences in excavation and data recovery strategies. Nonfood grinding tools, for example, may have been scavenged or removed from one village for use in another, such as was suggested to have happened at Stove Canyon. However, food grinding equipment was also more apt to have been neglected by the excavators than axes or other tools, such as happened at Turkey Creek.

The increased quantities of nonfood processing and procurement tools lower the percentages of food processing tools at pueblos; however, this is not to imply that food processing became less important. For example, one pit house village (Stove Canyon) and one pueblo (W:10:51) stand out with the highest percentages of food processing tools (Table 8.2). The higher percentage of food processing tools at Stove Canyon is probably a result of abandonment strategies as explained in Chapter

TABLE 8.2

Summary percentages from each site of tools used in activities

VILLAGE	FOOD	NON FOOD	AMBIGU	PROCURE	CONTRCT	NON PROCESS
PIT HOUSES Crooked Rdg	50.4	21.0	21.3	.3	3.5	3.5
Stove Canyon	65.3	9.7	23.4	.8	0	.8
Lunt	49.2	19.3	26.9	1.5	0	3.0
Nantack	47.7	18.1	28.4	1.9	0	3.9
SUBTOTAL Pit houses	52.4	18.1	23.8	.9	1.7	3.0
PUEBLOS W:10:37	38.8	20.3	33.0	6.1	1.4	0.9
Turkey Creek	24.2	35.5	6.1	21.6	.2	12.5
W:10:50, Maverick Mnt	52.9	23.8	10.3	9.4	1.3	2.2
W:10:50, Canyon Creek	36.2	32.6	16.6	11.9	.6	2.2
W:10:51	60.9	15.1	11.4	11.1	0	1.4
W:10:50B	41.6	25.1	19.4	14.0	0	0
SUBTOTAL Pueblos	42.2	25.3	14.6	13.3	.5	4.1
TOTAL	44.5	23.7	16.7	10.4	.8	3.9

6. Many of the easily transported tools (abraders, polishing stones, axes) were not found at Stove Canyon, inflating the percentage of the bulkier food processing tools left to become the archaeological record.

Some other process was impacting the assemblage at W:10:51, however. The

higher percentage of food processing tools at this village is attributable to a different social organization of food production than at the other villages, this will be discussed later in this chapter. From a more generalized perspective, the differences between tools used by pit house and pueblo occupants are in the design of some artifact types, the specialization of other artifact types, and in short-lived innovations. These changes are discussed below for artifacts involved in the various previously defined activities.

Food Processing Activities

Food processing may have been the most important activity for which ground stone tools were used. The technological tradition for grinding food was developed early, long before the Mogollon moved into the Point of Pines area (Wheat 1955:110). This tradition remained essentially unchanged until pueblofication created a social environment more conducive to technological development. The development of food grinding technology involved changes in grinding strategy. The concept of strategy incorporates tool design, motor habits, and activity location.

Changes in tool design are exemplified by the distribution of metate designs (Table 8.3). Three-quarter trough metates remain the most common type throughout the pit house occupation and until supplanted by a more efficient, open-trough design in the earliest pueblo occupation. While a few flat metates are in the assemblages from the latest pit house village (Nantack) and the earliest pueblo (W:10:37), they are the most common design (64.5%) in the late pueblos (W:10:51, W:10:50B), where they are incorporated into bins.

TABLE 8.3

Metate types in pit house and pueblo villages

METATE TYPE	PIT HOUSE	EARLY PUEBLO	MIDDLE PUEBLO	LATE PUEBLO	TOTAL
BASIN	9.4	2.5	17.1	0	5.9
3/4 TROUGH	46.2	2.5	8.6	6.5	18.3
OPEN TROUGH	0	92.4	45.7	25.9	44.1
INDET TROUGH	30.2 *	0	2.9	0	10.2
FLAT	.9	2.5	20.0	64.5	15.8
INDETERM	13.2	0	5.7	3.2	5.6

Early pueblo includes W:10:37 and Turkey Creek pueblos; middle pueblo includes W:10:50, Maverick Mountain occupation, and Canyon Creek phase; late pueblo includes W:10:51, W:10:50B.

- trough type not identified on stone catalogue cards, but probably 3/4-trough.

If 3/4-trough metates are the traditional Mogollon design, then where did the open-trough design come from? Neither open-trough or flat metates originated with the Point of Pines Mogollon. Both designs occur earlier elsewhere; however, the source for open-trough design is less clear than the source for the flat design. The open-trough design was used by the eastern Mogollon (Martin and Rinaldo 1950a:452; 1950b:304; Martin et al. 1949:136; Wheat 1955:115) and Mimbres (Lancaster 1984;fig. 17.4) during the same time period, or slightly earlier, than by Point of Pines Mogollon, and was the primary metate design of the Hohokam

(Haury 1976:281). There is no other evidence to suggest trade relations with the Hohokam, once pueblofication began. However, the co-occurrence of certain ground stone tools and food grinding features at both eastern Mogollon and Point of Pines villages may be evidence of knowledge transmission from east to west.

Flat metates, as part of a grinding bin complex, are an Anasazi design (for examples, see Anderson 1969a:3, 1969b:189; Dean 1969:33; Hayes and Lancaster 1975:151; Jennings 1966:61; Lindsay 1969:152-156; Lindsay et al. 1968:159, 273; Rohn 1971:202; Swannack 1969:42; Woodbury 1954:63-65) that came to the Point of Pines area with Maverick Mountain people, around A.D. 1265. During the latest phase (Point of Pines phase), at least 100 years after they were introduced, flat metates in bins became the most common grinding equipment. Flat mano/metate equipment is better designed for intense use than trough mano/metate equipment (Adams 1993:339-340). Intense use is when a woman spends many hours grinding in a single sitting. Metates designed to accommodate intense grinding have an untroughed surface that allows for minor changes in motor habits, thereby relieving fatigue. Manos designed for intense use have finger grooves and those used intensely show evidence of wear management (see Chapter 5 for more development of these concepts).

The information available on manos indicates there were some changes in wear management techniques (Table 8.4). Although no wear management was applied to most manos (manos with one surface), during the pit house occupation grinders managed wear on some (32.9%) by flipping the upper and lower surfaces to

TABLE 8.4

Number of mano surfaces in pit house and pueblo villages;
used to infer wear management strategies

SURFACES	PIT HOUSE	EARLY PUEBLO	MIDDLE PUEBLO	LATE PUEBLO	TOTAL
ONE	52.0	59.9	29.0	57.7	50.5
2 OPPOSITE	32.9	32.0	13.6	31.1	28.0
2 ADJACENT	.4	4.1	.5	8.7	4.2
THREE	0	4.1	0	1.2	1.1
UNIDENT	14.7	0	57.0	1.2	16.2

Early pueblo includes W:10:37 and Turkey Creek pueblos; middle pueblo includes W:10:50, Maverick Mountain occupation, and Canyon Creek phase; late pueblo includes W:10:51, W:10:50B.

create two opposing surfaces. Puebloan grinders continued the same technique on some manos, and on others they rotated the mano to create two adjacent surfaces (Table 8.4). The discussion of food grinding tools in Chapter 5 explains that wear management techniques might have become important if a grinder spent long hours in a single grinding session. This more intense grinding might have encouraged a grinder to prolong mano use-life through wear management.

Manos and metates must be considered together as tool components; one cannot be used without the other. If considered independently, the mano data and the metate data suggest differing percentages of tool design (compare Tables 8.3 and 8.5). For example, the metate data indicate flat design was predominate (64.5%) at

TABLE 8.5

Mano types in pit house and pueblo villages

MANO TYPE	PIT HOUSE	EARLY PUEBLO	MIDDLE PUEBLO	LATE PUEBLO	TOTAL
BASIN	3.6	3.4	.9	0	1.6
TROUGH	32.1	51.7	72.4	.5	30.9
FLAT	3.2	4.1	26.7	10.7	11.2
INDETERM	61.1	40.8	0	88.8	56.2

Early pueblo includes W:10:37 and Turkey Creek pueblos; middle pueblo includes W:10:50, Maverick Mountain occupation, and Canyon Creek phase; late pueblo includes W:10:51, W:10:50B.

the late pueblos, contradictorily flat manos tally as sparse (10.7%). The different distributions may be influenced by a lack of information, or by field analyses that sometimes blurred the distinction between handstones and manos, and between manos used in basin and trough metates (refer to the discussion on manos in Chapter 5). Only by controlling for these historic behaviors is it possible to get an accurate assessment of prehistoric behaviors.

The situation of grinding activities is as important to the development of food grinding technology as the changes in tool design. Different behaviors are reflected in the use of free-standing equipment and constructed grinding receptacles, or bins. A grinder using free-standing equipment could alter the location of her food grinding activities, even move outside or to another structure. If it were set up inside, she would have to dismantle her equipment when pit house floor space was needed for

other activities. Dismantling is a valid concept in that most metates found in use positions were propped with several rocks to an appropriate angle. It may have taken some adjustment to achieve comfortable grinding.

The construction of permanent receptacles or bins indicates that food grinding activities were located in areas of pueblo rooms (no bins or receptacles were found in pit houses) dedicated to that purpose and no other. In pueblo rooms the space and the grinding equipment were always available. The grinder living in the pit house might have scheduled her food grinding time around other activities, while the grinder living in the pueblo would not.

Grinding bins and grinding receptacles are similar in that they fix the location of grinding activities, but they differ in design. Grinding receptacles are a Mogollon design and they occur about the same time, or slightly earlier, in the eastern Mogollon area (Martin et al. 1956:38-39; Martin et al. 1957:32-33) than in the Point of Pines area. The only receptacles found at Point of Pines villages are at Turkey Creek, and they co-occur with open-trough metates. Receptacles are variable in construction, and range from a hole in the floor with the distal end of a metate angled into the hole, to an adobe ridge that creates a catchment area at the distal end of a metate propped by rocks. They may have been a Mogollon adaptation of Anasazi grinding bins, or a Mogollon innovation for catching meal.

Grinding bins incorporate several slabs and often one wall of the masonry structure to create a box around the metate. The metates are mortared into place at an angle, with containers at the distal end to catch the ground meal. Sherds or

smaller stones are placed in the bin wall near the distal end of the metate where meal could have been easily scooped into another container. Slab-lined mealing bins are an Anasazi design well established during Pueblo II or sometime around A.D. 1000 (Woodbury 1954:63), and not used in the Point of Pines area prior to the arrival of the Maverick Mountain people in the mid 1200s. Slab-lined mealing bins were found in 5 rooms at W:10:50, Maverick Mountain occupation; one room at W:10:50, Canyon Creek phase; and during the Point of Pines phase, 11 rooms at W:10:51; and 2 rooms at W:10:50B. Their configurations range from single to multiples of 2, 3, and 4 continuous bins. W:10:51 has the largest concentration of mealing bins, the highest percentage (52.3%) of rooms with mealing bins and the largest number of total bins (n=23). Two rooms at W:10:51 had only free-standing mano/metate equipment in use-positions, and six rooms had both mealing bins and free-standing equipment in use-positions. These occurrences of multiple grinding equipment are interpreted to mean that grinding was a social activity in which more than one woman participated at a time.

With the arrival of Maverick Mountain people, not only is there evidence of new food grinding equipment, but there is also evidence about how an immigrant population fit in with a resident population. Apparently, it was not necessary for the immigrants to make new food grinding tools. Open-trough metates found among the Maverick Mountain assemblage were perhaps scavenged from earlier trash deposits or given by Point of Pines residents. If new tools were manufactured, traditional Anasazi flat designs were used. This is evident not only in the placement of open-

trough metates in bins, but also in the reuse of trough manos on flat metates.

Within the Maverick Mountain rooms, there were no 3/4-trough metates, but this tool design did not disappear as a small percentage of 3/4-trough metates (6.5%) were found in late pueblos (Table 8.3). These later occurrences may have been curated tools, or tools manufactured by grinders who preferred the traditional Mogollon design.

The combination of multiple bins in many rooms and the use of wear management techniques on manos indicates that food grinding was more intense during the late pueblo occupation than previously when individual free-standing equipment was more common and when less attention was given to managing wear. The reasons for these differing strategies may have been related to different networks of food distribution. The woman in the pit house may have had fewer people consuming the fruits of her labor, and the potential consumers were probably a small group of people within her immediate household.

Ethnographic accounts of pueblo women grinding food are probably most similar to the grinding strategy of the late pueblo occupation, while the accounts of non-puebloan grinding strategies are probably most similar to the strategies employed by pit house grinders. As noted in the discussion on food grinding tools in Chapter 5, the two different strategies probably reflect different social organizations of food production. Several late puebloan women using flat equipment in multiple bins would have produced more ground food, more efficiently and working more intensely, than one or two pit house women using free-standing 3/4-

trough metates.

The larger quantities of food ground by Point of Pines puebloan women may have been distributed through a network larger than the household, and this wider distribution may have been orchestrated through social events, such as public ceremonies. A late puebloan woman still would have ground food for her household to consume, but in preparation for special redistribution events, large amounts of ground food would have been stockpiled. Some days a puebloan woman would have ground for a few hours to provide for daily consumption, and other days she might have spent many hours, several days running, grinding food for mass consumption.

This change in food grinding strategy is where technological behavior can be recognized as social behavior. Knowledge of new tool designs (flat mano/metate equipment) was employed to facilitate increased food production required by a different social demand than was previously fulfilled with the old tool design (trough mano/metate equipment). More efficient equipment, usable for longer grinding sessions, was selected by the grinders who were required to produce more food resources for redistribution within an expanded social network. By placing the "improved" equipment in permanent locations, situated for the use of several women simultaneously, food grinding took on a social life of its own.

Manos and metates may have served in 99 percent of the food processing activities, but they were not the only ground stone, food processing tools. Mortars and pestles, specifically those identified as used in food processing activities, are less

than 1 percent of both the pit house and puebloan assemblages. During the pueblo occupation, there were innovative mortar designs with holes, handles, or spouts that might have been useful in extracting liquids. Wooden or pottery mortars may have also served in this capacity, and stone may have been either an experimental use of a different material, or part of a new extractive strategy explored with stone tools. Either way, this is another example of puebloan expansion of grinding technological knowledge.

Nonfood Processing Activities

Nonfood processing tools can also be used to illustrate the broader application of grinding technology by puebloan Mogollon. Developments in nonfood processing tools were brought about primarily through innovations. For example, a new design strategy was employed by the manufacturers of some tools, whereby, one tool was redesigned as a second tool. For most, the redesigning allowed concomitant use in either activity; the rest were redesigned for sequential use, so that the attributes of the original tool were destroyed.

Such redesigning can be seen with grooved abraders and some mortars. Grooved abraders were found only at the earliest pit house village (Crooked Ridge) and at all the pueblos. Abandonment strategies or scavenging activities may have removed them from the other pit house villages (refer to the village descriptions in Chapter 6). It is the redesigning strategies that distinguish the puebloan tools from those found at Crooked Ridge. No tools redesigned for concomitant use were found at Crooked Ridge. The designing of tools usable concomitantly may have served to

broaden the tool repertoire of the puebloans without expanding the number of tools. Those redesigned for sequential use were nothing more complex than recycled tools.

Polishing stones and abraders can be used to demonstrate both innovation and conservatism. In general, pottery-polishing stones and flat abraders changed very little through time. Pottery-polishing stones, particularly, are elegant in their simplicity. They are of expedient design, whereby naturally smoothed river pebbles were selected for use without further modification. If they were used a lot, wear facets were created; if used lightly, a few abrasive scratches or a sheen may be the only identifying attributes. Similarly, flat abraders are expediently designed from material selected for their natural granularity. Variations in configuration are mainly related to the surfaces they altered. The intergenerational transmission of knowledge (teaching frameworks) did not alter the design or manufacture of pottery-polishing stones or flat abraders.

Developments in other polishing stones and abraders include innovative designs probably created to accomplish specific tasks. For example, faceted polishing stones and similarly faceted abraders may have been involved in the manufacture of axes. The use-wear damage patterns are consistent with contact with a smooth stone surface. The abraders were probably for shaping bit edges to a point, and the polishing stones for smoothing the surface during the finishing stages of manufacture.

Another tool also might have been employed in axe manufacture, but its identification as such is tenuous. The stones, commonly called "doughnut stones,"

may have been used like grooved abraders to smooth and shape wooden shafts, such as axe handles, digging sticks, or other large wooden tools. Use-wear damage patterns in the holes of doughnut stones found at the Point of Pines villages are consistent with wood contact. One found on the floor of a Maverick Mountain phase room was associated with an axe that had a groove width of 2.2 cm. The hole in the doughnut stone is 2.6 cm in diameter. The axe handle would have fit in the hole of the doughnut stone where it could have been smoothed and possibly bent. This archaeological association is tenuous, but axe handle shaping is another possible use for doughnut stones. They are most commonly found among Hohokam assemblages and their use is largely unexplained; however, Haury (1976:291) suggests they were employed in games or to shell corn. Similar stones have been identified as digging stick weights in South America (Costin et al. 1989:121).

Other tool types found in pueblos but not in pit house villages are awls and bobbins. These tools were usually made of animal bone or wood and their manufacture from stone was perhaps experimental. The fact that they did not become commonly made of stone suggests there was a preference for making them out of wood or bone.

The typology used in this analysis of grinding technology distinguished between palettes and lapstones (refer to Chapter 5 for tool type definitions). Palettes were probably a Hohokam technology, and lapstones were a local technology. Both may have been used to process pigments, but some Hohokam palettes were also associated with cremation rituals. The presence of Hohokam palettes is too sporadic

to know whether this is the result of Mogollon acquisition of Hohokam tools, technological knowledge, or the practice of Hohokam cremation rituals at Point of Pines. Cremated human remains were found at Turkey Creek and Point of Pines pueblos, and some of the palettes found at these pueblos are of Hohokam design; however, it is unclear whether the human remains are Hohokam or Mogollon (Merbs 1967).

Grinding technology used in nonfood processing activities has only a slightly different history than the technology used in food processing activities. During the pit house occupation grinding technology remained fairly conservative with no apparent changes in either food or nonfood processing activities. For nonfood processing tools some of this conservatism may be more apparent than real due to abandonment strategies. However, during the pueblo occupation new tool types were developed with some innovations creating multiple purpose tools and others creating specialized tools.

Artifacts of Ambiguous Use

Handstones, grinding slabs, and netherstones are artifacts whose intended use is often difficult to identify. Their occurrence in both pit house and pueblo villages (Table 8.1) indicates that sometimes tools were not designed for specific use but could have been involved in processing either, or both, food and nonfood resources. There are fewer handstones at pueblos (11.6%) than at pit house villages (20.3%); however, in the field typologies, basin manos were included in the handstone category. Thus, the difference may be more a factor of record keeping than of

prehistoric behavior.

Construction Activities

Few ground stone tools have been identified as construction tools; only some specialized pestles and polishing stones. The pestles were so identified because of a possible tool kit found in a pit house at Crooked Ridge. Some tools in this kit may have dug house pits, storage pits or post holes, and others may have shaped or positioned the wooden components of pit house superstructures. At no other village was there such an association of tools. Individual tools were found through out the pit house and pueblo occupation, and it is assumed their use was equivalent to those in the tool kit. This assumption is tenuous, but has some support in the use-wear damage patterns on the tools.

Floor polishers might have been involved in both construction and structure maintenance activities. They were employed in the final stages of room construction to apply and finish the plaster, probably on both walls and floors, and to burnish fresh plaster applied over old (Adams 1979:51-52; Woodbury 1954:90). Although never plentiful, floor polishers were found in both pit house villages and pueblos. This may be another example of conservative Mogollon technology.

Procurement Activities

Only two tool types have been associated with procurement activities; axes and fire-drill hearths. Hafted axe technology was not developed by the Mogollon, and only a few axes of Hohokam design were found in the pit house villages. Wheat (1955:124) ponders the reasons why the Mogollon did not have hafted axe

technology when both the Hohokam and the Anasazi did. He concluded that "(s)uch a circumstance can only be the result of different cultural traditions" (Wheat 1955:124). It is suggested here that hafted axes were known and used through out the Point of Pines pit house occupation, even though they were not found in great quantities. More wood is involved in the construction of a pit house superstructure than in the construction of a pueblo roof. If axes were known by the builders of pit houses, they surely would have been used. A single axe was found on the floor of a Crooked Ridge pit house, fragments were found at Stove Canyon and Lunt villages, and two whole axes were found at Nantack village (all probably Hohokam design) indicating that axes were known to the Mogollon prior to pueblofication. Axes, especially if they were imported, were probably valuable enough to have been stored, curated, inherited, and used until they had no remnant use-life. Any abandoned at pit house villages could have been scavenged, and stockpiles created pending future use. Larralde and Schlanger (1994), working in the Four-Corners area, came to a similar conclusion.

While there are few axes in the pit house villages, the first aggregated pueblo village (Turkey Creek) has an unusually large number of axes, many (33.3%) of which had no remnant axe use-life. Axes are found in the archaeological record at pueblos because they were used and discarded differently than at pit house villages, and because they were manufactured locally, no longer imported. The few axes found at pit house villages have use-wear damage patterns consistent with chopping wood (Mills 1993:405). Use-wear damage patterns on the axes found at pueblos

indicate that some chopped wood while a few others were worked in soil (Mills 1993:407). Ultimately, many axes were used for pounding wooden stakes, shaping building stone, or making other stone tools. Faceted polishing stones and faceted abraders, which are suggested here to have been involved in axe manufacture, were only found in pueblo assemblages. Thus, while the pit house occupants may have imported tools from the Hohokam, making them valuable commodities, eventually Hohokam technological knowledge was acquired and the Mogollon manufactured their own axes. Local manufacture might have made axes more plentiful and more apt to have been employed in activities other than those for which they were designed.

The design of axes changed somewhat through time. The earliest axe found in the Point of Pines area was of Hohokam design with a 3/4 groove and groove ridges. All of the axes from the pit house occupation have 3/4 grooves; those from the latest pit house village (Nantack) do not have the groove ridges. Full-groove axes were found in the earliest pueblo (W:10:37), and are most common, but still infrequent (14.4%), at Turkey Creek (Table 5.8). At all but the earliest pueblo (W:10:37) there is evidence of two hafting techniques coexisting; several examples of 3/4-groove axes regrooved with full-grooves, as well as, one example of a full-groove axe regrooved with a 3/4 groove. Thus, it seems that people who employed different hafting techniques continued to coexist from the occupation of Turkey Creek until the Point of Pines area was abandoned.

Fire-drill hearths made of stone may be a puebloan technological experiment.

Usually, fire-drill hearths were made of wood (refer to Chapter 5). No stone fire-drill hearths were found at the pit house villages, and only four were found at two of the pueblos (Turkey Creek, W:10:50, Canyon Creek phase). This "experimentation" in material once again reflects the expansion of puebloan grinding technology not evident in the pit house technological traditions.

Nonprocessing Activities

Grinding technology was used to make artifacts, such as pipes, tubes, balls, bowls, plugs, and caps, which were involved in nonprocessing activities. These artifacts are part of the baseline tradition of the pit house villages and continue in use throughout the pueblo occupation, except at one of the latest pueblos (W:10:50B), where none were found. Pipes were not found at either of the Point of Pines phase pueblos, and only at the two earliest pit house villages (Crooked Ridge, Stove Canyon). It is possible these items were removed upon abandonment of the villages, as pipes are easily carried and probably highly valued.

Plugs and caps are infrequent through out the occupation except at Turkey Creek. There must have been some sort of storage container at this aggregated pueblo sealed with plugs and caps. Perhaps plugs and caps were just as necessary at other times but were made out of wood and are therefore undocumented. It is difficult to assess whether this unusually high number of stone plugs and caps at Turkey Creek reflects new technology or experiments in the use of materials.

The History of Point of Pines Grinding Technology

The Point of Pines area provides a rich archaeological record usable in the

assessment of how prehistoric people lived their daily lives over a thousand-year period. The work of the field school and the resulting published and unpublished reports create a foundation, built upon by this analysis of ground stone artifacts to create several concepts useful in a discussion of technological behavior as social behavior.

The pit house Mogollon established a conservative grinding tradition; tool design, motor habits, and the location of activities remained virtually unchanged during the 600 years of pit house village life. The teaching frames within which knowledge was transmitted, faithfully reproduced the same techniques generation after generation. With pueblofication, there were changes suggesting the acquisition of new technological knowledge, either through familiarization with other traditions or through innovation. During the pit house occupation there were no new tool types created by the Mogollon, and only a few were introduced, such as axes and bordered palettes.

The only evidence for a foreign technology in the early pit house occupation is on the floor of one structure at Crooked Ridge. This assemblage may represent trade for some personal items, or the presence of a Hohokam individual. No where else at the site is there evidence of Hohokam grinding technology. During the occupation of Stove Canyon village, there is architectural evidence of Hohokam residents, but only a few palette fragments indicate the presence of Hohokam grinding technology. Evidence for Hohokam technology at Nantack village is only in the presence of some palette fragments and two axes. Thus, while the Mogollon

were well aware of the Hohokam, they acquired very little Hohokam grinding technology.

Around A.D. 1000-1100, the Point of Pines Mogollon began building masonry pueblos. Haury (1989:116) has suggested, primarily on the basis of architectural and ceramic evidence, that pueblification was the result of Anasazi immigration. He also noted (1989:116) that Anasazi-type pottery found at the early pueblos was not made locally, but rather imported. Perhaps this is an indication of trade rather than immigration. The only evidence in the ground stone assemblage of Anasazi influence is in the small number of full-grooved axes. If an Anasazi population moved into the Point of Pines area, it is logical to believe they would have brought their own food grinding technology. By A.D. 1000, the Anasazi had well established food grinding technology of flat mano/metate equipment in slab lined grinding bins (Bartlett 1933:25-27; Woodbury 1954:63-65). No such equipment was found in the Point of Pines villages prior to A.D. 1265, long after the first pueblos were built.

It should be noted that at the same time that puebloan architecture was introduced to the Point of Pines Mogollon, so was open-trough mano/metate equipment and grinding, and mealing receptacles. Open-trough metates were used by the eastern Mogollon and Mimbres (Lancaster 1984:252; Martin and Rinaldo 1950a:452; Martin et al. 1949:137) perhaps earlier (prior to Reserve phase) than they were used by Point of Pines Mogollon (during the Reserve phase). Martin and Rinaldo (1950a:451; 1950b:305) intimate that open-trough metates were a local

Mogollon development from earlier prototypes. During the same period, a few full-grooved axes were found in eastern Mogollon villages (Martin et al. 1949:138). An affiliation between the more eastern branches of Pine Lawn Mogollon and the Point of Pines Mogollon (also called the Black River Mogollon) has been suggested (Neely 1974:xxxii; Wheat 1954:181-182). Perhaps this connection was not only that they shared the same baseline grinding traditions, but also that the pueblofication of the Point of Pines Mogollon was sparked by the acquisition of Anasazi technological knowledge from the eastern Mogollon region, rather than directly from the Anasazi region. The eastern Mogollon may have introduced puebloan architecture, open-trough metates, mealing receptacles, and a few full-groove axes into the Point of Pines area, and the Anasazi had a less-direct effect than previously thought on the pueblofication of the Point of Pines Mogollon.

Nothing in the ground stone assemblage suggests a major change in Mogollon grinding technology until the Point of Pines phase. Then there is a change to a more intense food grinding strategy, especially at W:10:51. Here many of the manos have evidence of wear management, there are multiple bins with both flat and trough metates, and free-standing, open-trough metates arranged so that many women could grind together. Most of the rooms in this late pueblo were contemporary and devote space to accommodate grinding activities. At W:10:50B, a contemporaneous pueblo, there was very little space devoted to grinding activities. Perhaps W:10:51 was a specialized village where food was ground to supply a large social network that included people in nearby pueblos. This is not the traditional Mogollon strategy of

individual grinders using free-standing equipment.

Why was there a change in food grinding strategy during the last 50 years of Point of Pines occupation? This change happened after the "abandonment" of the large Point of Pines pueblo, about A.D. 1400 (Haury 1958:415), when several smaller settlements were built on and around the ruins of the large pueblo. The two included in this analysis (W:10:50B, W:10:51) are slightly different from each other in food grinding strategies as just described. I suggested earlier that late puebloan food processing strategies were related to changes in the social network of food distribution. It would be interesting to see if an ecological study could determine the reliability of agricultural resources at this time, taking into account climate, hydrology, and the system of agricultural terraces and water control systems (Woodbury 1961). Variations in reliability may have prompted changes in food distribution strategies. Food grinders occasionally may have been supplying a larger group of people, especially if some fields were productive and others were not, through some social mechanism to facilitate the redistribution of stock-piled food (see Ford 1972:6-14 for a discussion of food redistribution among historic eastern pueblos). Food redistribution is one of many aspects to historic pueblo katsina ceremonies (Adams 1991:13; Eggan 1983:188). Such a social solution to the problem of feeding groups of people would have capitalized on food processing strategies that included efficient tool design, allowed for long grinding sessions, and situated grinding activities where many grinders could work together.

In conclusion, this analysis of grinding technology has covered many topics.

By considering grinding technology on a scale larger than artifact type, and by looking at changes over a long period of time it has been possible to keep track of the baseline Mogollon technology. Developments in grinding technology did occur; some were induced by foreign technology and some were local innovations. To add my opinion to the discussion about who these people were (see LeBlanc 1986:299-300), I suggest that the Point of Pines Mogollon continued relatively unchanged in the way they accomplished their daily activities until very late in the occupation. Puebloification did not change the Mogollon, they merely began living in masonry pueblos while continuing to grind their food and perform their other daily activities using the same basic technology they had while living in pit house villages. There was foreign technology introduced with full-groove axes, but this technique of hafting was never adopted; rather the Mogollon continued to make 3/4-groove axes with knowledge acquired from the Hohokam. Some food grinders used slightly more efficient open-trough equipment, but the motor habits and the social organization of food grinding remained unchanged.

Around the mid-1200s, an Anasazi group did immigrate to the Point of Pines area and took up residence in a large Mogollon pueblo (W:10:50). Again foreign technology (flat mano/metate equipment in bins) was introduced but not immediately adopted by the resident Mogollon. The conservative Mogollon continued to use their own traditional technology. Grinding equipment of two different designs coexisted for about 100 years through the Maverick Mountain and the Canyon Creek phases. Then an important social development is reflected in the clear change in

food grinding strategy, which began with the Point of Pines phase, sometime around A.D. 1400. It is this change, a socially driven change rather than a change instigated by immigrants, that signals the blending of Mogollon and Anasazi into Western Pueblo. Haury (1986:454) writes that the Point of Pines people "...cease to exist as a discrete Mogollon people..." during the eleventh century A.D. I argue that they continued the same technological traditions until around A.D. 1400.

Pueblofication of the Point of Pines Mogollon may have been Anasazi inspired via the eastern Mogollon, but it was not a product of Anasazi occupation. Mogollon food grinding technology continued in a conservative fashion after pueblofication with the addition of a slightly different metate design, and a couple examples of multiple grinding receptacles. Nonfood processing technology developed multiple use tools, and a few innovative experiments in tool material composition. Procurement technology was supplemented with a full-groove, axe-hafting technique. Only 100-150 years after the immigration of the Anasazi, called the Maverick Mountain people, was there change in the social organization of grinding technology, specifically food grinding technology, and it is this social change that warrants considering the Point of Pines people *mestizos*, and labeling them Western Pueblo. The ideas presented here should highlight areas in need of further research; I believe that pottery and other artifact analyses will support the assertions I have made about the Point of Pines Mogollon.

APPENDIX A: ARTIFACT DESCRIPTIONS

Crooked Ridge Village

Food Processing ActivitiesManos and Metates

Crooked Ridge has a large assemblage of manos (n=123) and metates (n=47; Appendix A, Table 1). The metates are not available for analysis, but stone catalogue cards and Wheat (1954) provide some information. Most (57.4%) metates were designed with a 3/4 trough; seven (14.9%) are commonly called Utah metates because they have a "mano rest" or "shelf" pecked into the closed end. A few (12.8%) metates were designed with a basin, some (29.8%) are not identified by design.

Ninety-seven (78.9%) of the 123 manos are not available for analysis. Of the 26 available, 96.0 percent were manipulated in trough metates, the remaining (4.0%) against flat metates. Wheat's (1954:110-112) typology mixes manos used in basin metates with those used in trough metates, making it difficult to obtain specific counts of each type (Table 5.3). While most (86.0%) manos have only one surface, the rest have two opposing surfaces indicating that wear was managed by flipping the manos (Table 5.5). At least three manos were roughened by pecking. Several manos were involved in more than one activity: three on the upper surface as lapstones and one redesigned as a maul. A stone catalogue card described one mano as supporting a metate in use-position.

Thirteen pit houses, including one identified as ceremonial (pit house 9), had

APPENDIX A, TABLE 1

Summary of all inventoried (In) and analyzed (An) ground stone artifacts

ARTIFACT TYPE	CROOK RIDGE		STOVE CAN		LUNT		NANTK		W:10:37		TURK CREEK	
	In	An	In	An	In	An	In	An	In	An	In	An
ABRADER	5	23	2	1	1	0	4	1	15	16	3	83
AWL	0	0	0	0	0	0	0	0	0	0	0	0
AXE	0	1	0	1	0	1	1	2	9	12	2	120
BALL	0	1	0	0	0	1	1	3	1	0	0	4
BOBBIN	0	0	0	0	0	0	0	0	0	0	0	0
BOWL	0	3	0	0	0	1	0	1	0	2	1	34
DISK	0	0	0	0	0	0	0	0	0	2	0	8
FIRE HEARTH	0	0	0	0	0	0	0	0	0	0	0	3
GRIND SLAB	1	1	3	0	4	0	1	0	3	0	0	0
HANDSTONE	55	11	21	3	9	2	31	8	97	1	10	4
LAPSTONE	0	4	0	0	0	2	1	1	0	0	0	9
MANO	97	26	50	1	18	7	40	13	114	1	10	22
MAUL	6	13	0	0	0	1	0	4	1	9	1	16
METATE	47	0	30	0	8	0	21	0	16	0	102	1
MORTAR	2	9	0	0	0	0	0	4	1	10	0	55
NETHERSTN	0	0	1	1	3	0	0	1	1	0	4	9
PALETTE	0	0	0	2	0	3	0	3	0	1	0	13
PESTLE	3	14	0	0	0	0	1	2	3	3	1	6
PIPE/TUBE	0	8	0	1	0	0	0	0	0	0	0	2
PLUG/CAP	0	0	0	0	0	0	0	1	0	0	0	31
PLUMMET	0	0	0	1	0	1	0	0	0	1	1	7
POLISH STN	0	13	3	3	0	4	1	7	12	14	0	16
SPNDLE BASE	0	0	0	0	0	1	0	2	0	0	0	0
SITE TOTAL #	216	127	110	14	43	24	102	53	273	72	135	
%	63	37	89	11	64	36	66	34	79	21	443	23 77
POP TOTAL #	343		124		67		155		345		578	
%	11.3		4.1		2.2		5.1		11.4		19.1	

APPENDIX A, TABLE 1 - *Continued*

Summary of all inventoried (In) and analyzed (An) ground stone artifacts

ARTIFACT TYPE	W:10:50 MAV MT		W:10:50 CAN CRK		W:10:51		W:10:50B		TOTAL		ASSEMB TOTAL	
	In	An	In	An	In	An	In	An	In	An	#	%
ABRADER	9	22	35	36	11	21	16	15	101	218	319	10.6
AWL	0	1	0	1	0	1	0	0	0	3	3	.0
AXE	5	17	24	20	0	72	0	29	41	275	316	10.4
BALL	1	0	1	0	0	3	0	0	4	12	16	.5
BOBBIN	0	0	0	0	0	1	0	0	0	1	1	.0
BOWL	0	1	0	1	0	3	0	0	1	46	47	1.5
DISK	0	5	0	3	0	0	0	0	0	18	18	.6
FIRE HEARTH	0	0	0	1	0	0	0	0	0	4	4	.1
GRIND SLAB	1	1	0	0	1	0	0	0	14	2	16	.5
HANDSTONE	16	0	46	0	56	3	38	0	379	32	411	13.6
LAPSTONE	2	0	4	4	3	7	2	1	12	28	40	1.3
MANO	99	3	111	1	333	2	65	2	937	78	1015	33.5
MAUL	1	1	0	2	0	1	0	1	9	48	57	1.9
METATE	16	0	18	1	48	0	17	0	323	2	325	10.7
MORTAR	0	0	3	5	1	0	2	2	9	83	94	3.1
NETHERSTN	2	1	6	2	8	0	0	0	25	14	39	1.3
PALETTE	0	2	0	2	0	0	0	0	0	26	26	.9
PESTLE	0	5	2	1	2	3	5	1	17	35	52	1.7
PIPE/TUBE	0	1	0	2	0	0	0	0	0	14	14	4.6
PLUG/CAP	1	0	0	2	1	0	0	0	2	34	36	1.2
PLUMMET	0	0	0	0	0	0	0	0	1	10	11	.3
POLISH STN	1	9	10	18	18	30	10	1	55	115	170	5.6
SPNDLE BASE	0	0	0	0	0	0	0	0	0	3	3	.0
SITE TOTAL # %	154 69	69 31	260 72	102 28	482 77	147 23	155 74	52 25	1930 64	1103 36		
POP TOTAL # %	223 7.4		362 11.9		629 20.7		207 6.8		3033		3033	

manos and metates on the floors. In seven pit houses, the metates were propped at an angle so that the proximal ends were higher than the distal ends. Two pit houses (1,2) had multiple metates propped so that more than one grinder could work at a time. Several pit houses had metates near post holes as if they had been stored against the posts and fell as the posts rotted away. The metate on the floor of the ceremonial structure was upside-down, near a wall, probably in storage.

Mortars and Pestles

One pestle is described here as a food processing tool. There are impact fractures and abrasive scratches on the distal end that indicate it was used in a stone mortar. The pestle is most comfortably held in the left hand--assuming the depressions toward the proximal end are grips. Two mortars were recovered from the same pit house (15) as this pestle; however, they are too small to have been used with it. Two larger mortars described by Wheat (1954:115) are included here as food processing implements because of their size and lack of pigment or nonfood residues. Apparently, the mortar and pestle were not frequently used as food processing tools.

Nonfood Processing Activities

Abraders

Twenty-eight abraders were identified from Crooked Ridge. The largest percentage (46.4%) has one or more U-shaped grooves and was used to smooth or straighten shafts. Abraders with U-shaped grooves have various configurations: grooves on 14.3 percent are oriented parallel to the length of the stone (Wheat

1954;fig. 45g), 7.1 percent are parallel to the width. Those with grooves oriented parallel to the width have shorter grooved areas in which to work the shaft. Several (14.3%) have grooves oriented both ways so that they cross each other at right angles (Wheat 1954;fig. 45d-f). A small percentage (7.1%) is not identified by orientation. Eight abraders with U-shaped grooves have multiple grooves: four have two grooves, two have three grooves, and two have four grooves. Two abraders with U-shaped grooves may have been heated as part of the shaft straightening process. However, both were found on the floor of Pit house 2, which was partially burned, and it is possible they burned after they were no longer used.

Twenty U-shaped grooves were measured to see what size shafts were worked with these tools. Groove diameters range from 0.5 cm to 1.2 cm with 80 percent measuring 0.5 cm to 0.9 cm, and the remaining 20 percent measuring 1.0 cm to 1.2 cm. Several perforated sherd disks found at Crooked Ridge have holes ranging in diameter from 0.4 cm to 1.0 cm, suggesting that most grooved abraders are within the size range needed to shape spindles. However, the various wooden artifacts found in the nearby dry caves are also of dimensions compatible with the variation in groove widths on Crooked Ridge abraders.

A small percentage (7.1%) of abraders has V-shaped grooves and a smaller percentage (3.6%) has both V and U-shaped grooves. These were probably used to sharpen a point on wood or bone tools. How the abrader with both V and U-shaped grooves was used is difficult to determine because the grooves intersect each other in a random pattern (Wheat 1954;fig. 45h). All the grooves have use-wear damage

patterns consistent with shaping wood or bone shafts or points.

Flat abraders are 39.3 percent of the abrader assemblage; most are unavailable for analysis. The surfaces on the three that are available were worn flat and smooth, probably from rubbing against something broad and pliable, such as wood.

Lapstones

Four lapstones were recovered; one has two opposing surfaces with remnants of pigment on one surface. Another lapstone might have been used concomitantly as a polishing stone. Two lapstones have unidentified residues, one has use-wear damage patterns consistent with shaping shell or soft stone.

Mauls

Thirteen of the 19 mauls identified at Crooked Ridge are available for analysis; combined with the descriptions on the stone catalogue cards for those not available, it is possible to determine that the largest percentage of mauls (47.4%) was designed with a seven-eighths groove (Wheat 1954;fig. 48e), 26.3 percent with a full groove (Wheat 1954;fig. 48d), and 15.8 percent with a 3/4 groove. One (5.3%) is ungrooved and one (5.3%) is broken so the hafting technique is not identifiable. Six mauls have rounded impact fractures from pounding something pliable; perhaps wooden stakes or in the construction of the wood pit house superstructure. One maul has sharp impact fractures and chips removed, indicating it was forcefully pounded against a hard surface. This maul may have served in the manufacture of metates or other large stone items. Wheat (1954:66) describes one maul, on the floor of Pit house 11, as covered with clay, possibly from processing

pottery clay.

Mortars

All nine mortars recovered from Crooked Ridge are identified as nonfood processing tools, primarily because of their small size (Wheat 1954;fig. 44e-f). The entire mortar fits in the palm of a hand and has a basin shallow that would not have held much. No remnant pigment is visible in the basins but they have not been examined microscopically. Similar "pebble mortars" from other Point of Pines sites retain remnants of pigment. Most pebble mortars from Crooked Ridge have more impact fractures from crushing strokes and less abrasion from grinding strokes.

Polishing Stones

Thirteen polishing stones were recovered from Crooked Ridge; 12 are discussed here, one was involved in construction activities and is discussed in that section. Eight (66.7%) are pebbles selected for their naturally smooth surfaces and probably were used to polish pottery; however, no microscopic use-wear analysis was done to confirm this. Three pebbles (23%) were worked enough to produce wear facets. Four polishing stones have no distinctive attributes to infer whether they were used on pottery, wood, bone, or smooth stone surfaces.

Artifacts of Ambiguous Use

Grinding Slabs

Two grinding slabs were identified from Crooked Ridge. One is not available for analysis, the other one is available, but it is only a corner fragment.

Handstones

Sixty-six handstones were recovered, but only 11 are available for analysis.

One handstone has use-wear damage patterns most similar to that of a hide-processing stone (Adams 1979:53, 1988:307-315). Most handstones have abrasive scratches created through contact with a stone surface. One has two surfaces, each manipulated with a different motor habit. Both surfaces have abrasive scratches from reciprocal grinding; one surface also has impact fractures caused by pounding. Two handstones have residue; one has finger grooves and remnants of clay.

Pestles

Five pestles from Crooked Ridge might have been involved in either food or nonfood processing activities. Three were placed in this category because they are not available for analysis. One of the two available for analysis was used against a flat hard surface to process something soft. Use-wear damage patterns include impact fractures with wear extending into the lowest parts of the stone material. Such use-wear damage patterns could have been created by processing fibers from yucca or agave, or from processing pulpy food resources, but because there was no use-wear damage to suggest use in a mortar, these were classified as ambiguous. Another pestle was used too lightly or too infrequently to leave distinctive use-wear damage patterns.

Construction Activities

Pestles

Eleven pestles involved in nonfood processing activities were identified from Crooked Ridge, but all are too big to have been worked in the pebble mortars

described above. In fact, there are no use-wear damage patterns on the pestles suggestive of manipulation in a mortar. Pestle is probably not the proper term for these tools, except in a generic sense indicating use with a pounding motion. Wheat (1954:117) calls these tools pestles and digging tools. They were all found stored on the shelf of a pit house, possibly as a tool kit. Each tool is slightly different in configuration and use-wear damage pattern. Perhaps this collection of tools represents the tool kit of someone who constructed the wooden superstructure composing the pit house walls and roof.

The term mallet might better classify three of the tools. Each has a grip created by depressions along the sides, making the tool fit comfortably in the right hand. These mallets are narrower toward the proximal end and have either flat or concave distal ends. Use-wear damage patterns near the distal end indicate they were pounded against pliable surfaces. All five tools may have been used to make or position slats and beams in the roof and wall construction. Two other tools have similar use-wear damage patterns but the damage is located at a different spot on the tools, probably from manipulation with a different stroke.

Two tools have handgrips with one or both ends pointed and damaged by abrasive scratches that extend up the sides (Wheat 1954;fig. 43a). Perhaps these were used to dig post holes for the roof supports. One of the stored, pestle-like tools is a combination of a mallet and a digging tool. One end has rounded impact fractures like the possible mallets, and the other is worn like the digging tool.

One tool has the shape of a modern rolling pin, except one side is concave

with a sheen and rounding of the elevations, suggesting it was worked against a large, convex and pliable surface (Wheat 1954;fig. 43b). The ends of this tool were rubbed smooth where it was held in both hands and might have been used to smooth support posts or primaries. One of the stored tools was broken, and another was shaped but not used.

The eleven tools stored in the pit house were manipulated with a variety of motor habits and each might have been part of a larger activity. The motor habits and use-wear damage patterns are consistent with those used in a construction project that requires the splitting, pounding, and smoothing of wood framing.

Polishing Stones

One floor polisher was identified by its smooth surface and central pecked area. It might have been involved in the application and finishing of plaster on pitstructure walls and floors.

Procurement Activities

Axes

Only one axe was recovered from the pit houses at Crooked Ridge. It was designed with a 3/4 groove and a wedge groove on the fourth side (Wheat 1954;fig. 51a). This axe has raised ridges bordering the groove, which is a hafting technique common to Hohokam axes (Haury 1976:291). This axe was found on the floor of a pit house (2) along with several other artifacts of Hohokam origin.

Nonprocessing Activities

Balls

One ball was recovered from Crooked Ridge. It was ground to a spherical shape and would make a good kick ball. There are, however, few impact fractures and it may not have been used.

Bowls

Three bowls were recovered from Crooked Ridge. One has a pointed bottom and was found buried in the floor of a pit house, possibly in an ash pit. A second bowl was carefully shaped, embellished with incised lines on the outside, possibly to represent a melon (Wheat 1954;fig. 44d). The interior is stained red and the exterior bottom is burned; perhaps it was suspended over a fire. The bowl is of unusually fine craftsmanship, and it may have been of Hohokam origin. It was found on the floor of a pit house along with several other Hohokam-like artifacts.

The third bowl is also a handstone (Wheat 1954;fig. 44b). This multipurpose tool has a flat surface on one side and a basin pecked into the other side. The reuse of this item would have been sequential as the basin makes the handstone awkward to hold. The basin is rectangular and has a rounded rim. There is no use-wear damage to suggest that the bowl was anything other than a container.

Pipes/Tubes

Two of the eight pipes or tubes recovered from Crooked Ridge have burned residue in them, two others were burned but not from use. The rest were either unused pipes or were tubes made for some other purpose. One such tube (Wheat

1954;fig. 53) has an incised design on the outside which could be lightening. It is of unusual stone and craftsmanship and was found on the floor of Pit house 2 along with other artifacts of Hohokam origin.

Stove Canyon Village

Food Processing Activities

Manos and Metates

The only food processing tools from Stove Canyon are manos and metates. Of the 51 manos and 30 metates for which there is information only one mano is available for analysis, and it had been manipulated in a trough metate. A small percentage (6.7%) of the metates is of basin design, the rest are of trough design. Most were designed as 3/4 troughs (Neely 1974;fig. 84c), although some were just called trough and could be either 3/4- or open-troughs.

Information from room notes and stone catalogue cards indicates that most (90%) manos and metates were fragmentary, making it difficult to determine design. Five pit houses (1,2,4,7,10) were described by Neely (1974:129-157) as having metates possibly in use positions on the floors. Pit house 4 has three metates, pit house 7 has two. Four of the above pit houses also had other ground stone artifacts creating assemblages either used or stored in the structures. On the floors of at least four rooms were manos but no metates. Thus, at Stove Canyon, food processing was primarily accomplished with trough mano/metate equipment (probably 3/4-trough design) propped at an unknown angle and situated primarily facing the center of the structure.

Nonfood Processing Activities

Abraders

All three abraders from Stove Canyon are flat, but only one is available for analysis. This abrader has a V-shaped groove, but it has not been used to shape another tool; perhaps it was the start of a manufacture process for converting the flat abrader into another, unfinished, tool.

Palettes

Two palettes were recovered from Stove Canyon. One has no border, but the corners were shaped into large knobs (Neely 1974;fig. 87h). A depression in the center of the surface has abrasive scratches where, possibly, a powdery substance was worked. The other palette has a raised border and three small corner knobs (Neely 1974;fig. 87f). There is burning on the surface and the palette may have shattered during the burning. This palette is more reminiscent of Hohokam palettes than the first and the damage from fire suggests it may have been part of a mortuary ritual, like some Hohokam palettes. Both palettes were found in pit house fill, so their archaeological context provides no evidence for how they were used.

Plummets

Only one plummet was recovered from Stove Canyon (Neely 1974;fig. 95d). It has a slightly different configuration than most plummets. The widest part is like a cap, with only 1/4 of the body grooved and a second groove across the top. There is no obvious use-wear in the groove or anywhere else on the body.

Polishing Stones

Of the six polishing stones identified from Stove Canyon, three are available for analysis. All three are pebbles selected for their natural smoothness and were used enough to create a facet. One has remnants of reddish-orange pigment. These were probably involved in the manufacture of pottery, although no microscopic use-wear analysis was conducted. The polishing stones identified on stone catalogue cards are also pebbles and were probably part of pottery manufacture as well.

Procurement Activities

Axes

The only axe recovered from Stove Canyon is a bit fragment reused as a polishing stone. That no axes were found in the pit house occupation at Stove Canyon may not mean none were used here. Perhaps whole axes were taken by those who left the site, or those axes left behind were scavenged later (Larralde and Schlanger 1974).

Artifacts of Ambiguous Use

Grinding Slabs

The three grinding slabs found at Stove Canyon are not available for analysis. Two were identified on the stone catalogue cards as being flat.

Handstones

Of the 24 handstones identified at Stove Canyon only three are available for analysis. Two had one surface used against stone; the third might have been a pottery anvil. On one convex surface there is a sheen and a small area of impact

fractures; similar damage patterns have been identified on pottery anvils (Adams 1994). Three handstones described on stone catalogue cards have also been used as hammerstones.

Netherstones

Two fragments were identified as from netherstones; one is available for analysis. It probably had been part of a basin, but it is impossible to tell because it is so small. The fragment is burned and it may have been used in a roasting pit.

Nonprocessing Activities

Pipes/Tubes

One tube was recovered from Stove Canyon (Neely 1974;fig. 95a). It is cylindrical with a hole drilled from both ends. The inside of the tube is not fire-blackened and, therefore, was not identified as a pipe.

Lunt Village

Food Processing Activities

Manos and Metates

The mano/metate assemblage from Lunt is small: eight metates (none available for analysis) and 25 manos (seven available for analysis). Neely (1974:233) identifies one whole 3/4-trough metate found on the floor of pit house 1 that might have been in use position. Four pit houses had manos on the floor but no metates. The metates were probably removed from the pit houses when they were abandoned or scavenged sometime later.

Of the seven manos available for analysis, one (4.0%) was not used enough to

determine metate type. Sixty-eight percent of the manos were manipulated in trough metates, with smaller percentages in basin (12.0%) and against flat (8.0%) metates. Most manos (64.0%) have one surface, the rest have two opposing surfaces (Table 5.5). One mano has use-wear damage most similar to that created by grinding oily seeds, perhaps sunflower seeds (Adams, in press).

All metates were designed with a trough, but 75.0 percent are fragmentary and it is impossible to determine if the troughs were 3/4 or open. All whole metates were designed with 3/4 troughs, so it is assumed that the fragments were from the same design.

Nonfood Processing Activities

Abraders

One flat abrader identified from Lunt is not available for analysis.

Lapstones

Two lapstones from Lunt are available for analysis; both have flat surfaces. One has abrasive scratches on the surface where something slightly more asperite was rubbed and the other has remnants of pigment on the surface. The center of the pigment-stained area is clean, possibly as a result of grinding or mixing another substance.

Mauls

One maul available for analysis is covered with an ashy residue. It was designed with a 3/4 groove and has impact fractures on both ends indicating it was pounded against a hard surface.

Palettes

All three palettes recovered from Lunt are broken. One has three pieces that when reconstructed show a raised border with an incised decoration (Neely 1974;fig. 87a). This palette fragment is typical of certain Hohokam palettes (Haury 1976:286-287) and may have shattered from exposure to heat. One other palette fragment also has a raised border with a knob on the only corner that remains intact (Neely 1974;fig. 87c). The third palette fragment has a border area indicated by an incised line and embellished with running Xs (Neely 1974;fig. 87d). The break has been ground as if the piece had been used to smooth another object. The back of the palette is burned, possibly as part of a mortuary ritual. It is unclear how these palettes were used by the Lunt village inhabitants.

Plummets

One plummet was identified from Lunt (Neely 1974: fig. 96c). It has the characteristic incised line encircling the end; however, there is no obvious use-wear damage in the groove.

Spindle Bases

The only spindle base recovered from Lunt (Neely 1974;fig. 96g) has two shallow basins, one on each opposed surface, which would have served to confine a spinning spindle. Such a spindle could have been served as a base for winding thread. The use-wear damage patterns indicate that something pliable was worked in the basins and this would be consistent with the use of a wooden spindle.

Polishing Stones

Only four polishing stones were identified and all are available for analysis. Three of the four polishing stones analyzed are small pebbles selected for their natural smoothness; each was used enough to wear a facet. These were probably pottery-polishing stones, although, a microscopic use-wear analysis was not conducted to. The fourth polishing stone, which had not been used very much, might also have been a pottery-polishing stone.

Artifacts of Ambiguous Use

Grinding Slabs

None of the four grinding slabs found at Lunt is available for analysis. Three were described on the stone catalogue cards as having concave surfaces.

Handstones

Eleven handstones were identified from Lunt; two are available for analysis. One has use-wear damage patterns consistent with an experimental stone used to process a deer hide (Adams 1988). The other handstone had been involved in more than one activity. One faceted surface was used to polish a hard, smooth surface; the opposite side is more asperite with a central pecked area. Perhaps one of the activities in which this was used was the application and burnishing of plaster. Several pit houses at Lunt had remnants of wall and floor plaster that could have been applied or finished with such a tool.

Netherstones

Three netherstones were identified, but none is available for analysis. Two

were described as having concave surfaces, the other was not described. One served as a base for both grinding and for pounding.

Procurement Activities

Axes

The only axe recovered from the pit house occupation at Lunt is a bit fragment reused as an abrader/polishing stone. As was proposed for the axe assemblage at Stove Canyon, it is possible that axes were more abundant when the site was occupied, but either the occupants took the axes with them when they left or the site was left open and axes were scavenged.

Nonprocessing Activities

Balls

One ball was recovered from Lunt. It is mostly spherical with one flattened side and the few impact fractures suggest it was probably a kick ball.

Bowls

One bowl fragment was recovered from Lunt (Neely 1974;fig. 88b). It is embellished on the outside with vertical incised lines and is reminiscent of Hohokam bowls. Burned areas on the outside may have been from use or from being in a burned structure.

Nantack Village

Food Processing Activities

Manos and Metates

None of the 21 metates identified at Nantack is available for analysis. Based

on the information from the stone catalogue cards, room records, and Breternitz (1959), most metates (85.7%) are 3/4 trough, one of which is commonly called a Utah metate. Smaller percentages are basin metates (9.5%) and flat metates (4.8%) (Table 5.4). Breternitz (1959:39) notes that a basin metate, found in a pit intruding into the great kiva, has a hole worn in it.

Breternitz (1959:39) also identified a trough metate with a trough on each opposing surface, another that was "worn out," and a third broken metate that might have been an open trough metate. The room map for Pit house 8 illustrates an open-trough metate, but none was mentioned on either the stone catalogue cards or in Breternitz (1959). Maps included with the room reports also suggest that in at least three pit houses metates were in use positions and in two others they were in storage positions. Three pit houses and the Great Kiva have multiple metates. Two in the Great Kiva were found in pits where they were probably stored. It is unclear whether those found in pit houses 7, 5, and 6 were in use or storage positions. The pit houses have many manos associated with the metates, but there is no way of determining if these manos were used with the associated metates.

Thirteen of the 53 manos identified at Nantack are available for analysis. However, the analyzed data combined with information from stone catalogue cards indicates that most manos were manipulated in trough metates (71.7%), with smaller percentages in basin metates (11.3%) and on flat metates (9.4%) (Table 5.4). A small percentage of manos (7.5%) is not identifiable by the type of metate with which they were used.

Most manos (62.3%) were used only on one surface; however, a sizable percentage (35.8%) was flipped to create two opposing surfaces (Table 5.5). A small percentage (1.9%) was rotated to create two adjacent surfaces against a trough metate. The side opposite the adjacent surfaces was also a lapstone for grinding pigment. Two other manos were used as lapstones for grinding pigment, as well.

Nonfood Processing Activities

Abraders

Five flat abraders were identified from Nantack, but only one is available for analysis. This one abrader had been used on opposing surfaces against a pliable surface; perhaps to shape a broad, flat wood surface.

Lapstones

Two lapstones were identified from Nantack, but only one is available for analysis. Something hard and abrasive had been rubbed against this lapstone, leaving many scratches, it might have been used to shape a stone artifact with a more asperite surface.

Mauls

Four mauls were recovered from Nantack, each one designed with a slightly different groove configuration: one $3/4$ groove, one $7/8$ groove, one full groove, and one $3/4$ groove situated so that a broad side was left ungrooved instead of the typical smaller ungrooved side. Such a hafting technique may have allowed for the use of a different type of stroke. Sparse use-wear damage makes identification difficult. Impact fractures on the other mauls suggest they were pounded against hard

surfaces.

Mortars

All four mortars recovered from Nantack are pebble mortars. Breternitz (1959;fig. 34f,g) types them as stone bowls. The use-wear damage in the basins, however, indicates they were used for processing and not just as containers. Small, wooden tools might have been used to process or mix some substance within the basins. At least one mortar has pigment on it, but none have pigment in the basins. One is decorated on the outside with green, yellow, red, and black painted stripes (Breternitz 1959;fig.35).

Palettes

Two of the three palettes recovered from Nantack are such small fragments that only a corner remains. These two palettes have raised borders and are embellished with incised designs (Breternitz 1959;fig. 36a,b). One fragment is broken in such a way as to suggest that a hole was worn through the surface. Breternitz (1959:42) recognizes these fragments as from Hohokam palettes. The whole palette was created out of a pebble (Breternitz 1959;fig. 36c) with an incised line that separates the border with no further embellishment. There is burned residue on the surface. This palette could have been a local imitation of a Hohokam palette and, with the burned residue, might have been served in the same way as Hohokam palettes (Haury 1976:288). No cremations were discovered at Nantack (Merbs 1967).

Polishing Stones

Seven of the eight polishing stones identified at Nantack are available for analysis. Of these seven, all but one are pebbles used lightly to polish another surface. Most were probably pottery-polishing stones, although a microscopic use-wear analysis was not conducted. One polishing stone is a larger handstone rubbed against a hard, smooth surface.

Spindle Bases

Two spindle bases were recovered from Nantack. One is a small fragment, the other is a small disk with a shallow depression in each opposed surface. Breternitz (1959;fig. 34a) identifies this as a pitted tuff discoidal. A third possible spindle base is discussed under handstones, as the handstone was probably redesigned for use as a spindle base.

Artifacts of Ambiguous Use

Grinding Slabs

One grinding slab was identified from Nantack but it is not available for analysis.

Handstones

Eight of the 39 handstones are available for analysis. These handstones are too rough to have been polishing stones, but they have been worn smooth. They may have served in the application and burnishing of plaster; however, they do not have the characteristic central pecked area taken as indicative of floor polishers. One has a clayish residue, but this may have been a post-use deposition. Another

handstone is also a pestle and has pecked depressions that could have served as finger grips. One handstone was manipulated against two different surfaces.

Breternitz (1959:41) notes that some handstones could have been used in basin metates. In trying to reconcile counts of manos and handstones between room records, catalogue cards, and published totals, 12 tools are unaccounted for and may be either manos or handstones, so they are included under this ambiguous use category.

Netherstones

One netherstone was recovered from Nantack. It has a slightly concave surface. A pestle found in a pit in Pit house 1 is compatible with the surface; perhaps they were used together. The netherstone was found in the fill of Pit house 8. If they had been used together, their deposition would have implications for assessing structure contemporaneity, and for illustrating how artifacts were moved across the site either systemically or post-depositionally.

Pestles

Two of the three pestles identified from Nantack are available for analysis. One was described above as possibly compatible with the netherstone. Abrasive scratches and a few impact fractures indicate it was manipulated more for grinding than crushing. The other pestle has an unusual rectangular groove along with impact fractures on both ends from pounding against a hard surface. The groove has no use-wear damage patterns and its function is unknown.

Procurement Activities

Axes

Two of the three axes recovered from Nantack are whole and available for analysis. The unavailable axe is broken and nothing more is known about it. Both whole axes were designed with a 3/4 groove (Breternitz 1959;fig. 37b,c), and are sharp and considered usable. Both axes were found in fill deposits of pit houses. Use-wear damage patterns include abrasive scratches on both bit edges consistent with chopping wood (Mills 1993:405); one also has chips removed. The more damaged axe is also more massive (1942 grams) than the axe damaged only by abrasion (451 grams) and may have chopped larger trees with a more forceful motion. Groove widths of 2.8 cm and 3.2 cm indicate that the more massive axe head was hafted with a larger handle (Table 5.10).

Haury (1976:291) found axes of similar design at Snaketown. Assuming these axes were used by the pit house occupants, but not made locally, they might be further evidence of contact between Mogollon and Hohokam. No tools were found that might have been used in their manufacture; however, the material does not look particularly exotic to the Point of Pines area. Petrographic analysis of the axes is needed to establish their source.

Nonprocessing Activities

Balls

Three of the four balls identified at Nantack are available for analysis; two are spherical and two have flattened sides. These could have been used as noisemakers,

but those with flattened sites were probably kick balls. One spherical ball is made of gypsum and would not have withstood heavy use as either a kickball or a noisemaker. There are no distinctive use-wear damage patterns.

Bowls

One bowl was recovered from Nantack (Breternitz 1959;fig. 34d). The craftsmanship and configuration is similar to a bowl found in Pit house 2 at Crooked Ridge; however, this Nantack bowl is not embellished on the outside. Both bowls may have been of Hohokam origin.

Plugs/Caps

One cap was recovered from Nantack (Breternitz 1959;fig. 36f); it has been ground to create a cylindrical body and a flat top.

Pueblo AZ W:10:37

Food Processing Activities

Manos and Metates

What we can learn about the manos and metates from AZ W:10:37 is limited to interpreting what was written in room records, on stone catalogue cards, and in Alan Olson's dissertation (1959). I tried to reconcile Olson's classification with the stone catalogue card descriptions; the result is an estimate, more than an analysis, of what the manos and metates were like. Olson made the distinction between manos and handstones based on size; handstones were less than 13 cm in length and manos were greater than 13 cm (Olson 1959:137). Because I defined manos as any tool with damage patterns from manipulation against a metate, many of the tools Olson

called handstones I would consider manos used in a basin or small trough metate. Thus, the large number of handstones (98) from AZ W:10:37 may have been inflated by an indeterminant number of manos. Only one mano is available for analysis, and this one broke and was redesigned into an abrader with a U-shaped groove.

None of the 16 metates described by Olson (1959:138-141) is available for analysis. However, as he describes them, basin and 3/4-trough metates were equally common (18.8%), open-trough metates were most common (56.3%), and flat metates the least common (6.3%). The presence of so few metates, however, suggests that metates were removed prehistorically.

Based on reconciled mano descriptions (n=115), it can be inferred that 63 (59.8%) were used on a single surface, 41 (35.7%) on two opposing surfaces, nine (7.8%) so as to create two adjacent surfaces and one opposed surface, and two (1.7%) were worn so that two adjacent surfaces were formed with a remnant of the original flat surface between them (Table 5.5). It is impossible to determine the type of metate in which each mano was manipulated, and those used in basin metates were probably typed as handstones. Of the 58 identified manos, most (93.1%) were used in trough metates, 5.2 percent against flat metates, and 1.7 percent in basin metates.

Mortars and Pestles

Only one mortar and none of the pestles recovered from AZ W:10:37 can be identified with any confidence as involved in food processing activities. The one

mortar most likely used in food processing has a deep basin and a notch in the rim that would have facilitated pouring of liquids. Thus, it is suggested that this tool was used, possibly with a wooden pestle, to pulp or juice a fruit or vegetable food. This may have been an innovative design, as no similarly shaped mortars were found at the earlier pit house villages.

Nonfood Processing Activities

Abraders

Thirty-one abraders were recovered from AZ W:10:37; sixteen are available for analysis. Fourteen (45.6%) are flat, of which two are of a finer texture. Use-wear damage patterns on these tools are consistent with the damage produced by working shell or soft stone of equally smooth texture (Adams 1989a:269-270); perhaps these abraders were involved in manufacturing personal ornaments. At least three flat abraders were used on opposing surfaces; one against surfaces of different configurations creating one concave abrader surface and another convex.

Ten abraders (32.3%) were designed with U-shaped grooves for smoothing or straightening shafts (Olson 1959;fig. 35c). Groove widths range from 0.6 cm to 2.5 cm; with 55.5 percent, 0.6cm to 0.8cm wide, 33.3 percent, 1.2 cm to 1.6 cm wide; and 11.1 percent, 2.5 cm wide. The smaller grooves may have been served to shape spindles, awls, or prayer sticks, and the larger grooves to shape digging sticks, axe handles, or other large staffs. One grooved abrader has a single U-shaped groove on one surface and multiple U-shaped grooves on the opposing surface. Most (75.0%) abraders with U-shaped grooves were designed with the groove parallel to

the width of the stone; the rest (25.0%) are oriented parallel to the length. Five abraders with U-shaped grooves were also handstones or polishing stones and could have been used concomitantly as either tool type. The U-shaped groove in one handstone was reused with something very abrasive, more abrasive than expected from shaping a wooden implement. Another handstone also has a V-shaped groove small enough to have been used to sharpen a needle (Olson 1959;fig.35e).

Four abraders have V-shaped grooves, two of which were probably used to sharpen bone or wood tools. One has 2 V-shaped grooves, is covered with red pigment, and was probably involved in shaping bone or wood tools. This abrader was also a polishing stone and could have been used concomitantly in either activity. The V-shaped groove in another abrader could have been from use to dull the edges of flaked lithic tools.

Disks

Two disks recovered from AZ W:10:37 are available for analysis. One is broken; the other has a large biconical hole that gives it more of a ring than disk shape. There are no obvious use-wear damage patterns for inferring how this item was used.

Mauls

Ten mauls were recovered from AZ W:10:37, and nine are available for analysis. All are heavily damaged with impact fractures from having pounded hard--probably stone--surfaces (Olson 1959;fig. 36a-c). Two were broken, one of which continued in use after breaking. One had been more carefully shaped than the others

and has a wider hafting groove. Half (50%) were designed with a full-groove, 30 percent with a 3/4-groove, and 20 percent with a 7/8-groove. One 3/4-groove maul has ridges, reminiscent of a Hohokam axe-grooving techniques.

Mortars

Ten of the eleven mortars identified at AZ W:10:37 are available for analysis. Four of these are identified here as nonfood processing tools, the rest are either food processing tools or their use is ambiguous. Three nonfood processing mortars are pebbles with shallow, lightly used basins. These tools were probably held in one hand while small amounts of wet or powdery substances were mixed. One pebble mortar has two basins on opposing sides. A larger mortar has four depressions, one on one side and three on the opposite side; the depressions have remnants of red and yellow pigment.

Palettes

The single palette recovered from AZ W:10:37 has a raised border but does not resemble those previously identified as typical of Hohokam palettes (Olson 1959;fig. 34). Three corners have an encircling groove that creates a knob; the fourth corner has two knobs. The center has been worked with a hard, non-asperite pestle, probably to work something soft or powdery.

Plummets

One plummet identified at AZ W:10:37 is available for analysis. A groove encircles one end creating a knob; two diagonal grooves extend over the top of the knob. These grooves might have served for suspending the plummet.

Polishing Stones

Twenty-six polishing stones were identified at AZ W:10:37; 14 are available for analysis. Most (61.5%) are pebbles selected for their smooth texture, 11.5 percent are floor polishers (described in the section on construction activities), 7.7 percent are large, faceted stones, and 19.2 percent are unspecific polishing stones. The faceted polishing stones are generally rectangular in plan, triangular in profile, and have a narrow facet running the length of the stone. The use-wear damage patterns on the facets are the same as those on axe bits. It is possible that these faceted polishing stones were used in the final stages of axe manufacture, and perhaps for resharpening dull bits.

Two pebble polishing stones have wear facets and were probably pottery-polishing stones. The rest are either lightly used pottery-polishing stones or they were used against some other hard surface. A microscopic use-wear analysis was not conducted to determine the nature of the contact surface.

Artifacts of Ambiguous Use

Grinding Slabs

Three grinding slabs were identified at AZ W:10:37, but none is available for analysis. Two have flat surfaces and the surface of the other was not described.

Handstones

Only one handstone is available for analysis. It was manipulated lightly against a flat netherstone on opposing surfaces. According to the descriptions on the stone catalogue cards, four handstones were involved in more than one activity. One

each was also an abrader, a chopper, a hammerstone, or a lapstone.

Mortars

Five of the 11 mortars from AZ W:10:37 are identified as having been used in either food or nonfood processing activities. One was designed with a protrusion that could have functioned as a handle and is grooved, possibly for suspension. The basins on these mortars have more abrasive scratches than impact fractures, indicating that the intermediate substances were stirred or mixed more than crushed.

Netherstones

One flat netherstone was identified from AZ W:10:37. It is not available for analysis.

Pestles

The two pestles described in this section could have been involved in either food processing or nonfood processing activities. They are not available for analysis, and the descriptions do not provide enough information to determine how they were used.

Construction Activities

Pestles

Four of the six pestles identified at AZ W:10:37 are available for analysis; two were involved in nonfood processing activities, and are described in that section. The two involved in construction activities are similar to those stored in a pit house at Crooked Ridge Village. One has impact fractures on both ends from pounding a pliable surface (Olson 1959;fig. 32a). The other was used lightly on one pointed

end, perhaps to dig post holes.

Polishing Stones

Three floor polishers were recovered from AZ W:10:37. The only one available for analysis has a smooth surface probably from burnishing plaster on walls or floors.

Procurement Activities

Axes

Twenty-one axes were identified from AZ W:10:37 and twelve are available for analysis. Most (85.7%) were designed with 3/4 grooves (Olson 1959;fig. 36d-g,i), but a small percentage (9.5%) was designed with full grooves (Olson 1959;fig. 36h). One 3/4-groove axe (4.8%) also has a wedge groove that runs lengthwise on the forth side; another has a ridge on one side of the groove. Both the wedge groove and the groove ridge are Hohokam attributes. The axe with the groove ridge split during use and was notched to accommodate a new haft.

This assemblage of axes was heavily used, with 83.3 percent resharpened, 58.3 percent damaged by impact fractures or impact fractures and chips, and 16.7 percent damaged from pounding flat, hard surfaces. The latter were ultimately used as stone-shaping tools, either for pueblo construction or stone tool manufacture. Only 16.7 percent are usable despite abrasion damage, probably from felling trees. Groove widths indicate that handles were made from shafts 2.2-3.6 cm in diameter, with most 3.0 cm (Table 5.10). Grooved abraders could have been used to shape the smallest handles, but those wider than 2.5 cm would have been shaped with

another tool type. There is much variation in axe mass, ranging from 237 to 1261 grams, with 66.7 percent less than 700 grams.

While I think the axes found in the pit house components of Crooked Ridge and Nantack were of Hohokam origin, those found at AZ W:10:37 were probably manufactured locally. A petrographic analysis of the lithic material is needed to confirm this hypothesis. Faceted polishing stones, mentioned previously as possibly used in shaping axe bits, do not occur in the earlier pit house villages; this may indicate only that the axes were resharpened locally, but I think axe production became a local endeavor using acquired Hohokam technological knowledge.

Nonprocessing Activities

Balls

One ball was identified at AZ W:10:37. It is not available for analysis; however, based on the description on the stone catalogue card it might have been a kick ball.

Bowls

The two bowls identified from AZ W:10:37 are available for analysis. One is a fragment too small to identify use-wear damage patterns. The other is a carefully shaped item with a flat bottom and straight sides (Olson 1959;fig. 35a). The basin is square. There are no obvious abrasive scratches that might have resulted from use so it probably served as a container.

Turkey Creek Pueblo

Food Processing Activities

Manos and Metates

Of the 135 manos and metates inventoried, no metates and only 22 manos are available for analysis. What is known of food processing activities at Turkey Creek comes from these few analyzed manos and summary information from Johnson's (1965) and Lowell's (1991) dissertations. Almost all of the metates for which there is information are open trough (98%); the rest are flat metates. A field photograph of a 3/4-trough metate shows that it had been redesigned with a mortar basin.

While the majority of manos (68.8%) were manipulated in trough metates, a small percentage was used in basin metates (12.5%), and a smaller percentage against flat metates (9.3%); a few (9.3%) were not identifiable by metate type. That there is more variation in the manos than in the metates may reflect the possibility of some manos having been scavenged from other deposits and stockpiled for future use. This possibility is reinforced by the fact that 21.9 percent of the manos were involved in second activities. Two manos were reused as handstones against a stone surface other than a metate. Two manos are also lapstones; one to work something hard and not very granular, such as stone or shell personal ornaments. One mano was manufactured and never used as a mano, but one surface was used as an anvil, creating an area of impact fractures. One mano has two small mortar basins but the basins are unused.

Of those manos available for analysis, seven (31.8%) had been manufactured

with finger grooves. One mano and metate were found in association and it is assumed they were worked together as food-grinding equipment. There is information on 26 manos indicating the number of surfaces used against metates: 88.5 percent on one surface, 7.7 percent on two opposing surfaces, and 3.8 percent on three surfaces. Turkey Creek has a higher percentage of manos with single surfaces than any other Point of Pines site (Table 5.5). It seems that the Turkey Creek grinders were not as concerned with wear management as grinders from other sites. However, Turkey Creek grinders were interested in using more efficient metates. More open-trough metates were found at Turkey Creek than at the earlier pit house and pueblo villages (Table 5.4).

Mortars

Only one mortar might have been involved for processing food. The use-wear damage patterns in the basin indicate that a soft surface was rubbed against it; possibly a wood pestle was used to crush and grind something soft or a wood spoon was used for stirring. A notch on the edge would have facilitated the pouring of liquids, and a knob handle is positioned so that the contents would have been poured through the notch using the left hand. No pestles were identified that could have been used with this mortar.

Netherstones

Four netherstones have holes or spouts that would have facilitated the pouring of a liquid or semi-liquid substance; perhaps these were for pulping or juicing some type of food resource. Abrasive scratches in the basins indicate use with asperite

handstones. These netherstones are distinguished from mortars by their irregular shape, and because they were used with handstones rather than pestles.

Nonfood Processing Activities

Abraders

Eighty-six abraders, many (46.5%) with one or more U-shaped grooves, were recovered from Turkey Creek Pueblo. Several (44.8%) abraders with U-shaped grooves were also handstones, probably used concomitantly in both general grinding and shaft-shaping activities. Similarly, smaller percentages are also lapstones (7.7%), polishing stones (5.1%), and pestles (2.6%).

Sixty groove widths were measured. Most (56.7%) range from 1.0 cm to 1.8 cm wide; 40 percent are 0.3 cm to 0.9 cm wide; and 3.3 percent are greater than 2.0 cm wide (Table 5.7). No other Point of Pines village has such a large range of groove widths. One abrader with a single groove has black residue that looks like graphite, and another has black residue that looks like resin. Perhaps a greater variety of wooden artifacts was manufactured at this large pueblo than at other villages. Grooved abraders also could have been used to make spindle whorls, weaving tools, and prayer sticks, among other items. The designers of Turkey Creek grooved abraders took advantage of surface area more than the designers at other Point of Pines sites. More grooves are oriented parallel to the length of the stone (46.5%) than parallel to the width (34.9%), with a small percentage oriented diagonally (4.7%), and some (14.0%) indeterminable.

Five abraders have V-shaped grooves: two have multiple grooves, two have a

single groove, and one has both V- and U-shaped grooves. One abrader with multiple V-shaped grooves, and another with a single V-shaped groove were used concomitantly as handstones. All but one abrader with V-shaped grooves were probably used to sharpen bone or wooden points; the one was probably used to dull the edges of stone tools.

Flat abraders are plentiful (40.6%). Their surfaces range from flat to concave, and some have both a flat and a concave surface. These abraders were probably worked opportunistically on whatever surface needed alteration at the time. Some were worn smooth, so that continued use would have polished rather than abrade a surface. One flat abrader may have been a reamer. Similar tools were identified as used in the manufacture of personal ornaments (Haury 1976:284).

Faceted abraders are a variety of flat abraders not found at earlier pit house or pueblo villages. They are basically triangular in profile with at least one corner of the triangle worn to a long, flat facet. The use-wear damage patterns on the facet most resemble damage patterns on experimental stones created through stone-against-stone contact. I suggest that these were axe-manufacturing tools for shaping or resharpening bits. Seven faceted abraders (8.1%) are identified from Turkey Creek; an additional abrader has the characteristic triangular profile but not a facet. Except for texture, these faceted abraders are similar to the polishing stones at AZ W:10:37 identified as possibly used in axe manufacture. The tools described here were considered abraders because their material texture is granular enough to be abrasive, but the facets are worn smooth.

Disks

Six of the eight disks from Turkey Creek have a perforation; most (66.7%) are of the configuration commonly referred to as "doughnut stones." One (16.7%) was probably a whorl; and another (16.7%) was more ring- than donut-shape. The whorl has a hole diameter of 1.0 cm. Seventeen grooves on grooved abraders are 1.0-1.1 cm wide, and these could have been used to shape the spindle used with the whorl.

A macroscopic use-wear analysis of the holes in the doughnut stones indicates that something pliable rubbed inside the hole, rounding the most prominent projections on the stone. Similar stones were found at Snaketown and identified as either chunky stones used in the hoop and pole game, or as corn shellers (Haury 1976:291). It is suggested here that they were used in the same way as grooved abraders--to smooth or shape shafts; however, this hypothesis needs more empirical evidence.

Two disks are larger than the doughnut stones and are unperforated. One is a nicely shaped disk with smooth surfaces against which something equally hard and smooth was worked. The other unperforated disk has basins that, if they had been pecked completely through, would have created a doughnut stone. The use-wear damage patterns in the basins, however, appear to resulted from use and not manufacture. There is pigment on the tool, suggesting it was involved in pigment processing.

Lapstones

All nine lapstones identified from Turkey Creek have small areas on at least

one surface with use-wear damage from having served as the base for processing something. Two retain remnants of red or yellow pigment; two have impact fractures from crushing an intermediate substance. One has several small areas where something not very asperite was worked, perhaps soft stone or shell (Adams 1989a:269-270).

Mauls

Most (58.8%) of the 17 mauls were designed with a full groove; smaller percentages have 3/4 grooves (23.5%) and 7/8 grooves (17.6%). One maul has ridges along the grooves similar to the ridged grooves on Hohokam axes. All mauls have impact fractures that indicate they pounded a hard surface. These may have been used to dress the building stone with which the pueblo walls were constructed, or to shape large stone tools, such as manos and metates.

Mortars

The artifacts classified as mortars in the Turkey Creek assemblage are quite varied. More than half (65.4%) of the 55 mortars have basins created in other tools. The positioning of the mortar basins in all but three (a mano, a disk, and a grinding slab) indicate that use in different activities could have been concomitant. The second uses of the mano, disk, and grinding slab were sequential.

The 30 mortars shaped into handstones may have had multiple uses in the production of pigment. Seventeen (56.7%) mortar/handstones have pigment on them. Perhaps they were used to grind pigment which was then mixed with a mordant in the mortar basins for application on pottery or some other surface. It

would be interesting to compare the presence of specialized pigment-processing tools with the pottery assemblage from Turkey Creek to see if there is a simultaneous development of a particular painted pottery type. The pigments on the mortar/handstones are various shades of red and turquoise. Several other mortar/handstones have residues, possibly pitch or something else that might have served as a mordant.

Similarly, a few mortars (3.7%) are also grooved abraders. One mortar/abradar has two U-shaped grooves; both are 1.0 cm wide; another has a U-shaped groove 1.1 cm wide.

Two unusual mortars were carefully shaped. One is bilobe with an encircling groove dividing the stone in half. The basin has been worn smooth, indicating that a fine, nonabrasive substance was mixed in the bowl with a pestle no more asperite than the mortar. The other mortar has two basins located on opposite sides of the stone, so that only one basin was usable at a time. Two other mortars each have two basins situated on the same side, so that the basins were usable simultaneously. One double-basin tool has pigment in one basin but not in the other.

Ten pebble mortars are small and fit comfortably into the hand. Most have abrasive scratches in the basins, indicating they had been used for mixing; one has burned residue in the basin.

Palettes

All thirteen palettes recovered from Turkey Creek have either raised borders or a groove that sets off a border area from the mixing surface. Only three palettes are

whole. Two are broken but the break has been ground smooth, and may have been used to polish. A couple of palettes had been used on opposite sides for grinding pigments. The whole palettes and a couple of palette fragments have depressions created through contact with a non-abrasive pestle. The palette borders are embellished with incised designs of cross-hatched lines, ticked lines, running triangles with hatchures, zig-zag lines, nested Vs, and encircling lines on the edge. Two palettes have a resin-like residue on their surfaces, and another palette has residue on the side opposite the surface.

Plummets

Seven of the eight plummets identified from Turkey Creek were analyzed; all have a groove encircling one end. The groove is usually located horizontally around the tool, but on a couple, the groove is positioned more diagonally around the tool. The possibility that this groove was for suspension is reinforced by the presence of use-wear damage patterns created through contact with a soft surface.

Polishing Stones

Of the 16 polishing stones recovered from Turkey Creek, most (75%) are water-worn pebbles selected for their smooth texture. One is a floor polisher described in the construction activities section. Seven pebble polishing stones were used enough to produce wear facets, probably from polishing pottery. The rest could have polished either pottery, bone, wood, or stone surfaces; microscopic use-wear analysis was not conducted.

Two polishing stones are expediently designed and do not have distinctive use-

wear damage patterns. Two polishing stones had been involved in other activities; one concomitantly as a hammerstone, and the other sequentially as an adze.

Construction Activities

Polishing Stones

One polishing stone was designed and manufactured as a floor polisher. There is a central pecked area and a residue covering the stone that might be plaster.

Artifacts of Ambiguous Use

Handstones

Ten handstones from Turkey Creek Pueblo were inventoried; seven were available for analysis. Each has use-wear damage patterns consistent with use against another stone surface.

Mortars

Five mortars may have been used to process either food or nonfood substances. One is a tripod with abrasive scratches in the basin from either mixing something abrasive or using a pestle that was more asperite than the basin. One has a burned basin.

Netherstones

Five netherstones have concave surfaces, or depressed areas on the surface from use with a small handstone. It is unclear whether these were food or nonfood processing tools.

Pestles

Six of the seven pestles identified at Turkey Creek are available for analysis.

One has use-wear damage patterns that suggest contact with a wooden mortar, two were probably used in stone mortars, and two on pliable, flat surfaces. One of the latter has use-wear damage patterns similar to those on pottery anvils; however, there are no finger grips or other recognizable attributes to confirm this possibility. One pestle is similar to another found at Crooked Ridge in that it has a worn area on one side, possibly used to smooth a wooden beam. The ends are pointed and have use-wear damage patterns that could have resulted from being held by a hand on each end; for now it is included with pestles.

Procurement Activities

Axes

The large (n=122) and varied axe assemblage from Turkey Creek provides an opportunity to examine variations in design that might indicate differences in technological traditions. Most (68.9%) axes were resharpened and 32.0 percent still have a sharp bit edge. Use-wear damage patterns on the bits include abrasive scratches (13.9%), impact fractures (46.7%), and chips (33.6%). Assuming these were designed for felling trees, it seems that most were ultimately pounded against hard, probably stone surfaces. Forty percent were used until they were so worn and rounded they could not have been resharpened for use as an axe. On 28.7 percent, the bit edges were rounded from wear but could have been resharpened. A small percentage (5.7%) was never used.

While most axes were hafted by means of a 3/4 groove, a noticeable percentage (13.9%) has full grooves. As noted elsewhere, full groove is a hafting

technique common to the Anasazi. Groove design was a fixed part of the technological knowledge of axe manufacturers, as suggested by several axes (6.6%) originally manufactured with one groove design and then regrooved with a different design (Table 5.9). Six axes manufactured with 3/4 grooves were regrooved with a full groove, one manufactured with a full groove was regrooved with a 3/4 groove, and one manufactured with a 3/4 groove was regrooved with a 3/4 groove.

Two important behaviors are indicated: (1) The designers and manufacturers of both 3/4-groove and full groove axes maintained their design technique even when confronted with a different way of accomplishing the same task. This indicates a "recipe for action" (Schiffer and Skibo 1987:597) used by tool manufacturers that was not changed simply because they became aware of different design techniques; (2) Axe manufacturers selected existing axes as raw material. Axe heads may have been scavenged and possibly stockpiled from earlier deposits for reuse as needed. A similar behavior was suggested for axe-head curation among the Anasazi in southwestern Colorado-northwestern New Mexico (Larralde and Schlanger 1994).

Groove widths are another indication that axe manufacturers had a standardized set of rules for axe hafting. While groove widths range from 1.7 cm to 4.9 cm (Table 5.7); 30.1 percent are 2.8 cm to 3.1 cm wide, a variation of 0.3 cm. There may have been some standardization in handle size suggested by a small coefficient of variance around the central tendency of 2.9 cm to 3.0 cm. Grooved abraders could have been used to shape the smallest axe handles, but those larger

than 3.5 cm would have been shaped by other tools.

Fire-drill Hearths

Three fire-starting hearths were identified at Turkey Creek. Each has only one notched cupule, but they may not be complete tools. One has an incised zig-zag line.

Nonprocessing Activities

Ball

Four balls from Turkey Creek have flat surfaces characteristic of kick balls (Adams 1979:90, called racing balls). Two are made of a material that seems less than suitable for a good kick ball; however, they are all covered with impact fractures as would be expected from a stone kicked across the country side.

Bowls

All but one of 35 bowls identified from Turkey Creek were available for analysis. One was selected for its natural shape as there is no evidence of manufacture. Two, and possibly a third, have evidence of exposure to fire on the exterior bottom; these could have been cooking vessels. Two other bowls, one broken, have grooves that might have served for suspension. Two are embellished; one with pecked dimples, the other with incised nested Vs encircling the outside, reminiscent of a Hohokam bowl found at Snaketown (Haury 1976;fig. 14.25c). One bowl has yellow pigment on it but there is no evidence that the pigment was processed in the bowl.

Most bowls were carefully shaped on the outside but they do not always rest

stable or level. Five have square or rectangular basins, the rest are circular. There is some evidence of use-wear in the basins, but it does not seem to be related to the processing of intermediate substances. Rather, the use-wear damage patterns on all the bowls are sparse and probably the result of using some sort of utensil to remove the contents.

Pipes/Tubes

One of the two pipes found at Turkey Creek is fragmentary, yet still contains remnants of tobacco. The other is whole, carefully shaped, and discolored by smoke.

Plugs/Caps

Caps (n=8) and plugs (n=23) are relatively numerous at Turkey Creek. The caps all have irregularly shaped tops and long narrow bodies. The plugs are shaped so that the ends are either rounded, flat, or irregular; most are smooth and well shaped, but some are not as smooth as others. A couple are more rectilinear than cylindrical. There is some sparse use-wear damage that indicates contact with a soft surface, but most do not show damage beyond what was created by manufacture.

Pueblo AZ W:10:50, Maverick Mountain Phase

Food Processing Activities

Manos and Metates

Not much is known about the 102 manos recorded as from the Maverick Mountain occupation. Only three are available for analysis. All three were designed with finger grips. Information recorded on the stone catalogue cards indicates that

most (69.6%) were manipulated in trough metates, and a sizeable percentage (28.4%) was used on flat metates (Table 5.3). Information about the number of surfaces on manos was not always recorded, but for 41 manos, most (70.7%) were used on one surface and the rest on two opposing surfaces (Table 5.5).

The information on metates does not quite follow the same pattern as the manos; however, all that is known about the metates comes from room records and a few stone catalogue cards. Of the 16 described, most (50.0%) were designed with open troughs. There were more basin metates (25.0%) than flat metates (12.5%); however, there were no manos identified as having been manipulated in basin metates. This discrepancy could not be verified, and it is possible that some tools identified as handstones were used with basin metates.

Some information about food grinding activities can be added by considering the rooms with grinding bins. Maverick Mountain mealing bins were constructed of slabs and sherds. The slabs created a box, sometimes using the wall of the room as one side. The metate was situated in the box with the proximal end raised at an unrecorded angle. Sometimes near the distal end a "baffle sherd" made up part of one side of the box. This baffle sherd may have facilitated cleaning.

The "bins" described at Turkey Creek were constructed out of ridges or rings of adobe, and are more appropriately called grinding receptacles. The ridges acted as catchments at the distal ends of angled metates. None of the pre-Maverick Mountain mealing bins was box-like. Thus, while it appears that both the indigenous and immigrant food grinders employed a strategy of meal collection, the

technique was slightly different. One Maverick Mountain mealing bin was found with an open-trough metate in place, suggesting the possibility that either indigenous metates were scavenged and reused by the immigrants or metates were presented as gifts from the local residents. Most Anasazi mealing bins were outfitted with flat metates (Anderson 1969a:3, 1969b 189; Bartlett 1933:24-27; Dean 1969:33; Hayes and Lancaster 1975:151; Jennings 1966:61; Lindsay 1969:152-156; Lindsay et al. 1968:273; Rohn 1971:202; Swannack 1969:42; Woodbury 1954:63).

Nonfood Processing Activities

Abraders

Thirty abraders were recovered from the Maverick Mountain occupation. One abrader has a single V-shaped groove, but it is not available for analysis. Most abraders (53.3%) are flat, and most flat abraders (83.3%) were rubbed against more than one surface configuration to shape something pliable, such as wood. Four have two broad surfaces worn to a wedge shape, and two have narrow facets worn from use against a similarly pliable surface. Surface configurations indicate that a variety of strategies were used to shape wooden objects. One flat abrader had been used against a surface harder than wood or bone and also had been grooved. This multi-purpose tool might have been used to shape stone and bone artifacts.

Thirteen abraders have one or more U-shaped grooves; most (76.9%) have a single groove, the rest have multiple grooves. Only six abraders, all with single grooves, are available for analysis. One is a flat abrader that also has a groove. Groove widths on the six single-grooved abraders range from 0.8 cm to 1.4 cm.

Half (50.0%) of the abraders have grooves oriented parallel to the width of the tool; 37.5 percent are oriented parallel to the length, and 12.5 percent are unidentifiable by orientation.

One grooved abrader was also a handstone. The second use of this tool was sequential, as the groove was cut into the working surface of the handstone. Two other grooved abraders were also handstones, but the different uses were concomitant. Another grooved abrader was concomitantly used as a lapstone. The lapstone has remnants of red pigment. One single grooved abrader has use-wear damage patterns consistent with contact against a hard, possibly stone, surface. Another grooved abrader has remnants of resin or other residue that might have been part of a tool-making activity.

Awls

One stone awl was recovered from the Maverick Mountain occupation. The awl point has a sheen from use against a soft surface. The cylindrical shape of this piece must have been created against a stone of similar asperity, as few abrasive scratches remain from its manufacture. An abrader with two grooves was identified as having use-wear damage patterns consistent with shaping a hard shaft; however, the grooves are broken in such a way as to preclude width measurements. The stone awl may have been shaped by this, or a similar, grooved abrader. Two other grooved abraders have the appropriate-size grooves, but they are too asperite, and use-wear damage patterns indicate they were rubbed against pliable, probably wooden shafts.

Disks

Five perforated disks were recovered from the Maverick Mountain occupation. All are commonly called "doughnut stones," and have biconical holes. The smallest, inside hole diameters are 1.4 cm, 1.5 cm, 2.6 cm, 3.0 cm and 3.3 cm. There is use-wear damage in the holes similar to that created through contact with wood.

Lapstones

Two lapstones were recovered; one has a small basin, and the other has a concave depression from use with a small, hard handstone.

Mauls

One of the two mauls recovered was hafted using a full groove and the other has a 7/8 groove. Only the 7/8-groove maul is available for analysis. One end was battered more than the other, but both pounded hard, possibly stone surfaces.

Palettes

Two palettes were recovered from the Maverick Mountain occupation. One has a raised border embellished with incised zig-zag lines and hatched triangles. The surface has several depressions with many abrasive scratches. Either something granular was worked on the surface or a handstone more asperite than the palette was used.

The other palette is broken and was burned. It has a raised border with incised zig-zag lines and triangles. The bottom was scored with a grid pattern.

Polishing Stones

Ten polishing stones were recovered from the Maverick Mountain occupation,

half of which might have been involved in axe production. Long, narrow facets have use-wear damage patterns consistent with rubbing a stone surface of comparable asperity. These faceted polishing stones might have been part of the final shaping of axe bits. One of the possible axe-polishing stones was redesigned with a groove. This tool was used sequentially as a polishing stone and then as a grooved abrader.

Three polishing stones are pebbles selected for their smooth texture. One has red pigment and was rubbed against a hard surface. Two other stones were worked against more than one surface, each with a different hardness and configuration. They could have been used concomitantly to polish pottery, wood, or bone.

Artifacts of Ambiguous Use

Handstones

Of the 16 handstones identified from the Maverick Mountain occupation, only two are available for analysis. Each was also used as a pecking stone.

Grinding Slabs

Two grinding slabs from the Maverick Mountain occupation are available for analysis. Both are flat; one was used on opposing surfaces. The single-surface grinding slab is of a coarser texture than the double-surface slab. The double-surface slab has red pigment on one side that may not have been associated with its use.

Netherstones

Only one of the three netherstones from the Maverick Mountain occupation is

available for analysis. It has an area of wear on one surface against which something pliable was worked.

Pestles

Two pestles may or may not have been food processing tools. One, perhaps, was used in a stone mortar but the use-wear damage is indistinct. The other pestle was pounded against a flat surface to work something pliable.

Procurement Activities

Axes

Twenty-two axes were recovered from the Maverick Mountain occupation. One is described in the nonprocessing activities section. Most (72.7%) have a 3/4 groove, 13.6 percent have a full groove, 9.1 percent were originally designed with a 3/4 groove and regrooved with a full groove, and 4.5 percent were originally grooved with a 3/4 groove, broke and rehafted with a notch. Three axes have groove ridges reminiscent of earlier Hohokam hafting techniques. The ridges are not as prominent as on Hohokam axes, and two have ridges only on one side of the groove. These ridges may have functioned to improve the seating of the haft.

Seventeen axes are available for analysis and a microscopic examination of the bit edges indicates that most (64.7%) were probably chopped trees, leaving abrasive scratches on all, and tiny chips on several. Some axes (29.5%) have impact fractures that suggest they ultimately were pounded against stone or some other hard surfaces. Some (37.5%) are still usable; half (50.0%) are dull, but could be made usable with resharpening. The rest are not usable as axes, even with maintenance.

One 3/4-groove axe has a double bit, each manipulated with a different amount of force or against surfaces of differing resiliency. One bit edge is rounded and has tiny chips; the other is not as rounded and has larger chips removed. Both sides were probably used against wood.

These axes may reflect the ways in which immigrant populations acquire and design new tools. The assumption is that the immigrants designed axes with a full groove, and the resident population designed axes with a 3/4 groove. When the newcomers arrived they may have scavenged abandoned axe heads and rehfted them using their full-groove technique. They may also have acquired hafted axes from the residents, either through barter or as gifts. What is important is the evidence that 3/4-groove axes were regrooved with a full groove suggesting the immigrants maintained their axe design even when confronted with an alternative design.

Groove widths range from 1.6 cm to 3.3 cm with most 2.8 cm. The number of axes is too small to suggest that there was some standardization in axe handle size. Grooved abraders could not have been used to shape axe handles because the largest groove is 1.4 cm wide, too narrow for the smallest handle. The hole in doughnut stones is 2.5 cm in diameter and could have been used to shape some of the smaller axe handles.

Construction Activities

Pestles

The three pestles described here have no evidence of use in mortars; two have

use-wear damage patterns consistent with use as a digging tool. One broke and was then reused against a flat, hard surface. These three tools are similar to those found in a pit house at Crooked Ridge and identified as a possible construction tool kit. The tools found in the Maverick Mountain occupation may have been scavenged from earlier deposits.

Nonprocessing Activities

Axes

One 3/4-groove axe was neither hafted nor used, and was made out of material (tuff) not normally associated with axes.

Balls

One ball was recovered from the Maverick Mountain occupation, but is not available for analysis.

Bowls

One bowl from the Maverick Mountain occupation is available for analysis. It has been carefully shaped with bifurcated ends that might have functioned as lugs for suspension. The bowl is burned, with an oxidized residue or pigment on one lug.

Pipes/Tubes

One conical tube with a biconical hole was recovered from the Maverick Mountain occupation. The tube is not burned and may not have been intended as a pipe.

Plugs/Caps

One plug was identified from the Maverick Mountain occupation, but it is not available for analysis.

Pueblo AZ W:10:50, Canyon Creek Phase

Food Processing Activities

Manos and Metates

Only one of the 112 manos from the Canyon Creek occupation is available for analysis. This mano was originally manipulated in a trough metate and reused against a flat metate. The grinder employed a wear management technique against the flat metate that created two adjacent grinding surfaces. The opposite flat side is a lapstone. Information on the stone catalogue cards indicates that four other manos were also used as lapstones, and that eight others were used in two different metates. Over half (54.5%) the manos are not described by number of used surfaces; however, of those for which there is information: 73.3 percent have one surface, 37.8 percent have two opposing surfaces, and 22.2 percent have two adjacent surfaces. Most manos (75.0%) were manipulated in trough metates with the rest used against flat metates.

Nineteen metates were identified from the Canyon Creek occupation, but only one is available for analysis. This one was probably collected because it is unusual with a lightly-used closed trough. Information on the stone catalogue cards indicates that the largest percentage of metates is open trough (42.1%), with smaller percentages of flat (26.3%), 3/4 trough (15.8%), and basin (5.3%). One mealing bin was identified on the floor of Room 61, but the metate had been removed.

There is little information on the food grinding tools, but it does seem clear that many were scavenged and reused. The design of the food grinding tools was not dramatically different than those found in the Maverick Mountain occupation. The Canyon Creek people may have continued the same food processing strategy as the Maverick Mountain people, including reusing scavenged or gifted metates.

Nonfood Processing Activities

Abraders

Seventy-one abraders were identified from the Canyon Creek occupation; 36 are available for analysis. Most (50.7%) abraders are flat. There is a larger percentage of abraders with U-shaped grooves (33.8%) than with V-shaped grooves (5.6%); one has both U and V-shaped grooves. Small percentages are cylindrical (1.4%), faceted (5.6%), triangular (2.8%), or unidentified (2.8%).

Five flat abraders had been worn to a wedge-shape cross section and the use-wear damage patterns are consistent with wood contact. Four flat abraders also have use-wear damage patterns indicating use as hammerstones against hard surfaces.

The use-wear damage patterns on the faceted abraders differ from those on other abrader types. While the texture of the tools started out fine, most were worn smooth. Two have use-wear damage patterns consistent with use against hard, possibly stone surfaces; one was used against a more asperite stone surface. The use-wear damage patterns on the other two are not as distinct, and they may not have been used as much. Perhaps the faceted abraders were involved in manufacturing axes or resharpening axe bits. Two retain traces of pigment, but it is

unclear if the pigment was part of their use.

Of the eleven grooved abraders, seven (63.6%) have more than one groove. One abrader has 11 V-shaped grooves, one other has multiple V-shaped grooves, and two have single V-shaped grooves. One abrader with a single V-shaped groove was also used concomitantly as a polishing stone. Two abraders with multiple U-shaped grooves were also used concomitantly as handstones, and four concomitantly as polishing stones. Three abraders with single U-shaped grooves were used concomitantly as polishing stones; one is faceted and may have shaped axe bits. More abraders with U-shaped grooves were designed with groove orientation parallel to the length of the tool (40.0%) than to the width (30.0%); 30.0 percent have unidentifiable orientations. Groove widths on abraders with U-shaped grooves range from 0.2 cm to 1.2 cm, with most (80.0%) less than 1.0 cm. Groove widths are similar to the diameters of pahos, spindle, weaving tools, and arrows found in nearby cry caves (Gifford 1980). The use-wear damage patterns in the grooves are consistent with wood contact.

Awls

One stone awl was identified from the Canyon Creek occupation; it is pointed on one end and rounded on the opposite end. Use-wear damage patterns on the pointed end indicate it was worked against a soft surface. The diameter of the awl is 0.6 cm. Five abraders have grooves of an appropriate size for shaping the awl; however, the use-wear damage patterns in the grooves are more consistent with wood than stone contact.

Disks

Three disks were identified from the Canyon Creek occupation, and two are available for analysis. One is perforated with a biconical hole, 0.9 cm in diameter, which has use-wear damage patterns consistent with wood contact possibly resulting through use as a whorl. The second disk is an unperforated "doughnut stone." Depressions on both sides may have originally been the start of a hole; however, use-wear damage patterns in the depressions suggest contact with a wooden utensil. Perhaps this was a spindle base, or a very shallow mortar used with a small wooden pestle.

Lapstones

Eight lapstones were identified from the Canyon Creek occupation. Most (62.5%) have concave surfaces, 1 (12.5%) has a small basin, and the rest (25.0%) have flat surfaces. Four are available for analysis. One with a flat surface has use-wear damage patterns consistent with shell or soft stone contact, possibly from the production of personal ornaments. Another lapstone is notched on one end, perhaps for use as a handle as there are use-wear damage patterns in the notch consistent with hand-wear.

Mauls

Two mauls were identified from the Canyon Creek occupation, and both are available for analysis. One was designed with a full groove and the other with a 7/8 groove. The use-wear damage patterns on the 7/8-groove maul are consistent with wood contact, suggesting the maul was employed to pound stakes or wedges. The

other maul has flattened ends and may have pounded a harder surface than the 7/8-groove maul.

Mortars

Four mortars identified from the Canyon Creek occupation are considered nonfood processing tools primarily because of their size. Three are pebble mortars that would have been held in the hand for mixing small amounts of a powdery substance. The fourth mortar has a carefully shaped basin formed in a handstone; handstone and mortar use were concomitant. There are abrasive scratches in the basin, indicating either that something granular was mixed or the tool worked in the basin was more asperite than the mortar. None of the pestles identified from the Canyon Creek occupation were usable with any of these mortars.

Palettes

Two palettes were identified from the Canyon Creek occupation, and both are available for analysis. One palette has an unembellished border with several depressions worn in the surface. One has a hole in it suggesting that it was "killed." This palette was used concomitantly as a grooved abrader, with a V-shaped groove that has use-wear damage patterns similar to those created by wood or bone contact.

The second palette has a border embellished with vertical notches around the perimeter. There is a shallow depression in the center and some burned residue on the surface. This burned residue may not have been associated with the use of the palette if it was reclaimed from the burned Maverick Mountain deposits.

Polishing Stones

Twenty-seven polishing stone were identified from the Canyon Creek occupation, eighteen of which are available for analysis. Seventeen are pebbles used on one or more edges or surfaces. Three are faceted polishing stones and may have been involved in axe manufacture. The use-wear damage patterns on the facets are consistent with contact with a stone surface of equal asperity. Nine pebbles were probably pottery-polishing stones. One has been used enough to create wear-facets, and another has red pigment. The rest of the polishing stones were used against hard, smooth surfaces.

Artifacts of Ambiguous Use

Handstones

None of the forty-six handstones identified are available for analysis, and the information on the stone catalogue cards is not helpful. As happened with collections from other sites, some may have been manipulated in basin metates and should have been typed as manos.

Mortars

Four of the eight mortars identified from the Canyon Creek occupation are considered of ambiguous use. Three are unavailable for analysis and the fourth could have been used to process either food or nonfood items. It has an elongated basin with use-wear damage patterns suggesting that either something granular was ground or a tool more asperite than the mortar was used for mixing.

Netherstones

Eight netherstones were identified from the Canyon Creek occupation; only

two are available for analysis. One has several areas on one surface where something soft was worked enough to create a sheen. The other handstone was not used enough to create distinctive use-wear damage patterns.

Pestles

Two of the three pestles identified from the Canyon Creek occupation are considered of ambiguous use. Neither is available for analysis.

Construction Activities

Pestles

Only one of three pestles identified from the Canyon Creek occupation is available for analysis. This tool was used like a digging stick and is similar to others described from Crooked Ridge. Use-wear damage patterns include abrasive scratches extending up the sides of the tool for 11 cm and a sheen on the opposite end probably created by hand contact.

Polishing Stones

One floor polisher was identified that has two opposing flat surfaces, each with a central pecked area. This tool has been burned and was, perhaps, scavenged from the burned Maverick Mountain deposits.

Procurement Activities

Axes

Forty-four axes were identified from the Canyon Creek occupation; 20 are available for analysis (two are described in the section on nonprocessing activities). Most axes (86.3%) were designed with 3/4 grooves, the rest (13.6%) have full

grooves. Three 3/4-groove axes have slight ridges on one or both sides of the groove. All full-grooved, and two 3/4-groove axes have use-wear damage patterns similar to experimental tools used to grub sagebrush (Mills 1993:407); perhaps these Canyon Creek phase axes were used similarly, to clear brush from fields or to do other gardening chores.

While 62.5 percent of the 3/4-grooved axes are still usable, the rest have remnant use-life but need some maintenance to make them usable as axes. Two 3/4-groove axes ultimately battered something pliable, possibly wooden stakes; one 3/4-groove axe ultimately shaped stone. Only 3/4 groove-axes have use-wear damage patterns consistent with wood chopping (n=9). Thus, it seems that 3/4-groove axes were more frequently used, as designed, for cutting wood, while full-groove axes were involved in second activities.

One 3/4-groove axe was regrooved from a broken axe. The new groove was situated so that one of the larger sides was ungrooved. This regrooved axe may have been manipulated more like an adze, with a motor habit different from the rest of the axes. It was found on the floor of Room 98, associated with a polishing stone that may have been used to finish the axe. One other axe was designed for manipulation with a different motor habit, and also may have been used as an adze.

Axe groove widths range from 1.2 cm to 4.3 cm, with most 2.6 cm to 2.7 cm. Axes from the Canyon Creek phase generally have the smallest handles and the greatest amount of variance (Table 5.10) compared to the other Point of Pines sites. A few grooved abraders could have been used to shape the smaller axe handles;

however, no grooved abrader could have accommodated a shaft more than 1.4 cm in diameter. Another tool must have been used to shape the larger handles.

Fire-drill Hearths

The only fire-drill hearth from the Canyon Creek occupation has two worn out cupules and one cupule that is still serviceable. The wornout cupules are deep and have holes worn in the bottoms. The still serviceable cupule is not as deep as the other two, but the use-wear damage patterns in each cupule are consistent with wood contact.

Nonprocessing Activities

Axes

Two full-groove axes were never hafted, never used, and made out of material (tuff) too soft for a tool. One was burned and may have been retrieved from the Maverick Mountain deposits.

Balls

One ball was identified from Canyon Creek; it is not available for analysis.

Bowls

One bowl was identified from the Canyon Creek occupation. It is broken, but the remaining section has notches that could have served for suspension. Use-wear damage patterns in the notches are consistent with contact against a pliable surface. There are no distinctive use-wear damage patterns in what remains of the basin.

Pipes/Tubes

Two tubes were recovered from the Canyon Creek occupation. One was

carefully shaped, has a biconical hole and may have been intended as a pipe, but it is not burned. The use of the other tube is unclear. It looks like a pebble mortar that has been drilled completely through with a biconical hole deeper on one side than the other. There are no use-wear damage patterns in the hole, nor has it been burned.

Plugs/Caps

Two caps were identified from the Canyon Creek occupation. One is small and has a groove under the large cap. Use-wear damage patterns in the groove suggest contact with a soft surface; perhaps a thong served to hold the cap in place.

The second plug is large and was identified by the excavators as a ventilator plug. The stem is smoke-blackened.

Pueblo AZ W:10:51

Food Processing Activities

Manos and Metates

While there was a large number of manos (n=335) and metates (n=48) identified from AZ W:10:51, no metates and only two manos are available for analysis. Some information is available from Wendorf (1950). However, Wendorf (1950:54-56) did not classify the manos according to the types of metates in which they were used. Those described on stone catalogue cards identify manos as primarily manipulated against flat metates (Table 5.3). Wendorf (1950:54-56) did describe manos by the number of surfaces: 59.4 percent were used on one surface, 29.0 percent on two opposite surfaces, 10.1 percent on two adjacent surfaces, and

1.5 percent on three surfaces (Table 5.5). Grinders at this village, more than any other, used wear management techniques to keep more than one mano surface compatible with the metate.

Wendorf (1950:53-54) classified metates on the basis of surface configuration. Most (60.4%) are flat, with a few (6.3%) that were probably flat but worn concave through use with a mano shorter than the width of the metate. Many metates (31.3%) were designed with open-troughs, and a few (2.1%) with 3/4 troughs.

Special note should be made of the manos and metates found in Structure 7. The two bins in this structure were surrounded by piles of manos and other artifacts. The excavator of this room noted that six manos fit the metate in one bin and seven other manos fit the metate in the other bin. This determination was made by placing the manos on the metates and assessing the fit. Other manos on the floor of this structure fit neither metate. Perhaps these incompatible manos were scavenged and stockpiled for eventual use with these metates, or they were stored in this room for use with a metate positioned elsewhere, or they were stockpiled for use in a second activity. No additional information was recorded for any of these tools.

Nonfood Processing Activities

Abraders

Thirty-two abraders were recovered from AZ W:10:51, the largest percentage of which (46.9%) has one or more U-shaped grooves used to smooth or straighten shafts. Forty percent of those with U-shaped grooves were burned, suggesting that they had been heated during the straightening process. Most abraders with U-shaped

grooves (57.1%) were made from fine-textured material, and had been worn too smooth to abrade. Combined with the abraders made from material with no texture, 92.8 percent of the abraders with U-shaped grooves were probably used for straightening shafts.

One abradar with a single U-shaped groove was used to smooth a stone shaft. A stone awl recovered from this site might have been shaped using such a grooved abradar, or the abradar could have been used to shape stone beads, as illustrated by Jernigan (1978;fig. 95).

Abraders with U-shaped grooves were designed with grooves oriented parallel to the length (31.6%), parallel to the width (42.1%), and diagonally (26.3%). Groove widths range from 0.8 cm to 1.1 cm, with most (52.6%) 0.8 cm wide. These widths are generally larger than some of the grooved abraders from earlier sites (Table 5.7), yet are still within the size range for the many wooden artifacts found in nearby dry caves (Gifford 1980:).

Eleven abraders (34.3%) were involved in second activities; most (54.5%) concomitantly as polishing stones, or handstones (36.4%). One abradar/handstone was probably used to grind the red pigment that covered the stone.

Twenty-five percent of the abraders have one or more V-shaped grooves for sharpening points on wood or bone tools. One abradar with multiple V-shaped grooves was used concomitantly as a lapstone, and is also covered with red pigment. Several tools retain pigment which may or may not have been related to their use as abraders.

Of the nine flat abraders identified from AZ W:10:51, only one is available for analysis. It is a rough pebble rubbed against a pliable surface, probably in shaping wood objects.

Awls

One stone awl was recognized among the artifacts from AZ W:10:51. The awl was shaped all over by grinding which left abrasive scratches that were smoothed by subsequent use against a soft surface. One abrader with a single U-shaped groove has use-wear similar to that created by stone-on-stone contact. The groove is 1.1 cm wide. The awl, which is 0.8 cm in diameter, could have been shaped on this or a similar abrader.

Bobbins

One bobbin was recovered. This is a narrow piece of stone with V-shaped notches in both ends and both sides. The surface has a sheen all over from having rubbed against something soft; possibly it served as a bobbin or shuttle in weaving. Thread or thin yarn could have been wound around the stone, either for storage or for holding the yarn as it was passed between the warp threads.

Handstones

Two handstones were identifiable as having been used to grind pigment; however, the use of most handstones is ambiguous. All handstones were used against granular stone surfaces, and the presence of pigment in the interstices of the lithic material suggests that pigment processing was their primary purpose.

Lapstones

Ten lapstones were identified from AZ W:10:51; three are not available for analysis. Five may have been used as palettes or some type of mixing surface. These have slightly concave surfaces where a small pestle might have processed something soft or powdery. None are bordered, so they are considered lapstones rather than palettes. One lapstone has a residue that may be a resin or something sticky used as a mordant. Two have depressions on opposing sides; one with red pigment in each opposing depression.

Two lapstones are of a material with no texture and use-wear damage patterns consistent with smooth stone contact. It is possible that these were involved in manufacturing axes or some other smooth stone object.

Mauls

Only one tool designed as a maul was recovered from AZ W:10:51; it has a 7/8 groove. There are no impact fractures to indicate use and no wear in the groove, suggesting that it was never hafted. However, several axes have impact fractures that probably resulted from their ultimate use as mauls.

Polishing Stones

Of the 48 polishing stones documented from AZ W:10:51, 30 are available for analysis. A microscopic use-wear analysis indicates that a variety of objects were polished: 46.7 percent were used to polish pottery; 43.3 percent to polish stone or something equally smooth and hard; and the rest to polish something pliable, such as wood or bone. A few polishing stones were also involved in second activities either

as pecking stones (8.9%), handstones (2.1%), or as pestles (2.1%).

Those polishing stones, identified as stone-polishing tools, are faceted and may have been involved in the manufacture of axes. The material make-up of the polishing stones is similar to the axes, and the sheen on the tools is nearly identical to that on experimental stones used to polish other stones of similar material.

A cluster of six polishing stones was found on the floor of Structure 7, possibly left where they were used between the hearth and the grinding bins but closer to the hearth. Five are pottery-polishing stones; one probably was used to polish either wood or bone, and might have been involved in the manufacture of a nearby bone artifact.

Artifacts of Ambiguous Use

Handstones

Only two of the 59 handstones identified from AZ W:10:51 are available for analysis; these are described in the section on nonfood processing activities. The rest are considered of ambiguous use because of a lack of information.

Grinding Slabs

One grinding slab was recovered from AZ W:10:51, but it is not available for analysis.

Mortars

The only mortar recovered from AZ W:10:51 is not available for analysis. Wendorf (1950:57) describes it as having an oval grinding basin which is not enough to identify it as a food or nonfood processing tool.

Netherstones

Eight netherstones were recovered from AZ W:10:51, but none are available for analysis.

Pestles

Five pestles were recovered from AZ W:10:51; two are not available for analysis. The three that are available were used in stone mortars with both grinding and crushing strokes. There is nothing to identify the type of activity in which these could have been used.

Procurement Activities

Axes

Seventy-two axes were recovered from AZ W:10:51; most (84.7%) were designed with 3/4 grooves. A small percentage (4.2%) has full grooves. Twenty-seven axes are still usable and another 27 could be made so with resharpening. One usable axe was originally designed with a 3/4 groove and was regrooved with a full groove, suggesting that at least one artisan maintained Anasazi axe production knowledge. Two full-groove axes and four 3/4-groove axes were involved in an activity other than wood chopping; either working in the soil or shaping stone.

A few (11.1%) were regrooved to change the position of the handle; one so that the ungrooved side was regrooved and the previously grooved side was left ungrooved. These regrooved axes were used so much that extensive resharpening would be needed to make them serviceable. Five were involved in more than one activity as polishing stones, lapstones, or pestles.

Non Processing Activities

Axes

Two axes may have been symbolic in that they were made of a material inappropriate for axe use, were never hafted, and have no evidence of use.

Balls

Two of the three balls recovered from AZ W:10:51 are covered with impact fractures that might have been created from use as a kick ball. The other ball has a few impact fractures but they have been rounded as if rolled against something pliable. Perhaps this stone was a "thunderstone" and was rolled over a wooden plank.

Bowls

Three bowls were recovered; all were pecked and ground to shape the perimeter, and the basins were ground to form shallow depressions. There are no use-wear damage patterns in the basins. The bottoms are flat enough that they rest stable on the ground, but in so resting the basins are not level. Basin depths range from 0.2 to 0.6 cm, and could not have held much.

Plug

One plug was recovered, but it is not available for analysis.

Pueblo AZ W:10:50B

Food Processing Activities

Manos and Metates

There were many more manos (n=67) recovered from the pueblo occupation of

AZ W:10:50B than metates (n=17) (Table 7.6). As noted earlier most mealing bins were abandoned and their metates removed—possibly before the pueblo was completely abandoned. Food processing activities may have been moved to another part of the pueblo that was not excavated, or ground foods were obtained from contemporaneous AZ W:10:51, which had a concentration of rooms devoted to food processing.

Most metates (65%) recovered from AZ W:10:50B are flat (Table 5.4) and most manos (57%) were manipulated against flat metates (Table 5.3). The trough design was less common, with 29 percent of the manos manipulated in trough metates, and 18 percent of the metates designed with a 3/4 trough and 6 percent with an open trough. Only the grinders at the other Point of Pines phase village (AZ W:10:51) used flat mano/metate equipment more than trough equipment. All earlier grinders used primarily trough equipment, either open- or 3/4-trough.

No metates from AZ W:10:50B are available for analysis, so it is not known if they were involved in a second activity. Two of the seven manos available for analysis had been used in second activities. One mano was redesigned and used sequentially as a hoe, with notches manufactured on the sides for holding a wooden handle. Use-wear damage patterns in the notches indicate that such a handle was attached at one time. One edge has impact fractures from where it came into contact with the ground. The second mano was used concomitantly as a lapstone to grind red pigment.

Mortars

Only two mortars may have been used in processing food resources; two other mortars were probably used to process nonfood resources. Only one food processing mortar is available for analysis; use-wear damage patterns indicate that a stone pestle crushed and ground an intermediate substance. This large, deep mortar is similar to those used ethnographically to crush mesquite pods (Euler and Dobyns 1983:259). No pestles were recovered that might have been used with this mortar.

Nonfood Processing Activities

Abraders

Thirty-one abraders were identified from AZ W:10:50B: 16 (51.6%) were inventoried, and the rest are available for analysis. The largest percentage (48.4%) is flat; however, only one is available for analysis. This one has a fine-textured working surface and use-wear damage patterns consistent with contact against either a wood or bone surface.

Fourteen abraders (45.2%) have one or more U-shaped grooves. Fifty percent of these shaped wooden or reed shafts. Groove widths range from 0.7 cm to 1.3 cm with 62.5 percent, 0.7 cm to 0.9 cm, and 37.5 percent, 1.0 cm to 1.3 cm. These widths are well within the dimensions of various wooden artifacts found in nearby dry caves (Gifford 1980). Most (71.4%) were designed with groove orientation parallel to the width of the tool; the rest (28.6%) are oriented parallel to the length.

One grooved abrader from AZ W:10:50B is covered with red pigment that might have colored wooden shafts. Another had been heated, probably to aid in

straightening shafts, and has a black residue, possibly graphite. One abrader with a single U-shaped groove has use-wear damage patterns resulting from contact with another stone surface. This tool could have been used either to shape stone beads or cylindrical stone awls. Two abraders with single U-shaped grooves had been heated, probably to aid in straightening shafts, but they also could have been used concomitantly as handstones to grind an intermediate substance against a netherstone. One ground red pigment.

Similarly, one abrader with multiple U-shaped grooves was used concomitantly as a handstone to grind pigment. One groove has pigment, as if used to apply the pigment to the shaft. Four other abraders have multiple U-shaped grooves but they were not multiple-use tools. One is not available for analysis, one had been heated for shaft straightening, and one has grooves of different widths where different size shafts were worked.

One abrader has a single V-shaped groove used to sharpen either a wood or bone tool, and concomitantly to polish other surfaces. The polishing surface is covered with red pigment. One abrader has both U-shaped and V-shaped grooves, and was used concomitantly as a polishing stone. The V-shape groove may have been used to dull the edges of flaked-lithic tools as the use-wear damage patterns are different than those created by sharpening bone or wood tools.

Lapstones

Of the three lapstones recovered, only one is available for analysis. It has a slightly concave working surface where pigment was crushed and ground, remnants

of which is visible in the interstices of the stone. The impact fractures and abrasive scratches are most similar to those created by stone-against-stone contact.

Mauls

One maul was identified among the collection of ground stone artifacts from AZ W:10:50B. A groove completely encircles the stone, with use-wear damage patterns that indicate it was hafted with a wood handle. Both ends are battered but the impact fractures are rounded possibly from pounding something pliable, such as wooden stakes, or from pulping something soft against a pliable surface.

Mortars

Two mortars are classified as nonfood processing tools, primarily because of the presence of pigment. Only one is available for analysis. Impact fractures and abrasive scratches suggest the use of a stone pestle to crush and grind the pigment.

Pestles

Four pestles are identified as having been used in nonfood processing activities because the stone catalogue cards noted the presence of pigment. None is available for analysis.

Polishing Stones

Eleven stones altered the surface of another artifact through polishing; however, only one is available for analysis. This polishing stone is unusual in that it had multiple uses. A V-shaped groove suggests that a bone or wood tool might have been worked against this stone, but the groove is not as deep as on grooved abraders. This tool is also a lapstone for grinding pigment. The surface used to

polish has a facet and use-wear damage patterns most similar to stone-against-stone contact. This tool might have been involved in the production of axes or some other smooth stone object.

Artifacts of Ambiguous Use

Handstones

Thirty-eight handstones were classified in the field, but none is available for analysis. Based on information provided on the stone catalogue cards, at least two were involved in second activities as hammerstones. It is unclear if these were used to process food or nonfood resources, but based on their descriptions it can be assumed they were worked against a netherstone to reduce an intermediate substance to a finer texture.

Pestles

Two pestles may have been used in either food or nonfood processing activities; one was available for analysis. The distal end has impact fractures and round grains consistent with pounding against a flat, pliable surface. Depressions near the proximal end were manufactured for gripping, and use-wear damage patterns are consistent with hand contact. Perhaps this pestle was employed to pulp a food resource, or to smash a stalk or leaf for separating fibers.

Procurement Activities

Axes

All of the 29 axes recovered from AZ W:10:50B are available for analysis and all were designed with 3/4 grooves: three were regrooved; two with another 3/4

groove, and one with a full groove. Axe groove widths range from 2.0 cm to 3.7 cm with a central tendency toward 2.8 cm. No grooved abraders from AZ W:10:50B could have shaped the axe handles, some other tool must have been used.

Eight axes, including the full-regrooved axe are still usable; 13 could be made usable with some resharpening. Five were ultimately used for something other than chopping wood, and one was no longer usable as an axe. Those involved in another activity have use-wear damage on the bit edge from pounding stone blocks or shaping other ground stone tools. The bit edges are rounded and covered with impact fractures.

The majority of axes (72.4%) have use-wear patterns consistent with wood chopping. Three axes have use-wear damage patterns consistent with use as chisels. One axe has the poll reshaped into a bit edge to create a double bitted axe with an off-center groove. The poll on another axe had been used on both flat sides to grind pigment.

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