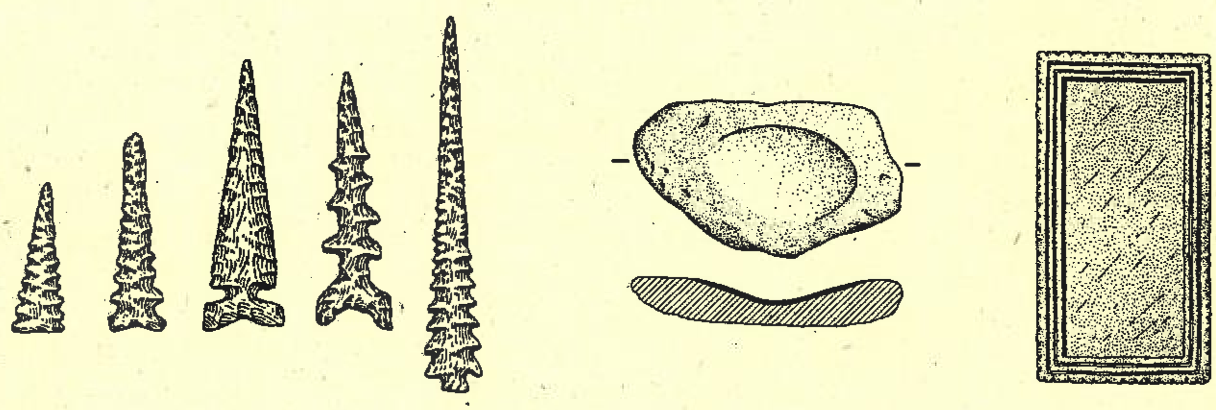
MAKING AND USING STONE ARTIFACTS: LITHIC SITES IN ARIZONA



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MAKING AND USING STONE ARTIFACTS: A CONTEXT FOR EVALUATING LITHIC SITES IN ARIZONA

Project Identification Number SP9017-50

Submitted to

ARIZONA STATE PARKS

Submitted by

**SWCA, Inc.
Environmental Consultants**

By

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Lee Fratt
Kirk Anderson
Richard V.N. Ahlstrom**

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CHAPTER 1
DEVELOPING A HISTORIC CONTEXT FOR LITHIC MATERIALS: AN INTRODUCTION

Richard V.N. Ahlstrom and Mark C. Slaughter

1.0 Introduction

The production and use of tools was long thought to be an exclusive and defining characteristic of humanity--until Jane Goodall observed chimpanzees modifying sticks and leaves to produce rudimentary tools. Although the making of tools can no longer be considered a uniquely human trait, it is clear that, in the complexity of human tool production and the essential role that tools play in human adaptation, human tool-use eclipses that of any nonhuman animal. Almost the entire history of the genus Homo has involved the production and use of stone, or "lithic," tools. Metal tools did not begin to replace stone tools until a few thousand years ago, and, in some parts of the world, the Stone Age survived into the present century. Stone was not the only material made into tools; in fact, the first tools were probably made of wood and bone. These materials are, however, much less durable than stone, and, therefore, any empirical history of human tool use must be first and foremost a history of stone tools.

Students of lithic technology recognize two major classes of lithic tools, flaked stone and ground stone. Flaked lithic tools are produced by the controlled breaking of pieces of stone, usually with the goal of producing a tool with a sharp edge or point that can be used for cutting, chopping, or penetrating a material or an object. Initial shaping of ground stone tools may begin with the removal of flakes from a piece of stone, however, completion of a tool and, particularly, production of a working surface involves battering, pecking, or abrading the object, typically with another stone. The antiquity of flaked stone tools has been documented with the association of lithic artifacts with archaic forms of Homo sapiens, whereas ground stone tools do not appear until later in time and are usually associated with horticulture/agricultural beginnings.

This study addresses the interpretation of lithic sites and lithic artifacts located in Arizona. An archaeological site can be considered a lithic site if stone tools (flaked, ground, or both) and waste flakes (debitage) provide the predominant evidence of human activity. In practical terms, this means that pot sherds and formal structures are either absent or relatively few in number and the lithic materials are the principal means of interpreting archaeological questions, such as site function, subsistence, settlement, and technology.

Lithic sites may be associated with an aceramic culture (cultures that did not use pottery) or with nonhabitation activities affiliated with Ceramic period groups. The distinction between lithic sites and other sites (e.g., pueblos, pithouse villages) is perhaps arbitrary; it does, however, address a real need in Southwestern archaeology. That is, it provides an opportunity to redress the bias of Southwestern prehistorians in favor of sites of the Ceramic period and sites with more or less substantial architectural remains.

We view patterned differences in the form and function of stone tools as the result of different adaptive strategies arising out of distinct environmental and cultural settings. Although the title of the study refers specifically to lithic sites, it is impossible to understand these sites without considering the artifacts as well. Procedures for investigating lithic sites are largely, though by no means entirely, an outgrowth of techniques for studying lithic artifacts.

In this report, we have attempted to summarize the available information on lithics and lithic technology in Arizona. There are many stone tool shapes, forms, and styles found in Arizona.

Indeed, to attempt to record all the differences, changes, and shapes would be not only futile but unrealistic, because our interpretation of the use and function of stone is subject to constant modification and redefinition. Additionally, there are numerous difficulties with the recording and the interpretation of the lithic data. For example, the early excavations by archaeologists sought only to collect the finished lithic tools rather than the debitage and unformalized tools. The lack of adequate information has skewed our knowledge and subsequent data interpretations pertaining to lithic materials. Another quandary is the abundance of complexes and cultural assignments present in the archaeological literature; recent interpretations have begun to question the use of area-specific complexes and the sample size on which they were formulated from. A final dilemma that plagues the whole of archeology is the limited information that has been recovered for aceramic cultures. In Arizona, these groups account for over 80 percent of the known human past, yet lithic sites are often overlooked and/or inadequately investigated.

In order to more fully understand Arizona's prehistory it is critical that prehistorians and historians accurately interpret the lithic record, which underscores the need for management guidelines to be established to aid in the assessment of lithic sites. Recent breakthroughs in method and theory allow archaeologists to interpret lithic sites with more accuracy. This progress towards developing a context for lithic sites reflects a growing emphasis on the preservation and interpretation of aceramic sites.

To provide the reader with a clear, concise, easy to use manuscript, three distinct formats are presented: a narrative (Chapters 2 through 7), glossaries of lithic terminology (Glossaries A through C), and an annotated bibliography (Appendix B). Additionally, there is a map of selected raw-material sources in Arizona enclosed on the back cover. It is hoped that this map of lithic source areas will be helpful as well as often amended. This report was prepared under contract with the Arizona State Parks, State Historic Preservation Office, Contract No. SP 9017-50.

1.1 The National Register of Historic Places

This report has been written within the broad context of the National Register of Historic Places. That is, it addresses issues that have been identified, defined, and organized as part of the ever-growing literature on the process whereby cultural-resource sites are nominated to, and listed on the National Register. The National Register is both a list of places and a preservation tool:

> As the official list of properties significant in American history, architecture, archeology, engineering, and culture, the National Register of Historic Places was designed to be used by the general public, local communities, state governments, and federal agencies in their preservation planning efforts. Properties listed in the National Register receive a limited form of protection and certain benefits [National Park Service 1982:1].

In addition, the National Register has come to play a critical role in the management of properties--e.g. archaeological sites--that will never be listed on it, or even be nominated for listing. In order for a site to come under the protection of antiquities legislation, it must be demonstrated that the site is potentially eligible for the National Register of Historic Places.

There is a large and growing body of guidelines for applying National Register procedures to archaeological sites and other "historic" properties (see the National Register Bulletins). These guidelines are organized around a body of key concepts, which are linked in sometimes complex ways. Although a thorough discussion of this conceptual framework is unnecessary in the present context, it is appropriate to introduce some of the key terms. This can be accomplished through a series of quotations from the National Register Bulletin. The relevance of these terms to lithic sites will be addressed later in Chapters 6 and 7 of this report.

> The Secretary of the Interior's standards state three distinct requirements for properties listed in the National Register of Historic Places. First of all, properties must possess significance. Second, the significance must satisfy at least one of the National Register criteria. And finally, significance must be derived from an understanding of historic context [National Park Service 1986:6, emphasis added].

There are four criteria for evaluating the significance of a property. In most cases, a lithic site will be evaluated with reference to Criterion D, which applies to "properties that have yielded, or may be likely to yield, information important in prehistory or history" (National Park Service 1982:n.p.).

> A historic context is a body of information about historic properties by theme, place, and time. It is the organization of information about our prehistory and history according to the stages of development occurring at various times and places [National Park Service 1986:7].

> A theme is a means of organizing or grouping properties into coherent patterns based on elements such as environment, transportation networks, technology, or political developments that have influenced the settlement and development of an area in one or more periods of history or prehistory.... A significant theme is one which can be demonstrated by scholarly research to be of importance in American history [National Park Service 1982:10, emphasis added].

Thus, significance is a quality both of individual properties and of the themes used to group those properties.

These statements about the National Register in general and about criteria for evaluation, historic contexts, and themes in particular all refer to the concept of the property. A property can be a district, site, building, structure, or object (National Park Service 1982:2). "A property type is a grouping of individual properties based on a set of shared ... characteristics" (National Park Service 1986:8, emphasis added).

In addition to the above-stated conditions, a property must possess integrity to be eligible for the National Register: "Integrity is the authenticity of the property's historic identity, evidenced by the survival of physical characteristics that existed during the property's historic or prehistoric period" (National Park Service 1982:35). Seven categories of integrity are recognized: location, design, setting, materials, workmanship, feeling, and association.

Based on these considerations, and on others not mentioned, it is possible to assess an archaeological site's eligibility for the National Register of Historic Places. As noted, a determination of eligibility brings a site under the jurisdiction of Federal and Arizona State antiquities laws. This finding does not mean that the site will be protected from destruction. However, a portion of a site's information potential may be preserved, and archaeological research may be required to "mitigate" any impacts. In addition to determining that a site is eligible for the National Register, it is possible for an important site to be nominated to the Register and eventually listed on it. Although such listing will not guarantee protection, it can provide access to funding related to preservation, and it is likely, especially in the case of a site on Federal lands, to discourage projects that would have a negative impact on the site.

CHAPTER 2
FLAKED STONE IN ARIZONA

Mark C. Slaughter

2.0 Introduction

The use of flaked stone materials for economic, social, and subsistence needs accounts for over 90 percent of human history. However, connecting stone artifacts with the complex set of human behaviors is often difficult. Influenced by advances in lithic analyses methods and encouraged by trends in anthropological theory, recent works attempt to examine the variation between lithic sites (assemblages) and to subsequently make inferences about production technology, artifact form, land use, subsistence, settlement, and mobility (e.g., Bamforth 1991, 1986; Bayham and Shackley 1986; Binford 1979; Bostwick 1988; Henry 1989; Kelly 1988; Parry and Kelly 1987; Shott 1989, 1986). Thus, current lithic studies tend to focus on site function, the inclusive set of behavior exhibited at a locality as inferred by the lithic materials, and the complex conditions that governed human decision making.

The purpose of this chapter is three-fold: (1) to present a brief summary of the flaked stone artifacts that have been recovered in Arizona, (2) to indicate the production trends that dominate distinct periods of time in prehistory, and (3) to identify artifacts and/or assemblages that are diagnostic. This is by no means an inclusive list of flaked stone artifacts. Rather, this brief summary is intended to introduce the lay reader, as well as the more experienced archaeologist, to the temporal trends represented by the lithic data in Arizona. Many of the tool types discussed here are further defined and illustrated in the Flaked Lithic Glossary (Glossary A).

2.1 Basic Concepts of Flaked Stone Production

Before proceeding with the discussion of flaked lithic materials found in Arizona, a succinct introduction to the mechanics and methods of flintknapping is needed. For a more in depth discussion of lithic tool manufacture and use, see the "classics" in flintknapping literature such as Crabtree (1972), Callahan (1979), and Swanson (1975). Basically, the manufacture of flaked stone tools is a reductive process; a larger piece of stone becomes smaller in size and weight with the purposeful removal of mass from the surfaces and margins of a lithic. Flaked stone artifacts, then, are those that are the product and by-product of the intentional removal of mass from a piece of stone by a human. Specifically, flaked stone artifacts are produced when force is applied to the surface or margin of a rock.

There are a number of decisions and steps involved is producing flaked stone forms. These decisions and steps include, but are not limited to, the selection of raw materials based on desirable qualities (such as the degree of isotropism, crystalline structure, homogeneity, elasticity, etc.), selection of a percussor (e.g., a hard rock, an antler), selection of a reduction method (e.g., bifacial, amorphous), the initial reduction by applied force (direct or indirect percussion flaking), secondary reduction, and tertiary reduction into a desired form (*sensu* Crabtree 1972).

As previously indicated, there are a number of cognitive choices that have to be made during the production of a stone tool; for example, the knapper must make a choice in technique, materials, and final tool form (i.e., an expedient tool versus a higher-labor-input item). Because of all the choices and decisions that are made, archaeologists and replicative practitioners infer that prehistoric knappers knew, previous to the reduction of the stone, what the final products were to resemble (flake, thin biface, etc.). Thus, reduction technology and the final form of a tool are deliberate and are implemented for extended periods of time, and are oftentimes geographically bound.

2.2 Concept of Diagnostics

Critical to the discussion of the use of flaked stone in Arizona is the identification of artifacts that represent specific groups and distinct periods of time. These artifacts, hereafter referred to as diagnostics, are important because they place sites into their proper context, time, and cultural affiliation. Point styles, other chipped stone tools, and to a limited degree reduction debris, all have the potential to be diagnostic. Additionally, combinations of lithic forms, such as tool kits, have also been used to indicate specific cultural affiliations (e.g., Sayles and Antevs 1941; Irwin-Williams 1973).

Points (spear, dart, and arrow) are the most commonly recognized and accepted diagnostic flaked lithic form. Point styles exhibit change through time and oftentimes have spatially bounded distributions. "Projectile point styles are the most sensitive indicators of ethnic identity, although a very few other flaked stone artifact types may ultimately be found to have some value in this regard" (Huckell 1984a:210). It should be noted, however, that the absolute dates associated with individual point styles, as well as the dispersion of the distinct point styles, continue to be identified and refined as additional research and advances in archaeological method are made, new areas surveyed, and materials from previous collections reexamined.

Classification of projectile points into various types and subtypes has been previously accomplished in many of the archaeological studies in Arizona as well as in the surrounding states (e.g., Bayham 1986; Bostwick 1988; Christenson 1987b; Formby 1986; Haury 1975; Huckell 1984a; Tagg 1991; Wormington 1957). There are two basic kinds of classification systems that have been developed to organize points recovered from archaeological sites. The first system, an intuitive morphological approach, uses attributes of size, shape, hafting modifications, and flaking styles to classify points into types and subtypes. The intuitive morphological approach has been employed in the Southwest to order assemblages (e.g., Heizer and Hester 1978; Irwin-Williams 1973; Wills 1988), and in Arizona specific regional typologies have been constructed using this approach to identify variation in point styles throughout the diverse geographic areas found in the state (e.g., Bayham 1986; Formby 1986; Huckell 1984a; Haury 1975; Sayles 1983; Tagg 1991). The second method of point classification, a quantitative attribute system, employs metric parameters and can include the use of multivariate statistics to define mutually exclusive types. The quantitative attribute system of analysis has been developed only recently as a technique for the creation of mathematically based typologies. This analytic method has yielded positive results in regions surrounding the Southwest, such as in the Great Basin (i.e., Holmer 1986; Thomas 1981), but attempts to create mathematically based typologies in Arizona have had mixed results (Plog 1981:92).

As suggested earlier, debitage is considered diagnostic of reduction techniques and conceivably, but certainly not conclusively, suggestive of a prehistoric temporal period. Before preceding with how debitage can be a rough temporal marker for a period, a brief introduction to the labor costs of tool manufacture is needed. Basically, there are two major categories of tool-production labor input, low and high. Low labor input is often associated with an expedient technology, that is, a system of tool manufacture that produces a high ratio of tools that are minimally finished and retouched. A low labor system is usually indicated by a flake-core technology and by a high ratio of low labor tools to "formal" tools. Flakes, cores, and raw material type can be used to infer this low level of input; for example, flake-cores, flakes from multidirectional cores, less-than-optimal use of the material (lots of waste), and selection of raw materials that are locally available and of marginal quality (e.g., basalt) are some of the attributes that possibly indicate this system. The second system of tool manufacture requires a high labor input to make finished tools. This technology produces a higher ratio of high-labor-input tools to expedient tools. Attributes of this system are diagnostic reduction techniques such as bifacial reduction, maximization of a raw material, selection of high-quality materials (e.g., cherts), procurement of distant or exotic raw materials, and the presence of finely worked tools (e.g., bifaces, points). The concept of temporally diagnostic patterning of debitage can only be roughly inferred. The Paleo-Indian and the most of the Archaic periods are usually associated with a high-labor-input system. The later Ceramic period and Historic Period are often dominated by an expedient technology and a low level of labor input to make flaked stone tools (this does not hold true, however, for the ground stone tools). It should be stressed, however, that most assemblages contain remains from both labor-input systems, although the proportions of lithics represented by each technology may vary.

2.3 Diagnostics, Chronology, and General Trends of Flaked Stone Production and Use in Arizona

Arizona has a long tradition of stone tool production and use. There is a vast assortment of stone artifacts found throughout the state, some of which are diagnostic of specific cultures and traditions. In the following section a brief overview of the flaked tools is presented by distinctive time periods.

2.3.1 Paleo-Indian Period (ca. 10,000-6,500 B.C.)

Paleo-Indian material remains have been recovered from areas throughout the Southwest in stratified contexts as well as from surface localities. Many of these artifacts that are found in Arizona, however, are from isolated surface finds (cf. Huckell 1982). To date, intact Paleo-Indian sites are known only from localities in the southeastern part of the state (see Haury et al. 1953; Haury et al. 1959; Hemmings 1970; Haynes 1980b; Haynes and Hemmings 1968).

From the research of many individuals (e.g., Antevs 1948, 1952, 1955; Haynes 1968; Martin 1963; Mehringer 1965, 1967; Mehringer and Haynes 1965; Van Devender and Spaulding 1979; Schoenwetter and Dittert 1968; and Betancourt and Davis 1984), we know that the Late Pleistocene climate was cooler and moister than that of the present. These past environmental conditions supported varieties of now extinct megafauna, including but not limited to mammoth, giant ground sloth, and extinct forms of bison. These animals and others were the focus of the subsistence activities by Paleo-Indian hunters. Paleo-Indians are believed to have relied on a highly mobile, wide-ranging adaptation geared towards the procurement of these large game animals. This interpretation is based on the lack of grinding implements at Paleo-Indian sites and the absence of large base camps. Paleo-Indian sites include temporary gearing-up camps, and kill and butchering locales. It is, of course, possible that other yet undiscovered site types exist.

The Paleo-Indian emphasis on hunting is reflected in the chipped stone artifacts that they left behind. General characteristics of the Paleo-Indian chipped stone assemblage include the use of a bifacial flaking technique, diagnostic point styles, retouched flake tools, relative scarcity of cores in proportion to reduction debris, a lack of grinding implements, the use of quality (fine-grained) and/or exotic raw material types, and bone tools. Many of the tools from this period were curated rather than discarded; that is, they were used, reworked, and served as multi-task tools. Additionally, the high-quality raw materials (usually cryptocrystalline silicates) are often from distant sources and indicate, besides mobility, a high degree of selection and choice, as well as a maximization of the stone. The Paleo-Indian occupation of Arizona encompasses several complexes, including the Clovis, Folsom, Agate Basin, and Cody. These complexes are discussed in their approximate chronological order below.

<u>Clovis</u>

The earliest Paleo-Indian remains recovered in Arizona are associated with the Clovis culture and date from 9500 to 9000 B.C. (Haynes 1980b). The most distinctive markers of Clovis culture are the lanceolate-shaped points. These points vary in size (± 10cm) and are basally fluted (approximately 1/3 of length), basally and laterally (approximately 1/3 of the lateral margin) ground, bifacially knapped, and minimally pressure flaked. Clovis points are almost always made from high-quality raw materials, which often come from non-local sources. Clovis points were likely made from bifacial preforms (Haynes 1980b). Although many of the known Clovis sites are only cursorily reported, a pattern of manufacturing techniques emerges. At a majority of the Clovis sites, there is a high ratio of bifacial flakes to any other flakes attributed to a distinct reduction method. For example, Murray Springs yielded over 12,500 flakes, most of which were produced by bifacial methods (Haynes 1980b). These bifacial flakes were found in discrete clusters, indicating activity areas of both bifacial reduction and retooling (Haynes 1980b:118). Like other Paleo-Indian points, Clovis points were designed to be hafted onto either foreshafts or shafts that would be hand-held and thrust at and in the selected animal.

Although more equivocal than the projectile points of the Clovis, channel or fluting flakes are a second class of potentially diagnostic artifacts. These thin flakes have prepared (beveled) platforms and numerous flake-removal scars on their dorsal surface. Fluting flakes detached during the manufacture of Clovis points can usually be distinguished from flakes associated with the manufacture of Folsom points by the latter's greater length. The tool kit that is associated with Clovis sites includes various flaked tools such as side, concave, and end scrapers, unifacial, bifacial, and flake knives, gravers, and burins (Haynes 1980b).

The distribution of Clovis materials in Arizona indicates that this group once roamed throughout most of the state. Clovis points, generally found as isolated surface finds, have been recovered in areas throughout Arizona (cf. Huckell 1982). In contrast, more than five subsurface stratified sites have been found in the southeastern portion of Arizona. These sites include Naco, Murray Springs, Escapule, Lehner, and Navarrete (Haury et al. 1959; Haury et al. 1953; Hemmings 1970; Haynes 1976, 1978, 1979, 1980; Haynes and Hemmings 1968). The lack of stratified sites outside of the southeastern valleys is puzzling, but is probably associated with the range and availability of the animals they were hunting. The scarcity of Paleo-Indian materials in the other areas of Arizona, such as the basins that are occupied by Phoenix and Tucson, could reflect a lack of exposure (deeply buried deposits), removal of cultural deposits (either natural or cultural), or a deficiency in archaeological survey in these areas (also see Huckell 1984b; Betancourt 1978).

Folsom

The Folsom period (9000-8000 B.C.) follows the Clovis Paleo-Indian period. Folsom material remains are not abundantly recovered in Arizona, but Folsom materials have been found in the northeastern and eastern parts of the state (see Tagg 1991; Huckell 1982; Agenbroad 1972). The Folsom period is characterized by a warmer and drier climate than that of the preceding Clovis period. Additionally, there is a change in the primary protein source, as the procurement of animals such as mammoth declines and is replaced by the procurement of a now-extinct form of bison. Coincident with these shifts in hunting practices is the development of a new point style. Folsom points are distinguished from the preceding Clovis points by their size and morphology; Folsom points are generally smaller, have longer flutes, are parallel flaked, have been basally ground, and are laterally ground higher on their margins. No in situ sites with Folsom materials have yet been located in Arizona, and Folsom points seemingly are restricted to surface finds (Huckell 1982:19-24).

Technologically, Folsom lithic materials are similar to those of the preceding Clovis period. The use of high-quality materials, the employment of a bifacial technology, the manufacture of points from bifacial preforms, and the presence of analogous tool types all suggest a continuation of trends from the earlier period.

San Dieguito

The San Dieguito complex, although of dubious dating, has been associated with the Paleo-Indian and Early Archaic periods in eastern California and western Arizona. San Dieguito was defined as a distinct complex based on geographic position, one radiometric date, artifact style, reduction debris, and the degree of weathering exhibited on artifact surfaces (see Rogers 1929, 1939, 1958, 1966; Warren 1967). The three phases of the San Dieguito, I, II, and III (originally, Malpais, Playa I, and Playa II [cf. Rogers 1939]) were derived from the lithic sites found in the Mohave Desert of eastern California. Later, they were extended to include areas of the Sonoran desert of western Arizona (Rogers 1966). San Dieguito II and III are reminiscent of the Lake Mohave complex (see Campbell et al. 1937), and Warren and True (1961) indicate that these phases of the San Dieguito may be related to the Lake Mohave complex of eastern California and western Arizona. It should be noted that the Malpais was later resurrected by Hayden (1976). From his work in the Sierra Pinacate, the dates were pushed back to at least 30,000 before the present (see Hayden 1979; Figure 9). The Malpais, despite the claimed antiquity, has no radiocarbon dates, unique artifacts or features, or stratified sites (McGuire and Schiffer 1982). Thus, the Malpais phase's place in prehistory, if it is a real construct at all, must be reexamined, and cultural materials must be firmly dated to reaffirm its validity.

Much like the Malpais, the San Dieguito suffers from a lack of absolute dates. There are two spatially distant subsurface sites that have been dated to the San Dieguito, Ventana Cave in western Arizona (Haury 1950) and the C. W. Harris site near San Diego (Warren 1967). Of these two sites, one is a stratigraphic sequence and the other has a single radiocarbon date from bone (McGuire and Schiffer 1982). Thus, a firm and definitive chronology of the San Dieguito does not exist. To further complicate the development of the San Dieguito chronology and phase designations, no site has been identified with all three San Dieguito phases. The real basis for the San Dieguito chronology (the features, tools, desert varnish thickness, and geologic superposition of the sites) are not firmly demonstrated. Further, none of the attributes that define the San Dieguito are exclusive to the complex. As a result, the chronological sequences and terminology proposed by Rogers have been subject to review (Warren 1967) and eventually has been changed by several authors (see Warren 1984; Warren and Crabtree 1986). To further the confusion, a number of traits (artifacts) have been associated with the individual phases of the San Dieguito (see Warren 1967). The summary of the artifacts, which range from reduction debris to tools, associated with the San Dieguito I-III can be found in McGuire and Schiffer (1982:168, Table 5.1). The impression that these classes of artifacts and debitage (traits) are associated with any of the individual San Dieguito phases is perhaps misleading. Without the aid of firm dates, such as radiocarbon, the traits are just as easily interpreted as representing functionally different sites (task specialization locales), possibly of synchronic affiliations.

Other Paleo-Indian Materials

Other Paleo-Indian materials found in Arizona include those of the Cody complex and Agate Basin complex in the east and northeastern portions of the state, the Ventana complex in the south-central part of Arizona, and many lithic artifacts from the Great Basin and eastern California that are identified in western Arizona. The Cody and Agate Basin complex points are surface finds (see Tagg 1991:9, 1987:44-45; Nichols and Smiley 1984:90) and probably indicate a limited use of eastern and northeastern portions of Arizona. It should be noted that the Agate Basin materials are usually considered a northern plains Paleo-Indian variant, and their occurrence on Black Mesa is puzzling. The Cody and Agate Basin complexes include mostly lanceolate points that have constricted bases and are collaterally flaked, leaving a raised ridge down their center. In addition to the array of point styles, the Cody complex has knives, end scrapers, denticulates, and notched flakes in its tool-kit (Cordell 1984:135).

Lake Mohave and Silver Lake points (10,000-5,000 B.C.) are the best indicators of Paleo-Indian/Early Archaic presence in the western portion of Arizona (Warren 1967). Lake Mohave points range in time from the Paleo-Indian period to the early Archaic. Other tool forms associated with these point styles include flaked stone crescents, scrapers, cobble choppers, rock hammers, and lanceolate knives (Cordell 1984:132-133; Warren and Crabtree 1986:185). Recently, a Lake Mohave point has been found near Alamo Lake (Gregory 1988), Silver Lake points were recovered from the middle Virgin River area (Fairley 1989:89), and Lake Mohave-like and Silver Lake-like points were both found south of Tucson (Huckell 1984a). The "like" points reflect the general similarities (tapering stem, general morphology) that are assumed to have specific temporal and spatial definition.

Later Paleo-Indian sites and isolated occurrences that have distinct point styles (i.e., Eden, Belen, Scottsbluff, etc.) are rare and usually occur only as surface finds. It is interesting to note that Rio Grande Paleo-Indian materials have been identified from the eastern part of Arizona (Tagg 1991). These isolated artifacts probably indicate a temporary use of eastern Arizona by groups usually associated with Rio Grande Paleo-Indians of New Mexico (e.g., Judge 1973).

2.3.2 Southwestern Archaic (8,000 B.C.- A.D. 300)

The term "Archaic" is and has been used to indicate both an adaptation and a time period (Bostwick 1988). The Archaic period differs from the Paleo-Indian period in settlement pattern, environment, and technology. Throughout most of the Archaic period the populations continued to follow a mobile settlement pattern, but in contrast to that of the Paleo-Indians, their movements were less wide-ranging and possibly constricted to geographic regions. The degree of mobility decreases through time until, during the Late Archaic, pit-house communities appear (reflecting the increased tendency towards sedentism).

Archaic period research indicates a diversity in the technologies that were employed to produce chipped stone tools. Archaic assemblages contain artifacts using flake, core, bifacial, and bipolar technologies (see Bostwick and Lewenstein 1988; Bostwick and Shackley 1987; Bayham 1982; Huckell 1984a; Shackley 1986; Rozen 1981; Whalen 1971; Haury 1950). Lithic tools associated with the Archaic period include various functional forms such as scrapers (ovoid, end, and side), bifacial knives, unifacially altered flakes (various styles), drills, perforators, planes(?), bifacial and flake cores, and points. Archaic points were probably hafted onto short shafts and thrown by the use of atlatls or hafted to longer shafts (spear-like use).

Archaic materials are widespread throughout Arizona. Numerous sites have been identified in southeastern Arizona; these include, the Rosemont Sites (Huckell 1984a), Cienega Creek (Damon and Long 1962; Haury 1957; Crane and Griffin 1958), and the Willcox Basin sites (Sayles and Antevs 1941; Sayles 1983; Whalen 1971; Woosley and Waters 1990). In the western and central portions of Arizona, Archaic period sites are usually surface or shallow subsurface sites. Buried sites, however, are not unknown, and sites have been excavated in western and central Arizona in the Haraquahala Valley (Bostwick 1988), Aquarius Mountains (Linford 1979), Big Horn Cave (Stone 1987), and Ventana Cave (Haury 1950, 1975). In northern Arizona Archaic period sites are not well represented, although several sites have been recorded on Black Mesa (Parry and Christenson 1987; Nichols and Smiley 1984) and within the Kaibab National Forest (Dan Landis, Soil Systems Inc., personal communication 1991). In addition to these sites, isolated Archaic points are found throughout eastern and northern Arizona (e.g., Tagg 1991; Fairley 1989). This general information suggests that the southeastern portion of the state was the most intensively occupied area in Arizona during the Archaic period. However, the greater number of sites in this region may indicate the inadequate sampling of the other regions in Arizona. There was a temporary and sporadic use of all the regions in Arizona throughout the Archaic sequence.

One of the more recent problems with interpretations of the Archaic data is the assignment of specific cultural identities. A few of the Archaic cultures/complexes/traditions that have been identified in Arizona, as well as in the surrounding states (cf. Huckell 1984a:200-201, Table 6.1), are the Gypsum complex (Harrington 1933), the Pinto complex (Harrington 1957), the Amargosa complex (Hayden 1967; Stacy and Hayden 1975), the San Dieguito/Playa culture (Rogers 1939), the Concho complex (Wendorf and Thomas 1951), the Cochise culture (Sayles and Antevs 1941; Sayles 1983; Eddy and Cooley 1983), Cochise-Amargosa (Haury 1975), the Desert culture (Jennings 1973), the Picosa (Irwin-Williams 1967, 1979), and the Oshara tradition (Irwin-Williams 1973, 1979). This myriad of Archaic cultures, complexes, and traditions reflects previous archaeological study, leading to the eventual hypotheses of regional variation and cultural affiliations. For example, the Amargosa and Cochise complexes are found in the west, central, and southeastern parts of Arizona, the Concho complex and Oshara are associated with the eastern and northeastern portions, and in the northwestern (Arizona Strip) the Archaic materials are associated with the Colorado Plateau and Great Basin groups.

The normative approach in defining the Archaic is to differentiate the previously mentioned cultures, complexes, and/or traditions for the various areas of the Southwest. The problem is that these complexes, cultures, and traditions have become static, are not well reported (synthesized), and were defined on the basis of limited data and, thus, reflect a sampling problem (Huckell 1984a). Often, archaeologists feel a need to pigeon-hole their data because they are near or in a region where the complex, culture, or tradition was originally defined (the nearest-fit method). Problems with the Archaic are not new ones, and recent archaeological studies of Archaic assemblages have pointed out the constraints, sampling bias, lack of flexibility, and chronological problems encountered when dealing with Archaic sites (e.g., Berry and Berry 1986; Huckell 1984a, 1988). With the aforementioned issues in mind, the following Archaic groups are introduced in order to familiarize the reader with several of the previously defined Archaic sequences found in Arizona.

Cochise

The Cochise culture was initially defined by Sayles and Antevs (1941) and later refined by Sayles (1983) from the materials recovered from southeastern Arizona. Originally, there were three phases of the Cochise: Sulphur Spring, Chiricahua, and San Pedro. Whalen, in his dissertation (1971), incorporated the Cazador phase into the Cochise sequence. Recent studies have questioned, first, the existence of the Cazador phase (Irwin-Williams 1979) and, second, the early dates from a locality associated with the Sulphur Spring Cochise (Woosley and Waters 1990).

Originally, the Sulphur Spring Cochise, based both on geologic and paleontological materials, dated greater than 10,000 years before present; the Chiricahua stage was dated from 5,000 to 10,000 years before present, and the San Pedro stage dated between 2,500 to 5,000 years before present (Sayles and Antevs 1941). The artifact assemblages for these stages include a variety of flaked lithic and ground stone forms. The Sulphur Spring stage includes a few crude tools such as choppers, unifaces, flakes, and milling equipment (Sayles and Antevs 1941; Sayles 1983:87, Figures 7.3 and 7.4). The Chiricahua stage materials include various point styles, bifaces, cores, debitage, and milling equipment (Sayles 1983:120, Figure 9.4). The San Pedro stage of the Cochise contains an assemblage of materials that include bifaces, San Pedro points, unifacial tools, cores, and ground stone (Sayles 1983:130, Figure 10.4).

Oshara

The Oshara tradition was originally defined and initially reported by Irwin-Williams (1973, 1979). There are five phases associated with the Oshara tradition: Jay, Bajada, San Jose, Armijo, and En Medio. All of the phases differ chronologically, in tool styles, and the inferred subsistence strategies (see Irwin-Williams 1973: Figure 7).

The earliest phase of the Oshara sequence is the Jay, which dates from 5500-4800 B.C. (Irwin-Williams 1979). The tool kit for the Jay phase contains Jay points (Lake Mohave-like), bifacial knives, side scrapers, and bifaces. Irwin-Williams (1979:36) indicates that Jay materials are the equivalent of the Concho complex (see Wendorf and Thomas 1951) materials found in northeastern Arizona. The Bajada (4800-3300 B.C.) follows the Jay phase and differs slightly from the Jay phase material remains. The most notable difference between the Jay and Bajada points is the notch found at the base of the Bajada points. Following the Bajada phase is the San Jose. The San Jose phase (3000-1800 B.C.) includes differences in the chipped stone assemblage and incorporates the introduction and use of ground stone. San Jose points vary in size and style, from a lanceolate-like point to Pinto Basin-like points (see Irwin-Williams 1979:40, Figure 8). Subsequent to the San Jose phase is the Armijo phase (1800-900 B.C.). This phase has various attributes ascribed to the point styles; a few of the point styles have serrated margins, one is a basally notched style, another is side notched, and these points vary from either having convex or concave basal elements (see Irwin-Williams 1973: Figure 5). The last phase associated with the Oshara tradition is the En Medio (900 B.C.-A.D. 400). The En Medio phase also has various point-style attributes found among an array of points, the most notable of which are the corner notched points (see Irwin-Williams 1973: Figure 6).

Amargosa

The Amargosa complex was defined by Rogers (1939) as the successor to the earlier San Dieguito phases of western Arizona and eastern California. The Amargosa was further defined and reevaluated by the work of Haury at Ventana Cave (1950). Collaboration between Rogers and Haury led to the eventual development of the three Amargosa phases (I-III). Various dates have been proposed for the Amargosa, as early as 5000 B.C. (Rogers 1966) to A.D. 1 (Haury 1950). Recent interpretation by Irwin-Williams (1979:38) established the dates of 3000 to 500 B.C. as the beginning and end points of the Amargosa. As with the aforementioned San Dieguito, the majority of sites that have been associated with the Amargosa are surface sites. Two sites, Ventana Cave and the Stahl Site, have yielded stratified materials of the Amargosa, but no firm radiocarbon or other absolute dates. The material culture that has been reported includes scrapers, scraping planes(?), points of various styles, and ground stone (see Rogers 1939). The features associated with the Amargosa range from sleeping circles (cleared circles), linear alignments of rocks, trails, and intaglios.

As with the Cochise culture, ground stone tools are perhaps the best indicators of change in the subsistence system. The Amargosa tradition has various grinding implements associated with each of the phases. The flaked lithic materials of the Amargosa also change dramatically, but the diagnostic materials are not restricted to any particular complex/culture/tradition. For example, during the Amargosa II phase Pinto Basin points and Gypsum points are both found. These have a widespread distribution throughout Arizona as well as in the surrounding states. There are no unique flaked lithic artifacts that can be associated with the Amargosa.

Discussion

Perhaps the best way to order (in terms of a temporal placement) the Archaic period is by the point styles that, as a whole, comprise a large chronological category, and then establish (redefine) regional Archaic complexes/traditions/cultures based on their material culture. In response to the similarities in the lithic materials and subsistence-settlement systems associated with the various Archaic cultures/traditions/complexes, Huckell (1984a:209, 1988:58) proposes a general classification of "Southwestern Archaic" in place of the myriad of existing Archaic designations. The Southwestern Archaic is subsequently divided into a basic chronological framework: the Early, Middle, and Late Archaic (Huckell 1984a, 1988). Within each of the three periods there are distinct point styles.

The Early Archaic period (8500-4800 B.C.) is characterized by the tapering-stemmed points, such as the Lake Mohave, Jay, and Silver Lake points. The Middle Archaic period ranges from 4800-1500 B.C. and is characterized by the Pinto, San Jose, Bajada, Chiricahua, and Gypsum point styles. The Late Archaic period, 1500 B.C.-A.D. 300, can be associated with the San Pedro (side and corner notched), Armijo, Cienega, Archaic triangular, and Elko Corner notched point styles (*sensu* Huckell 1984a).

The three chronological divisions, Early, Middle, and Late, are also presently employed in the Arizona Strip (cf. Fairley 1989:90-100) and in western Arizona (Stone 1987). Early Archaic in these areas includes Lake Mohave and Silver Lake points, which are also associated with the late Paleo-Indian period. The Early Archaic in northern and northwestern Arizona also includes the point styles of Elko Corner-notched and Side-notched, the Pinto, and Northern Side-notched. Middle Archaic point styles in northern and northwestern Arizona consist of Sudden Side-notched, Elko, Hawken Side-notched, and others. The Late Archaic in this area includes the distinct point styles of the San Rafael, Gypsum, Elko Eared, and Gate Cliff Stemmed points.

As presented above, there is little reason to use the previously established subregional variants of the Archaic. For example, the Cochise, which has been a definitive complex of the Southwest, "cannot be characterized or defined on the basis of such a small sample of sites and artifacts" (Huckell 1984a:204). In addition, the earliest of the Cochise stages, the Sulphur Spring, has been reevaluated at localities and remains problematical (see Woosley and Waters 1990; also Kelly 1959). More work (archaeological survey and excavation) needs to be performed to establish firm chronologies for the Archaic.

2.3.3 Transitional

The "known" and most widely studied lithic materials from this period are those of the Basketmaker II, found in the east-central part of the state as well as in the north and northeast, and the early Mogollon in the east and southeastern parts of Arizona. Additionally, during this transitional phase the Hohokam entered or developed in Arizona, and the Anasazi were developing from the preceding Basketmaker into a distinctive tradition. The Transitional Period exhibits changes in settlement, tool morphology, structures, subsistence (greater reliance on horticulture/agriculture), and storage.

During this period point styles are seemingly becoming similar in size and shape, such as those of the Mogollon and Basketmaker groups. In order to differentiate points styles the two methods of projectile point analysis, an intuitive based system and the quantitative attribute system, have both been employed to understand and create morphological typologies for this time period. Basketmaker points in eastern Arizona have been identified using the quantitative system by Tagg (1991) based on stem and base measurements, and at Black Mesa the intuitive approach was applied by Christenson (1987b:304). Variation in point styles is well represented during the Basketmaker periods, and intrasite and intersite variations are known from the Black Mesa work (e.g., Christenson 1987b:301-305, Plates 5-9).

During this transitional period dramatic cultural change occurred. These changes altered the role of flaked lithic materials in the cultural system. The lithic data from this time period are perhaps the least understood and studied of any of the discussed periods. Future study of the flaked lithic materials from sites or collections of this period can contribute valuable information pertaining to the changing role of flaked lithics associated with transition from foragers to farmers, tool use, as well as the reductive techniques employed for tool manufacture.

2.3.4 Ceramic Period

With the introduction of ceramics the Archaic period ends. The Ceramic Period is very different from the preceding periods. Some of the major differences are a decrease in mobility and a predisposition towards sedentism, a reliance/dependence on agriculture, and an increase in the human population that eventually leads to the development of aggregated communities--all of these trends escalate through time. In addition, this period marks a dramatic change in the use and role of flaked lithic materials. Less attention and labor is put forth for producing flaked lithic tools. Furthermore, the bow and arrow were introduced or invented and greatly influenced the size, shape, and overall morphology of the final forms of point styles.

Within the Ceramic period there are several main cultural groups such as the Hohokam, Anasazi, and Mogollon. Rather than specifically referring to these various and distinct cultures, because of the near homogeneity of the flaked lithic assemblages, the following discussion presents only the general trends in the form and function of lithic materials. Basically, there are too few diagnostic flaked lithic artifacts that indicate a distinct temporal or cultural affiliation.

The majority of the material-culture studies of Ceramic period sites focus on other data, such as ceramics and architectural forms. Limited synthesis has been rendered concerning the flaked lithic data. Additionally, the styles and forms of the flaked lithic artifacts exhibit a general trend in similar production techniques and final tool forms. Some of the common characteristics in the flaked lithic assemblages of the Ceramic period are: the continuation of the use and manufacture of basally notched points, a small projectile point size, a high ratio of use of local raw materials, minimally retouched tools, a flake-core technology, expedient tools (low labor input), a less-than-efficient use of stone (lots of waste), a high discard rate of tools, and numerous tool forms.

Contrasting to the earlier periods, point styles become less reliable as area- and time-specific markers. Other materials, most notably ceramics, are more sensitive. Point styles of this period, often reflect less labor input in the manufacturing process. Many of the point styles of the Ceramic period are thought to have been hafted and used with a bow, in contrast to the larger and heavier points of the Archaic that were made to be either thrown with an atlatl or thrust like a spear. Thus, projectile points of this period are variable in terms of manufacture and shape within assemblages. Some authors have tried to establish a point chronology for Ceramic period materials; for example, those of the Hohokam by Haury (1976:297) and Gladwin et al. (1937:113). These early attempts at point chronologies, however, need to be further refined and the sample expanded in order to confirm distinct temporal affiliations. There are differences between the point styles of the different cultural groups, such as between the Hohokam and the Anasazi. As a whole, puebloan points vary in size and shape, without a distinct form, and are light as well as small. These puebloan points were quite quickly made; marginal retouch removed the arris and served to form the shape of the point, and the side or corner notches are often shallow. The puebloan points are reflective of the major change that occurred during the Ceramic period, the shift from a high-labor-input to a low-labor-input system of flaked tool manufacture. This decrease in labor input is reflected in the abatement in formal tool manufacture and increase of an expedient tool technology (see Olszewski and Simmons 1982; Rozen 1981). However, there are points in the Ceramic Period that do have a high labor input, such as some of the Hohokam points (see Haury 1976:297, Figure 14.39 and 14.40). These points were probably produced by only a few individuals (craft specialization) and may not be associated with subsistence (i.e., hunting), but made for other needs, such as for ritual or for burials goods (see Haury 1976; Kisselburg 1987; Neitzel 1991).

The most notable change in flaked stone artifacts from the preceding periods is exhibited in the types of debitage produced; a more expedient technology largely replaces the preceding period's predominately bifacial technique (curative technology). This shift, from a technology with a high ratio of bifacial and high labor tool forms, to a flake-core technology with a plethora of tool types reflecting limited labor input, began in the terminal Archaic and early Ceramic periods (e.g., Basketmaker II and III) and continued throughout the remainder of Southwestern prehistory. Parry and Kelly (1987) clearly demonstrate this shift in technology, reductive techniques, and labor input from their analysis of flaked lithic materials from Black Mesa. For example, the ratio of bifaces to cores changes from 5.75 to 1.0 during the Archaic period to 0.04 to 1.0 during the Pueblo II period (Parry and Kelly 1987:292, table 12.3). Another indicator of the change to a more expedient technology is indicated in the amount of labor input into making stone tools. The percent of tools reflective of a high labor input from the Dolores Archaeological Project area, southwestern Colorado, is 15 percent during the Archaic period contrasting with 5 percent during the Pueblo II occupation (Parry and Kelly 1987:293, Table 12.3, citing Phagan 1985).

The discard rates of tools and the quantity of stone tool forms increases during the Ceramic period. The main factor of a higher discard rate is raw material availability (Parry and Kelly 1987). Because of the sedentary nature of the Ceramic period peoples, localized materials were used. Location of sites was often near or on stone procurement areas (e.g., terrace gravels, drainages, etc.). Because of the availability of raw materials as well as the technology employed for tool manufacture, there is a large amount of waste. The location of these sites made it possible for them to stockpile raw materials. Techniques employed during the Archaic and Paleo-Indian periods minimally wasted stone in comparison to the Ceramic period. For example, bifaces, as cores and tools, can be resharpened and maximize the material with the removal of little mass in contrast to the flake-core technology employed by the Ceramic Period. "Disk or bifacial cores maximize tool material; they provide a variety of flake forms for use as tools, yet these can be thin while having extensive, usable edge length (high edge-to-weight ratio)" (Nelson 1991:74). Debitage from a flake-core technology often indicates the reduction and production of flakes from multidirectional cores and the lack of a formal reduction strategy that would maximize the raw material.

Tools of the Ceramic period exhibit diverse morphology and these are usually of single function in contrast to the multifunctional-multitask tools of the earlier periods. These expedient tools are often produced quickly, used, and discarded rather than retained for later use. The role and the function of flaked stone tools in the Ceramic period reflects the changes in subsistence strategies, from hunting to farming. Flaked tool forms that are commonly recognized and associated with the Ceramic period are tabular knives, utilized flakes, large utilized flakes to pound and slash, utilized cores, side scrapers, small projectile points, and perforators.

In contrast to flaked lithic trends, the use of ground stone becomes increasingly important and more distinctive as a rough temporal marker. Distinct forms, shapes, and styles exist which are associated with different cultures found in Arizona (Chapter 3). Ground stone artifacts, then, appear to be a better indicator of cultural and temporal affiliations during the Ceramic period than products of the flaked stone industry.

Settlement and other data indicate that major cultural changes occur in Arizona near the end of the prehistoric sequence. These changes, however, are not clearly reflected in the flaked stone data. Thus, the connection and or transition with these earlier cultures with the Protohistoric and Historic period use of flaked stone is not evident. It is possible that there was a return to desert adaptive strategies, and the lithic scatters that are often thought to be affiliated with earlier prehistoric periods may actually date to the Protohistoric period (Upham 1988). This, however, has yet to be fully demonstrated.

2.3.5 Protohistoric and Historic

Little is reported or known about the manufacture and use of flaked stone by Native Americans during the Protohistoric and Historic periods in the Southwest. There are limited diagnostic materials for this time but there is a basic pattern that can be identified: the use of "introduced" materials, the reuse of older tool forms, and the continued employment of an expedient technology.

Tool manufacture dramatically changed during these periods. Several distinct point styles associated with the Protohistoric, such as the Sobaipuri and Pai points, indicate the continued use of stone. However, as contact and trade with the Europeans increased other materials, primarily metal and glass, tend to supplant the use of flaked stone. Neither glass nor metal were available prior to contact with the European settlers.

Glass artifacts have been recorded at a number of aboriginal historic sites in Arizona (see DeCosta 1983:79, Figure 4.11; Keller and Stein 1985:42). Glass has the same properties as the stone that was used prehistorically, but glass is more consistent (lacking flaws) and, thus, better and easier to work with. The general use and manufacture of glass tools by Native American groups has been documented by Deal and Hayden (1987), Shaeffer (1961), Buskirk (1949), and Bourke (1891). As referred to earlier, glass artifacts have been reported from several post-contact sites, but many of these may be pieces that were unintentionally modified by trampling or some other postdepostional modification (e.g., Keller and Stein 1985:42). Cautionary remarks concerning unintentional modifications to glass, that may result in the appearance of purposeful retouch, are noted by Sheets (1975) and Knudson (1979). Simply stated, glass is very brittle and can be modified by unintentional trampling, and thus, definitive glass artifacts are those hat have been bifacially worked, have a specific shape, and/or use-related wear.

Metal projectile points also supplant the use of flaked stone. These points have been documented from various localities in Arizona by Ferg and Kessel (1987:50-52, Figure 5.3), Di Peso (1953:169, Figure 62c'), and Foose (1982:312, Figure 109t-u). Metal points are more durable than glass or lithic materials and "were made of any scrap material, such as metal barrel hoops" (James Ayres, personal communication 1991; also see Buskirk 1949).

Besides using introduced materials, some Native American groups reused older tools that were made prehistorically. One such example is the Western Apache who "routinely scavenged them [prehistoric sites], collecting such items as projectile points, shell and turquoise artifacts, jet, grinding stones, and building stones" (Gregory 1988:264). Pimans also collected Hohokam points for their own use (Russell 1975:111). The Hopi used the older point styles but these points were probably incorporated into a different system (ceremonial use or decoration) rather than for subsistence (see Adams 1982:159, 161). Besides scavenging earlier points, ethnographic evidence suggests that "flint" and obsidian projectile points were not used for hunting but only for war (see Pfefferkorn 1949:202-203). Stone-tipped arrows were used only for war, while fire-hardened, sharpened sticks were preferred for hunting (Russell 1975:96, Footnote a and b).

Stone working did not end during these periods; in fact, the use of stone continued in various forms such as gunflint manufacture (see Knowles and Barnes 1937; White 1975; Witthoft 1966). Gunflints are very rare in Arizona, but have been excavated from several sites such as the Tubac presidio in southern Arizona (see Shenk and Teague 1975). These, like glass, can easily be mistaken for other artifacts forms, such as wedges or small scrapers.

CHAPTER 3
GROUND STONE IN ARIZONA

Lee Fratt

3.0 Introduction

Ground stone assemblages recovered from archaeological sites in Arizona underwent several major changes in manufacturing technology and use from the Archaic period into the Historic period. Some of these trends occur virtually statewide, and some are specific to particular environmental zones, cultures, or regions. Changes in ground stone technology in one area are often instituted in assemblages from other areas. In this chapter, general changes in the technology of ground stone utilitarian artifacts are reviewed and regional assemblages discussed. This discussion also includes some nonutilitarian artifacts that are diagnostic of a particular time period or cultural area. Nonutilitarian artifacts that are not particularly diagnostic, such as beads, and eccentric items such as figurines, pipes, effigy stones, and other articles probably used for personal adornment or in ceremonial contexts are not included because of their diverse nature and because they are rarely found in surface contexts.

3.1 Ground Stone Diagnostics: Fitting into a Slot

Archaeologists plot change over time and space by identifying "diagnostic" artifacts. Woodbury (1954:16) lists four criteria for diagnostic artifacts, including abundance, successive variations in form, ease of classification, and geographical variation. In sum, "diagnostics" are artifacts that have specific temporal or regional distributions. Piki stones, finely finished cooking slabs with a distinctively smooth, oily, burned surface, are diagnostic ground stone artifacts from the Pueblo III period in the Pueblo area (Woodbury 1954:176-177; Fratt 1991), whereas effigy palettes are one of the hallmarks of the Colonial and Sedentary period Hohokam (Haury 1976:286).

Archaeologists use diagnostic artifacts to place sites and features in time and space as well as to identify contact with other areas or cultures. Unfortunately, few ground stone artifacts are considered to be diagnostic. Many of the most common implements, such as cobble manos or handstones, mortars, and grinding slabs or basin metates occur over large areas encompassing two or more prehistoric cultures and range in age from Archaic to Historic. The lack of diagnostic artifacts on lithic sites encountered during survey is a frequent and frustrating problem for archaeologists and is a major, but not insurmountable, constraint on interpreting surface lithic assemblages.

3.2 Ground Stone: Catch-all Category or Specific Tool Group?

The term "ground stone" as it has come to be used in casual conversation and in many survey and excavation reports is problematic. Strictly speaking, "ground stone" artifacts as opposed to "chipped stone" artifacts are implements that have either been shaped primarily by abrasion or were used to grind or abrade various substances (Jennings 1971:283); that is, artifacts that were either manufactured by or used for grinding. In general, the term "ground stone" has become a catch-all category that includes any artifact made of stone or mineral that does not qualify as a chipped stone artifact. It is not uncommon for artifacts such as hammers and mauls, hoes, architectural remains, hammerstones, ornaments, and eccentric objects that have been flaked or pecked, but not ground, to shape or that are unshaped but used for some purpose (such as some architectural materials) to fall under the ground stone analyst's wing. Some authors qualify their use of the term "ground stone" by adding another category or class of artifact, for example, "ground stone and tabular lithics" (Bruder nd:115), "pecked and ground stone artifacts" (Hoffman 1985:565), "ground and polished stone" (Sayles 1937), or "miscellaneous small artifacts and ground stone" (Euler 1987:239). Other authors avoid using the term by substituting alternative phrases such as "grinding tools," "nongrinding, nonchipped stone" (Christenson 1987:44, 58), "nonflaked lithic tools" (Phagan 1988:179), or simply "lithics."

It is apparent that the term "ground stone" has become the convention because it is concise and convenient. In accord with convention, "ground stone" is used in this report in its broadest sense. However, it is also apparent that despite the diverse artifacts fitted and lumped into this category, it's primary referent is to tools used for grinding or crushing various substances, especially foodstuffs. In the case of archaeological surveys, this situation generally holds; the most commonly reported ground stone surface artifacts are food-grinding tools such as manos, metates, and mortars. Nevertheless, applying the term so broadly masks much material-culture diversity. In turn, this glossing over may influence expectations about the range of artifacts encountered during survey and, therefore, the types of artifacts reported. Lack of formal training in artifact identification and analysis contributes to the inconsistency in terminology and referents. Analyzing the ground stone assemblage often seems to be an afterthought rather than a research priority. In order to obtain more detailed and useful data from these artifacts, some training and standardization of terminology is necessary. Otherwise, ground, pecked, and polished stone artifacts will continue to be the poor handmaiden in archaeological research.

3.3 Classifications: When is a Mano a Mano?

Classifications of ground stone artifacts also pose a problem for the researcher or analyst. In the 1950s, Woodbury (1954:15) bemoaned the fact that "no standard terminology for stone artifacts exists in the Southwest, and many terms are used with a great variety of meanings." Unfortunately, this situation remains virtually unchanged. For example, the terms "mano" and "handstone" are used relatively indiscriminately and interchangeably and are often not defined. Even when distinctions are made, such as between "manos" and "handstones," the distinctions may not be used by other researchers working in the same region and with similar assemblages. For example, Haury's (1976:281) distinction between manos and handstones from Snaketown includes differences in direction of use as well as in degree of shaping and size (two-handed vs. one-handed). In contrast, Bernard-Shaw's (1984:299-340) distinction between "manos" and "manolike informal ground stone tools" recovered during the Salt-Gila Aquaduct Project excavations is based primarily on degree of shaping and differences in material and Hoffman's (1985:578-590) distinctions between "cobble manos," "manos," and "ground cobbles" is based on differences in material and manufacture (which may or may not be commensurate with degree of shaping) . Although the data that Haury, Bernard-Shaw, and Hoffman provide allow a certain degree of comparison between the manos and handstones of their assemblages, analyses of these tools based on the published information alone is constrained because the definitions differ among the reports. Similar problems also are encountered in reports of Anasazi ground stone assemblages because the terms for raw material types are used inconsistently and the information about morphological characteristics of some artifact types, especially manos, varies.

The lack of standardized terminology constrains ground stone analysis and subsequent archaeological research. Although some of this lack of synonymy may be attributed to differences in material and in research orientation, this is not always the case. Of course, there are problems in standardizing ground stone terminology. In addition to differences in material, the function and use of many ground stone artifacts, whether whole or fragmentary, are unknown. Also, ground stone implements may have multiple uses or have been reused (Woodbury 1954:13), and almost no assemblages, even if from the same time period and culture, are completely synonymous. Nevertheless, the tremendous increase in archaeological field work beginning in the 1960s and the subsequent increase in data makes it all the more urgent to reach some degree of agreement as to ground stone artifact classification and recording. In fact, establishing some degree of standardization could serve to significantly increase the research potential of ground stone assemblages encountered on surveys.

3.4 General Trends in Ground Stone Morphological Change

The general trends that characterize changes in the ground stone artifacts and assemblages recovered from Arizona sites include: (1) increasing diversity of forms, (2) persistence of earlier forms in later assemblages, (3) increased shaping of artifacts, (4) increasing size of manos and metates and in number of grinding surfaces of manos, and (5) a shift in the shape of grinding surfaces. These trends in technological change have been interpreted as responses to changes in subsistence, however, they also apply to other contexts, such as ceremonial, of which ground stone artifacts are a part.

Through time, ground stone assemblages manifest increasing numbers of diverse forms that are more restricted in their distribution. Archaic assemblages are characterized by relatively few forms that show little shaping and have a widespread distribution (Sayles 1983:58-70). For example, grinding stones that are similar to the shallow basin "metates" or "grinding slabs" (Sayles [1983:69] refers to them as "nether stones") that have been recovered from lithic sites in southern Arizona also have been found in Archaic period contexts in the eastern (Wheat 1955), northern (Jennings 1971), western (Linford 1979), and central (Doelle 1985) parts of the state. In contrast, the assemblages from post-A.D. 1000 Hohokam, Mogollon, and Anasazi sites include artifacts such as stone rings (Haury 1976:290-291), polished stone axes (Wheat 1955), and piki stones (Woodbury 1954) that are not found in earlier contexts. Increasing variation within particular types of ground stone artifacts imply increases in specialization (Christenson 1987a), while increases in the number of artifact types in an assemblage suggest increases in ground stone tool function and use.

The persistence of Archaic forms in later ground stone assemblages would seem to be opposite of the trend discussed above. In fact, it contributes to the increasing diversity of ground stone tools. Instead of later forms replacing earlier tool types, they simply are adopted as part of the tool kit. As Sayles (1983:59) notes, the fact that Archaic forms persist into later periods demonstrates a certain amount of cultural continuity, especially within the Mogollon (Wheat 1955:68). The disadvantage of this trend is the constraint it imposes on placing lithic sites in time and space (Sayles 1983:59).

Archaic implements are generally less well-shaped and stand in marked contrast to the extremely well-made troughed vesicular basalt metates and effigy palettes of the Hohokam and the finely shaped slab metates and piki stones of the later Anasazi sequence. Protohistoric ground stone assemblages diverge somewhat from this pattern. Well-shaped ground stone artifacts continue to be made by the Pueblo people in the northern part of the state (Adams 1979), but in southern Arizona, the few ground stone assemblages recovered that can be attributed to the Protohistoric period indicate that ground stone manufacturing technology as well as artifact diversity declined from its peak during the Sedentary period (Haury 1976; Sayles 1937; Doelle 1983).

For food-grinding tools, increased grinding-surface size, more grinding surfaces on manos, and changes in mano and metate shape from round or oval to roughly rectangular (Bartlett 1933; Woodbury 1954) reflect changes in the grinding process, such as increases in grinding efficiency and intensity (Adams 1991). Changes in grinding-surface size are linked to the shift in form and to changes in the way that manos articulated with metates. In Anasazi assemblages, the shift to rectangular slab metates and to manos that were as long as the width of the metate incorporated the entire surface of the metate into the grinding process, thereby increasing the grinding-surface area (Woodbury 1954:58-65). The appearance of manos with two or more grinding surfaces represent wear management techniques that affect grinding intensity (Adams 1991). In Hohokam assemblages, the increase in grinding-surface size was due to an overall increase in the size of trough metates and their associated rectangular, two-handed manos (Sayles 1937).

3.5 Regional Developmental Sequences

3.5.1 Paleo-Indian Period

Ground stone tools are not a hallmark of the Paleo-Indian period in Arizona or elsewhere in the New World. Whether this reflects differential site obtrusiveness, accessibility, density, or preservation (Schiffer and Wells 1982) or is a direct reflection of the Paleo-Indian subsistence system is debatable. The absence of grinding tools but the presence of processable plant materials in Paleo-Indian assemblages, has been interpreted to mean that although Paleo-Indian people probably gathered and used wild plant resources, they did little or no processing prior to consuming them.

Researchers have noted that the functional range of known Paleo-Indian sites is very restricted. Virtually all sites are associated with hunting, butchering, and/or chipped stone resource procurement and therefore, our reconstructions of Paleo-Indian lifeways may be biased. The Lindenmeier site in Colorado and Ventana Cave in Arizona are both "non-kill" sites with Paleo-Indian deposits that have yielded ground stone hand tools. Although critics have raised the possibility that the Ventana complex at Ventana Cave may actually be an early Archaic assemblage (San Dieguito I) rather than Paleo-Indian (McGuire 1982:170-172), the evidence from both Lindenmeier and Ventana Cave suggests that Paleo-Indian people may have used grinding implements to some degree for processing plant food or for other tasks, such as working hides.

3.5.2 Archaic Period

Cochise

Wheat (1955:68) states that "grinding tools are the most characteristic artifacts of the Cochise culture." Their presence in the Archaic period and virtual absence in the preceding Paleo-Indian period signals a major change in subsistence away from a focus on big-game hunting and plant gathering with little to no processing to more extensive and intensive plant procurement and processing.

The Cochise culture was defined by E. B. Sayles and Ernst Antevs (1941) from materials recovered from the Sulphur Spring Valley in southeastern Arizona. The ground stone component of the earliest phase, labelled Sulphur Spring, includes a relatively large number (compared to other periods) of thin, flat, nether stones and small, oval handstones with flat, pitted, used surfaces that reflect the tools' use for crushing, cracking, pounding, and pulverizing. Both types of grinding tools were modified only by use and lack any specialization (Sayles and Antevs 1941:77).

The Chiricahua stage is marked by the introduction of more efficient and specialized grinding tools, such as the shallow-basin mortar or grinding slab and accompanying shaped handstone. Sayles (1941:77) has associated this development with a possible increasing dependence on grass seeds, especially maize, in Cochise subsistence and economy. New tools for crushing, grinding, and cracking include pestles, pebble mortars, and modified handstones (Sayles 1941:77).

San Pedro ground stone assemblages show further refinement in grinding-tool technology. The differences in the contour of grinding surfaces on the deep-basin mortar, basin nether stone (metate), true mortar and pestle, and convex-surfaced handstone (mano) reflect specific grinding motions--rotary and slightly arching in the case of the deep-basin mortar and basin nether stone and circular for pounding and crushing in the case of the true mortar. The convex surfaces of the handstones indicate that a new grinding technique involving reciprocal motion had been developed. Both the handstones, deep-basin mortars, and basin nether stones increase in size (Sayles 1941:77). Sayles (1983:79) illustrates the major changes in Archaic ground stone technology.

Oshara

This northern Archaic tradition, the predecessor of the Anasazi culture, was defined by Irwin-Williams (1973) and her associates as a result of their research in the eastern drainage of the Puerco River. As in southern and western Arizona, Oshara assemblages are most marked by the appearance of stone grinding tools that become better shaped and more heavily used through time. Basin metates and oval, one-hand manos do not appear until relatively late in the Oshara sequence. According to Irwin-Williams (1973:5,fig 7), no grinding equipment has been found on Jay phase sites. Ground stone tools do not appear until the San Jose phase that begins about 3000 B.C. Excavations of sites dating to this period have yielded shallow basin grinding slabs and cobble handstones, that probably were used to grind grass seeds, (Irwin-Williams 1973:8). Pounding stones also have been recovered and Irwin-Williams (1973:8) raises the possibility that some may have been hafted for use. During the Armijo phase, limited maize agriculture appears. By the succeeding En Medio phase, the ground stone tool kit includes deep basin grinding slabs and cobble handstones, as well as the additional flat and troughed grinding slabs and long, flat handstones.

In his review of Archaic cultures in southern Arizona, McGuire (1982:177) notes that the similarities in the material culture of the San Dieguito, Cochise, and Amargosa traditions reflects the similar economies and adaptations of hunters and gatherers occupying an arid environment. McGuire further (1982:178) suggests that the differences in Cochise and Amargosa assemblages may reflect the slightly moister conditions in southeastern Arizona that make grass more plentiful in contrast to the more arid conditions in the southwest that would favor mesquite. Further research, such as conducting use-wear studies and residue analysis to determine artifact use and investigating the distribution of metates and of grasses from southeast to southwest, could clarify some of the relationships between these Archaic cultures and their material assemblages.

3.5.3 Ceramic Period

In southwestern Arizona, the appearance of pottery signals the end of the Archaic tradition, although a basically Archaic lifestyle continued into the Historic period in some areas (McGuire 1982:179). McGuire (1982:179) notes that much of the controversy surrounding Hohokam culture involves nomenclature. The same can be said of the disagreements concerning the Mogollon culture, especially after A.D. 1000. Like McGuire (1982:179), I use the terms Hohokam, Mogollon, Anasazi, Patayan, and Hakataya to refer to contrasting patterns of material culture that occur in particular geographical regions.

Hohokam

Major sources of information on ground stone artifacts can be found in Gladwin et al. (1937), Haury (1976), and Di Peso (1951, 1953, 1956). Haury (1976:300) states that the most distinguishing aspect of Hohokam lithic technology is their preeminent skill in stone carving. This skill is manifest in the development of stone effigy palettes that is illustrated in the 1937 Snaketown report (Haury 1937:124).

Hohokam ground stone assemblages also exhibit extremes in curated and expedient technologies. At the former extreme are finely sculptured implements such as stone effigy palettes, cups, and bowls, as well as other objects like axes, manos, and metates, that reflect care in shaping and in handling during use. At the other extreme are artifacts that represent casual and comparatively brief use prior to discard and usually lack elaborate shaping. Artifact types that most obviously reflect expedient technology are utilitarian tools used to cut, chop, crush, and scrape various substances; however, any artifact type, including those mentioned as examples of curated objects, can include examples of both categories. Haury (1976:300) notes that the finely worked stone artifacts seem to have no Archaic period antecedents, and suggests that they may represent the merging of two traditions, one indigenous and one intrusive, probably from the south. Although acknowledging that stone axes seem to represent an intrusive form, Sayles (1937:115) states that elaboration by carving objects such as palettes and bowls in later stages appears to have been an indigenous development.

Another general characteristic of Hohokam ground stone assemblages is that different artifact types manifest different rates of technological change. Some artifacts, such as cups and axes, exhibit temporal change while other artifacts, most notably implements related to food preparation, show little drastic change or even the introduction of new types (Haury 1976:300). Charts illustrating changes in axes, plain stone bowls, and effigy stone bowls are in Sayles (1937:114, 115)

Sayles (1937:118) states that virtually all of the major elements of Hohokam ground stone assemblages were present by the late Pioneer period. Notable exceptions are the formal hand-held stone hoe, ridged and grooved arrow shaft polishers or straighteners, and "two-handled food crushers" ("fergoliths"), all of which appear during the Classic period (Haury 1976:285-286; Di Peso 1951:144). Elaborate carved-stone palettes and bowls are present throughout the Hohokam cultural sequence and are excellent diagnostic artifacts but are usually not found on site surfaces (Haury 1976:286-290). Utilitarian tools, although less culturally distinctive, are far more common in both surface and excavated assemblages and do display some diagnostic characteristics. The rest of this discussion focuses on these implements.

The major temporal changes in the Hohokam utilitarian ground stone implements are shown in Sayles (1937:116-118). Manos, metates, mortars, pestles, and abraders usually form major portions of assemblages dating from all periods, but the general trends in mano and metate change are the most significant (Sayles 1937:116). General changes in mano assemblages include a shift in shape from oval to rectangular forms, increasing length, and decreasing width. Grinding-surface contours change from convex to flat. Short rectangular manos used in narrow trough metates may date no earlier than the Colonial period.

Trough, slab, and basin metates occur during all periods but differ in relative percentages in assemblages. Trough metates are the most ubiquitous form, appearing throughout the Hohokam sequence. Major changes include an increase in the grinding surface, a decrease in grinding-surface convexity, and an increase in shaping. Haury (1976:280) notes that the rectangular, full-troughed metate, open at both ends and often made of vesicular basalt, represents one of the most finely shaped grinding implements north of Mexico. Shallow basin metates appear during the Pioneer, Colonial, and Sedentary periods. Rectangular slab metates with slightly concave grinding surfaces worn across the entire surface appear during the Colonial, Sedentary, and Classic periods. Generally, the grinding area on Hohokam slab metates does not extend over the entire surface as is typical of Anasazi slab metates (Dawn Greenwald: pc).

<u>Anasazi</u>

Major sources of information on Anasazi ground stone assemblages include Woodbury (1954), Adams (1979), Anderson (1969), Bartlett (1933, 1936), and Kidder (1932). The most distinctive aspect of Anasazi ground stone assemblages is the great diversity of implements (Haury 1976:300). This diversity is most apparent in the variety of artifacts recovered in association with nonfood-processing tasks and in the proliferation of mano forms (Woodbury 1954:206-207). Assemblage diversity begins to increase during the Pueblo II-III transition but is most marked in assemblages dating from the Pueblo III, Pueblo IV, and Pueblo V periods in the areas extending from southern Black Mesa (especially the Hopi Mesas) south (Woodbury 1954). In the northern part of Black Mesa, the period of greatest grinding-tool diversity is the Basketmaker III period. Christenson (1987a:88-89) notes that prior to abandonment of the area in the Pueblo II period, ground stone assemblage diversity had declined.

Almost all Anasazi ground stone implements appear to have developed from tools of the indigenous Archaic period hunters and gatherers located in the Four Corners region (Wright 1990:6-8; Cordell 1984; Morris 1980). Notable exceptions are mortars, 3/4-grooved axes, and piki stones, all of which appear relatively late (Pueblo III) and seem to have a southern origin (Woodbury 1954:29-31, 176-177, 202). Other implements that may have had their origin in the eastern prehistoric Pueblo cultures include notched axes and hammers, jar lids, tcamahias, and elongated shaft smoothers. All of these artifacts apparently date no earlier than Pueblo III times (Woodbury 1954:201-202).

Several types of nonfood-processing artifacts show diagnostic temporal changes and distinctive characteristics. For example, highly specialized forms of axes include lipped, double-bitted, oblique-grooved, and partial spiral-grooved. These forms appear during the Pueblo IV period and persist into the seventeenth century, except for the spherical and lipped full-grooved forms that disappear prior to the historic period (Woodbury 1954:35-37, 200). Cylindrical hammerstones and notched hammers and axes seem to date no earlier than the Pueblo III period, while paint-grinding stones and pestles appear no earlier than the Pueblo IV period. Flat abraders appear during the Pueblo II period, and shaft smoothers seem not to predate the Pueblo III period. Palettes with raised borders may date no earlier than the Pueblo IV period (Woodbury 1954:200-201).

Implements associated with food processing, especially manos and metates, are usually the most numerous ground stone artifacts recovered from surface assemblages. Luckily, changes in metate form, and therefore, in the grinding-surface contour of associated manos, are temporally diagnostic. Basin metates with oval, one-hand manos that were used with a rotary motion and flat grinding slabs appear on sites dating from the Archaic to Basketmaker III periods. During the Basketmaker II period, two-handed manos appear along with troughed metates, but they do not become common until Basketmaker III .

From the Basketmaker III through the Pueblo II periods, there is an increase in the size of both mano and metate grinding surfaces and in the number of grinding surfaces of manos (indicated by changes in transverse cross section from oval and rectangular to triangular, beveled, and diamond-shaped). By the Pueblo III period, trough metates were replaced by rectangular slab metates that were ground across the entire used surface. The associated two-handed manos continue to manifest a diversity of transverse cross-sections. The slab metates commonly were plastered into mealing bins (Woodbury 1954:62-64; Christenson 1987a:56). The actual replacement of troughed metates by slab metates during the Pueblo II-III periods, rather than the addition of the new slab forms to assemblages that retain troughed metates, appears to be unique to the Anasazi and is one of the most important diagnostic traits of this area.

Mogollon

In contrast to the Hohokam and Anasazi areas, there are virtually no major references for Mogollon ground stone assemblages. Wheat (1955) summarizes ground stone assemblage data for the period prior to A.D. 1000, and most of the present discussion relies heavily on his information. But Wheat's data are generally very sketchy and in need of updating. Sources for information on post-A.D. 1000 ground stone assemblages include Anyon and LeBlanc (1984), various volumes of Fieldiana (such as Martin et al. 1952, Martin and Rinaldo 1950, Rinaldo 1959, and Martin et al. 1957), Teague and Mayro (1979), Reid (1982), and Lancaster (1983). Unfortunately, little of these data have been synthesized.

Mogollon ground stone assemblages are dominated throughout the sequence by artifacts that are, at the most, casually shaped. One of the most distinctive aspects of Mogollon ground stone artifacts is the persistence of forms from the Archaic period into the fourteenth century. This cultural continuity is apparent in such artifacts as basin and slab metates, their corresponding manos, grinding slabs, pestles, abraders, stone balls, and hammerstones that appear in forms that are little changed from the earliest to the latest parts of the sequence.

As in the Anasazi area, the diversity in the ground stone tool kit increases with time and differs by area. Wheat (1955:113-114) summarizes artifact types by area. There are little synthesized data on diagnostic characteristics and changes in nonfood-processing artifacts. Grooved-stone mauls may represent an indigenous development because they are typical of the central Mogollon and date from the earliest periods (Wheat 1955:123). As in other areas, polished stone axes do not appear until relatively late and seem to be intrusive (Wheat 1955:123). Wheat (1955:123) notes the apparent anomaly of this situation given that many areas of Mogollon settlement are forested and that polished stone axes are associated with tree felling and woodworking. Ungrooved abraders are common in Mogollon sites, whereas grooved abraders are less common (Wheat 1955:121). Two types of agricultural tools, hoes and elongated stones that may have been picks, also have been recovered from Mogollon sites (Wheat 1955:120, 124). Earlier hoes show no sign of hafting, but later, better-shaped specimens may have been hafted (Wheat 1955:124).

The little information available about changes in Mogollon ground stone assemblages comes from implements associated with food processing. Basin and trough metates are widely distributed and apparently occur throughout the Mogollon sequence. Wheat shows a possibly unique metate form that he refers to as a basin-trough. Apparently, this form is distinctive of earlier periods (Wheat 1955:110-111). The most typical Mogollon metate is the troughed type with one closed end. Troughed metates with both ends open appear later. The degree of shaping increases with time but never reaches the level of workmanship exhibited by Hohokam troughed metates. Utah-type metates occur in the northern Mogollon area. Slab metates appear late in the sequence and represent an addition to the grinding tool kit.

The most common type of mano used was a one- or two-handed ovoid to rectangular stone with a unifacial or bifacial convex grinding surface that was used on basin metates and on trough metates with one end closed. From early to later periods, there is a general increase in mano length, and later assemblages include manos with flat grinding surfaces resulting from use with a slab metate. This latter group of manos displays a variability in transverse cross section similar to that found in Anasazi assemblages dating from the Pueblo III period and later.

A characteristic that appears to be distinctive of Mogollon assemblages is variability in mortar forms. Several different types have been found including boulder mortars, pebble mortars, and "metate-mortars." The latter consists of a round depression pecked into the grinding surface of a basin metate. Other specialized mortars include more finely shaped pebble mortars with relatively larger and shallower depressions, thin, well-finished oval slabs with a dish-like depression, and a stone slab with several small mortar depressions pecked into one or both faces. Wheat (1955:119) notes that the first two specialized mortars were found in Forestdale branch sites and the third type has been reported from the Pine Lawn and Mimbres valleys.

Three types of pestles have also been recovered from Mogollon sites, including a short, squat, multifaced stone that used on both ends, elongated stones that were used on one or both ends, and symmetrical, shaped, elongated stones that were also used on one or both ends. The first pestle type mentioned is the most common (Wheat 1955:119-120). Thin stone slabs that show use over a fire may have been griddles (Wheat 1955:121).

Cerbat, Cohonina, Prescott, Amacava (Hakataya?)

Information about technological change in ground stone assemblages of these prehistoric cultural groups is almost nonexistent. To a large degree, this reflects the nature of the material-culture remains. Sites consist mostly of artifact scatters with little or no depth or stratigraphy and of relatively undistinctive characteristics that make assigning dates or even determining cultural affiliation very difficult (Stone 1986; Linford 1979; Euler 1963). Manos and other kinds of handstones, metates, bedrock mortars, pestles, grinding slabs, 3/4- grooved axes, and other unknown ground or pecked implements have been reported (Stone 1987; Linford 1979:22; McGregor 1951). Metates seem to be the most diagnostic ground stone artifact of this area. Variation in general shape, size of the grinding area, and degree of shaping are the most important characteristics. Slab metates generally made of sandstone with shallow, oval pecked areas on the surface, along with one-hand manos, appear to be characteristic of the Cerbat. The Prescott had both trough and basin metates, as well as trough metates open at both ends, that appeared relatively late. Other ground stone artifacts reported for this group include 3/4-grooved axes and perforated stone disks. The Cohonina may have used both slab metates and trough metates open at both ends. McGregor (1951:91) reports a Utah-type metate recovered from excavation. Whether this metate type was typical of the Cohonina is unknown. The fact that specimens were recovered in which the platform had been partially or wholly ground away suggests that the Utah metates may have been an introduced form that was subsequently used like trough metates with both ends open. Slab metates utilized across the entire grinding surface are characteristic of the Amacava (Euler 1963:82-83; Linford 1979:33-34). For all groups, the degree of shaping is presumed to increase through time.

Yuman (Patayan?)

Rogers (1945:196) states that grinding implements are relatively rare on sites in the western desert. As a result, there is very little information about the sequence of technological change in ground stone assemblages recovered from sites in southwestern Arizona. Again, this situation largely reflects the shallow deposits and nondistinctive nature of the material-culture remains in the area. Assemblages do show Hohokam influence, such as the presence of 3/4-grooved axes (Stone 1986).

Diagnostic ground stone artifacts are scarce, and the emphasis is again on variations in metate form and use. Metate form changes from basin to flat; the earlier flat metates are unshaped while the later ones are rectangular. Manos also change through time, the earliest ones that were used in basin metates being unshaped whereas the later ones used with the flat metates change from unshaped, single-handed implements to shaped, rectangular one- and two-handed varieties. Bedrock mortars also are present in the area (Rogers 1945:187).

3.5.4 Historic Period

Ground stone assemblages from late protohistoric and historic contexts have received relatively little attention from archaeologists, and few studies have traced the changes in material culture that accompanied European settlement. In eastern Arizona, the lack of information about historical ground stone assemblages results from difficulties in locating and identifying Apache sites. A similar problem exists in southern Arizona, where archaeologists have been hard pressed to find archaeological sites dating from the protohistoric and early historic periods; however, ground stone assemblages have been recovered from several protohistoric Sobaipuri and Upper Piman sites (Doyel 1977; DiPeso 1953; 1956). Recent surveys along the San Pedro River and Altar Wash in southern Arizona and around Picacho Peak and in the Salt-Gila Basin in south-central Arizona have located probable protohistoric and early historic sites (Seymour 1988; Bayham et al. 1986). None of these sites have undergone detailed archaeological investigation.

Excavations in contact sites and turn-of-the-century Papago and Pima sites in southern Arizona have yielded ground stone assemblages consisting primarily of manos, metates, handstones, and pestles. Both trough and slab metates have been recovered, and most of the manos are oval and show little shaping (Doelle 1983:95-97; DaCosta 1983:80). Doelle (1983:95-99) states that the ground stone implements from Nolic appear to have been used for processing wild and cultivated plant foods and for pottery manufacture. Both Doelle (1983) and DaCosta (1983) mention the similarity between the archaeological assemblages and the ground stone implements reportedly used by the Pima Indians around 1900 (Russell 1975:108-110).

All of these investigations show that with contact, ground stone assemblages in southern Arizona decreased in quantity, quality, and variety. Russell's (1975:108-110) comment that some of the ground stone implements used by the Pima were artifacts salvaged from prehistoric sites adds a cautionary note to the study of historic Piman assemblages.

Adams's (1979) analysis of the ground stone assemblage from Walpi, a Hopi village located on First Mesa, provided a unique opportunity to trace the changes in an assemblage from 1690 to 1975. The opportunity to interview First Mesa residents also provided valuable insights into ground stone implement use. The ground stone assemblage from Walpi numbered in excess of 2,000 artifacts and included a great variety of tools associated with food-processing and non-food-processing tasks (Adams 1979:111). In fact, the general nature of the assemblage seems little different from the Pueblo IV assemblage recovered from Awatovi (Woodbury 1954). This probably reflects the relatively isolated condition of the Hopi until the late nineteenth century. Adams states that the most interesting changes in the Walpi assemblage are a percentage decrease in nonfood-processing implements through time due to the selective replacement of stone tools by Euro-American manufactured implements such as electric flour mills (Adams 1979:111). By the 1970s, ground stone tools associated with food processing, especially those used to grind corn, were almost entirely relegated to ceremonial contexts (Adams 1979:26). Adams (1979:111) also attributes the increase in personal ornaments in the Walpi assemblage to the influence of Euro-American culture.

CHAPTER 4
LITHIC RAW MATERIAL SOURCES IN ARIZONA

Kirk Anderson

4.0 Introduction

The purpose of this chapter is to provide basic information concerning the location of various raw material sources. The map (in pocket), and the accompanying narrative and legend are intended to familiarize the researcher with the type and location of lithic material sources within the state. The map scale (Geologic Source Map) of 1:1,000,000 was selected because of its manageability; this scale is identical to that used in the Arizona Highway Map (Arizona Highways 1989) and the Geologic Map of Arizona. The small scale does not allow for pinpoint accuracy of some of raw-material source areas; therefore, this map is not intended to be the definitive road map to major lithic sources within the state. We recommend that the references included on the map and elsewhere in this portion of the manuscript be studied prior to field work or other related research within a particular area of the source map. For example, surveys on and near Black Mesa (northeastern Arizona) should acquire Green (1985) and Parry and Christenson (1987); their map(s) scale, pinpoint plotting of sources and sites, and text discussions provide excellent data for examination and comparisons. It is also assumed that the reader has a basic knowledge of the major physiographic features in the state.

Pragmatically, any lithic source exploited by human groups for subsistence and societal needs can be considered a major source and procurement area. Because of the numerous lithic sources documented by previous archaeological survey, it is impossible to plot each lithic procurement area that has ever been recorded or deemed a major source for a specific group or site. The task of plotting all the sources of prehistorically exploited raw materials, although necessary, is outside the scope of this work. Therefore, in order to furnish functional data for future archaeological work concerning raw material source areas in Arizona, a fairly precise definition was established. We defined major lithic sources as those that reflect one of the following characteristics: (1) were exploited extensively, temporally; (2) were exploited extensively, spatially; (3) were sources of raw material identified from sites throughout the state; (4) were economically important to a specific culture and geographic region; and (5) are outcrops of material that have the potential to yield prehistorically desirable raw material. Examples of each of these are: the rhyolite of Picacho Peak, which was exploited since Archaic times (Callahan 1988); sandstone from the Navajo Formation (Green 1985); Government Mountain obsidian (Shackley 1988); chert from the Redwall Formation in the Grand Canyon (Euler 1983); and the Kaibab formation, respectively.

4.1 Map Preparation

Compiling a map of the major lithic raw-material sources in Arizona is a complex task. Arizona is 113,909 square miles in size (Hoffman 1987), including three complex geologic provinces: (1) the Colorado Plateau; (2) the Transition Zone (or Central Mountain Province); and (3) the Basin and Range.

Defining each of the three geologic provinces, and exploring the archaeological literature of the known raw material source areas that were procured in each area facilitated the compilation of this map. The review of the literature produced vagaries such as the terms "probably occurs nearby" and "is known to occur in the general project vicinity," which not only complicates but confuses accurate source area location. When such vagaries were encountered their usefulness and application to this project was limited. Such references were therefore not included. Documents that contained maps of procurement areas or alluded to names of the physiographic features where raw-material sources occur, were incorporated in this map.

Expansive procurement areas such as the Kaibab Formation, which covers thousands of square miles, present additional problems. In such cases, the entire geologic formation was plotted in order to signify the potential areas for raw material occurrence within those formations. It should be noted that there is high variation in quality and quantity within these geologic formations, and thus, the geologic formations presented are intended to be used as a visual reference of the possible areas that lithic material occur within large formations.

The lithic sources and raw material procurement areas from secondary deposits, such as Pleistocene river gravel, bajada surfaces, and alluvial fans, were not mapped because of their irregular spatial distribution or insufficient information relating to their map location. Such sources of raw materials provide a wide variety with regard to quality, mineralogy, and material quantity.

In addition to chert, chalcedony, quartzite, and more resistant igneous and metamorphic rocks that occur in river gravel along all major and some minor streams in the state, Tertiary gravel deposits also occur and were exploited. "Rim gravels" are found along the Mogollon Rim (Dosh 1988), and the Tolchaco Gravels are found along the Little Colorado River from Holbrook to Cameron, Arizona (Bartlett 1943). Such deposits, although extensive and widely utilized by the various Native American groups, were not included on the map because no maps locating the distribution of such deposits were found. All the major drainages in Arizona are included on the map; these drainages are a source of gravel that was potentially exploited for lithic materials by prehistoric groups in Arizona.

4.2 Lithic Sources in Arizona

The following discussion of the geology of Arizona presents only a general summary of the landforms that characterize the three geologic provinces. Landforms that are presently encountered began to take initial form in the period of mountain building during the late Cretaceous and early Tertiary, approximately from 80 to 5 million years ago (Nations and Stump 1981). The southern portion of the state, the Basin and Range, underwent the most dramatic deformation and vulcanism whereas the northern portion of the state, the Colorado Plateaus, underwent less dramatic folding and less intense periods of vulcanism. The central portion of the state, the Transition Zone, also experienced sever deformation resulting from the intrusion of igneous bodies and associated metamorphism. As a result, the Colorado Plateau consists primarily of horizontal sedimentary strata that are laterally continuous for hundreds of miles. The other two provinces, the Basin and Range and the Transition Zone, do not contain spatially extensive formations, and are characterized by isolated mountain ranges.

4.2.1 Colorado Plateau

The Colorado Plateau is distinguished by horizontal and gently folded Paleozoic and Mesozoic sedimentary rocks. Tertiary and Quaternary volcanic materials and riverine deposits also are present. Sedimentary rocks such as the Moenkopi, Shinarump, and Navajo formations provide excellent and often-used sandstone for prehistoric ground stone tools. These formations cover a large area of the land surface of northern Arizona, along the north, west, and eastern edges of Black Mesa (Cooley et al. 1969). Wherever these formations are found, there is a potential raw material for ground stone tool manufacture. These sandstones have been used to make ground stone tools from Archaic times through the present (Green 1985). On the Geologic Source Map, the Navajo Formation is included within the Jurassic/Triassic Glen Canyon Group (JTr gc). Although the Navajo Formation is of primary importance, other sandstones within the Glen Canyon Group, such as the Moenave and Kayenta, also contain usable sandstone for ground stone tools. In addition, the Navajo Formation contains a chert of moderate knapping quality, called the Navajo Chert (Green 1985).

The Cretaceous sedimentary rocks of Black Mesa have been used for the manufacture of ground stone tools (Green 1985). In addition, quarries for both grey and white baked siltstone have been identified on Black Mesa (Green 1985); the siltstone was used for the production and manufacture of chipped stone tools. The Cretaceous rocks, for this map, are included within a single mapping unit (Ks). This unit includes the following formations, from oldest to youngest: Morrison, Dakota, Toreva, and Wepo.

Although the sandy units within these formations provide good ground stone material, it is not uncommon for a cherty unit, either in the form of nodules or bedded cherts, also to occur. Such chert units vary in quality for chipped stone tool manufacture (Parry and Christianson 1987). Many cherts contain fracture planes within the material that make them useless except for the most expedient of tools. Good quality cherts have been documented in all of the above mentioned formations except the Moenkopi (Table 4.1). Other chert source areas are the Kaibab Formation, Shinarump Conglomerate, and the Petrified Forest and Owl Rock Members of the Chinle Formation (Table 4.1). For a more detailed map of the locations of the baked siltstone, and Navajo and Owl Rock chert, see Green (1985).

Kaibab Chert is found throughout the Arizona Strip, as well as the Kaibab National Forest and can occur, potentially wherever the Kaibab Formation outcrops. Kaibab Chert is described in Table 4.1.

Another source of chert is in the Redwall Limestone that is found in the Grand Canyon and along the entire length of the Mogollon Rim (Euler 1983). There are also many other sedimentary rocks that outcrop throughout the northern part of the state that have the potential of yielding usable chert.

Igneous material that has accumulated on top of the older sedimentary rocks provide excellent sources of vesicular basalt and andesite for ground stone artifacts, and rhyolite and obsidian for chipped stone artifacts. The obsidian sources of northern Arizona have been exploited throughout prehistory and were traded long distances (Shackley 1988). Volcanic centers for obsidian occur in the San Francisco Mountains and Mount Floyd Volcanic Fields (Geologic Source Map). In the San Francisco Mountains, several important sources occur: Government Mountain, Sitgreaves Mountain, Kendrick Peak, R.S. Hill, the saddle between Agassiz and Fremont, Arizona, O'Leary Peak, Robinson Crater, Fish Sawmill, and Slate Mountain (see Shackley 1988). The are also several sources within the Mount Floyd Volcanic Field: Partridge Creek, Presley Wash, Black Tank, and Round Mountain (see Lesko 1989). All of these sources are plotted on the Geologic Source Map, and their descriptions can be found in Table 4.1.

Fine-grained igneous material for chipped stone, and coarser grained material for ground stone can be found in the Hopi Buttes (Cooley et al. 1969), White Mountains (Dosh 1988), and Mormon Mountain Volcanic Field, as well as in other more isolated igneous outcrops. Vesicular basalt occurs throughout the region, and is indicated on the map (Geologic Source Map).

4.2.2 Transition Zone

The Transition Zone extends diagonally across the state, from Safford to Kingman (Nations and Stump 1981). It is characterized by highly faulted and folded Precambrian and Paleozoic rocks. Cenozoic-age basin fill and igneous materials are also found within the Transition Zone. The general topography of this region is one of rugged mountains, such as the Bradshaws, Mazatzals, and Sierra Ancha, separated by broad basins, such as the Verde Valley and Tonto Basin.

Major chert sources occur in the Paleozoic Redwall and Supai formations along the Mogollon Rim, in the Tertiary limestone of the Verde formation within the Verde Valley, and in the bedrock sources of the Precambrian mountains throughout the region. Along the bajada surfaces in Tonto Basin, extensive chert, quartzite, and chalcedony gravel occurs (Minnis and Rice 1989). The rivers in the area, such as the Verde River, Tonto Creek, and portions of the Salt River contain extensive gravel deposits. These sources, however important, are not included in our map because of the deficiency of specific point locations in the literature.

Granite and granodiorite for ground stone manufacture are found and were exploited extensively in the Prescott region (Stone 1986). In addition, vesicular basalt is abundant throughout this region as a result of Cenozoic volcanic activity. Peridot Mountain, north of San Carlos Lake, is a source for basalt (Callahan 1988).

Two mountain ranges in the northwestern portion of the Transition Zone, the Aquarius and Mohon mountains, contain basalt and rhyolite that were exploited prehistorically (Stone 1987). Obsidian sources, in the form of "Apache tears," can be found at Picketpost Mountain near Superior, and in the alluvial deposits of Cow and Burro creeks (Shackley 1988).

Argillite, steatite, quartzite, greenstone, and schist, which were economically important to the prehistoric inhabitants, are known to occur in the metamorphosed bedrock, rivers, and within the gravel and pediment deposits of Tonto Basin (Ciolek-Torrello 1987).

4.2.3 Basin and Range Province

The Basin and Range Province has undergone extensive deformation in the form of thrust faulting, volcanic extrusions, plutonic intrusions, and associated metamorphism. Precambrian granite, granodiorite, gneiss, schist, and other crystalline rocks are present providing excellent material for ground stone and chipped stone tools. Additionally, the many basin fill deposits, and fanglomerate and alluvial deposits that have occurred during the quiescent periods between mountain building episodes, provide numerous gravel that were probably used as procurement and reduction locations. Areas where granite, granodiorite, and other felsic igneous rocks occur are the Cerbat and Hualapai Mountains (Stone 1987). In the mountains surrounding Tucson, several quarries containing vesicular basalts have been identified (Callahan 1988). These sources of vesicular basalt occur in the Tucson, Roskruge, Sierrita, Tortilita, and Galiuro Mountains. Vesicular basalt also occurs near Ajo (Geologic Source Map). Oftentimes, several different lithic sources are found together; for example in the Black Mountains, in the northwest portion of the state, there are andesite, granite, and basaltic materials for ground stone manufacture as well as rhyolite for chipped stone tool manufacture (Huckell 1986; Stone 1987).

The Basin and Range Province also has several areas where raw materials for chipped stone artifacts are found. There are important chert, jasper, and chalcedony sources in the Basin and Range Province, in the Harquahala, Little Harquahala, Eagle Tail, and Harcuvar mountains prehistorically exploited raw materials have been found (Stone 1986).

Ground stone quarries and manufacturing areas are becoming increasingly important to lithic studies in the state (see Huckell 1986). In recent studies along New River (Doyel and Elson 1985), Agua Fria (Green 1989), and Cave Creek (Bruder 1983) archaeologists have identified extensive quarry sites. Some of these quarries have been inferred to be procurement locations for materials that were transported great distances. For example, the recent archaeological studies at New River (Doyel and Elson 1985) deduce that raw materials for ground stone production and use were transported many miles to the large settlements in the Phoenix Basin. In addition, the extensive andesite quarry near Bullhead City illustrates the importance of ground stone procurement and reduction areas to the prehistoric peoples (Huckell 1986).

Obsidian sources in the Basin and Range Province are few, but there are several locations that provide high-quality obsidian in the form of small nodules and pebbles that have been secondarily deposited. Such pebbles and nodules, termed "Apache tears" or marekanite, are often quite small and therefore require a specific reduction technique (i.e., bipolar reduction). "Apache tears" are found in the Sauceda and Vulture mountains (Geologic Source Map). These small pieces of obsidian also can be located in the alluvial deposits of the Hassayampa River.

4.2.4 Summary

Within Arizona, lithic materials and their geologic sources are varied and extensive. The Geologic Source Map presents known locations for major lithic sources and also illustrates the differences in geology and physiography that have defined those differences. The essentially flat lying strata of the Colorado Plateaus present very different lithic sources than the isolated mountains and slopes of the Transition Zone and the Basin and Range Province.

The Colorado Plateaus contain geologic formations that extend for hundreds of miles, providing a fairly widespread source of lithic materials for several different geographic regions, and for different cultural groups. For example, chert and petrified wood from the Chinle Formation occurs naturally as far south as the White Mountains, and as far north as the border with Utah. The material was utilized by cultural groups in these different areas.

In addition to the laterally continuous, older horizontal strata are extensive volcanic materials, such as basalt and obsidian, that were so important to groups throughout the Plateau. Because of their high knapping quality, certain sources in the San Francisco Volcanic Field, such as Government Mountain obsidian, can be found on archaeological sites throughout the state.

The Mogollon Rim defines the northern boundary of the Transition Zone. The Supai and Redwall formations found within the Grand Canyon also are exposed in the cliffs of the Mogollon Rim. These formations provide chert for stone-tool manufacture. Much of the remainder of lithic sources in the Transition Zone are found in the igneous and metamorphic mountain ranges, where basalt, rhyolite, granite, gneiss, and schist have been exploited. The Tonto Basin is rich in such materials as are the river and alluvial fan deposits located throughout the region.

The Basin and Range Province is characterized by numerous isolated mountain ranges, each containing a variety of lithic materials. This variety has resulted from several periods of mountain building and volcanic activity. Therefore, a single range, such as the Harcuvar Mountains, contain exploitable material as diverse as metamorphic quartzite and jasper and igneous rhyolite. Such mineralogically heterogeneous mountains characterize the Basin and Range Province.

The Geologic Source Map illustrates numerous locations of the major lithic sources in the state that have been recorded by archaeological work in recent decades. Notwithstanding this extensive listing, it is understood that there are many unrecorded and poorly located sources known to the archaeological community. It is hoped that this initial study will be updated on a regular basis to incorporate additional sources as they become more widely known and recorded.

Table 4.1. Descriptions of Lithic Sources Identified in Geologic Source Map.

ZONE	LOCATION	TYPE'	FEATURE NAME	DESCRIPTION \ MATERIALS
COLORADO PLATEAU	San Francisco Mountains Volcanic Field	OB	Government Mountain	Gray-black, nearly opaque to vitreous, with minor red oxidation. One of the most commonly exploited sources of obsidian in the state, from Archaic times to the present. Pebble- to cobble-sized nodules.
		OB	RS Hill	Black, vitreous but contains phenocrysts up to 3 mm in diameter. Pebbles to boulder- sized nodules.
		OB	Kendrick Peak	Gray-black, nearly opaque. Large phenocrysts and devitrification occurs, creating poor flaking material. Pebble-sized nodules.
		OB	Sitgreaves Mountain	Gray-black, with large alkali-feldspar phenocrysts, creating poor flaking material. Large, pebble-sized nodules.
		OB	O'Leary Peak/Robinson Crater	Gray-black, granular, and nonvitreous with bands of ash in the nodules, creating cleavage plains, and therefore, poor quality. Pebble-sized nodules.
		OB	Slate Mountain	Black-mahogany red nodules, vitreous, with small phenocrysts, providing good quality flaking material.
		OB	Agassiz-Fremont Saddle	Black and glassy with abundant large phenocrysts creating poor quality material. Pebble-sized nodules.

COLORADO PLATEAU	Mount Floyd Volcanic Field	OB	Partridge Creek	Black and very glassy with few interior flaws creating high-quality flaking material.
		OB	Presley Wash (Mt. Floyd)	Gray to gray-green, opaque with black flow bands, and moderate quartz phenocrysts. Nodules are pebble to boulder in size.
		OB	Black Tank (Rose Well)	Black and glassy to reddish brown, with a few phenocrysts and small nodules, less than 5 cm in diameter pebbles.
	Black Mesa	SiS, PW	Wepo Formation	Clinker or baked white and green siltstone. Generally occurs in thin beds located in proximity to baked coal seams within the Wepo Formation. The nature of this material is that it contains natural "flake scars" and "potlids," and therefore it is very difficult to identify natural verses culturally altered materials. Additionally, coarse grained petrified wood with quartz filled fractures with poor conchoidal fracture also occur.
		SS	Toreva Formation	Purple conglomerate sandstone may originate from this formation, although it has never been definitely sourced.

COLORADO PLATEAU	Black Mesa	CH, PW, QZ	Dakota Formation	Fractureline chert, iron-stained cleavage plains in a milky translucent chert, characterizes the material in this formation. Locally abundant chert, silicified wood, and quartzite gravels are also abundant in the base of this conglomerate formation.
		SCS	Morrison Formation	Brushy Basin Member, associated with the creamy opaque silicified claystone that ranges in color from light blue, green, gray, pink, tan, and brown.
		CH, SS	Navajo Formation	Location of the well known "Navajo Chert." This chert ranges in color from gray, black, red, maroon, blue, brown, and purple. Also located in this formation is tabular sandstone.
		SL, CAL	Chinle Formation -Owl Rock Member	Red, purple, green silicified limestone and purple-white chalcedony are found in this formation.
		PW	Chinle Formation -Petrified Forest Member	Petrified wood that ranges in color from grey, yellow, red, brown, opaque, white, to black. This material can have either a conchoidal fracture or break along angular plains.
		CH, JS, QZ, CAL	Chinle Formation -Shinarump Member	Resistant gravels comprised of cherts, jaspers, chalcedonies, and quartzites.
		SS	Moenkopi Formation	A red sandstone is located within this formation that is excellent for ground stone tools.

COLORADO PLATEAU	Coconino Plateau, Grand Canyon, and Mogollon Rim	CH, SM, LS	Kaibab Formation	Kaibab chert, glossy chert to coarse silicified mudstone: white, pink, red, cream, and is never translucent. Sandy units of this formation can be used for ground stone tools.
		CH	Red Wall Limestone	Redwall chert varies from red, gray, whitish, brown, and can be brecciated.
TRANSITION ZONE		OB	Superior (Picketpost Mountain)	Black to brown glassy obsidian in the form of "Apache tears." Used from the Archaic to the present. Pebble-sized nodules.
		OB	Burro Creek	Black, brown, and brown-gray "Apache tears" are present. Pebble-sized nodules.
		OB	Cow Canyon	Gray-green to brown-green opaque "Apache tears" are present. Pebble-sized nodules.
		BS	Aquarius Mountains	Basalt
		BS, RHY	Mohon Mountains	Basalt, Rhyolite
		VBS	Peridot Mesa	Vesicular Basalt
		GRN, GD	Prescott Area	Granite, Granodiorite
BASIN AND RANGE		OB	Sauceda Mountains	Green-brown, black, green and black banded, and gray and black banded colored "Apache tears" are present. Pebble-sized nodules.

BASIN AND RANGE		OB	Vulture Mountains	Opaque brown-green to translucent "Apache tears" are present. Pebble sized nodules.
	Southeastern Arizona	VBS	Tucson Mountains	Vesicular Basalt
		VBS	Tumamoc Hill	Vesicular Basalt
		VBS	Roskruge Mountains	Vesicular Basalt
		VBS	Sierrita Mountains	Vesicular Basalt
		VBS	Tortolita Mountains	Vesicular Basalt
		GR, RHY, VBS	Picacho Mountains	Vesicular Basalt, Granite, and Rhyolite
		VBS	Galiuro Mountains	Vesicular Basalt
	West and Central Arizona	RHY, JP, CH	Eagle Tail Mountains	Rhyolite, Jasper, Chert
		CH, JP, CAL	Little Harquahala Mountains	Chert, Jasper, Chalcedony
		JP, CH, QZ, CAL	Harquahala Mountains	Quartzite, Chert, Jasper, Chalcedony
		JP, CH, QZ, RHY	Harcuvar Mountains	Rhyolite, Jasper, Chert, Quartzite
		AN, VBS	New River, Agua Fria, Cave Creek	Andesite, Vesicular Basalt

BASIN AND RANGE	West and Central Arizona	RHY, JP, CH	Alamo Lake	Rhyolite, Jasper, Chert
		GR, F-I	Hualapai Mountains	Granite, Felsic-igneous
		AN, GR, RHY	Black Mountains	Andesite, Granite, Rhyolite
		GR, F-I	Cerbat Mountains	Granite, Felsic-igneous, Turquoise

NOTE: In addition to the raw materials found in Arizona there are several major sources that are found outside the state boundaries: 1) obsidian sources include Antelope Wells, N.M., Red Hill, N.M., Mule Creek, N.M., Gwynn Canyon, N.M.; Mount Taylor, N.M.; Jemez Caldera, N.M., Los Vidrios, Sonora, Mexico, and Obsidian Butte, CA., 2) chert sources include Washington Pass Chert from near Crystal, N.M.; and Cerro Pedernal, north-central N.M.

1. **TYPE** OB= obsidian, SiS= siltstone, PW= petrified wood, SS= sandstone, CH= chert, QZ= quartzite, SCS= silicified claystone, SL= silicified limestone, CAL= chalcedony, JS= jasper, SM= silicified mudstone, LS= limestone, BS= basalt, RHY= rhyolite, VBS= vesicular basalt, GR= granite, GD= granodiorite, AN= andesite, F-I= felsic-igneous.

CHAPTER 5
PROPERTY TYPES

Mark C. Slaughter

5.0 Introduction

Property types are site classifications that provide information about the site character and function. "Form, function, associations, events, or physical characteristics should be considered in selecting and determining the name of a property type" (National Park Service 1986:29).

Identification of a lithic property type is based on recognizing and making logical connections from *artifact classes* present at a site, to the *activities* that were conducted there, to an inference of the site's *function(s)*. In this way, one can construct an argument from the lithic assemblage of a site to past human behavior. Property types have been organized on the basis of site function. This organization is intended as a management tool to help the archaeologist evaluate a site's potential for National Register eligibility. Eligibility is also based on integrity (see Chapter 6) and significance of a cultural resource to answer research questions (see Chapter 7). A site's function needs to be identified to assess the types of research domains that it can relate to; then a property should be examined as to its importance for answering spatial and temporal issues. Thus, the identification of a lithic property type is firmly rooted in delineating a site's function. The position of "lithic analyst" requires special skills, including the ability to make inferences and decisions pertaining to the function of a site based on the available lithic data and general site information.

The basic unit, the artifact class, is a grouping of like data. Bifacial-thinning flakes, slab metates, and bipolar cores, for example, all represent individual artifact classes. These classes form the basis for identifying the activities that occurred at a site; for example, where a large number of bifacial-thinning flakes have been identified, one can infer the activity of bifacial reduction. Interpretation of site function is, in turn, derived from the sum of the activities identified at a site. For example, at a site where hammerstones, alternate flakes, bifacial-thinning flakes, biface fragments, and bifaces are present, the activities indicated would include the percussion flaking of tabular pieces of raw material and the subsequent reduction of these pieces into bifacial forms. Thus, one could infer that the function of this site was the procurement and reduction of raw materials into specialized forms. The intent of identifying artifact classes, activities, and functions is to perceive and make inferences about past human behavior in relation to the use of stone. The classification of lithic property types presented here is based on the identification of site function as inferred from the artifact classes present and the activities they represent.

Two general divisions of lithic property types are Single Activity and Multiple Activity. Single Activity Property Types are predominantly associated with one activity (possibly represented by several artifact classes), such as hide processing. Multiple Activity Property Types bear evidence of various activities. Most lithic sites will have several activities present, and the assignment of an aceramic site to the Single Activity Property Type should be made only when one activity clearly dominates the assemblage. Additionally, for sites that are classified as multiple activity, each recognized activity should be cited.

Additional site manifestations should also be recorded in conjunction with the identification of the lithic property type represented at a site. For example, recording the presence or absence of pottery, the presence of diagnostics (i.e., points, pottery), middens, or habitation structures, in turn, would provide valuable information.

5.1 Single Activity Property Types

1) **Lithic Acquisition Sites**: quarries, procurement sites, mineral procurement sites.

This property type usually is associated with rock outcrops or with locations that have exposed lithic materials on the surface, such as river terraces and washes. Acquisition sites can posses some or all of the following attributes: rejected (tested) pieces of raw material, discarded cores, blanks, and a high percent of decortication flakes. Hammerstones, hammerstone spalls, and spatially discrete knapping areas (chipping stations) may also be present.

2) **Reduction Sites**: core trimming and shaping

This property type has a variety of flake types, such as primary, secondary, and tertiary reduction flakes. No particular specialized reduction technique (e.g, bifacial) dominates. Distinctive flakes, such as error-recovery flakes, and tools such as cores and hammerstones may also be present. Reduction sites occur near, but not at, the raw material source locality because this property designation implies that the materials have been transported a distance and then reduced.

3) **Specialized Lithic Reduction Sites**: bipolar, bifacial, retooling, core reduction (core-flake), tool manufacturing, etc.

Artifacts at these sites reflect emphasis on a specific reduction technique. For example, at bifacial reduction sites there will be more bifacial-thinning flakes than any other flake class. Tools associated with specific techniques also are associated with this property type; for example, anvils and hammerstones in conjunction with bipolar cores would indicate a specialized bipolar reduction site.

4) **Processing Sites**: hide, plant, mineral, other

This property type will have tool classes reflective of the functional activities conducted at the site. There will be little other lithic debris present. For example, a hide processing site can be identified by various lithic tools such as scrapers, utilized flakes, bifaces, handstones with appropriate use-wear, and miscellaneous unifacial tool forms found at a site. Plant processing sites can have cobble tools, utilized flakes, specialized tool forms (e.g., agave knives), bifaces, grinding implements (e.g., mano, metate, mortar, pestle), and utilized natural forms (e.g., bedrock metates). Mineral-processing sites should have the mineral present that was exploited, and tools such as cobble tools, possibly hoes and other digging tools, manos or handstones, paint palettes, and lapstones.

5) **Ground Stone Manufacturing (Macroflaking) Sites**

Ground stone manufacturing sites should have some of the following tools and debris associated with them: large flakes (with and without cortex), large hammerstones (usually of a hard/dense material type), possibly tool blanks/preforms, spalls from hammerstones, and pecking stones.

6) **Lithic Cache Sites**

Lithic cache sites contain groups of like or similar materials. Cache sites can contain lithic tools such as points, cores, hammerstones, or bifaces. This is an unusual and rare property type, and it should be used with discretion.

7) **Kill Sites/Butchering Sites**

Kill sites and butchering sites are usually found with specific classes of tools and associated with animal remains (i.e., bones). In addition to animal remains, associated tools should be present, including the butchering tools such as expedient flake tools, bifacial knives, and possibly projectile points (whole or broken). Spatially discrete work stations may also occur at butchering sites. For example, one station may reflect the primary disarticulation of the animal, another the removal of meat from the leg bones, and another the stripping of meat into long strands for drying or for portability.

8) **Heat Treatment Sites**

A heat treatment site should have lithic materials associated with a hearth and should demonstrate firm evidence of purposeful thermal alteration. Heat-treated flakes, bifaces, and debris should exhibit some or all of the following attributes: spalls from their surfaces, angularly fractured debris (shatter), pot-lids (spalls), fire checks, and luster differences within the raw material. Other knapping debris may also be present at this property type, resulting from the preparation of the materials to be heat treated, or from the post-alteration testing or reduction of the treated lithic pieces.

9) **Maintenance and Harvesting Sites**

This property type pertains to the exploitation of floral materials. Maintenance sites should have tools such as hoes, metates, manos, tabular knives (agave knives), etc. , and possibly the debitage from the resharpening of tools (i.e., stone hoes). Harvesting sites are location specific (near probable agricultural fields, etc.), are associated with specific tools, and can be associated with the procurement of a specific plant species. For example, woodworking tools (i.e., stone axes) should be found in an area that has or has had trees; bedrock mortars, bedrock metates, and grinding slicks along with pestles and manos are located near harvesting areas such as mesquite stands.

Three additional property types are "lithic" in the sense that they include the use of stones, though not necessarily as tools or other intentionally modified forms.

10) **Shrine, Religious, Burial, Storage Bins, Ceremonial, Communication Sites**

This lithic property type should be identified with caution. At this property type there must exist an association of a feature, such as rock pile in a location where there are no agricultural possibilities or an intaglio, with culturally modified/maneuvered lithic materials.

11) **Roasting Pits**

This property type is recognized by the presence of fire-cracked rock and/or associated feature stains, such as ash and charcoal. Ground stone artifacts, flaked stone debris and ceramics may also be present (either used within or around the feature).

12) **Miscellaneous**

Although not a definable property type, this designation was provided to assimilate newly identified property types or anomalous sites with this classification system.

5.2 Multiple Activity Property Types

13) Multiple Activity Sites

This category includes sites where more than one activity can be identified and no single activity predominates. It may, however, be possible to identify discrete activity areas (through dimensional analysis). Multiple Activity Sites include many of the different single activities. <u>All dominant activities should be noted using the terminology applied with the Single Activity Sites</u>. For example, a Multiple Activity Site may have a combination of artifacts associated with primary reduction, specialized lithic reduction, and plant processing.

CHAPTER 6
EVALUATING THE INTEGRITY OF LITHIC SITES

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6.0 Introduction

This chapter presents a general overview of natural and cultural processes that can affect the physical integrity of lithic sites. Hypothetical examples of sites that retain integrity and sites that have lost integrity are provided for clarification. In addition, seven integrity criteria defined in the National Register Bulletin No. 15 (National Park Service 1982) for evaluating prehistoric and historic sites are discussed. The remainder of the chapter presents recommendations for evaluating the integrity of lithic sites.

In order to adequately and accurately evaluate the physical integrity of lithic sites, an understanding of site formation processes is necessary. The following discussion relies heavily upon the ideas of Schiffer (1983, 1987) and the transformation view of post-abandonment site disturbance. The transformation view argues that "as a result of formation processes, the archaeological record is a transformed or distorted view of the artifacts as they once participated in the behavioral system" (Schiffer 1987:10). This statement implies that interpretations of the archaeological record without considering formation processes may lead to a distorted interpretation of the behavioral system. Limitations of archaeological inference result from formation processes (1) that affect the formal, spatial, frequency, and relational characteristics of sites, (2) that create natural patterning of artifacts unrelated to past behavior, and (3) that produce regularities that can be expressed by both chemical and physical laws (Schiffer 1987:12). Therefore, an analysis of archaeological sites that does not consider site formation processes in a synthetic evaluation may limit the accuracy and usefulness of integrity determinations. For comprehensive studies of site formation processes, see Schiffer (1983, 1987).

6.1 Formation Processes

The following section briefly discusses the physical effects of site formation processes on the integrity of lithic sites. This section is not comprehensive and cannot replace the literature or experienced personnel familiar with the evaluation of site formation processes. It is intended as a review of processes that affect sites in the natural setting, and it provides a foundation for the sections that follow.

Three natural processes that can affect sites are deposition, erosion, and soil formation. Although the basic concepts of erosion, deposition, and soil formation are quite simple, their manifestations are numerous and varied. These three processes commonly act on a site concurrently, and therefore, the interpretation of the effects of each process through time is quite difficult. Prior to a review of these processes, a brief discussion of the difference between soils and sediments is necessary, as they are often confused and as terms misused. In addition to natural processes, cultural disturbances can affect sites.

6.1.1 Soil and Sediment

Prehistoric sites exist in a complex medium (soil and sediment) that should be understood in order to completely evaluate the importance and integrity of lithic sites. When attempting integrity evaluations, it is important to be able to interpret both surface and subsurface soil and sediments, because they represent very different processes. Basically, soils represent periods of landscape stability, whereas sediments and erosional surfaces represent periods of landscape instability.

Sediments are materials deposited on the earth's surface by the forces of wind, water, or gravity. Sediments retain many characteristics indicating the processes of deposition, such as a general lack of cementation and a retention of primary depositional structures, texture, and color.

Soils, in contrast, retain no characteristics representative of the process of deposition because of the long exposure of soils to weathering processes. Soil can be thought of as old, weathered sediment. Weathering processes destroy primary depositional features and create new properties and characteristics representative of the conditions on the land surface. Initially, sediment is deposited and may remain unaltered for a period of time. Vegetation and soil organisms begin to break down the primary minerals and add organic matter to the sediment. Rainwater facilitates chemical reactions that break down original minerals, creating new ones. The resulting chemical, physical, and biochemical processes form a soil that has lost the characteristics of the original sediment. Comparing soil to sediment, the soil may be redder, due to oxidation; whiter, due to calcium carbonate buildup; or clay-enriched, due to the downward translocation of clay through the soil profile (Birkeland 1984).

Simply put, sediments are deposited, and soils form in sediments. Therefore, the recognition and differentiation of soil and sediment can provide information concerning past and present geologic processes, as well as indicate the condition of the cultural landscape (Butzer 1982).

6.1.2 Deposition of Sediment

Deposition refers to sediment that has accumulated on the earth's surface and can result in the burial of sites. Phenomena such as flooding of rivers, dune formation, and rising lake levels often are responsible for the burial of sites. Once a site is buried, it is protected from erosion, but may be subjected to surficial weathering (soil forming processes). Thus, burial of a site may preserve, at least until erosion once again exposes it. The nature of the buried sediments and the extent and type of soil development can provide information concerning geologic and perhaps climatic conditions that were active during and after occupation of a site associated with the sediment or soil.

6.1.3 Erosion

Erosion can cause the removal, transportation, and eventual redeposition of artifacts, in the process compromising the integrity of an archaeological site (Schiffer 1983). Degradation of an alluvial channel, the winnowing effects of wind, and mass wasting are a few of the erosional processes that can cause extensive disturbance to sites (Wildeson 1982). A common phenomenon is the concentration of lithic artifacts in the blowout areas between sand dunes, where they accumulate as wind removes the finer material.

Sites that have undergone erosion may retain integrity if substantial intact cultural materials--artifacts, features, and so on--remain buried below the surface. Erosion of soils and sediments that contain buried cultural material may expose those materials, subjecting them once again available to surficial weathering processes. Erosion can remove cultural material from the record, concentrate or scatter cultural material, or alter the original form of the artifacts and site. hen, are a transformed record that has been distorted from the original systemic context of the artifacts to an archaeological context (Schiffer 1983).

6.1.4 Soil Formation

Factors that determine the properties of a soil include time, topographic location, parent material, conditions of weathering, climate, and vegetation. As noted above, soil formation results from chemical, physical, and biological weathering processes that occur at the earth's surface. Such processes include bioturbation (floral and faunal), and pedoturbation (argilliturbation, cryoturbation, graviturbation, aeroturbation, aquaturbation, crystalturbation, and seismiturbation) (Wood and Johnson 1982). These processes can profoundly complicate observed patterns of cultural material, because of the mixing of the soil and sediments. Artifacts can be translocated through the profile and settle in strata unrelated to the cultural strata. Argilliturbation can open cracks in the earth wide enough to engulf whole manos.

6.1.5 Cultural Disturbances

Humans can cause numerous disturbances to archaeological sites. For purposes of this report, "cultural alterations" are limited to modern, post-abandonment processes. That is, we do not consider the damaging impacts by prehistoric human groups that initially occupied, reoccupied, or otherwise exploited a site (see Schiffer 1987). We will therefore focus on modern changes to sites and artifacts. Modern cultural disturbances can include construction of roads, paths, and buildings, leveling and plowing of fields, trampling and overgrazing by livestock, vandalism (including surface collection and pot hunting), collecting of raw materials by recent knappers, RV/ATV traffic, other recreational use, and even the activities of archaeologists. Of particular concern is the removal of artifacts by collectors of diagnostic artifacts such as projectile points, resulting in the loss of valuable data. Although incomplete, the above list provides a sample of the possible effects of modern cultural behavior on prehistoric sites. It must be admitted that the effects of some of these disturbances are not easily recognizable and may, in fact, be impossible to detect using the available techniques.

Some damaging effects may result in the complete destruction of a site's integrity--an example would be the removal of a site by mechanical equipment, such as bulldozers. It is more common, however, for direct and indirect effects attributable to humans to merely alter the integrity of a site, and not to cause total destruction. Direct effects would include potholes placed in features and middens and surface collection that resulted in the removal of diagnostic artifacts. Indirect effects include accelerated erosion caused by roads and paths. Perhaps the most widespread source of damage to sites in semi-arid portions of Arizona is overgrazing. Denuding the landscape of sensitive groundcover exposes sediments and soils to increasing erosion by wind and rain, which in turn may lead to destruction of cultural resources found in those areas. The role of grazing in the degradation of archaeological sites is a topic that warrants investigation.

It is the responsibility of the field archaeologist to become familiar with all aspects of site formation processes. A complete understanding of those processes is imperative so that a truthful integrity evaluation of transformed cultural deposits can be attained, and for the implementation of adequate research or management goals.

6.2 National Register Criteria for Evaluating the Integrity of Sites

In order to qualify for listing to the National Register of Historic Places, a property not only has to satisfy one of the four criteria of eligibility, but it must retain integrity. The following discussion of integrity is based on National Register Bulletin No. 15 (National Park Service 1982) and, therefore, that source is recommended for those interested in the subject. The Bulletin defines integrity as "the authenticity of a property's historic identity, evidenced by the survival of the physical characteristics that existed during the property's historic or prehistoric period" (National Park Service 1982:35). Seven kinds of integrity have been identified: (1) location, (2) design, (3) setting, (4) materials, (5) workmanship, (6) feeling, and (7) association. We would argue that the definitions of these categories and the accompanying discussions of their use are most applicable to historic properties and to prehistoric properties that include architectural remains. Their relation to lithic properties is, on the other hand, not entirely clear. To address this issue, we will identify each kind of integrity, by borrowing from the National Register Bulletin, and suggest ways in which the category does apply, or may be construed to apply, to lithic properties.

Location

"Location is the place where the historic resource was constructed or the place where the historic event took place.... Except in rare cases, the relationships between the resource and its natural and manmade surroundings are destroyed if a historic resource is moved" (National Park Service 1982:35).

A site may loose its integrity of location if the artifacts have been redeposited a distance from their original depostional locale. Although the individual artifacts from a site may be removed, it is difficult to imagine how the features "constructed" on a lithic site could be transferred to a new location. Although the point may be trivial, it would seem that, in most cases, a lithic property would possess integrity of location by virtue of the simple fact that it exists as an identifiable entity. The Bulletin also refers to the location of a historic event. In principle, a prehistoric site might be linked to a traditional or mythic event (National Park Service n.d.), or a protohistoric or early historic site might be linked to an event mentioned in documents.

Design

"Design is the composition of elements that comprise the form, plan, space, structure, and style of a property. It is based upon the needs, technologies, aesthetic preferences, attitudes, and assumptions of a people or culture in each period of history. Design results from conscious decisions in the conception and planning of a property...." (National Park Service 1982:35)

It is conceivable, though unlikely, that the arrangement of activity areas and features on a lithic site could be interpreted as an expression of conscious design on the part of the site's inhabitants. Although design might be inferred from the formal characteristics of the artifacts on a site, this inference would apply to the technology of the site's inhabitants and not to the site per se.

Setting

"Setting is the physical environment of a historic property. Whereas location refers to a particular place where a resource was built or occurred [sic], setting illustrates the character of the place in which the resource played its historical role" (National Park Service 1982:36).

It is an assumption of anthropological archaeology and, often, a demonstrated fact that sites are not randomly scattered over the landscape, but were placed in response to variation in the local environment and to the needs of the sites' inhabitants. Thus, the setting of a lithic site is likely to provide the prehistorian with data on how a landscape was utilized and the nonprofessional with a "sense" of the lifeway of the people who once occupied the area (see integrity of Feeling, below). The integrity of setting of a lithic site is likely to be compromised by "modern" development, to the extent that this development obscures the original condition of the landscape.

Materials

"Materials are the physical elements that were combined or deposited in a particular pattern or configuration to form a district, site, building, structure, or object in a particular period in the past.... The retention of the pattern of deposited materials is important in evaluating the integrity of materials in archaeological sites because often much of the important information that a site contains is based on the distribution of features and artifacts within the site" (National Park Service 1982:36).

Integrity of materials has already been discussed, in the context of natural and cultural site-formation processes (Section 6.1).

Workmanship

"Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history of prehistory. It is the evidence of craftsmen's labor and skill in constructing a building, structure, or object, or altering, adapting, or embellishing a site. It can apply to an entire property or to the manufacture of components within a property such as the machinery in a mill structure or the pottery in a prehistoric site" (National Park Service 1982:37).

In the case of a lithic site, the notion of workmanship is most applicable to the lithic artifacts that are present. There are two aspects to the workmanship revealed by these objects. First, there is the evidence of the finished tools--whole projectile points, scrapers, metates, manos, and so forth. A lithic site's integrity of workmanship will decline in direct proportion to the removal of these complete, or nearly complete artifacts. The second aspect of workmanship is the information potential of the objects that are present. Broken artifacts, debitage from the production of flaked lithic artifacts, and residue from the making of ground stone tools can provide information on lithic technology and, more to the point, document the workmanship of the people who made the artifacts. This evidence is likely to survive, even if the site has been damaged by natural and cultural transformations.

Feeling

"Feeling is the quality a historic resource has in evoking the aesthetic or historic sense of a past period of time. Although it is itself intangible, feeling depends upon the presence of physical characteristics to convey the historic qualities that evoke feeling. It may also require that an appropriate setting for the property be present" (National Park Service 1982:37).

We would argue that, in the case of most if not all lithic sites, integrity of setting is, in fact, a prerequisite of integrity of feeling. This is, in part, a function of a cultural predisposition to associate Native American lifeways with the natural environment. It is also a reflection of the fact that, to a considerable extent, the activities carried out at lithic sites involved the exploitation of "wild" resources--including, animal, plant, and mineral resources.

Association

"Association is the direct link between a property and an event, or person, and so on, for which the property is significant. If a property has integrity of association then the property is the place where the event or activity occurred and is sufficiently intact that it can convey that relationship" (National Park Service 1982:37).

The potential relationship between a lithic site and a historical or traditional event has already been mentioned (see integrity of Location, above). At least in the case of a documented event of the protohistoric or historic period, it may be difficult to say that a property is where the event occurred.

6.3 Levels of Evaluation for Artifacts and Sites

Questions inevitably arise concerning the practical evaluation of transformed criteria and accurate characterization of site integrity. By definition, integrity means " a quality or state of being complete" (Webster 1972), a condition that is satisfied by no archaeological site. Thus, the word "integrity" suggests an ideal that has subsequently been transformed into a relative and highly subjective meaning that lacks quantitative basis. Archaeologists speak of sites maintaining high, moderate, or low integrity--vague terms understood by all archaeologists yet only vaguely quantifiable.

Although it is tempting to apply arbitrary numerical categories to sites based on perceived percentage of integrity, such a classification is impractical as well as potentially destructive to the resource, and to research and management goals. Therefore, no attempt will be made to assign a quantitative hierarchical classification to evaluate the integrity of lithic sites.

In order to provide a foundation for integrity evaluations, however, the following discussion divides archaeological sites into three definable levels of investigation: the artifact, the site, and the region (Butzer 1982). Each of the three levels of evaluation necessitates that certain questions be asked in order to develop a complete idea of the integrity of a site. It should be stressed that these questions are a small sample of an essentially infinite number of questions that can be asked. In addition, each site should be treated as an individual problem, and dealt with accordingly. The answers to these and other questions, when combined with archaeological information on a site, should provide the researcher or cultural-resource manager with a fairly clear idea of the natural and cultural formation processes that occurred there in the past.

6.3.1 Artifact Level

In analyzing artifacts as individual items, specific questions can be addressed, such as whether the artifacts are sandblasted, have crusts, are rounded and abraded, or retain a fresh appearance. Change in the shape of artifacts can indicate whether they were exposed to wind erosion, were weathered on the ground surface or at depth, were transported by water, or have remained relatively unaltered since their original deposition.

If artifacts occur in concentrations associated with a natural feature, it is possible that they have been transported out of their original depositional context. If patterns are observable, it is possible that the patterning is a result of natural sorting processes rather than cultural activity. It is quite rare for any surface artifact to be in its original place of deposition. Certain patterns, in association with certain geomorphic features, can, however, allow the researcher to infer whether the artifacts are far removed from their "original" location.

Questions at the Artifact Level

1. What is the condition of the individual artifact? Is it abraded, rounded, sandblasted, broken, or with or without a soil crust, desert varnish, or evidence of other weathering phenomena?
2. What patterns, if any, do the artifacts form as a group?
3. Does the pattern follow some natural feature such as a gully?
4. Are the artifacts being exhumed?
5. Are any of the artifacts in their original depositional context?

6.3.2 Site Level

When assessing the site, processes such as erosion, deposition, and soil formation should be properly evaluated. The types of soils and/or sediments that are exposed on the surface can provide valuable clues to the possibility of encountering buried materials. For example, if a paleosol can be seen below a dune, and artifacts are found on the paleosol surface, it is possible that the dune may contain artifacts and features.

Questions on the Site Level

1. What is the dominant process on the site: erosion, deposition, or stability (soil formation)?
2. Are any erosional cuts present that might illustrate the subsurface stratigraphy and potential extent of cultural deposits?

3. Are there any features visible such as hearths or ash stains?
4. Are paleosols present on the surface?
5. What type of sediment is present on the surface?
6. What is the landform on which the site is situated?
7. How could the landform have affected formation processes?
8. Have the artifacts been exposed by modern use of the site, such as RV/ATV traffic, road cuts, or camping?
9. Are the artifacts exposed by plants (e.g., root growth), animals (e.g., deer trail, rodent canals, spider holes), or insects (e.g., ants).
10. Is there evidence of looting (e.g., sorting of artifacts into piles, shovel holes)?

6.3.3 Regional Level

On the regional level, the type and extent of natural processes that have occurred within the project area during the past should be evaluated so that the potential for encountering buried sites can be understood. Such a large-scale analysis should be included in any evaluation of lithic sites. That is, what is the probability of encountering buried material both within and outside the defined site boundary?

Questions on the Regional Level

1. What are the landforms in the area?
2. What are the dominant geologic processes in the area today, and what might have been the processes in the past?
3. Are similar sites present nearby that retain integrity and are located on similar landforms that would provide information on preservation and formation processes for comparative purposes.

6.3.4 Examples of sites that have retained integrity and those that have lost integrity.

The most difficult problem in determining site integrity involves the actual physical characterization and subsequent evaluation of a particular site. Clearly, some sites retain integrity, and their evaluation is straightforward. Such sites would include those with intact and definable features like hearths, fire pits, and rock alignments. Sites that have lost integrity would have no intact features, and perhaps only a few artifacts, most or all located outside of their original depositional context. Such a site would be one that has been completely moved to a new location, effectively destroying the original site. The new location would lack any associative properties with its previous location and, therefore, would probably be considered as an isolated occurrence.

Problems arise when attempting to define so called "borderline sites," where the information obtained (or interpreted) does not allow for a clear determination. For example, artifacts loosely concentrated on a high Pleistocene alluvial terrace, containing no observable cultural features but an array of diagnostic artifacts and debitage, will retain integrity for several reasons. The first is the recognition that the artifacts represent an identifiable activity, that is, lithic reduction and tool making. The second is the identification of the artifacts as belonging to a past culture. The third is the recognition that the artifacts have accumulated as a result of cultural activity and not natural process. Perhaps they have been moved by freeze/thaw and bioturbation, but their primary concentration and presence in that location is a result of cultural processes.

On the other hand, a concentration of artifacts located in an arroyo bottom or at the toe of an alluvial fan and that lack associative properties and have been removed from their original cultural depositional location lack integrity. For example, sites located on an older alluvial terrace commonly become eroded by post-abandonment processes. Such processes can remove artifacts from their original position and deposit them onto the lower, younger alluvial terrace. Without knowledge of the age of the terraces and the geomorphic setting of the cultural deposits, an accurate interpretation of the integrity of the artifacts cannot be made. If it can be determined that the artifacts have been moved and redeposited, then they lack integrity.

6.4 Recommendations

The evaluation of the physical integrity of lithic sites is not an easy process. Several recommendations are presented that, it is hoped, will help resolve some of the problems related to determining site integrity. The recommendations include (1) definition of research questions for each project as it relates to lithic artifacts, scatters, and sites, (2) compilation of a form covering geomorphology/formation processes as an aid in evaluating site integrity, (3) implementation of soil-test probes during survey, and (4) inclusion of a geomorphologist to assist in evaluating the physical integrity of sites.

6.4.1 Defining Research Objectives

It is recommended that specific questions be asked prior to the initiation of site evaluation because the types of questions asked will help decide whether or not certain lithic sites have integrity. For example, if a researcher is interested in flaking technology of a particular cultural or geographic region, then lithic artifacts located in disturbed areas, such as blowouts between dunes, may retain integrity. In this case, the loss of spatial or relational integrity is unimportant. Only the artifacts themselves are of importance. Such artifacts retain archaeological value, but not systemic integrity. If nonsystemic questions are important to a project, then nearly all sites or artifacts retain integrity. If systemic questions are addressed, then not all artifacts and sites retain integrity. Clearly, small surveys generally can not address complex research objectives. In cases where some type of lithic context is required, it is hoped that this document will serve to guide investigators to addressing research topics important to geographic and cultural regions.

6.4.2 Tools for Evaluating Integrity

It is recommended that a form be compiled that will facilitate addressing problems of formation processes and site integrity. The form should focus on the three levels of investigation mentioned above, namely, artifact, site, and region. Such a form would facilitate the synthesis of data at these three levels into a holistic landscape approach to the evaluation of sites. Completion of the form should be considered mandatory for accurately evaluating sites. The questions listed in the previous section should be used as a guideline for compilation of a more complete integrity-evaluation form.

One of the most difficult problems with lithic sites is determining the depth of cultural or natural deposits. One way of addressing this difficult problem is to apply soil-auguring techniques. Such procedures should be carefully considered and evaluated before they are applied. Much information can be gathered if soil augers are used appropriately (Stein 1986), and time, money, and the cultural resources can potentially be saved. Although controversial (Shott 1989), subsurface surveys may prove to be useful for evaluating the integrity of certain lithic sites.

When considering natural formation process and the archaeological record, the problem of evaluating the physical integrity of lithic sites can be considered as primarily a geological one rather than simply an archaeological one; although, indeed, the end result will hopefully address archaeological concerns. Hillslope processes, alluviation, eolian deflation, colluvial activity, and a myriad of other natural processes related to both geological and pedological processes affect the integrity of lithic sites. As such it seems wise to require that a geomorphologist (geoarchaeologist) be present to record the appropriate information and to be intimately involved in future recommendations. Although many archaeologists are familiar with soils and sediments and have been determining the integrity of sites for many years, the need for this document has been dictated by the oftentimes enigmatic nature of cultural deposits and the inherent problems of interpreting the extent of natural processes. Therefore, the expertise of a geomorphologist familiar with archaeological problems is strongly recommended.

CHAPTER 7
SIGNIFICANCE OF LITHIC SITES AND ARTIFACTS

Mark C. Slaughter and Lee Fratt

7.0 Introduction

In order for a site to come under the protection of antiquities legislation, it must be demonstrated that the site is potentially eligible for the National Register of Historic Places. In most cases lithic sites will be evaluated with reference to Criterion D, which apply to "properties that have yielded, or may be likely to yield, information important in prehistory or history" (National Park Service 1982:n.p.). The National Register procedures specify that a site's significance must be evaluated with reference to "historic contexts." Historic context then

> is a body of information about historic properties by theme, place, and time. It is the organization of information about our prehistory and history according to the stages of development occurring at various times and places [National Park Service 1986:7].

With the understanding that lithic properties are all potentially important in reference to their theme, time, and place, the following discussion of significance revolves around the interpretation of data and the evaluation of significance based on what can be learned from a lithic property.

7.1 Significance of Lithic Sites

How does an archaeologist assess the significance of a lithic site? The National Park Service (1982:13-ff.) tenders guidelines and methods for evaluating significance using a trinomial system: local, state, and national significance. To date, the prehistoric sites listed on the National Register have been deemed important based on their ability to yield information significant on the National level. Because the significance levels developed by the National Park Service were designed with other agenda in mind, they are not easily applied to aceramic sites. Therefore, we propose three different divisions that will elucidate the assessment of significance for lithic materials. These levels of investigation are: (1) *artifact*, (2) *site*, and (3) *regional* (*sensu* Willey and Phillips 1958). This is a hierarchial approach in examining and evaluating lithic properties where one investigative level feeds into the other(s).

7.1.1 Artifact Level

The first level is the artifact, the basic building block for all other investigative levels. We have expended much ink throughout this volume in the description and identification of lithic artifacts found in Arizona because these artifacts are the foundation for disclosing important information that can be recovered from aceramic sites. But, are individual or limited amounts of lithics significant? The answer to this question is often no, but there are exceptions, and these are usually related to the unique context and association of the artifact(s). For example, if a Clovis point is found in the skeleton of a mammoth in Arizona, this site would be significant, and thus, worthy of preserving. This is an extraordinary example, but not unheard of (see Hemmings and Haynes [1969], and Huckell [1982], for discussions of the Escapule mammoth site in southeastern Arizona). Another way in which an artifact or a few artifacts may posses significance is rooted in the research design of an archaeological project. For example, if the research design for a project includes examining the spatial patterning of basalt flakes in the upland areas near Safford, Arizona, then these isolated artifacts may, as a group, be significant. The combined data from this fictitious project are important and significant because they make use of spatial patterning via limited amounts of data to answer archaeological questions of a larger scale (either pertaining to the locality or region). Again, the point we emphasize is that individual artifacts, be they lithic or not, can be significant and worth preserving based on the research questions that are being addressed. In keeping with the preceding discussion of integrity (Chapter 6), and related this concept to this level of investigation, lithic artifacts almost never loose their integrity. Given the above examples, even if the integrity of location is lost, these artifacts are still significant given their unusual occurrence and the research design associated with the project.

7.1.2 Site Level

The second level of investigation is the site. An aceramic site is comprised of a group of lithic artifacts and possibly features relating to the use of the site. This level of investigation is the best to study prehistoric behavior. Of course, the decision as to what constitutes a site is often subjective and differs within governmental agencies and individual states, and thus, will not be directly addressed, but for the purposes of this discussion a site is

> the place where a significant event or pattern of events occurred. It may be the location of prehistoric or historic occupations or activities that may be marked by physical remains; or it may be the symbolic focus of a significant event or pattern of events that may not have been actively occupied [National Park Service 1982:6].

A site is studied by examining the artifacts that are present. Study of the lithic materials at a site will indicate a site's function, and thus, the property type. As discussed earlier in Chapter 5, lithic sites can be grouped into two main categories of property types, Single Activity and Multiple Activity, and twelve individual site types. To review, the twelve property types are (1) Lithic Acquisition sites, (2) Primary Reduction sites, (3) Specialized Lithic Reduction sites, (4) Processing sites, (5) Ground stone Manufacturing (Macroflaking) sites, (6) Lithic Cache sites, (7) Kill/Butchering sites, (8) Heat Treatment sites, (9) Maintenance and Harvesting sites, (10) Shrine/Religious/Ceremonial/Communication sites, (11) Roasting Pits, and (12) Miscellaneous. These are functional classes that are categorized into a property type(s) by identifying the artifacts and then inferring the activities that are present at a site.

What can be learned about the lithics at the site level? Artifact analysis can indicate the technology employed, site chronology, the specific activities that were conducted, the location of activity areas, and, possibly, cultural affiliation. At this level of investigation it is important to examine how the lithic technology was organized (see Binford 1979; Bamforth 1986, 1991; Shott 1986; Kelly 1988). The organization of the lithic technology refers to "the spatial and temporal juxtaposition of the manufacture of different tools within a cultural system, their use, reuse, and discard, and their relation not only to tool function and raw-material type and distribution, but also to behavioral variables which mediate the spatial and temporal relations among activity, manufacturing, and raw-materials loci" (Kelly 1988:717). Analysis and subsequent data manipulation discloses patterning such as tool production, task location, tool use, from which the organization of the lithic technology can be inferred.

It is apparent that what constitutes a diagnostic artifact is subject to review and modification. Nevertheless, diagnostic lithic artifacts such as projectile points and piki stones can be very useful as distinctive markers of cultural adaptations related to the various periods in prehistory (see Bostwick 1988; Bayham 1986; Christenson 1987b; Fratt 1991; Huckell 1984a; Woodbury 1954). But, given the lack of hard dating methods for some of the prehistoric cultures, and the use of intuitive based chronologies, the definitive use of the "older" established chronologies can be less than rewarding. Regardless, if diagnostic artifacts (lithic, ceramic, or other) are present, the relevant regional chronology should be applied.

One of the more rewarding and evolving studies is debitage analysis. Debitage is usually the largest class of lithic materials present at a site. Here, then, is the basic building unit for progression to theories of procurement strategy and reductive technology. Additionally, debitage can be used for inferring the function(s) present at a site (property type). Techniques of reduction are important when attributing a lithic site to the individual property types; there are many variants in reduction method, such as bifacial, bi-polar, flake-core, and alternate flaking. The identification of the raw materials, their source localities, and reductive technique(s) employed at a lithic property will encourage further studies pertaining to the recognition of mobility pattern(s) by prehistoric groups, the trade or exchange between sites and cultures, the organization of technology distinguished by specific periods of time and spatial location, and the procurement strategies employed by prehistoric groups.

Many methods of debitage analysis exist, ranging from intuitive to quantifiable (e.g., Sullivan and Rozen 1985; Bradley 1975; Burton 1980; Flenniken 1985; Patterson 1990; Phagan 1985). One of the important inferences resulting from the analysis of the debitage from an archaeological site are the identification of spatially distinct areas for specific tasks. Dimensional analysis (e.g., Behm 1983; Carr 1984; Binford 1980) is the recognition of the patterning of like or related data at a site. Oftentimes, these areas represent both spatially and functionally distinct locations of specific activities. From recent research involving ethnographic studies (e.g., Binford 1980, 1982), we know that spatially distinct areas were used for individual tasks. Debitage, then, can be culturally patterned and occupy distinct areas of space within a site; for example, if like classes of debitage cluster then the analyst can infer that this location was used for specific tasks such as retooling, ground stone manufacture, and primary reduction of raw materials.

Analysis of the stone tools at a site is important to understanding the organization of the lithic technology. Often, there is a wide range of data derived from the analysis of stone tools at a lithic property. This information can include, stages of reduction that tools pass through during manufacture (see Callahan 1979), the discard rate of tool forms, the level of labor put into stone tool manufacture, the reductive technique(s) employed for tool manufacture, tool use, and the variation of tool types required for the completion of a single or for a multiplicity of tasks. Clusters of tools, as with the debitage, can indicate loci where specific activities took place. For example, if a number of end scrapers, handstones, and bifaces cluster at a site locus, then one explanation is that this area was used for hide processing; another explanation might be that this locus is a cache. Clustering of tools and inferring distinct tasks should also be done in conjunction with other research methods, such as use-wear (see Hayden 1979; Keeley 1980; Newcomer and Kelley 1979; Semenov 1970; Tringham et al. 1974; Wright 1990; Adams 1988, 1989b) and residue analysis (see Hyland et al. 1990; Loy 1983; Newman 1990b; Shafer and Holloway 1979). Holistic methods of stone tool analyses further expand our knowledge of tool use for various tasks, and thus, should be appropriately applied.

As referred to earlier in this text (Chapter 5), the inferred activities at a site determine the property type. The identification of artifacts associated with an activity, and thus, the property type, makes it possible to infer the general pattern of technological organization of the stone materials; that is, does the site exhibit a curated or expedient technology. For chipped stone this inference is, in essence, based on mobility and the tool efficiency exhibited by a group (Binford 1979; Kelley and Todd 1988). A highly mobile group are thought to have a curated technology. A curated technology requires the efficient use of raw materials and the requisite of highly portable, light weight, and reusable tools (multi-functional). Groups affiliated with a curated technology will maximize their material and reuse their tools longer, extending the material and tool(s) use-life. Flaked stone artifacts and reduction attributes that can indicate a highly mobile group, such as the groups that comprise the Paleo-Indian and Archaic Periods, are finely worked points, tools and debitage made of materials from distant sources, a high ratio of specialized reduction flakes (e.g., bifacial), a high ratio of tools with bifacial retouch, and a lower ratio of cores to bifacial tool forms. Although mobility plays a large part in determining flaked stone curative technology, the nearness of a source area might be just as important in determining the efficient use of stone. A review of several ethnographic groups that are highly mobile suggests that an expedient core technology can be adopted if source materials are abundant (Parry and Kelley 1987:301).

An expedient chipped stone technology is usually associated with sedentary groups (e.g., Anasazi, Hohokam, Mogollon, Salado). The differences between the two technologies include the reduction techniques employed, the cost of labor for tool production (a high cost being associated with a curated technology), and the amount of tools that are needed for tasks. An expedient technology is usually associated with flake-core reduction, a higher proportion of waste, and a high discard rate of tools. An expedient technology might include the following attributes and artifacts: flakes from cores, tools and debitage made of locally available materials, a high ratio of cores to finished tools, large amounts of waste flakes in proportion to final tool forms, marginally retouched tools, and a diversity in the tool forms in contrast to multifunctional tools.

The concepts of expedient and curated technologies have been applied to ground stone analysis, although, with modifications (Benitez 1991; Calamia 1983). The indicator used to label ground stone implements as either expedient or curated is the measure of labor input into the shaping process. Other relevant factors for distinguishing expedient or curated technologies include the degree of use, condition of the artifact at discard, and the distance to the raw-material source. At one extreme, a curated ground stone implement will be elaborately and finely shaped, may show evidence of repeated use, and is made of an exotic non-local material. Examples include Hohokam effigy palettes and finely made vesicular trough metates. At the other extreme, an expedient ground stone implement has little to no shaping, only a brief use-life prior to its discard, and is made of local material. Examples include cobble manos or handstones and unshaped or poorly shaped slab metates common to the Mogollon culture. Researchers have also used the concepts of a curated and expedient ground stone technology to address questions of mobility (Calamia 1983), seasonality and site history (Stone 1991), and the degree of dependence on domesticated plants (J. Adams, personal communication 1991). Researchers concerned with assessing relative degrees of shaping ground stone implements are developing methods for quantifying this characteristic to delineate curated and expedient artifacts (Benitez 1991).

The property type, then, is the link between the framework of historic contexts--theme, place, and time--and the archaeological site record. The archaeologist's job is to determine, from the wide range of data potentially available from many lithic sites, which sites are potentially significant under the Nation Register criteria. The project's research design and current state of archaeological knowledge play major roles in making this determination. If the site is likely to yield the types of data needed to address questions posed in the research design, or significant unanswered questions for a specific spatial and temporal setting, then the site may be considered potentially significant. Integrity of the site also plays a role in determining significance. In most cases, when a site has been greatly altered and the artifacts moved from their original setting, integrity is considered lost and significance is absent. In some cases, however, sites may be considered significant even in the absence of integrity. If the research design for a project is to determine the sorting of lithic artifacts via fluvial activity, and the results are a definitive example of this type of formation process, then the site is significant. Again, determining significance depends on the research questions that are being addressed.

One way to aid in the evaluation of significance at the site level is to examine the how the property contributes to our understanding of the past at the regional level. That is, how does the lithic property contribute to the knowledge of a geographic region or cultural area?

7.1.3 Regional Level

The regional level refers an area larger than a site and is usually related to a geographic (e.g., San Pedro Valley, Coconino Plateau, Salt-Gila Basin) or cultural region (e.g., Hohokam, Anasazi, Mogollon). At this level, sites are compared and contrasted with regard to chronology, settlement pattern, mobility pattern, and organization of technology. Thus, hypotheses can be generated and traits identified in reference to the past use of stone and adaptations to a geographical or cultural area.

The use of the lithic property types, at this level, are effective in determining the patterns that occur (as inferred from debitage and tool analysis) temporally and spatially. If similar property types are identified in the nearby areas, a regional or cultural pattern emerges of similar adaptation to an environment. One of the more productive studies at the regional level are inquiries about the distance to and the location of raw materials utilized by the prehistoric inhabitants; that is, how far did someone have to go or how far did someone have to come to get this stone where it is now. The location of the raw material source, as well as distance to the source, can be used to examine theories of exchange, trade, and procurement method employed within a region. These studies often make use of petrographic analysis and trace chemical analysis to determine the source locale of stone (e.g., Euler 1989; Green 1984; Jack 1971; Lesko 1989; Shackley 1988; Bostwick 1988) and are a valuable tool for making inferences concerning how raw materials were procured.

There are two methods by which individuals could obtain raw materials firsthand. These contrasting procurement strategies are referred to as direct and embedded (see Binford 1979, 1980). A direct procurement strategy is one in which the location of the source area is known, and trips are undertaken for the express purpose of obtaining raw materials. An embedded strategy, in contrast, is one in which raw materials are obtained incidentally during the acquisition of other materials. A third procurement strategy is that of trade, in which materials are not acquired directly from the source, but are obtained from other individuals.

The different types of procurement strategies have been associated with differing settlement strategies. Binford (1979) has shown that residentially mobile groups will usually obtain their lithics by direct procurement in the course of their residential moves. In other words, raw materials for stone tool production will be either gathered during times when the base camp is located near lithic source areas, or express trips will be undertaken for the purpose of obtaining lithic materials. Direct procurement may also be used by residentially sedentary groups who are settled near lithic sources. In contrast, an embedded procurement strategy may be used by groups who regularly undertake procurement trips to acquire other resources. Thus, logistically mobile groups (i.e., groups that seldom move their residences, but regularly undertake long-distance resource procurement trips) will be expected to incidentally collect lithic materials as the opportunity arises. Although Binford applied the concept of embedded procurement to hunter-gatherer groups, the strategy may also be applied to sedentary agriculturalists who hunt or carry out other activities in distant areas. Procurement through trade may be employed by any group that does not have regular access to a desired source.

These theoretical constructs must be cautiously applied to archaeological sites. If a site has raw materials from a distant source, and was occupied for only a short duration, the procurement strategy is probably a logistically mobile group that utilized an embedded strategy. However, several recent studies have indicated that a wide diversity of lithic procurement strategies exists, and that different procurement strategies are often employed by one group (e.g., Bamforth 1991; Calamia 1983; Henry 1989; Green 1984, 1985; Shackley 1986). Additionally, problems exist in distinguishing trade from direct and embedded procurement. "Exotic" and "valuable" materials such as turquoise are believed to have been traded widely among groups, and during the Ceramic period other lithic materials (such as obsidian nodules and argillite) are believed to have been traded as well. Although identifying the source of many of these materials is now possible through characterization studies, inferring trade is based on indirect evidence such as technology, distance to source, and quantity.

Other important considerations at the regional level include: are there distinct points styles or other chronological markers (such as ground stone) found only within a single region, thus, signifying a distinctive culture; and, are there conflicting environmental conditions in the same region that influence differential settlement and procurement patterns? Analysis of a site's importance at the regional level, then, is one of the most important considerations when assessing significance. That is, does a site contribute significant information concerning its theme, place, and time. At this level a site is compared and contrasted in order to understand how it fits with adaptations to specific geographical regions. Certainly, understanding the role of stone in the regional systems (e.g., Anasazi, Hohokam) is an important research goal for the present and future. Thus, the importance, or significance of a lithic site at this level is ascertained by examining the role or the influence that the lithic property contributed to a specific culture or within a distinct geographical region.

7.2 Future Avenues of Flaked Stone Research

Past research of lithic data and lithic sites have addressed a wide range of topics varying from artifact seriations to cultural affiliations. Current theory suggests that archaeologists need to address the themes pertaining to the organization of technology, trade/exchange of raw-materials or finished forms, the temporal changes in the use and style of stone tools, and settlement patterning to more fully understand the role of stone tools in prehistory. Following, then, is a brief list of relevant research pertaining to flaked stone artifacts that should be pursued.

Early work by Rogers (1929, 1939, 1958), Sayles and Antevs (1941), Haury (1950), Hayden (1967), and others sought to provide frameworks for regional adaptations, tool use, chronologies, and spatial information of the prehistoric people. These works have long been the standards of Southwestern archaeological studies, and should remain so; however, methods have changed in data recovery, analysis of tools, analysis of debitage, sampling strategies, and dating techniques. Additionally, different models have been developed that concern settlement and mobility, exchange, and production.

As presented in Chapters 2 and 3, the definition of what is a diagnostic lithic artifact has changed. Temporal and spatial distinction of projectile points needs to be further refined and chronologies developed for the later cultural groups. In particular, do Ceramic period groups have distinctive point styles? Is the manufacture of projectile points during the Ceramic period associated with only a few individuals (craft specialists)? Are the higher-labor-input flaked lithic items for use other than subsistence (i.e., ceremonial, ritual)? Temporal information is not the only kind of data that can be derived from points. Processual studies have documented the multifunctional nature of many projectile points (Ahler 1971), information potential of broken points (Titmus and Woods 1986), rejuvenation of previously finished forms (Towner and Warburton 1990), and the use of minimally altered flakes as points (Odell 1988). Future studies can contribute important information about the cultural processes that affect the configuration of projectile-point assemblages.

Some studies have examined the subsistence and settlement of hunting and gathering groups (Whalen 1971; Bayham 1982; Bayham and Shackley 1986; Ackerly 1986; Bostwick 1988). These studies are based on the lithic industry present at sites and infer regional movements and patterning of sites in the area level. More of these type of studies are necessary in order to more fully understand regional patterns of subsistence and settlement strategies. Additional research would also help refine the typological problems within the lithic systems.

Another potential avenue for future study is the organization of hunter and gatherer technology (e.g., Kelly 1988). Current archaeological research has sought to understand the procurement and distribution of raw-materials at both the site and area levels (e.g., Green 1982; Parry 1987; Bostwick 1988; Harry 1989). Many more of these type of studies can contribute greatly to the past behavior patterns associated with the acquisition, trade, and exchange of raw materials.

Diagnostic attributes of individual technologies have been distinguished by experimentation and replication of those technologies (e.g., Flenniken 1981; Gilreath 1983). Although individual assemblages and lithic items undoubtedly show some variability, the identification of the different technologies and their role in an assemblage will contribute to questions of prehistoric mobility, settlement patterning, curational behavior, and generalized adaptations. Relative frequencies of the different size classes of debitage can be useful when comparing and contrasting assemblages from different sites. Size can provide some clues as to the distance from raw material sources and the procurement strategy. For example, was the artifact initially reduced at the raw-material source area or at a spatially distant area? A mixture of raw materials and technologies, however, limits the information that can be derived from size-sorted debitage. A second analytical method documents the "status" of individual lithic items. This approach was developed with data from the TEP St. Johns Project in east-central Arizona (Sullivan and Rozen 1985). Each piece of debitage is classified into one of four categories: complete flake, broken flake, flake fragment, and debris. Based upon the relative frequencies of these four debitage categories, Sullivan and Rozen (1985) identified statistically significant differences between aceramic and ceramic sites. This method is relatively quick and can be performed by individuals that are minimally trained in lithic analysis. Although this method has come under some criticism (see Ensor and Roemer 1986), it has demonstrated its utility, at least in the areas of east-central Arizona.

Recent "hard" science applications have made their way to the lithic analysts. These methods vary from residue identification to dating. One of the most recent of these new methods is identifying blood residues on stone-tool surfaces (see Loy 1983; Hyland et al. 1990). Future applications of this method may prove to answer use-related questions such as tool function, the range species that were exploited, and if a particular tool class is associated with a specific species. Another hard-science method, still in its infancy, is the dating of artifacts by their desert varnish on their surfaces (see Bierman and Gillespie 1991; Bierman et al 1991; Dorn 1983; Dorn and Oberlander 1981; Dorn et al 1987; Dorn et al 1986). Should this method prove accurate the possibilities of applying this dating technique, particularly in the desert regions of western Arizona, are promising.

Replication studies, such as those by Huckell (1986), Crabtree (1973), Bernard-Shaw (1984), and Towner and Warburton (1990), have all been useful in understanding the characteristics of flaking mechanics and tool use. More replicative studies should be undertaken. Replication of past techniques of tool manufacture and tool use can provide valuable information such as a task (or tasks) in which a tool was used, the cause of patterned breakage of stone tools, the debitage patterning of debitage from the production of a specific tool form, and general studies relating to what were particular tools used to do in the prehistoric system.

The reduction of stone produces both tools and unwanted/unused debris (debitage). As a result of the shaping processes that is required for flaked stone tools, debitage is the most common artifact class. Study of the debitage at a site is important because these artifacts exhibit attributes that can be diagnostic of distinct reduction techniques (e.g., bifacial, blade). From the analysis of the debitage inferences and hypotheses can be generated concerning a diversity of subjects such as site use, raw material procurement strategies, spatial distribution of tasks, and site function(s). Additional studies concerning stone artifacts can include finished and/or expedient tools that be examined to identify manufacture and use.

In summary, there a many ways in which studies of flaked lithics can contribute to processual theory. Among the lithic topics that directly need to be addressed in Arizona are chronology, tool function, organization of technology, raw-material procurement, trade, exchange, mobility, and intra- and inter-site variability.

7.2.1 Studies of Ground Stone and Future Avenues of Research

Ground stone assemblages include artifacts related to food-processing and non-food-processing activities (Adams 1979; Fratt 1991). Research involving prehistoric ground stone artifacts has focused on artifacts associated with food processing because the origins of agriculture and the shift to subsistence strategies dependent on domestic plants, especially maize, are of major interest to Southwestern archaeologists and because remains of manos and metates are usually the most numerous and most easily identified artifacts in ground stone assemblages. Most of what we know about hunting and plant procurement is inferred from chipped stone assemblages, and most of what we know about plant food processing and preparation is inferred from ground stone artifacts. It is unfortunate that ground stone artifacts associated with nonfood-processing activities have received so little attention from archaeologists since ground stone implements can also provide information about changes in prehistoric demography, social organization, exchange, nonfood-resource procurement, art and ritual, architecture and construction techniques, and economics. However, obtaining information about these topics requires that archaeologists begin to observe and record information about the non-food-processing implements present, such as grooved abraders and paint grinding stones, as well as the more familiar tools associated with food processing. If as much attention were given to documenting and analyzing surface ground stone assemblages as has been given to ceramic and chipped stone artifacts, our knowledge of site function, settlement patterns, prehistoric subsistence, and organization of technology would be greatly increased. The following discussion briefly reviews research topics of interest to ground stone analysts.

Morphological changes in ground stone artifacts and changes in ground stone assemblages have been closely associated with changes in subsistence. Relevant themes include the origins of agriculture and the shift from reliance on wild resources to reliance on cultigens, dietary change (especially the increasing dominance of maize), grinding efficiency, and changes in food preparation and cooking techniques. However, the relationship between forms of grinding tools and subsistence are often predicated on assumptions that recent research indicates are too simplistic. That changes in ground stone morphology and use are linked to changes in subsistence is undeniable, but the nature of these associations is the topic of much of the newly revived interest in ground stone artifact analysis.

For example, it has been assumed that basin metates, grinding slabs, mortars, and oval one-hand manos were used to process wild-plant resources and troughed and slab metates and two-hand manos were used for processing cultigens, especially maize. Other assumptions include associating the development of a reciprocal grinding motion and the appearance of larger grinding implements with maize processing. Recent studies have raised serious questions about these assumptions. Greenwald's research (1990, 1991) indicates that characteristics other than mano and metate shape, such as the type and texture of raw material and the size of the grinding surface, are also associated with processing particular types of plants. Based on the results of pollen washes obtained from a sample of Hohokam trough and slab metates, Greenwald (1991) proposes that Hohokam subsistence strategies included two different food-processing systems--one centered around slab metates and round or oval manos made of non-vesicular igneous material to process noncultigens except cacti and another centered around trough metates and rectangular manos made of vesicular material to process corn and cacti. Adams' (1991) research indicates that changes in mano and metate forms reflect the development of wear management techniques, while Woodbury (1954) associates the change from trough metates to slab metates to slab metates permanently set in bins among the Anasazi in Arizona with architectural change, specialized use of rooms, and a change in the nature of the grinding activity from a solitary chore to a more social activity. And Adams (1991), Morris (1990), Wright (1990), and Bartlett (1933) show that studying the motor habits and mechanics of grinding on a metate lends insight into grinding tool morphology.

Also relevant to questions about what kinds of ground stone tools were used to process what kinds of plants is the persistence of earlier, and presumably less efficient, types of grinding tools in later assemblages that are dominated by tools considered to represent a more efficient food-processing technology (Christenson 1987a; Adams 1986). The usual explanation is to assume that wild plant resources continued to be exploited (Wheat 1955). Morris (1990), however, suggests that the volume of corn ground rather than simply the presence of corn determined the use of two-hand rather than one-hand manos. And based on information from Hopi informants, Adams (1986) concluded that the one-hand manos from Walpi (whose occupation spans the protohistoric to the present) were used to process hides rather than corn. These studies question assumptions about actual use of tools identified as food-grinding implements as well as whether the implements had single or multiple uses.

Besides morphology, changes in the size of manos and metates, have also been associated with the shift from dependence on wild plant foods to cultigens, agricultural intensification, and changes in population size and density (Hard 1986; Lancaster 1983). It has been assumed that with increasing dependence on maize, larger manos and metates were used in order to grind ever increasing quantities of corn more efficiently. In his study of agricultural dependency in the Mogollon highlands, Hard (1986) argues that an increase in mano grinding surface area in order to promote grinding efficiency should be a direct response to an increasing dependency on corn in the diet. He proposes that since longer manos have more grinding surface area (mano width being constrained by hand size), then mano length should serve as an index of agricultural dependence (Hard 1986:102-150). Whether mano length is an adequate index of agricultural dependency for the Mogollon, as well as for the Anasazi and Hohokam, requires more extensive information about the ranges of mano length characteristic of particular regions and periods.

What is meant by grinding efficiency and how it should be measured is another important topic of ground stone research. Several characteristics of manos and metates have been associated with increasing grinding efficiency, including increases in implement size, number of mano use-surfaces and variety of transverse cross-sections, changes in grinding stroke and grinding motion, and increasing tool specialization (Hard 1986, Lancaster 1983, Christenson 1987a, Bartlett 1933). Adams (1991), however, distinguishes between grinding efficiency and grinding intensity, noting that many of the characteristics associated with grinding efficiency are more appropriately thought of as reflecting techniques of managing wear and of extending implement use-life that accompanied increases in grinding intensity. Other researchers have postulated that increases in the variety of two-hand mano transverse cross-sections that characterize Anasazi and some Mogollon assemblages are associated with changes in cooking techniques, in particular, the need for more finely ground flour to make piki bread and a change in the type of cooking fuel used (Fratt 1991; Christenson 1986). And the switch from single to multiple stages of grinding flour signaled by the presence of two or more metates made of material having different textures is associated with changes in cooking and in the nature of the grinding activity (Bartlett 1933; Woodbury 1954).

Besides processing food, ground stone artifacts also provide information about regional demographics and settlement patterns. Changes in agricultural and food-processing tools have been associated with changes in diet that, in turn, may reflect fluctuations in population due to aggregation or dispersal. For example, the appearance of new implements such as hoes in the later prehistoric periods may signal changes in agricultural or horticultural techniques such as expansion into areas with different kinds of soils (Woodbury 1954) or the collapse of the Hohokam irrigation system (Haury 1976). In order to answer questions about the kinds of agricultural techniques used and changes in those techniques requires that the distribution of agricultural implements such as hoes be recorded along with data on soils and the other agricultural features present in a particular region.

The study of the sizes, shapes, and distribution of the bedrock grinding features at the Los Morteros site, combined with ethnographic and ethnohistoric information on Pima and Papago subsistence practices, yielded data on patterns of land use, seasonality, and prehistoric environment as well as resource processing and site function (Wallace and Holmlund 1983:143-182). On the basis of their detailed investigation, Wallace and Holmlund (1983:171-173) concluded that the bedrock mortars, their associated pestles, and the bedrock metates at Los Morteros represent mesquite processing stations that were part of nearby habitation sites rather than autonomous processing camps and that cupules were the byproduct of pestle manufacture. Alternatively, Schaafsma (1980) offers a nonutilitarian explanation for cupules, correlating them with the distribution of petroglyphs in the Hohokam area and suggesting that they may have been used for grinding or holding pigments or for depositing prayer sticks. Although Wallace and Holmlund's (1983) interpretation of the bedrock features at Los Morteros is persuasive, it does not explain their appearance in other areas where mesquite does not grow and no evidence of mesquite has been found archaeologically. In-depth studies of the quality conducted by Wallace and Holmlund (1983) are needed in other parts of Arizona to better understand and interpret the bedrock features that appear throughout the state. Also, comparative studies of bedrock features that are and are not associated with habitation sites are required to more clearly delineate the differences between processing stations and processing camps.

Mobility and the shift from a relatively mobile to a sedentary existence has long been a focus of archaeological research in the Southwest (Cordell 1984). The primary focus of this issue has been architectural, but studies of ground stone assemblages, whose implements are generally the largest and heaviest items at a site, could provide a new perspective on the logistics entailed by a mobile lifestyle. Calamia (1983) links curation with mobility and, using ethnographic and archaeological data, argues that variability in the relative size and curation of grinding tools may reflect differing degrees of residential mobility and their associated plant-procurement strategies. Bernard-Shaw (1984) notes that evidence of curation is an important characteristic of Hohokam ground stone assemblage variability. By evaluating whole lithic assemblages, including both ground and flaked stone artifacts, from different types of sites, Bernard-Shaw was able to identify differences between hamlet and village sites compared to field house and plant processing sites. With regard to the ground stone assemblages present, Bernard-Shaw found that the latter sites had larger amounts of heavy tools showing reuse and an absence of specialized tools. Focusing on understanding variability in small, seasonally occupied sites, such as field houses and plant processing camps, Stone (1991) argues that differences in the density and diversity of food-grinding implements present reflects different degrees of site reoccupation rather than differences in site function or in the kinds of foods processed.

Detailed studies of ground stone quarries and attempts to source raw materials used for ground stone tool production are relatively recent but essential for understanding ground stone tool production systems, land use patterns, transportation, resource exploitation, and local and regional economics (Stone 1986; Euler 1989; Doyel 1985). The pioneering studies of ground stone quarries reported by Huckell (1986) and Hoffman and Doyel (1985) have increased our knowledge of how manos and metates were made and have placed grinding tools within a regional economic framework. These studies involve only two types of raw materials, andesite and quartz-bearing basalt. Manufacturing techniques for other raw materials, like sandstone and vesicular basalt, may differ and so may the systems of procurement and utilization. Questions about raw material procurement, the techniques used to manufacture ground stone objects, and where different stages of manufacture occurred requires that possible quarry areas be carefully inspected for evidences of use and that descriptions of mano and metate blanks and of the manufacturing techniques (flaking, pecking, abrading) used be recorded.

To date, ground stone sourcing studies using petrographic analyses (Schaller 1983; Schaller and Mitchell 1988) are not without their critics (Bostwick and Burton 1991). Nevertheless, these few studies have provided important new information about Hohokam regional exchange systems, and they could produce new information on exchange systems in other areas as well. Chemical analysis may prove to be a more precise method of identifying particular sources. Despite the problems inherent in raw material sourcing, these studies emphasize the need for analysts to be more explicit in their identification of material (Bostwick and Burton 1991). Dividing raw materials into finer categories can also provide new information about ground stone implement utilization. Fratt and Biancanello (1991) found that distinguishing between different kinds of cement in sandstone showed that prehistoric inhabitants of Homol'ovi III were more specific in their selection of raw materials for particular types of artifacts than previously thought.

Although primarily associated with utilitarian tasks, ground stone artifacts can yield much information on prehistoric art, ritual, and cultural identity. Studies of Hohokam stone carving are needed to supplement information obtained from studies of ceramic decorative content and style. Recent research associating Hohokam carved-stone palettes with the ritual use of snuff and tobacco (Lowell 1990) is intriguing and provides an alternative explanation for the use of these artifacts that avoids the anomaly created by referring to them as palettes and implying their use for grinding pigments when few show evidence of such use. The appearance of the highly specialized and distinctive piki stones in Anasazi assemblages may be associated with the introduction of a katsina-like cult (E.C. Adams 1991; Fratt 1991). If the prehistoric use of these artifacts parallels their modern use among the pueblos, their appearance also signals a change in cooking techniques (Christenson 1986). Logan's (1991) study of hematite processing and Elson's (1990) study of argillite indicate that more information is needed on the location of pigment sources used prehistorically, the kinds of ground stone tools used to process pigment, and the ways in which pigment was processed.

Ground stone artifact use has been inferred from morphological characteristics and information from ethnographic and ethnohistoric sources, however, such evidence can be deceiving, as recent analyses based on examination of microscopic use-wear have shown (Adams 1986; Fratt 1990a, 1991). Microscopic use-wear analysis is based on the general principles that govern microscopic analysis of use-wear on edges of chipped stone artifacts, but uses terminology and concepts derived from tribology, the study of the effects of friction on surfaces in dynamic contact (Adams 1986, 1988a). These studies have shown that different patterns of use-wear (such as microchipping, relative wear of sand grains to interstices, "polish", and abrasive wear) are associated with the kind of material that is ground (Adams 1986, 1989b; Zier 1981). Differences between microscopic use-wear resulting from stone-on-stone grinding with or without an intermediate material (such as corn) and use-wear resulting from processing resilient material (such as hide) are particularly marked (Adams 1989b). Fratt (1990a, 1991) has shown that many of these wear patterns can be identified, with some modifications, on prehistoric ground stone artifacts. Studies of microscopic use-wear on ground stone artifacts are relatively recent, and much more research is required to satisfactorily distinguish between some of the substances that were processed prehistorically, such as bone and wood (Adams 1989b), and to identify patterns of use-wear on material other than sandstone (Fratt 1991).

Much of the research on microscopic use-wear has involved replicating the manufacture and use of ground stone implements (Adams 1986, 1988, 1989a). Replication experiments have also been used to identify kinds of pigments on ground stone artifacts from Homol'ovi III and whether these artifacts were used for grinding, mixing, or both grinding and mixing pigment (Logan 1991). Benitez (1991) used information from experiments replicating ground stone implement production as a rough measure of time involved in manufacture. Wright's (1990) detailed examination of the tools used to simulate maize grinding at a site in southwestern Colorado provide valuable information on tool use-life as well as the rate of cornmeal production.

Studies of ground stone tool use also incorporate various techniques of residue analysis. Pollen washes have been used for some time to obtain information on ground stone artifact use (Greenwald 1991). Blood-antigen analysis is a relatively new technique that has produced some interesting and controversial findings (Newman 1990a; Yohe et.al. 1991). Other possible residues that may be extractable, but may require different techniques, include shell, oil from piki stones, and wood. Procedures used in blood-antigen extraction and analysis are specified in Newman (1990b). Additionally, the degree of weathering and the effects of weathering on traces of macro- and microscopic use-wear on ground stone surfaces (Walker and Fratt 1991) should provide further information on discard and the effects of post-depositional processes on ground stone artifacts.

Little research has been conducted on historic ground stone assemblages. Adams' (1979) report on the ground stone assemblage from Walpi details and discusses the change in ground stone assemblages resulting from first Spanish and then Euro-American influences. Doelle's (1983) study of the Nolic assemblage provides information on the late 19th-early 20th century use of ground stone artifacts at a village on the Sells Papago Reservation. Fratt (1990b) traced some of the changes in Hohokam metates from the late Classic Period into the Historic Period and associated those changes with changing subsistence and other socio-economic factors.

Ground stone surface assemblages, like those of other artifacts, may be heavily impacted by vandals. The impact of vandalism on ground stone assemblages may be more severe because of the smaller numbers of artifacts present initially. Whole metates and manos, as well as more exotic or eccentric artifacts, have been collected for years, and assemblages near towns or roads may be more impacted than those farther away (Rich Lange, personal communication 1991). Besides recent collecting, historic and probably prehistoric Indian groups periodically collected and reused whole ground stone artifacts from older sites (Woodbury 1954; Russell 1975). As a result of this activity, surface and subsurface ground stone assemblages may be significantly different. Schlanger's (1991) approach to studying the effects of site formation processes on individual tool types is one way to evaluate the effects of vandalism and reuse on the composition of ground stone assemblages.

Surface ground stone artifacts pose several problems for archaeologists. Ground stone assemblages, whether from surface collections or excavations, usually contain relatively few artifacts. Possible exceptions are Archaic period sites where the number of ground stone artifacts may approximate that of chipped stone artifacts. This situation poses a problem with regard to sampling and later assemblage analyses that require use of special statistical techniques. Ground stone artifacts are often large, cumbersome, and heavy, and, as a result, assemblages are often sampled differently than are those of ceramics and chipped stone, or they may not be formally sampled at all. If sampling is not consistent for all artifact groups present, problems of comparability arise, thus constraining artifact analysis and comparative studies. Ground stone artifacts may be the only artifact group to be identified and analyzed only in the field. Thus, the quality of the data as well as the actual sample of ground stone artifacts may not be comparable to analyses of other artifacts that are conducted in the lab. Ground stone artifacts, particularly fragments, can be very difficult to recognize during survey, especially if use-wear is ephemeral.

Ground stone assemblages have tremendous research potential, but sampling and analytic procedures must be improved in order for that potential to be realized. Particularly important are changes in sampling. Instead of collecting or recording only "diagnostic" ground stone artifacts, the strategy used to sample ground stone assemblages must parallel that used for other artifact classes. Differences in sampling ground stone assemblages both within and between sites is one of the greatest obstacles to using information in survey and excavation reports for comparative studies. Unless data about ground stone assemblages is comparable to data about ceramics and flaked stone, questions such as the relationship between changes in metate forms and changes in social organization or the nature of activities, mobility, and the management of material culture at different types of sites cannot be addressed. In this regard, the studies conducted by Bernard-Shaw (1984) and Bayham (1982) are notable because they demonstrate the value of using information from both ground and flaked stone assemblages to gain insight about subsistence strategies and settlement systems.

Analysis of microscopic traces of use-wear can reflect specific artifact use, but weathering may alter or destroy some or all evidence of microscopic use-wear on exposed surfaces. It is therefore important to note which surface of a ground stone implement is exposed and which surface is not when conducting collection surveys (Walker and Fratt 1991). Ground stone artifacts encountered on surveys should be carefully provenienced, and notes of the surrounding environment should be taken, especially with regard to bedrock grinding features. This detailed information is required if patterns of variability in such features are to be documented and interpreted. Recording the size of artifacts and their condition is particularly important for understanding discard and other site formation processes. During survey, large rocks and boulders, especially those occurring on sites, should be overturned and examined for evidence of grinding. Because metates were often stored upside-down (Bartlett 1933), this information, along with data on reuse, is important for answering questions about storage and mobility. Of course, "overturned" artifacts should be placed back in their original position unless they are collected.

Finally, the most effective way to improve the quantity and quality of data obtained from ground stone assemblages is to provide more formal training in ground stone identification and analysis. This training must also include raw material identification if we are to obtain more data on sourcing raw material. Unless more information is recorded about the kinds of ground stone implements present and their distribution at a site relative to other artifacts and features, and unless ground stone artifacts are systematically sampled and brought back to the lab for more intensive analyses such as examining microscopic traces of use-wear and conducting residue analyses of use-surfaces, the potential of ground stone artifacts to contribute new and different information to these issues will never be realized.

7.3 Relating a Concept of Significance to Lithic Properties

In the above sections we discussed past and present research that has been or yet valuable for evaluating the significance of a property. Just because a site is unstratified and lacks subsurface deposits, does not mean it does not have significance. Artifacts themselves are significant, even if the integrity of a site has been altered. As noted above, numerous methods can be employed to examine lithic sites located Arizona. The property type, integrity, and Criterion D should all be kept in mind when assessing the significance of a lithic property.

With all the aforementioned information in mind, the following is a brief list of important issues related to lithic sites that should be considered when nominating a lithic property for possible inclusion to the National Register of Historic Places: (1) the site is unusual for its geographic area, and remains one of the few examples of this property type in the regional level, (2) there are unusual lithic artifacts that are not found at any other site in the regional level, (3) there is a great information potential, for future research, at the site that will contribute presently and in the future to theoretical issues, (4) the lithic property defines and is representative of a diagnostic tool type(s), (5) the site is important because it is representative of distinctive environmental adaptation(s).

7.4 Significant Lithic Sites, a Brief Look

To date, few lithic sites in Arizona have been deemed significant for preservation. In fact, sites acknowledged for having unique lithic (as well as other) data that are included to the National Register of Historic Places are Ventana Cave, the Double Adobe site, the Naco site, and Lehner site. Thus, lithic sites lack the attention conferred to aggregated villages and Historic period structures. Reasons for the limited attention to aceramic sites can be possibly attributed to their lack of "romantic appeal" and because of the notion that lithic sites contain little information potential. However, as we have tried to establish throughout this document, lithic sites can potentially yield significant information on Arizona's prehistory. Appendix A presents a brief list of lithic properties that should be considered for nomination National Register of Historic Places. We hope that this is just the vanguard of lithic properties to be suggested and considered for possible inclusion to the National Register.

GLOSSARY A
FLAKED LITHIC

Mark C. Slaughter

This glossary is a composite of many terms that include flint-knapping jargon, reductive-technique attributes, major point styles identified in Arizona, and other terms related to flaked lithic materials. This is by no means an inclusive list, but a judgmental selection of lithic-related nomenclature that is intended primarily for novice lithic analysts. It should be noted, however, that there are many other analysis systems which would not include some of the terms found in this glossary (e.g., Sullivan and Rozen 1985).

Alternate flake(ing). Flake attribute and core-reduction technique (Figure 1). Alternate flaking is a method that reduces and eventually removes squared-off or steeply rounded edges from a piece of stone. Alternate flakes result from the reduction of tabular, subtabular, and ovoid pieces of stone. Alternate flaking results when pieces of stone are bifacially reduced such that the previous flake scar, from the opposite surface, is used as the platform. Alternate flakes possess some or all of these attributes: they have a triangular cross-section, a squared edge adjacent to the platform, possibly a second squared edge adjacent to the first squared edge, a platform that has a single facet, and a skewed orientation in relation to the axis of percussion (Root 1989:131).

Anvil. Artifact. Anvils or "bracing rocks" (Huckell 1986:17) are tools utilized to help fracture another rock. A anvil is a stationary rock that an object (lithic cobble or core) either rested on (i.e., bi-polar reduction) or was projected upon (cf. Crabtree 1972:15). Anvils often can be identified by unintentional crushing in or near the center of the stone.

Applied force. This is a combination of material properties, mechanics, and physics (mass x acceleration / area = applied force). Force is applied (e.g. via a hammerstone) to a piece (e.g. a basalt core) producing a result (e.g. a flake).

Archaic triangular point. Artifact. This point style has been proposed to be associated with the Late Archaic or Middle Archaic (see Huckell 1988:58-60, Figure 6.1c; Downum et al. 1986:47, Figure 4.6). This point is "a simple, unnotched, triangular, concave-based form that is provisionally placed in this [Late Archaic] period" (Huckell 1988:58). Research by Huckell (1988) has refined the geographical dispersion of this point style to southern Arizona. [illustration adapted from Downum et al. 1986:47, Figure 4.6n]

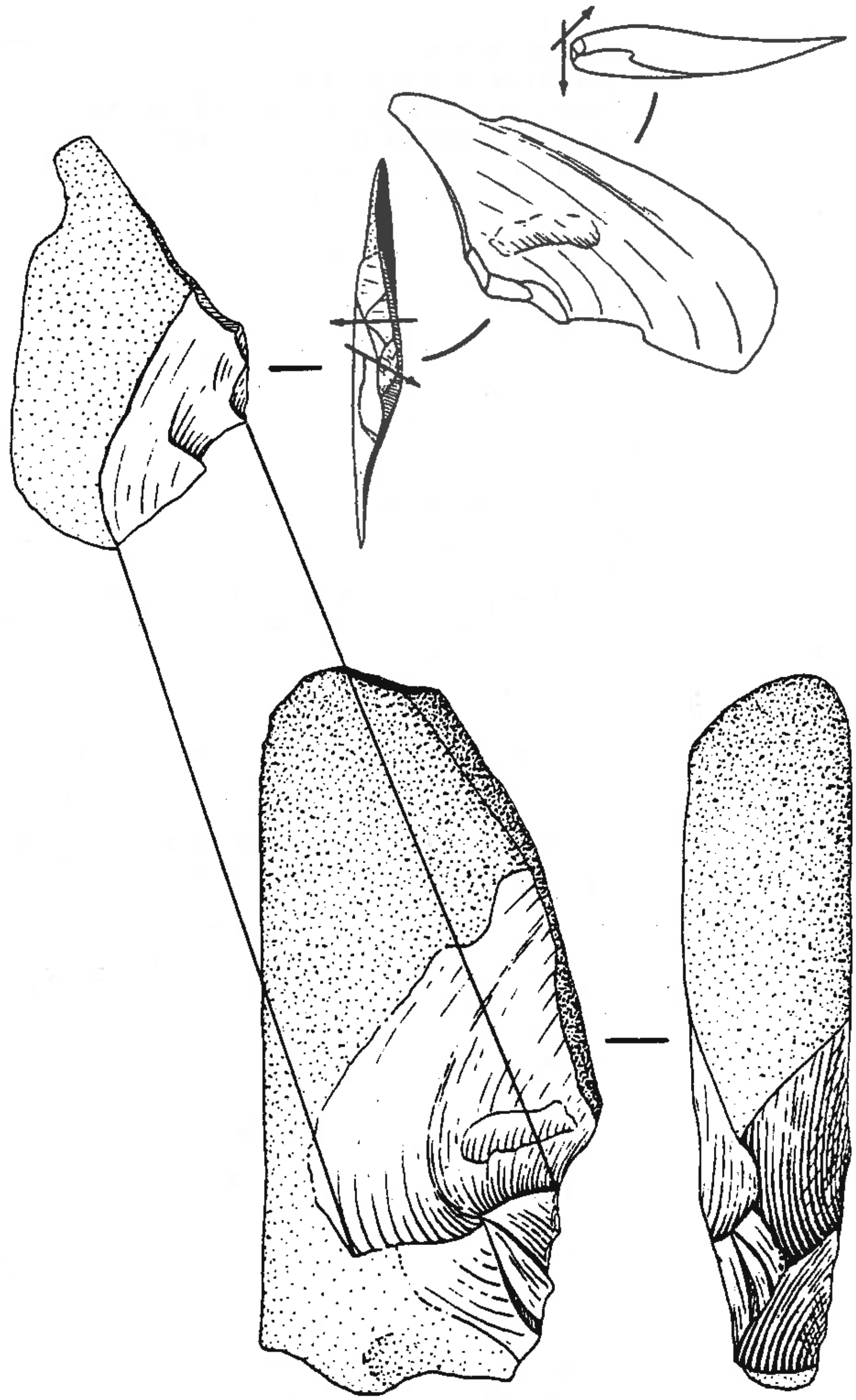


Figure 1. Alternate flake and core.

Armijo points.

Artifact. These points are associated with the Oshara tradition (see Irwin-Williams 1973: Figure 5). They have to be considered as Late Archaic point styles that Irwin-Williams dates from 1800 to 800 B.C. (1973:9). These look quite similar to the San Pedro point styles found widely dispersed in Arizona. These points have a range of different attributes, but most have concave bases and are corner notched. Irwin-Williams (1973) indicates that materials from this phase have been recovered from northeastern Arizona (1973:11, referencing Wendorf and Thomas 1951). [illustrations adapted from Cordell 1984:159, Figure 5.4; and Irwin-Williams 1973: Figure 5]

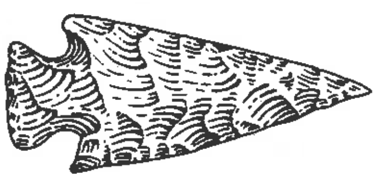
Arris.

Flake attribute. A raised ridge that extends down the dorsal surface (Figure 2f). An arris is produced by the previous removal of two or more flakes from an object piece. As with bifacial flakes and flakes from multidirectional cores, there can be more than one arris exhibited on a flake. Flint knappers often refer to an arris as the guide ridge.

Backed (backing).

Tool attribute. Flaked stone tools can exhibit intentional dulling on the edge opposite to their cutting edge as a result of grinding, abrading, or flaking. This allowed the tool to have been operated without cutting into the hand of the user. This dulled edge can be easily confused as the working margin if the analyst does not examine the margins carefully.

Basketmaker points.



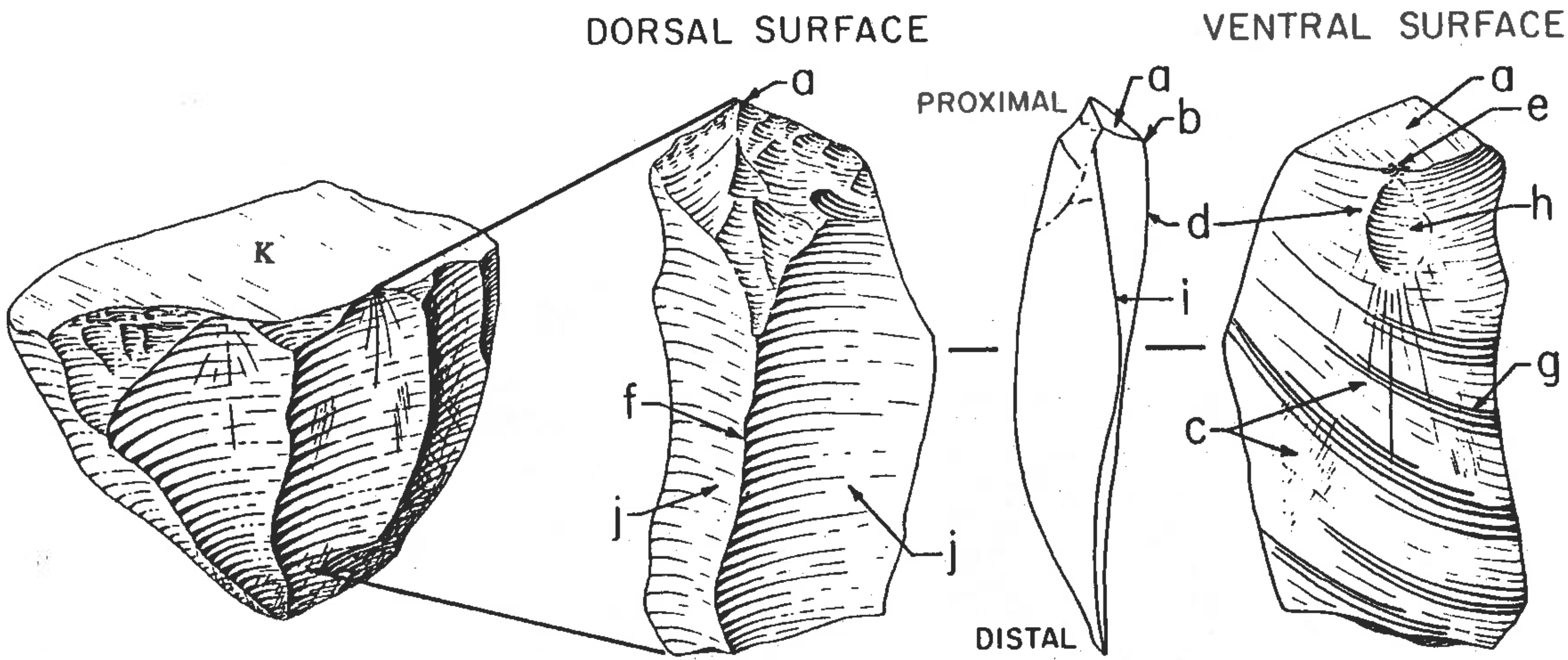
These points are associated with the Basketmaker occupation of Arizona (500 B.C.-800 A.D.) and are usually found in the north, northeast, and eastern portions of Arizona. These dart points vary in size and basal elements (see Christenson 1987b; Tagg 1991). [illustration adapted from Tagg 1991:Figure 6.7]

Belen points.

Belen points are usually associated with the Paleo-Indian use (8,000-6,500 B.C.) of the Rio Grande area in New Mexico (see Judge 1973), but have been identified from eastern Arizona (Tagg 1991:9). These points are lanceolates with a concave base.

Biface.

Artifact. A biface can be a tool, core, or result of the reduction technique being used (Kelly 1988:718-719). A biface implies that both surfaces were reduced by the use of diametrical margins by either percussion or pressure flaking (see Figure 3). Bifaces can go through stages of manufacture that can be identified and interpreted (see Callahan 1979; Gilreath 1983). Bifaces have been recovered from the Paleo-Indian to the contact periods. Tool classes of bifaces can include but are not limited to lanceolates, projectile points, drills, choppers, and knives.



a. Platform Remnant

b. Lip

c. Hackles/Fissures

d. Bulb of Applied Force

e. Contact Point

f. Arris/Guide Ridge

g. Rings of Compression

h. Eraillure

i. Lateral Margin

j. Negative Flake Scar

k. Platform

Figure 2. Flake attributes referred to in the Glossary.

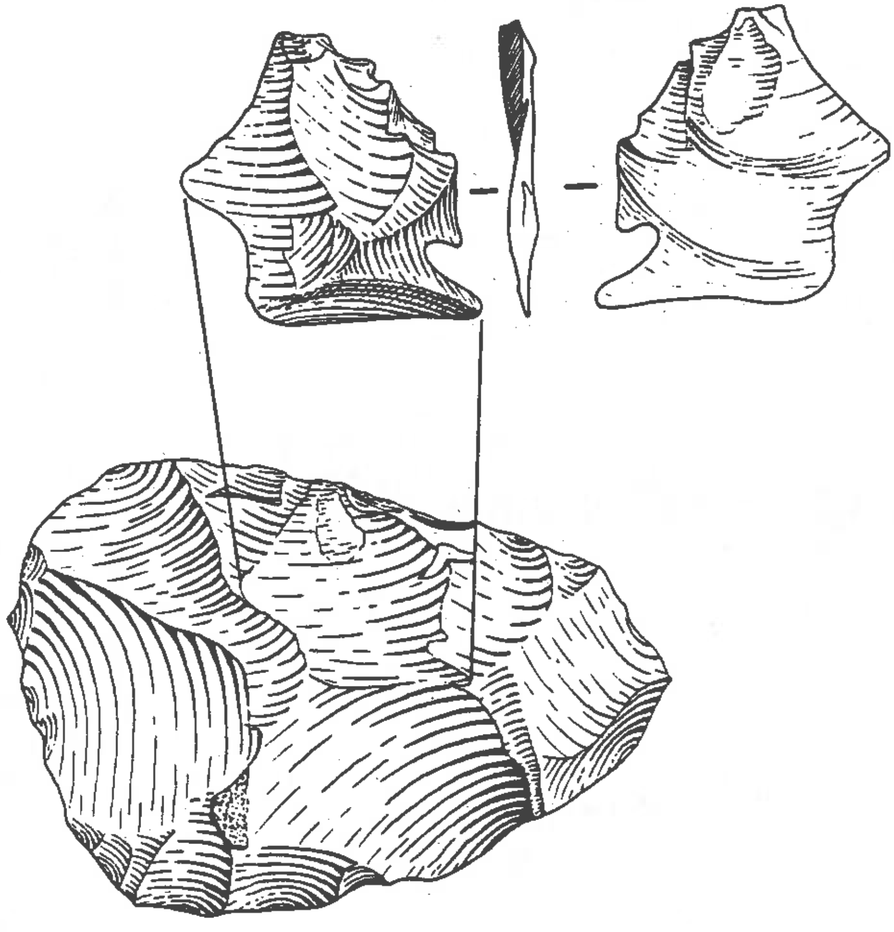


Figure 3. Biface and bifacial thinning flake.

Bifacial flake. Flake type. Bifacial-thinning flake is the result of the reduction of a biface (Figure 3). Such flakes resemble potato chips in shape and geometry. They are often thin, exhibit multiple flake scars on the dorsal surface, have a prepared platform, and have a diffuse bulb of applied force.

Billet. Artifact. A tool used for the reduction of desirable stone. A billet can be made from a variety of materials: wood, antler, or bone. This tool is rarely found due to decomposition. Use of a billet is one means of producing "soft hammer" percussion, which is often associated with bifacial reduction (see Callahan 1979:158; Crabtree 1970).

Bipolar flake. Flake type. As the term indicates, two poles (opposite ends of a stone) were used to fracture the rock. This type of flake is associated with the reduction of cobbles or pebbles. Bipolar reduction may be a response to the availability, size, or morphology of the raw material used. Diagnostic attributes are shattered platforms or platforms that are isolated (that is, only the "cone" remains), possible crushing at either end where force has been applied, diffuse or non-existent bulbs of applied force, and distinct ripple marks that sometimes indicate force applied from opposite margins.

Blank. Tool type. A blank is a potential tool and "usable piece of lithic material of adequate size and form" that might be reduced to produce a tool (Crabtree 1972:27; also see Bradley 1975). Blank is a term that is applied to flakes or pieces of raw material that have the potential to be reduced into various stages and, thus, final forms.

Blood antigen. Organic compound and Analytic technique. Tool surfaces and margins can contain blood residues; they recently have been studied to discover the source of the blood (see Hyland et al; Loy 1983). Analysts can use positive results for various behavioral inferences, such as the use of specific tool classes for a particular species of animal.

Bracing rock. Artifact. See **Anvil**.

Bulb of applied force. Flake attribute (Figure 2d). The bulb of applied force is located on the ventral surface of a flake. Bulbs can occur from hard-hammer and soft-hammer percussion, from natural fracture, and from pressure flaking. See also **Salient** and **Diffuse bulb**.

Bulb of percussion. See **Bulb of applied force**.

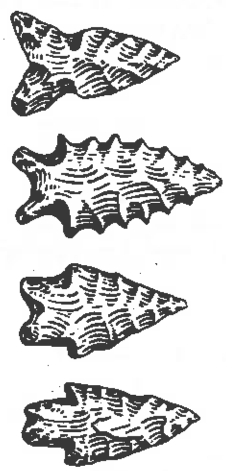
Bull Creek point.

Artifact. This point is "common in northeastern Arizona and southeastern Utah" (Fairley 1989:130) and is usually associated with Kayenta and Fremont Anasazi sites. The dates for the Bull Creek point range from A.D. 1000 to 1300. These thin points have fine tips and tangs and are "relatively narrow isosceles triangles with slightly concave to markedly concave bases" (Holmer and Weder 1980:61). [illustration adapted from Holmer 1986:108, Figure 21b]

Ceramic period points.

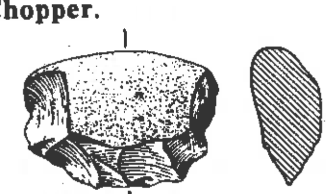
These points vary in size and style (Figure 4). Several of the points are associated with distinct cultures (e.g., Hohokam points). Many of these are quickly made, whereas others indicate some investment of labor. [from top to bottom and left to right, illustrations adapted from Haury 1976:297, Figure 14.39b, d, f, l, and m; Schroeder 1979:106, Figure 9; Tagg 1991: Figure 6.91, e, j, v, and Reid 1982:302, Figure A.1.10g; Sayles 1983:134, Figure 11.3b and c; Ravesloot and Whittlesey 1987:95, Figure 7.2d and v; and Reid 1982:302, Figure A.1.10i]

Chiricahua points.



Artifacts. These points are associated with the Cochise culture (see Sayles and Antevs 1941; Sayles 1983). They exhibit rather long ears and deep corner notches. Associated with the middle Archaic (4800-1500 B.C.). Within this group of points are diagnostic points that are found in other areas of Arizona (i.e., San Jose and Pinto). [illustration adapted from Sayles 1983: Figure 9.4c,e,g,j]

Chopper.



Artifact. This tool class is usually a large or heavy core tool. As the epithet implies, this tool is used to chop objects. This tool may be a uniface or a biface, and the margins should have use-wear such as micro- and macro-flake removal, crushing, and the scars from flakes (often step or hinge terminations) that were removed from use of the chopper.

Cienega point.

Artifact. This is a late Archaic point that may extend into the early Ceramic period. This point style has only been recently proposed for the late Archaic (see Huckell 1988; Downum et al 1986:46, Figure 4.5i-l) and possibly dates from 650 B.C. to A.D. 150. The Cienega point "is a triangular-bladed form with a deeply, diagonally corner-notched base" (Huckell 1988:58). This point style is widely dispersed in the southern and eastern portions of Arizona and has been recovered at a number of stratified and unstratified sites (see Huckell 1988:58). [illustration adapted from Downum et al 1986:46, Figure 4.5k]

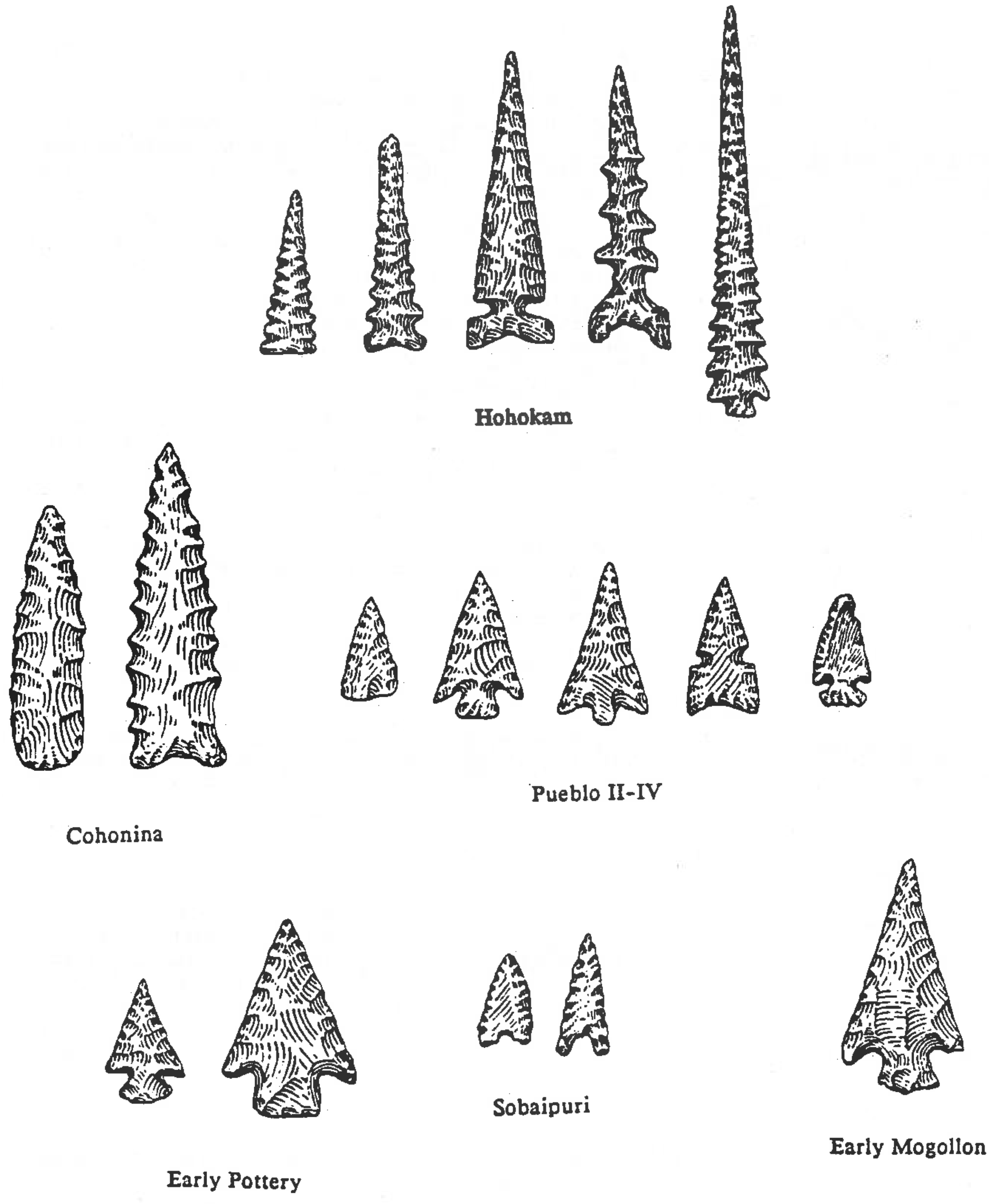
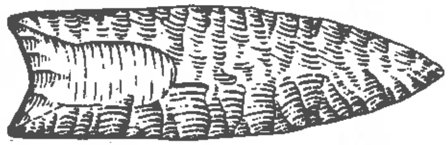


Figure 4. Ceramic period projectile points.

Clovis point.



Artifact. The earliest diagnostic point yet identified in the New World. This point is associated with the Clovis culture of the Paleo-Indian period and ranges in dates from 10,000-9,000 B.C. In Arizona, Clovis points have been recovered in primary depositional context from Naco (Haury 1953), Murray Springs (Haynes, personal communication 1991), Lehner (Haury et al. 1959), and from the Leikem Site (Huckell 1982). A number of isolated points have been found throughout Arizona (see Huckell 1982). This tool exhibits several diagnostic attributes: a basal flute, lateral and marginal grinding, and lanceolate shape; it usually is made of fine-grained, high-quality material. [illustration adapted from Wormington 1957:262, Figure 68]

Core.

Artifact. A core is a piece of stone, previously unaltered by artificial means, from which a portion of the stone (see **Flake**) has been removed by human action. Thus, a core will have one or more scars on its surface from the purposeful removal of material from its original mass.

Core, amorphous.

Artifacts. These cores have been labeled as irregular (Cameron 1987), expedient (Parry and Kelly 1987), and multi-directional-flake cores. They usually exhibit flake removals from multiple directions and multiple striking platforms. They are usually associated with the production of simple flake tools that require no additional modification (Parry and Kelly 1987; Parry 1987).

Core, bidirectional.

Artifact. A core specifically prepared to produce regular, uniform blades. Platform preparation and blade removals follow a systematic pattern (Crabtree 1968). There are no known blade technologies in Arizona.

Core, bifacial.

Artifact. These cores exhibit flake removal from two intersecting faces (Crabtree 1972; Parry 1987). Bifacial cores have been related to various stages of biface manufacture (Callahan 1979; Holmes 1919). Distinguishing bifacial cores from bifacial tools is often subjective, based on size, shape, cross-section, edge sinuosity, and technique of flake removal (Newcomer 1971). Bifacial cores may be used as tools, they may be stages of manufacture, or they may provide convenient "packages" for transporting lithic raw material (Kelly 1988).

Core, bipolar.

Artifact. Flakes are produced by resting the core on an anvil and striking it with a hammerstone. These cores often exhibit flake removal from opposite directions. Diagnostic attributes can include crushed striking areas from the hammerstone and anvil, possibly concentric rings generating from both ends, and no bulb of force present on the core or flakes because it is sheared during the flaking process. The bipolar technique often produces abundant amounts of nondiagnostic shatter and linear, flat flakes. For additional information see Crabtree (1972:41), Flenniken (1981), Hayden (1980), Patterson and Sollberger (1976), and Parry (1987).

Core, multidirectional.

Artifact. See **Core, amorphous.** This is a core that has flake removal from many directions. Often these cores are associated with an expedient technology.

Core, multifacet.

Artifact attribute. This is simply a core that has many flake removals. Multifacet cores can be characteristic of any of the core-reductive methods (e.g., amorphous, bipolar).

Core, unidirectional.

Artifact. These cores exhibit flake removal from a single platform in a single direction. Although they superficially resemble blade cores (Crabtree 1972:46), the platform is a natural plane or single negative flake scar that shows none of the intensive platform preparation indicative of true blade industries (Crabtree 1968). In Arizona, they are associated with simple flake-tool production.

Core, single facet.

Artifact. These cores have a single platform and flake removal. Often single-faceted cores are inferred to indicate testing of raw materials to examine the internal qualities of the lithic.

Core, utilized.

see **Core tool.**

Core tool.

Artifact. This tool is a core that subsequently was used for chopping, slicing, or both of these activities. Core tools are usually amorphous cores that have one or more utilized edges.

Core-top rejuvenation flake.

Flake type. This type of flake is produced when the platform of a core has collapsed from careless striking, so that a new platform needs to be created. The flake removed to rejuvenate a core top shows evidence of truncated flake removal on most or all of its margins.

Cortex.

Cortex is the natural surface or rind found on the exterior of a piece of stone (Crabtree 1972).

Cottonwood triangular point.

Artifact. Cottonwood triangular points are usually associated with the Intermountain West, but also occur in northern Arizona. These are either associated with Fremont Anasazi or Numic sites and have been dated to post-A.D. 1300 (Holmer 1986). As the name suggests, these are triangular in shape and often have a concave base. The manufacture technology suggests that these were low-labor-input tools. [illustration adapted from Warren 1984:Figure 8.24c]

Curative technology.

Technical attribute (cf. **Expedient technology**). Curative technology is a term that refers to the procurement strategies, reduction technique(s), and efficiency of flaked stone use by prehistoric groups. The research by Binford (1979) has influenced recent authors to hypothesize about the differences in the use of flaked stone by mobile populations, in contrast to sedentary populations (see Bamforth 1986, 1991; Binford 1979; Kelly 1988; Kelley and Todd 1988; Parry and Kelly 1987; Shott 1986). Mobile populations, such as those of the Paleo-Indian and possibly the Archaic, will have a curative technology. Curative flaked stone technology implies that materials (usually of high quality) will be obtained and efficiently used, in contrast to the higher discard and lower labor input (in tool production) found associated with the sedentary groups.

Debitage. Artifact. Designation for a class of lithic artifacts. Debitage is the waste material from the production of tools. A flake is a piece of debitage. Analysis of debitage is the best indicator of reduction technique and the lithic technology of a prehistoric people.

Decortication flakes. Flake type. See **Primary and Secondary reduction flakes.** These flakes result from removal of the cortex or the weathered surface of a raw material.

Desert side-notch point. Artifact. These points have been identified in the northwestern portion of Arizona (Fairley 1989). Desert side-notched points are associated with the late prehistoric, protohistoric, and historic periods. These points are "recognizable by their high side notches and pronounced basal notch or concavity" (Holmer and Weder 1980:60). [illustration adapted from Holmer 1986:108, Figure 20b]

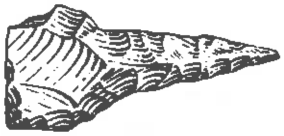
Desert varnish. Weathered surface of some prehistoric artifacts. Recent studies, specifically using cation ratios, have attempted to develop a method for dating stone artifacts (see Bamforth and Dorn 1988; Bierman and Gillespie 1991; Bierman et al 1991; Dorn et al 1987; Dorn et al 1986; Dorn 1983; Dorn and Oberlander 1981). Although these studies are in their infancy and subject to much criticism, further work could provide a useful dating technique for areas where artifacts are found covered with desert varnish, such as the desert pavement areas located in western Arizona.

Diffuse bulb. Flake attribute. The diffuse bulb of applied force is located on the ventral surface of a flake. A diffuse bulb of applied force has been inferred to indicate a soft-hammer percussion technique (cf. Keeley 1980; Newcomer 1971; Crabtree 1972).

Distal. Flake attribute (Figure 2). This is the end away from where force was applied. The distal end of a flake, if present, will have either a step, hinge, or feather termination. The distal is also the pointed end on a projectile.

Dorsal surface. Flake attribute (Figure 2). The "back" surface of a flake, with a ridge or ridges attributed to the removal of flakes.

Drill. Common artifact. Drills were used to perforate materials. A drill is along, narrow, pressure-flaked tool or small splinters of stone that would have been hafted or hand held. Drills were also produced by reworking projectile points (see Christenson 1987b).



Eastgate point.

Projectile point found in northwestern Arizona and the Great Basin (Fairley 1989). Dated to the Basketmaker III period, it is usually associated with the Freemont occupation and ranges from A.D. 500 to 800 (Fairley 1989:114). These points have a convex base and deep parallel side notches, and their length is almost equal to their width (Holmer and Weder 1980).

Eden point.

Paleo-Indian point found in east-central Arizona. This point is often associated with the Cody complex. The Eden point is a long, narrow lanceolate that has been bifacially knapped. This point was recently identified in Arizona by Tagg (1991), but probably does not occur with any frequency in the state. [illustration adapted from Cordell 1984:136, Figure 4.12A]

Edge angle.

Tool attribute. The angle of a tool's edge has often been interpreted as an indicator of the materials and specific tasks for the item was used, for example, for scraping hides (Wilmsen 1968, 1970; Semenov 1964).

Edge damage.

see Use-wear.

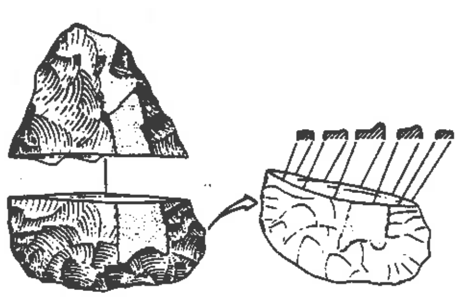
Elasticity.

Raw material property. This is the property of a raw material to rebound when force is applied (Crabtree 1972). An everyday example of elasticity is the way in which a rubber eraser returns to its original shape after a force applied to it has been removed. This property is desirable when selecting a raw material.

Elko point.

An Elko eared point (7800-1250 B.C.) has been recovered from the northern part of Arizona (Fairley 1989; Teague and McClellan 1978). These points are associated with the Late Archaic. [illustration adapted from Holmer 1986:101, Figure 11a, and c]

End shock.



Manufacturing occurrence. End shock is the result of a bending force that exceeds the tensile strength of the knapping object. The shape and support of the knapping object as well as the location and direction of the applied force are critical in this breakage type. This breakage type often occurs during biface production.

Eraillure. Flake type and a flake attribute (Figure 2h). Often found adhering to or as a scar on the ventral surface of a flake. This is directly associated with application of force and the removal of a flake from an object. An eraillure is a very small flake and is often not recovered from archaeological work. It is often concave-convex; the "dorsal side of the eraillure flake bears no compression rings, but the ventral side does bear compression rings that match the scar that is left on the bulb of applied force (Crabtree 1972:33).

Error-recovery flake. Flake type. Error-recovery flakes exhibit all the normal flake attributes but have a hinge or step termination on their dorsal surface. They are interpreted as representing the removal of mass that inhibits successful flake removal.

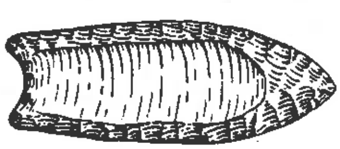
Expedient flake tool. Tool class. All flakes are potential tools. These were used without any further reduction (i.e., marginal retouch). One or more edges of these tools often exhibit evidence of use, such as rounding, abrasion, and snap terminations (see Semenov 1964; Odell 1981; Keeley 1980).

Expedient technology. Technical attribute (cf. **Curative technology**). Expedient technology is represented by tool diversity, lack of a formal technology, a lack of efficient maximization of the reduction technique, a lack of efficient maximization of the raw material, and a decrease in the amount of labor that is input to making a finished tool (see Parry and Kelly 1987:293, Table 12.4).

Fissures. Flake attribute (Figure 2c). Fissures are found on the ventral surface of a flake that is attributed to percussion flaking. They usually align with the lateral margins of the flake and the area where force was applied. These "are not cracks, but are crests and troughs" (Crabtree 1972:36).

Flake. Artifact. A flake is any piece of stone that was removed from a larger mass of rock (see **Core**). A flake produced by humans can have distinct attributes such as a striking area, platform remnant, hackles, bulb of applied force, etc. (see Figure 2).

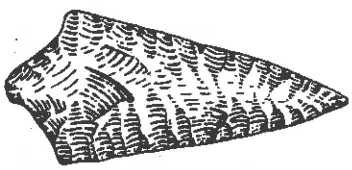
Folsom point. Artifact. Folsom materials are found at several of the major Paleo-Indian sites in the Southwest. Dates range from 9000-8000 B.C. First identified at Folsom, New Mexico, Folsom points occur rarely in Arizona. In Arizona, these points have only been found in context with the present ground surface and not with buried deposits (Huckell 1982). This fluted point is basally and laterally ground, with a flute on both surfaces. [illustration adapted from Wormington 1957:262, Figure 68]



Glass points. Artifact. Projectile points have been found that are made from historic period glass. Tagg (1991; referencing Bourke 1891:18) indicates that the Western Apache "are known to have made glass points." Glass offers all the properties that the best lithic materials have, but glass lacks the strength of other materials, such as chert, that were can be used for points.

Guide ridge. Flake attribute. See **Arris.**

Gypsum Cave point. Artifact. These points, which have a tapering stem and were percussion flaked, are found widely dispersed in the southern Great Basin and Arizona. They are associated with the Archaic (4800-1500 B.C.). [illustration adapted from Wormington 1957:270, Figure 72]



Hackles. See **Fissures.**

Hard hammer. See **Percussion flaking.**

Heat spall. Technical attribute. Heat spalls are pieces of stone that have "popped" off the parent portion (i.e., a biface). These are oftentimes referred to as pot-lids. The portion that popped off will have no attributes of percussion or pressure flaking.

Heat treatment Technical attribute. Many experimental studies have demonstrated the advantages of thermal treatment of silicious materials (Crabtree and Butler 1964; Crabtree 1967; Flenniken and Garrison 1975; Collins and Fenwick 1974; and Bleed and Meier 1980). Basically, when a selected raw material is heat treated it physically alters the stone, benefitting the knapper by making the material easier to flake and improving the distance of flake removal. This results in fewer failed terminations and produces sharper flakes. Overheating or internal flaws will produce **potlids** or **heat spalls.**

Hertzian cone. Technical attribute. The Hertzian cone principle applies to the removal of a flake from a core. "The flake is the positive cone part and the scar is the negative cone part" (Crabtree 1972:3). The principle applies to isotropic properties of a raw material and results in a conchoidal fracture (see Crabtree 1972b).

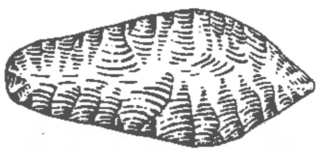
Homogeneity. Raw material property. The quality of a raw material for flaking is, to a considerable degree, a function of its homogeneity. A raw material that is homogeneous "can be worked with consistency because it has no planes of weakness or included material that would impair the conchoidal fracture process" (Crabtree 1972:37).

Inclusion(s). Raw material property. This is an undesirable quality in a raw material. Any inclusion, such as a phenochryst, will distract from the homogeneity of a material, and thus, make the material less desirable.

Isotropism. Raw material property. This property allows the material to be fractured (flaked) in all directions.

Jay point. Artifact. Early Archaic point (8500-4800 B.C.) that is associated with the Oshara tradition of New Mexico (Irwin-Williams 1973). This tapering-stem point is percussion flaked and has been recently identified by Tagg (1991) in eastern Arizona. Huckell (1984a) puts this point into the Early Archaic with other stemmed lanceolate point styles. The Jay point is very reminiscent of the Lake Mohave point styles. [illustration adapted from Irwin-Williams 1973:Figure 2b]

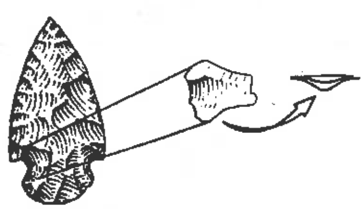
Lake Mohave point. Artifact. Archaic and Paleo-Indian point found in the west, north, and northwestern portions of Arizona, and in other states near the Great Basin. These are tapering-stem points, a category that Huckell (1984a) considers Early Archaic. In the Great Basin, however, this point style ranges from 9000-6000 B.C. (Holmer 1978). [illustration adapted from Wormington 1957:270, Figure 72]



Lanceolate. Descriptive attribute. This is a term for the shape (spear-like) of a point that usually is associated with Paleo-Indian points, such as Clovis or Folsom.

Metal point. Artifact. Historic projectile point; examples have been documented in Arizona by Ferg and Kessel (1987:50-52, Figure 5.3), Di Peso (1953:169, Figure 62c'), and Foose (1982:312, Figure 109t-u). Metal points are more durable than glass or lithic materials and "were made of any scrap material, such as metal barrel hoops" (James Ayres, personal communication 1991).

Notching flake. Artifact. This flake occurs from the making of a notch in a point (corner or side). Often these flakes are not recovered due to their small size. These flakes have a prepared platform and a negative bulb opposite or very near to the bulb of applied force.



Outrepassé. See **Plunging flake.**

Percussion flaking. Technical attribute. The striking of a rock (core) with another rock, antler, or use of an anvil technique. Hard-hammer flakes can possess some of the following attributes: salient bulb, defined point of applied force, eraillure scar, pronounced compression rings, and crushed platforms (Knowles 1944).

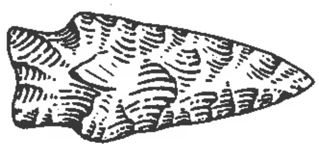
Percussor.

Artifact. This is any object used to strike a flake from a core (see Crabtree 1972:11). See **Hammerstone** in Glossary B.

Pièces esquillées.

Tool type. These are wedges that were presumably used to split wood, bone, or other materials (Flenniken 1981; Young and Harry 1989). Because of their morphology, they are often confused with bipolar cores (see Hayden 1980).

Pinto Basin point.



Artifact. Archaic point. Found widely dispersed in Arizona, New Mexico, California, Utah, and Nevada. There is a range of different dates for the point, but it is believed to have been used from 4500 B.C. to A.D. 1 (Bowen 1982). The Pinto Basin point is also called Amargosa II (Haury 1950:290). First identified by Campbell and Campbell (1935), the point is additionally documented in Harrington (1957), Euler (1983), and Formby (1986). [illustrations adapted from Wormington 1957:270, Figure 72, Tagg 1991, Figure 6.5f, and Formby 1986)

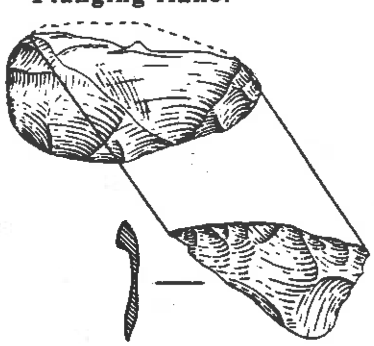
Platform.

Technical attribute. The striking surface on any core (Figure 2). The platform occurs on all kinds of cores (i.e., bifacial, multidirectional, etc.) and includes prepared and unprepared platforms.

Platform remnant.

Flake attribute (Figure 2a). Found on the proximal end of a flake, the platform remnant is a section from the platform associated with the object piece (core). From the platform remnant inferences are drawn concerning the amount of preparedness (single facet, multi facet, abraded, and so forth).

Plunging flake.



Flake type. This type occurs during thinning and core reduction. The flake turns to the opposite surface because of the angle of percussion and the force applied (see Tixier 1974:16, fig. 7 and 19).

Pot-lid.

Raw material modification attribute. Pot-lids result from the intentional heating of a cryptocrystalline silicate to make the raw material easier to flake, or from unintentional heating of stone. The spall, from overheating or from high content of water in the object piece, will not have the attributes diagnostic of a flake (i.e., platform, bulb of applied force, etc.). These pieces of debitage look like the top of a pot cover, thus, the name pot-lid. See **Heat spall**.

Preform.

Artifact. The term is often applied to an artifact recognized to be in a particular stage of reduction (Crabtree 1972:49). Preforms, like **blanks**, often are included in many biface-analysis systems. Metate preforms have been identified by Huckell (1986:9-13) at several sites in western Arizona.

Pressure flaking.

Method. Pressure flaking is a method of "pushing off" small, thin **pressure flakes**. This is often done with an antler tine.

Pressure flakes.

Flake type. These small flakes produced by pressure flaking exhibit prepared platforms, lipping, and flake scars on their dorsal surface.

Primary decortication flake.

Flake type (not bipolar). Flake where dorsal surface is entirely covered by cortex, produced as a result of the removal of unwanted material to get to the desired material.

Primary retouch.

Technical Attribute. This is the initial removal of material by pressure flaking or by light percussion flaking. The flake scars on the dorsal surface are irregular compared to later pressure flakes.

Projectile point.

Artifact. Although there are many different forms are associated with "projectiles," the definition of worked margins (bifacially and sometimes unifacially), symmetrical shape, and pointed piece of stone best describes functional and not ceremonial kinds of projectile points in Arizona. Hafting (basal attributes) can be one of the distinguishing characteristics of a projectile point; basal attributes include corner notched, side notched, basally notched, stemmed, concave, convex, and shouldered. Although stone is the most common material that points are made of, it should be noted that different materials other than stone, such as glass and metals, have also been used for projectile points.

Proximal.

Technical attribute. The proximal end of a flake is the end with the bulb of applied force and the platform remnant (see Figure 2). The proximal end of a point is the base, where the point was hafted or held.

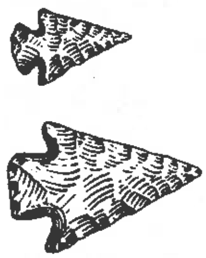
Punch.

Artifact. Tool used for controlled flaking and associated with an indirect percussion technique (see Crabtree 1972:6-7). It can be made of antler, bone, stone, or wood. The punch is a long, cylindrical tool that exhibits wear on both ends from use. Huckell (1986:17-18) identified a number of these at a ground stone manufacturing quarry that "were naturally pointed or deliberately shaped."

Rings of compression.

Flake attribute (Figure 2g). These are located on the ventral surface of a flake. Much like a pebble that is thrown into a pool, the rings flow away from where the force was applied. Identification of the compression rings allows flake to be oriented.

Rose Spring point.

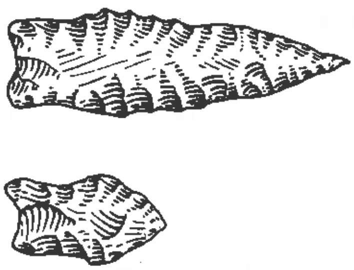


Artifact. Projectile point (A.D. 300-900) found in the Arizona Strip and the Great Basin. The Rose Spring point is slender "with stems that are either parallel sided or expand slightly toward their bases" (Holmer and Weder 1980:56). Fairley (1989) indicates, however, that these points can either be side-notched or corner-notched. This point style is often associated with the **Eastgate point** and "in conjunction with ceramics, they can provide corroborative evidence of a site's Basketmaker III temporal placement" (Fairley 1989:114).

Salient bulb.

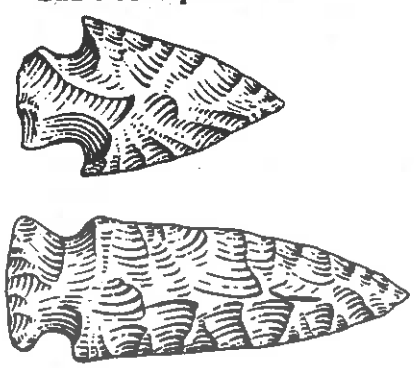
Flake attribute. This is a pronounced bulb of applied force. Crabtree (1972:50) indicates that a salient bulb indicates a confined contact force, probably indicating a hard (dense) hammerstone. Flakes with salient bulbs may also have crushed platform remnants, possibly indicating overloading with the percussor.

San Jose point.



Artifact. The San Jose point is usually associated with the Oshara tradition (Irwin-Williams 1973). This phase of the Oshara is dated to the Late Archaic, 3000-1800 B.C. (Irwin-Williams 1979). These points are very reminiscent of Pinto Basin point styles. [illustration adapted from Irwin-Williams 1973:Figure 4a and b]

San Pedro point.



Artifact. San Pedro points are widely distributed across Arizona and are often associated with the southeastern and east-central side of Arizona. They date to the late Archaic (1500 B.C.-A.D. 300). These points are either side or corner notched and are documented by Sayles and Antevs (1941), Sayles (1983), and Huckell (1984a). [illustration adapted from Tagg 1991:Figure 6.5k and l]

Scraper.

Artifact. There are many styles of scrapers--side, end, discoidal, transverse, basal, etc. These tools are inferred to be used for the removal of meats clinging to skins or for working wood. Scrapers are identified by a steep edge angle and the use-wear on the tools working margin (see Keeley 1980).

Secondary decortication flake.

Flake type. A flake produced during the initial reduction of a core (not bipolar). This flake has a quantity of cortex on the dorsal surface, but there are previous flake-removal scars on that dorsal surface. This type of flake is usually associated with the reduction of a core to remove the cortex that enables the knapper to have a surface that is void of cortex for subsequent flake removal(s). However, recording this flake type can be misleading; that is, the reduction of cobbles can yield flakes that can be considered to be secondary decortication flakes, but in reality these flakes are a reflection of a stones morphology when no other flakes (less cortex) were possible to obtain due to the size or shape of the rock (cf. Schiffer 1976:105). Thus, this type of flake may be the desired piece rather than solely being attributed to the removal of the cortex.

Serrated (denticulation). Technical attribute. This is the purposeful retouch of the margins of a flake or biface to make saw-tooth-like edge. Modification to the margin is executed much like notching, but at intervals in order to leave the original margin exposed and enclosed by the retouch on either side. Projectile points were serrated for functional reasons, such as to improve cutting (cf. Ahler 1971) or increase killing power (Christenson 1987b:147, citing Pfefferkorn 1949).

Shatter. Artifact(?). These pieces of debris are the result of reduction by percussion flaking. Shatter is often indicative of raw-material flaws and/or natural cleavages. They are "cubical and irregularly shaped chunks that frequently lack any well defined bulbs of percussion or systematic alignment of cleavage scars on the various faces" (Binford and Quimby 1963:278).

Silver Lake point. Artifact. A point usually associated with the eastern Great Basin, but found in northwestern Arizona (Fairley (1989:89). In the Great Basin, this point style is inferred to occur from Paleo-Indian times to the Early Archaic period (9000-6000 B.C.). Silver Lake points are stemmed and have a convex base. [illustration adapted from Wormington 1957:270, Figure 72]

Soft hammer. Technical attribute and artifact. Technique and percussion tool often associated with a billet (wood or bone). Bifacial flakes are often associated with a soft hammer technique. Flakes that are produced with a soft hammer have diffuse bulbs.

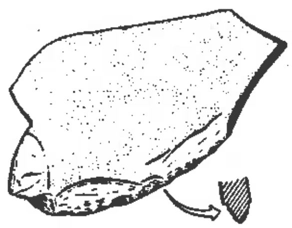
Spalling. Flake attribute. Spalling is often associated with the heat-treatment of cryptocrystalline silicates. Spalling can also occur in areas where there is temperature variation. Thus, spalling of stone can sometimes be attributed to natural causes rather than from cultural modifications to the rock.

Split flake. Flake attribute. A flake that has broken longitudinally, indicating that the knapper overloaded the piece with the percussor or that the raw material has limited elasticity.

Superimposed flake.

Flake attribute. This term is applied to pieces of debitage when a flake has been struck directly behind the preceding flake scar. Thus, the previous flake scar, on the dorsal surface, is directly in line with the positive bulb of applied force on the ventral surface of the subsequent flake.

Tabular knife.



Artifact. These tools have a margin that can be ground, unworked, or flaked. They have been associated with the processing of agave and have been given several functional designations, such as mescal knives, saws, and hoes (Bernard-Shaw 1984).

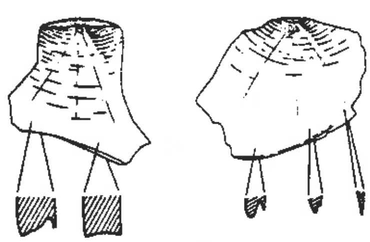
Technique.

This is the way an artifact is produced, that is, the actual physical labor with a specific method in mind. Bifacial reduction is a technique. Technique is rooted in the technology that being employed. Technique is "in your hand." See **Technology.**

Technology.

This is a preconceived framework, or cognitive model, that guides a knapper in making an object, such as an arrowhead. This is the mental template that a knapper will follow when employing a specific technique to produce a specific end-product. Technology is "in your head." See **Technique.**

Termination.



Flake attribute. Terms that are often used to describe the termination of a flake are step, hinge, or feather (see Crabtree 1972:35). Lithic analysts infer that the prehistoric knapper wanted to produce a successful termination (feathered) and avoid a step, hinge, or other termination that suggests a failed removal of a flake.

Thermal alteration.

Flake and tool attribute and method. See **Pot-lid** and **Spalling.**

Tool.

In a lithic context, any stone that was used for subsistence and social needs.

Use-wear.

Tool attribute. Tools, through use, are altered on their working margins and surfaces. Careful examination of use-related edge wear and postdepositional modifications must be attained when inferring that there is purposeful cultural modification(s) to an artifact's working margin/surface. Damage to the working portion of a tool can result in edge-rounding, micro and macro flake removals, snap fractures, etc.

Use-wear damage can be a signature of distinctive use, such as hide processing, sawing hard materials, tool use on abrasive surfaces, etc. Replicative experiments are most useful for comparative purposes (see Keeley 1980; Newcomer and Keeley 1979; Tringham et al. 1978; Ahler 1971).

Ventral surface. Flake attribute (Figure 2). Ventral refers to a surface opposite of the dorsal, interior to the core mass before its removal. Diagnostic attributes are bulb of applied force, eraillure, fissures, and rings of compression.

Wedge. See **Core, bipolar,** and **Pièces esquillées.**

GLOSSARY B
GROUND STONE AND OTHER NON-FLAKED STONE IMPLEMENTS

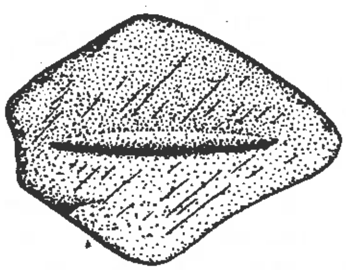
Lee Fratt

This glossary includes tool types most commonly found during survey, technological attributes, manufacturing processes, and some analysis terminology, including terms for use-wear. It represents a thorough, but not exhaustive, compilation of terminology relevant to ground stone artifact identification and analysis. Eccentric and exotic artifacts such as beads, figurines, effigy vessels, ornaments, and "ceremonial objects" are not included. Also omitted are less common variants of specific artifact types such as elongated shaftsmoothers, cylindrical and discoidal hammerstones, oval and spherical full-grooved hammers, miniature tool types, and functionally specific architectural remains. If applicable, specific temporal, regional, and prehistoric cultural associations are stated in parentheses immediately following the glossary entry.

Ground stone use-wear analysts have adopted several terms, especially polish, striation, and abrasion, that were originally used by analysts studying microscopic use-wear on chipped stone tools. In some cases, the adopted terminology is inadequate for ground stone analysis or has been used incorrectly. Adams (1986, 1988, 1989b) argues that terminology used by tribologists, who study the complex mechanics of friction, lubrication, and wear resulting when two surfaces are in dynamic contact, is more appropriate for analyzing use-wear on ground stone artifacts. Although not yet widely used in the literature of ground stone analysis, I anticipate that much of this terminology will see increasing use and I have included the most generally applicable terms in the glossary. For more detailed discussion of lithic use-wear terminology and definition of terms, see Semenov (1964), Keeley (1974, 1980), Kamminga (1979), Odell (1975), Vaughan (1985), and Adams (1986, 1988, 1989b).

Abrader. Tool group. Hand-held tools in a variety of shapes used to shape other objects by abrasion. Category includes various kinds of shaped or unshaped flat abraders (ungrooved) and grooved abraders. Some of these implements may be use-specific and some may be multiple-use (Adams 1979:40; Woodbury 1954:98-111). See **Abrader, grooved; Abrader, ungrooved; Arrowshaft straightener/smoother/polisher.**

Abrader, grooved. Tool type. Hand-held tools with one or more narrow grooves on one or more surfaces. Tool may or may not be intentionally shaped. Unshaped grooved abraders may be called irregular (Fratt 1991) or simple (Woodbury 1954:102) grooved abraders, whereas intentionally shaped grooved abraders may be called shaftsmoothers (Woodbury 1954:105-110) or arrow-shaft polishers (Haury 1976:285-286). See also **Arrowshaft straightener/smoother/polisher.**



Abrader, ungrooved. Tool type. Hand-held tools with flat to concave use-surface(s) that were used to shape other objects by abrasion. May or may not be intentionally shaped. Woodbury (1954:98) distinguishes ungrooved abraders from grinding slabs on the basis of size, with the abraders measuring no more than 10 cm long. Also called whetstones (cf. Sayles 1937:104), rasping stones or scouring stones (cf. Woodbury 1954:98), abrading stones (Haury 1976:284), and flat abraders (Woodbury 1954:98).

Abrasion.

See discussion of **Grinding**.

Abrasive wear.

Type of use-wear. The wear mechanism that leaves scratches, grooves, or striations in the softer material of surfaces in contact. This damage occurs when harder pieces of material, such as quartz grains, project above the spaces between grains or other pieces of material and press into and move through the softer material of the opposing contact surface. Occurs even when the surfaces in contact seem to be equally hard, such as when one piece of stone is used to abrade another piece of stone during manufacture (Adams 1989b:260).

Adhesive wear.

Type of use-wear. The wear mechanism that causes scars, such as flake and cone-shaped scars, pits, and other loose particles to appear on the surfaces of contact. Molecular bonds are formed when surfaces come into contact; these bonds are broken when the surfaces are parted, and damage occurs. This damage may only be visible at high magnification depending on the level and intensity of bonding (Adams 1989b:260).

Adz(e).

(Hohokam, Classic period). "Polished, wedge-shaped implement with a three-quarter groove" (Sayles 1937:119). Considered intrusive from Mogollon area, probably via the Salado.

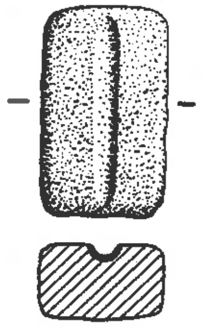
Apron.

Bedrock or boulder grinding feature. In conjunction with their study of the bedrock grinding features at Los Morteros in southern Arizona, Wallace and Holmlund (1983:168) define "aprons" as smooth ground areas appearing on or around the rims of mortars, especially the deepest mortars. Function unknown but these areas may be associated with pestle manufacture or maintenance.

Architectural remains.

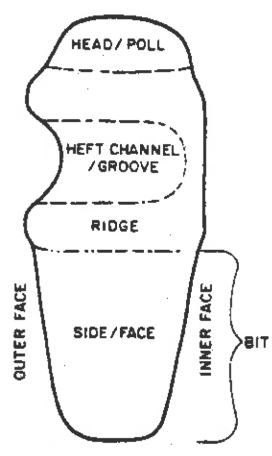
Artifacts. Remains of stone structures, such as masonry wall stones, flagstone floors, and thresholds, or of stone features associated with structures or that are found alone, such as hearth stones, ventilator or chimney covers, deflectors, storage-pit liners, and mealing bins. Most common in areas where masonry structures were built but also found in the Hohokam area (Haury 1976:274). Most often show evidence of having been flaked and pecked, not ground, to shape, although some grinding due to wear or manufacture (especially flagstones) may be present. Also may show little or no intentional shaping. In such cases, identification must be based on archaeological context. Manos and metates may be reused as structural elements (Adams 1979:15, 19).

Arrowshaft straightener /smoother/polisher.



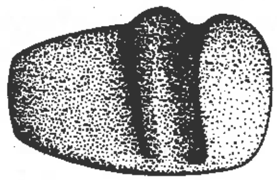
Tool type. (Hohokam, Classic period; Anasazi, Pueblo II). In the Anasazi area, where they may not predate the Pueblo II period, these implements are relatively thick, hand-held tools made of fine-grained material and having a groove running lengthwise. Groove profile is rounded and has led to the inference, based in part on ethnographic analogy, that these tools were used for manufacturing arrowshafts. A satisfactory typology for these tools has not been devised. Many researchers distinguish between "straighteners" and "smoothers" or "polishers" depending on whether the material is abrasive or non-abrasive. However, as Woodbury (1954:101) points out, the actual function and degree of specialization of these tools is unknown, and whether or not a stone is abrasive is very subjective. Unfortunately, Woodbury's (1954:101) alternative classification by degree of shaping is also subjective, and the relationship between shaping and artifact use is unknown. Woodbury's term, "shaftsmoother" is both a typological compromise and an acknowledgement that the use of these tools is not well understood. Haury (1976:285) refers to the grooved hand-held artifacts from Snaketown as "arrowshaft polishers" and describes them as "ridged and grooved tools used to straighten [by heating the tool] and polish arrowshafts." Likewise, Woodbury (1954:101) states that "nearly all these implements were capable of both smoothing and straightening" arrowshafts and that distinguishing between tools used for either purpose may not always be possible. Also called "grooved handstones" (Sayles 1937:119). [illustration adapted from Adams 1979:154]

Axe.



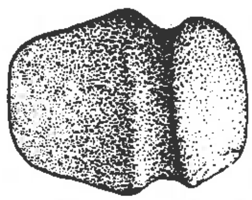
Tool type. A stone tool with a wedge-shaped blade that was presumably designed and used for chopping and that was hafted by fitting a wooden handle into the grooves or notches (Woodbury 1954:25; Sayles 1937:101). Most commonly inferred use is for chopping wood, although use-wear evidence suggests that they were used for other tasks as well (Woodbury 1954:25). Axes come in a variety of forms and notch or groove orientations. Most common types, designated by the hafting technique, are 3/4-grooved, full-grooved, and notched. In almost all cases, the raw material is a dense, fine-grained igneous material. Woodbury (1954:25) gives a good description of the large variety of axes that can occur in northern and eastern Arizona. He also describes and discusses reused and regrooved axes (Woodbury 1954:25-31). Also called "celts." [illustration adapted from Sayles 1937:101, Figure 40]

Axe, three-quarter grooved.



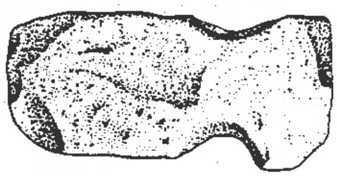
Tool type. (Hohokam, all periods; Anasazi, Pueblo I-II; Mogollon, Pueblo I). Groove extends across both flat faces, but only one side or edge (Woodbury 1954:25). Haury (1976:291-292) considers the 3/4-grooved, polished stone axe to have southern origins and to be intrusive in the prehistoric Southwest. Implement appears to have been adopted earliest by the Hohokam (Haury 1976:291-292) and to have spread north and east into the Mogollon and Anasazi culture areas, where they are not common until the Pueblo III period (Woodbury 1954:29-31). [illustration adapted from Haury 1976:292, Figure 14.30]

Axe, full grooved.



Tool type. (Anasazi, Basketmaker III-Pueblo I; Mogollon, San Francisco phase; Hohokam, sporadic and late). Groove extends completely around implement. Considered to originate in the northern Southwest, possibly in the San Juan region (Woodbury 1954:35-37). Presence in Hohokam sites reflects Mogollon or Anasazi influence (Woodbury 1954:36; Haury 1976:292). [illustration adapted from Woodbury 1954: Plate 34, Figure 14g]

Axe, notched.



Tool type. Axes with two notches on opposite sides for hafting. Otherwise, greatly variable (Woodbury 1954:37). [illustration adapted from Woodbury 1954:Plate 34, Figure 15x]

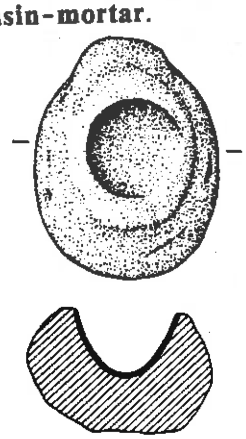
Axe, oblique and spiral-grooved.

Tool type. These axes probably originated in the Rio Grande no earlier than the Pueblo IV period and spread west and north, perhaps in association with Pueblo immigrants fleeing the Spanish conquest (Woodbury 1954:37).

Ball.

Artifact. See **Stone ball.**

Basin-mortar.



Tool type. (Archaic: Cochise culture). Made from large, thick boulders that could accommodate the deep, oval, grinding basins. Oval-shaped grinding area distinguishes these artifacts from mortars that generally have circular grinding areas. Shape of grinding areas attributed to rotary grinding with a handstone. Size and weight of artifacts suggests that they were not intended to be portable. Some artifacts have grinding areas on two opposing surfaces. The use surface of others exhibit pitting that may represent attempts to sharpen the surface. Other artifacts have holes that were purposely cut through the obverse surface. The function of these holes is unknown, but analogies to the hopper-mortar in California have been suggested. Basin-mortars are considered to be most typical of the later Archaic period (Sayles 1983:69-70). See **Gyratory crusher.**

Basin nether stone.

Tool type. (Archaic: Cochise culture). Comparatively small nether (bottom) stone with a shallow, oval-shaped basin. Typologically derived from the slab type in which a shallow depression was worn from the rubbing and grinding of the handstone. In the late Archaic period, larger and thicker stones were used and the basin was often partially shaped prior to use (Sayles 1983:69; Bartlett 1933:26). Also called "basin metate" (Wright 1990:6-8). **See Metate, basin.**

Battering, battered.

Type of use-wear. Repeated beating of an implement against another object that results in flake removal, pitting, and impact scars from the implement that is used to batter.

Bedrock grinding feature.

Includes mortars, cupules, apron, ground depressions, metates, and grinding slicks that appear in bedrock. Present throughout the state.

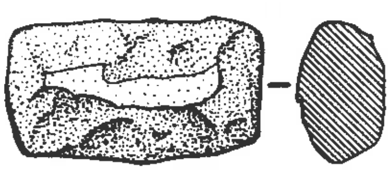
Bedrock metate or grinding slick.

Bedrock or boulder grinding features. Terms appear to be used interchangeably in the literature to refer to relatively shallow, ground areas on bedrock surfaces that range from irregular to square or rectangular in shape. "Metate" might be better restricted to those ground bedrock surfaces that appear to have a definite shape and "grinding slick" to irregular ground areas. In southern Arizona, these features are thought to be associated with mesquite processing (Wallace and Holmlund 1983:169-173).

Bedrock mortar.

Bedrock grinding features that are deeper than they are wide or at least as deep as they are wide. Depth can vary. The bottom is generally smooth and rounded or slightly conical with evidence of having been ground by a pestle (Wallace and Holmlund 1983:144). In southern Arizona they are thought to be associated with mesquite processing, especially breaking up the pods (Wallace and Holmlund 1983:148-150).

Blank.



Artifact. Roughly shaped pieces of rock that were intended to be finished and used for grinding but were never used. Usually refers to unfinished manos or metates (Hoffman and Doyel 1985; Huckell 1986).

Boulder grinding feature.

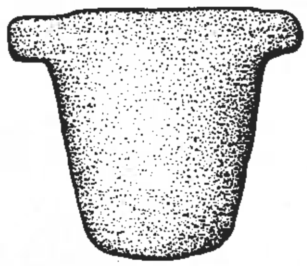
Mortars, cupules, aprons, grinding depressions, and metates or grinding slicks that occur on large boulders. Present throughout the state. See **Bedrock grinding feature.**

Cooking slab.

Tool category. Relatively flat pieces of tabular stone that were used over a fire to cook food. Cooking surface may be moderately to extremely well smoothed; bottom surface, opposite cooking surface, is burned and sooted from exposure to fire. Includes griddles and piki stones. The latter appear during the Pueblo III period in the Anasazi and Mogollon areas (Woodbury 1954; Wheat 1955). Stone cooking slabs do not appear in the Hohokam area (Woodbury 1954:177). See **Griddle; Piki stone.**

Cross section. Technological attribute. See **Lateral (or Transverse) cross section; longitudinal cross section.**

Crusher. Tool type. Large flat pieces of stone with two horizontal projecting handles. Thought to have been used for crushing plant foods (Di Peso 1951:144-145) or for hide processing. Di Peso (1951:144) speculates that these large implements were rolled back and forth on their curved edge over the food stuffs or were picked up and dropped on the material to be crushed. Also called handled crushers and "fergoliths." [illustration adapted from DiPeso 1951:144, Plate 53B]



Cupule. Bedrock grinding feature. Relatively shallow depressions that have been pecked into boulders or bedrock. Irregular but generally round shape with relatively uneven interior surfaces. Smaller than mortars, cupules are at least as deep as they are wide (Wallace and Holmlund 1983:144-145). Function unknown, but see Wallace and Holmlund (1983:176-182) for a discussion of several hypotheses. Present throughout the state.

Fergolith. See **Crusher.**

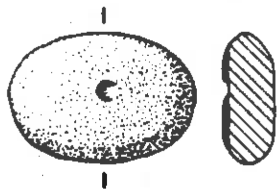
Finger grip. Manufacturing attribute. Elongated oval depressions that have been pecked into the sides of manos to facilitate gripping the tool. May be on one or both edges. Usually worn smooth from contact with the grinder's hand. Most frequent on two-handed manos with two opposite grinding surfaces, although may appear on other kinds of manos (Woodbury 1954:66-84). Present on manos throughout the state.

Fire-cracked rock. Artifact. Pieces of rock that have been heated in a fire. Distinguished by their angular broken surfaces that result from thermal fracturing (Haury 1976:273). It may be difficult to determine if artifacts are unused rocks that have broken due to differential expansion and contraction caused by the desert's temperature fluctuations or are rocks used as hearth or heating stones.

Flaking. Manufacturing process. A reductive process that results when pieces of stone are struck from an artifact, leaving visible flake scars with relatively sharp edges. Easiest to recognize macroscopically and on artifacts made of relatively fine-grained material (Fratt 1991; Adams 1986).

Floor polisher.

Tool type. Hand-held, approximately oval tool with varying degrees of intentional shaping. Distinguished by a round to irregular pecked area on one use-surface. May be categorized as a rubbing stone or a handstone (Adams 1979). [illustration adapted from Adams 1979:160]



Granularity.

Technological attribute. The size of the grains that make up the raw material, or the stone's texture (Adams 1979:113). Usually used in reference to a nonhomogeneous, noncryptocrystaline stone such as sandstone.

Griddle.

Tool type. Fine-grained stone slabs that have been used over a fire, presumably for cooking, and are often stained with carbon or soot (Woodbury 1954:176-177; Fratt 1991). See **Cooking slab.**

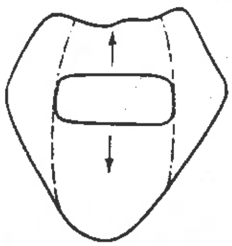
Grinding.

A reductive process that results when a stone is rubbed against some other material. Grinding differentially effects the use surface of a stone tool according to the technique used (stone against stone contact with or without an intermediary material or a single stone against material being ground) and whether the material being processed is relatively hard, oily, or resilient (Adams 1989a). During grinding, elevated areas of an artifact's unmodified, uneven surface are worn down so that the ground surface becomes progressively more even and smooth (Fratt 1991). Term is used interchangeably to refer to a stone implement manufacturing process as well as to a tool's function or use for pulverizing substances. Also used interchangeably with "abrasion" or "abrading" (Woodbury 1954:204). In the interest of making terminology more specific, "Grinding" should be restricted to describing a tool's use or function for pulverizing substances such as corn and seeds. Therefore, "manos are used for grinding corn." "Abrasion" and "abrading" should refer to a manufacturing process by which objects are intentionally ground, that is, abraded into a desired shape. Therefore, "flat abraders are used to abrade wooden artifacts into shape." The term "abrasive wear" should be used to refer to a particular kind of wear mechanism that results from using a tool for either grinding or abrading. See **Abrasive wear.**

Grinding kit.

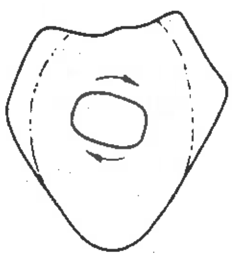
Tool type. Consists of two stones, a stationary nether stone and a smaller, handstone that is used to crush substances that have been placed between them. Also called grinding stones or milling stones. Sayles (1983) uses the latter phrase to refer to Archaic period grinding kits comprised of stones that exhibit little or no intentional shaping. With regard to manos and metates, refers to the metate and its matching mano. Also includes mortar and pestle.

Grinding, reciprocal.



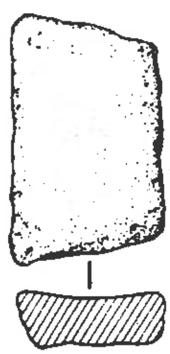
A technique that involves moving a handstone in a back-and-forth motion against a nether stone. Resulting use surface of nether stone displays a relatively flat or concave contour depending on the duration and intensity of use. Use surface may extend across entire surface of the stone depending on the size of the handstone relative to the nether stone. Use-surface contour of handstone varies from flat to convex depending on the grinding stroke used, and the number and orientation of the handstone's use surfaces depends on whether the stone is rotated along the lateral or longitudinal axis during use. Usually associated with grinding in a troughed or slab metate (Woodbury 1954:50-51); Morris (1990) discusses reciprocal grinding in basin metates. [illustration adapted from Sayles 1937:117, Figure 47]

Grinding, rotary.



A technique that involves moving a handstone in a circular motion against a nether stone. Resulting use surface of the nether stone displays a circular or oval depression that does not extend across the entire surface of the stone. Use surface contour of handstone ranges from flat to convex depending on the depth of the depression in the nether stone. Usually associated with grinding in a basin metate, grinding slab, or mortar (Woodbury 1954:50-51). [illustration adapted from Sayles 1937:117, Figure 47]

Grinding slab.



Tool type. Flat or tabular natural stones with shallow basins ground into one or two opposite use surfaces. They often display little or no intentional shaping. First appear in both northern and southern Arizona during the Archaic period (Sayles 1983:77-81; Irwin-Williams 1973) and persist into the Historic period (Adams 1979:64-66). Presumed use was to process nonfood substances, but probably had multiple uses (Adams 1979:64). Sayles (1937:105) refers to this group of artifacts as grinding stones. Distinctions between grinding slabs and metates are often unclear, and the two terms have been used interchangeably to refer to the bottom, stationary stone of a grinding kit. Distinguished from metates on the basis of grinding direction (primarily rotary or multidirectional rather than reciprocal), a use surface that does not extend across the entire upper surface of the stone, and little to no intentional shaping.

Grinding slick. Bedrock or boulder grinding feature. See **Bedrock metate**.

Grinding surface. Technological attribute. Surface of the implement that was used to grind or abrade various materials (Woodbury 1954:51; Fratt 1991). Also called use surface. All grinding surfaces are also ground surfaces, but not all ground surfaces are grinding surfaces. Excludes surfaces that were abraded to shape during manufacture (e.g. axes) and were neither used for grinding. See **Ground surface**.

Ground Depression.

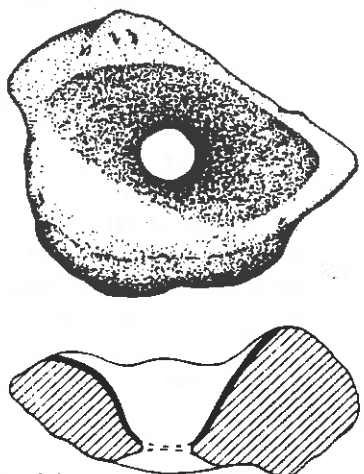
Bedrock or boulder grinding feature. At Los Morteros in southern Arizona, small smooth ground areas on or around the rims of mortars that often open into mortars. Most frequently found in association with the deepest mortars. Function unknown but Wallace and Holmlund (1983:169) hypothesize that they may have been used to clean pestles, further reduce mesquite meal or other types of plant food, or they may have served as pestle rests.

Ground surface.

Technological attribute. Surface of an artifact that has been worn by grinding due to use or during manufacture. Although this term implies that the portion of the artifact ground is worn through use, this is not always clear from the reference since a surface can be ground to shape during manufacture as well as from use. Terminology should be standardized to distinguish between these two circumstances. Not all ground surfaces are grinding surfaces. See **Grinding** and **Grinding surface**.

Gyratory crusher.

Tool type. Hohokam area. Hayden (1969) states that the gyratory crusher "resembles a perforated mortar, either in slab or block form, in which a wooden pestle with a projection extending through the perforation in the mortar base was gyrated" in order to grind mesquite pods. Such implements have been recovered from late Archaic through Sacaton periods in Arizona (Sayles 1983:70; Haury 1976:282; Hayden 1969). [illustration adapted from Sayles 1983:128, Figure 10.3a]

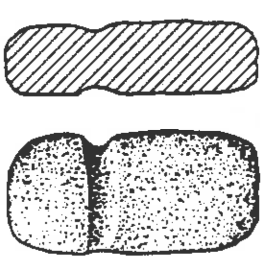


Hafting.

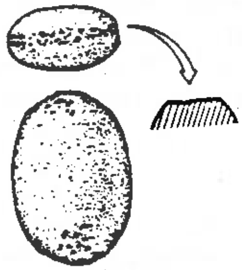
Technique used to attach a wooden handle to a tool such as an axe, hammer, maul, pick, or hoe. Two major techniques for hafting, which required different grooves, were used in the prehistoric Southwest (Woodbury 1954:26).

Hammer.

Tool type. A hafted tool designed and used for pounding that has a blunt, rounded end suitable for striking a blow to an object. Nomenclature follows that for axes. Hammers are classified as full- or 3/4- grooved, notched, or other, depending on whether the wooden handle was secured by means of a groove or notches. Sometimes referred to as mauls. Appearance is similar to full and 3/4- grooved axes and many hammers may actually be blunted and reused axes (Woodbury 1954:47-49). Several subtypes have been identified, as well as reused and reshaped hammers (Woodbury 1954:44-47). [illustration adapted from Woodbury 1954:Plate 34, Figure 15c]



Hammerstone.



Tool type. Among the most common and variable artifacts found at prehistoric sites in the Southwest. Used to manufacture stone tools by striking off flakes. Wheat (1955:122) notes that it is difficult to define subtypes given the range of variation, and Haury (1976:279-280) states that the weight and form differences of the Snaketown hammerstones do not lend themselves to further meaningful typological designations. Nevertheless, both Wheat (1955:122) and Woodbury (1954:89-90) describe three types of hammerstones based on differences in shape.

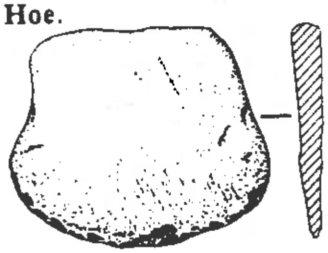
Handled crusher.

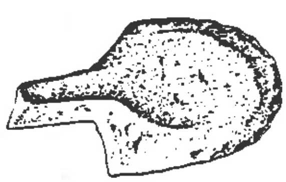
Tool type. See Crusher.

Handstone.

Tool type. Refers to a variety of hand-held tools that differ in the degree to which they were shaped and in their use (Fratt 1991). May be unifacial or bifacial. Wheat (1955) classifies manos as a type of handstone. Adams (1979:48) and Woodbury (1954:85-86) refer to such implements as "polishing, rubbing, pecking, and pounding" tools. According to Sayles (1983:68), "an implement small enough to be held in one hand while crushing, cracking, grinding, pulverizing, or otherwise processing plant foods and other materials on the upper surface of the larger and stationary nether milling stone." Also called "oval one-hand manos" (Wright 1990:6-8). Distinctions between manos, especially one-hand manos, and handstones are often unclear, and the two terms have been used interchangeably to refer to any hand-held stone, whether or not it was part of a grinding kit and whether or not it was used to grind maize. When manos and handstones are distinguished, the differences that are usually cited are that handstones exhibit a lesser degree of intentional shaping and reflect a greater variety of processing techniques.

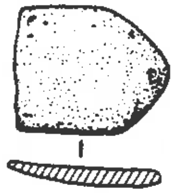
Hoe.





Tool type. According to Woodbury (1954:166), "tools shaped partly or wholly by grinding, with a broad blade that is relatively thin and sharp edged." Category is distinguished by a tremendous variety of form, size, and manufacturing technique, but the common characteristic is a edge or pointed end that is suitable for digging and working agricultural fields, which is their presumed use (Fratt 1991; Woodbury 1954:166; Haury 1976:285; Wheat 1955). For the Hohokam Classic period these are thin sheets of spalled rock that appear to have functioned as hand-held digging implements. Mostly made of rhyolite and andesite; degree of shaping varies (Haury 1976:285). [top illustration adapted from Haury 1956:259, Figure 49b; bottom illustration adapted from Woodbury 1959: Plate 34, Figure 35u]

Lapstone.



(Archaic: Cochise culture). Thin flat slabs that could be held in the hand. Presumed use is for grinding paint pigments, although specimens without pigment have been found (Woodbury 1954:114). Probably typological precursor of paint palettes. Also called "proto-palettes" (Sayles 1983:68). [illustration adapted from Sayles 1983:133, Figure 11.2a]

Lateral cross section.

Technological attribute. Especially with regard to manos and metates, handstones and grinding slabs, refers to the profile of the artifact's width (measured from side to side). Also called transverse cross section. On manos, indicates the kind of grinding stroke used. See **Mano and variants**.

Longitudinal cross section.

Technological attribute. Especially with regard to manos and metates, handstones and grinding slabs, refers to the profile of the artifact's length (measured from end to end). On manos, indicates the type of metate on which the artifact was used. On metates, indicates the duration and intensity of use as well as whether the direction of grinding was reciprocal or rotary.

Macroflaking.

Manufacturing process. See **Flaking**.

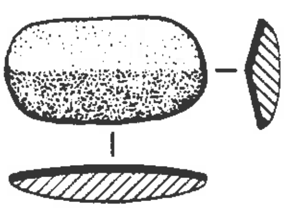
Macroscopic use-wear.

Evidence of ground stone artifact use or manufacture, such as flake scars, pecking, resharpening, or the sheen on grinding surfaces that can be seen without the aid of a microscope.

Mano.

Tool type. Upper stone usually held by both hands that is moved in a reciprocal motion across the surface of a metate, or nether stone, thereby grinding or pulverizing the substance placed on the metate (Sayles 1983:68). Also called "muller" or "mueller" (Sayles 1983:68). The distinction between manos and handstones is often not clear, especially in the Mogollon area, or the distinctions are inconsistent. In contrast to handstones, manos generally exhibit more intentional shaping, are larger, have a greater variety of transverse cross sections, were used in a reciprocal grinding motion, and were part of a grinding tool kit used to process maize (Haury 1976:281; Woodbury 1954:66; Sayles 1983:68; Wheat 1955:115). During Anasazi Pueblo II and later periods there are various transverse cross sections on manos used with troughed or slab metates, indicating that more than one grinding stroke was in use (Woodbury 1954:80-81).

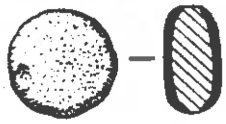
Mano, adjacent grinding surface.



Tool type. Distinguished by a triangular or diamond-shaped transverse cross section, the result of having been tilted during use and rotated longitudinally to facilitate wear management (Bartlett 1933:11-17; Adams 1991). Surface opposite may or may not have been shaped or used. If used, the mano has two opposed use surfaces, one of which has two adjacent grinding surfaces. Manos with diamond-shaped transverse cross sections have two opposed use surfaces, each with two adjacent grinding surfaces.

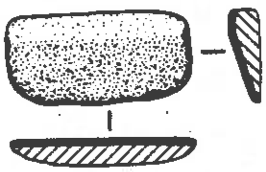
Mano, basin.

Tool type. Manos used in a basin metate. Contour of use surfaces depends on depth of depression and direction of grinding. As the depression gets deeper, the mano use surface contour becomes more convex (Sayles 1983:70-71,76). Generally smaller than manos used on trough or slab metates. May be unifacial or bifacial and exhibit a variety of transverse cross sections (Sayles 1983:70-71, 76).



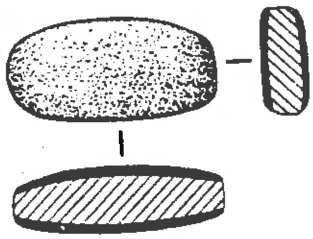
Mano, beveled.

Tool type. Distinguished by a beveled transverse cross section resulting from rocking the mano on the down stroke (Bartlett 1933:15-17; Woodbury 1954:69). May or may not be rotated longitudinally. [illustration adapted from Woodbury 1954: Plate 34, Figure 17.1]



Mano, bifacial.

Tool type. Manos with two opposite grinding surfaces.



Mano, exhausted.

Artifact. Mano that is too thin and short to have been used without scraping the grinder's fingers (Bartlett 1933:13; Fratt 1991).

Mano, loaf-shaped.

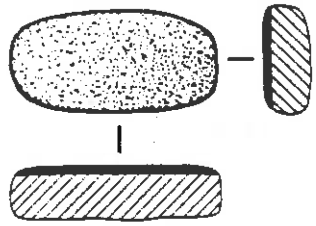
Tool type. Distinguished by a square, rectangular, subrectangular, or oval transverse cross section that results from using a flat grinding stroke and rotating the mano longitudinally (Bartlett 1933:13-17; Woodbury 1954:68-73). May be unifacial or bifacial, and opposing surfaces are parallel. If unifacial, opposite unused surface may or may not be shaped.

Mano, one-hand.

Tool type. Maximum length of mano is 18 cm. Used with only one hand (Woodbury 1954:79 fn 3). May have been a less specialized tool than two-hand manos that are thought to have been used to grind corn. Hopi informants identified such artifacts recovered from Walpi as hide processing stones (Adams 1979:1).

Mano, slab.

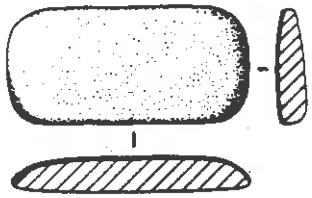
Tool type. Manos that have been used on a slab metate. Distinguished by their slightly concave to flat grinding surfaces and rectangular to subrectangular longitudinal cross sections. Use-wear does not extend down the ends, although the ends may have been abraded during manufacture. Despite the abraded ends, there is a break between the grinding surface and the ends that will distinguish manos used in a slab metate from those used in a trough metate. In the latter case, the wear due to grinding is continuous from the grinding surface onto the rounded ends.



Mano, two-hand.

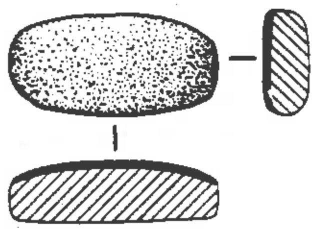
Tool type. Minimum length of mano is 18 cm. Required both hands for effective use (Woodbury 1954:79 fn 3).

Mano, trough.



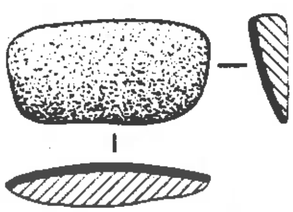
Tool type. Manos that have been used in trough metates. Distinguished by a concave longitudinal cross section and use-wear from grinding that extends from the grinding surface down onto the ends. Care must be taken not to confuse manos whose ends have been shaped by abrading with manos that have been used in trough metates.

Mano, unifacial.



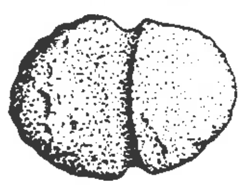
Tool type. Manos with only one grinding surface. Opposite unused surface may or may not be shaped by pecking and abrading.

Mano, wedge.



Tool type. Distinguished by a wedge-shaped transverse cross section that results from not rotating the mano longitudinally during use (Bartlett 1933:13-17; Woodbury 1954:68-73). May be unifacial or bifacial.

Maul.



Tool type. Large tools that are similar to hammers but with the groove located in the middle of the tool so that the poll and bit ends are approximately the same size and shape (Adams 1979:115). Presence of groove indicates that artifact was intended to be hafted with a wooden handle. Often identified as hammers. [illustration adapted from Sayles 1983:133, Figure 11.2e]

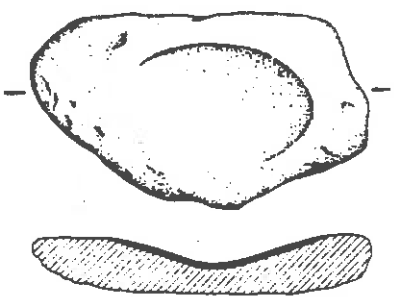
Mealing bin.

Architectural feature. (Anasazi, Pueblo III into Historic period). Specialized structures for grinding corn or other foodstuffs that first appear during the Pueblo III period in northern and eastern Arizona in association with changes in architecture and specialization of room use (Woodbury 1954:63). They range from a prepared area on the room floor where the metate was placed to a rectangular stone slab-lined box within which slab metates were permanently affixed (Christenson 1987a; Woodbury 1954:59-65).

Metate.

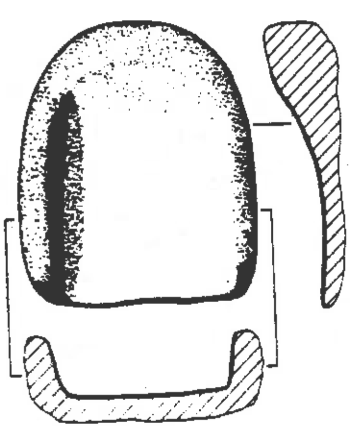
Tool type. Stationary nether or bottom stone with a prepared surface on which a mano was rubbed in a reciprocal or rotary motion (Sayles 1983:68). Bottom stone of a grinding kit on which substances to be ground are placed (Woodbury 1954:50). A handstone, or mano, is rubbed across the metate thereby grinding the substance. Metates are portable unless they are placed in a grinding bin. Criteria distinguishing metates from grinding slabs is often not clear or consistent, especially with regard to Archaic period artifacts. Distinctions are usually based on degree of shaping, amount of the upper surface that is used (longitudinal cross section), direction of grinding (reciprocal), and whether or not the stone is part of a grinding kit. Also referred to as a "milling stone."

Metate, basin.



Tool type. Nether or bottom stone with a round or oval depression that results from grinding with a smaller handstone used in a rotary or reciprocal motion. Use surface does not extend across the entire upper surface of the stone. Depression varies in size. Primary use is presumably to grind seeds and other wild plants, not to grind maize (Woodbury 1954:50-51; Sayles 1983:68-81). Present in all areas of the prehistoric Southwest and pre-dates troughed and slab or flat metates. Use of term extends to the basin nether stones that form the bottom half of the Archaic milling kit. To distinguish between stone slabs with rotary grinding that were intentionally shaped and those that were not, some researchers (Woodbury 1954:50-51; Sayles 1983:68) have suggested that the term "basin metate" be used only for intentionally shaped stones and that the term "grinding slab" be used for nether stones that were not intentionally shaped. Although this solution does not consider the possibility that all forms of metates were used to grind seeds and other wild plant foods as well as corn, it is useful for describing Archaic, Hohokam, and Anasazi assemblages. It is less useful for describing Mogollon assemblages because of the greater prominence and persistence of Archaic forms after maize farming was adopted (Wheat 1955). See **Basin nether stone**. [illustration adapted from Sayles 1983:118, Figure 9.3a]

Metate, closed-end trough.

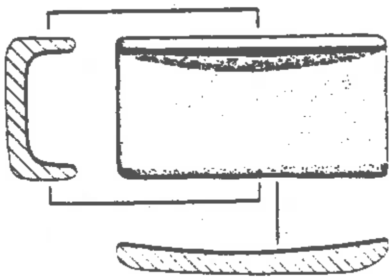


Troughed metate with the grinding surface extending only part of the stone's length. The closed end was toward the person grinding and is always thicker than the open end. Earliest appearance in the Anasazi and Mogollon culture areas (Woodbury 1954:58). See **Metate, trough**.

Metate, exhausted.

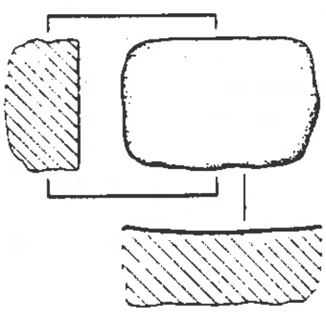
Artifact. Metate that is worn so thin that it broke and was then discarded or that has a hole worn through the grinding surface, rendering it unusable for grinding grain. The hole in an exhausted metate differs from the hole in a "hopper-mortar" by its jagged form and thin edges (Sayles 1983:70). Exhausted metates have been recovered in both whole and fragmentary condition.

Metate, full trough.



Tool type. Trough metate that has a grinding surface that extends from one end of the stone to the other. Earliest appearance in the Hohokam culture area, especially in the Salt-Gila Basin (Woodbury 1954:58). Present throughout the prehistoric Southwest. See **Metate, trough.** [illustration adapted from Haury 1976:280, Figure 14.9e]

Metate, slab or flat.



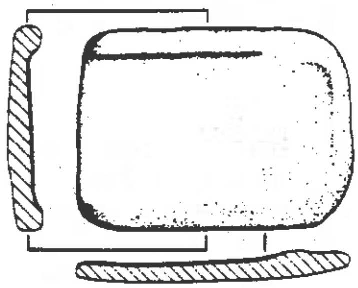
Tool type. (Anasazi, Pueblo II-III and later; Hohokam, Classic period). Post-dates troughed metates during Ceramic period in all areas. Replaced trough metates in Anasazi area. Represents an addition to the grinding-tool assemblage in the Mogollon and Hohokam areas because the earlier troughed form persisted after the slab metate appeared (Woodbury 1954:58-65). Metate on which the grinding surface extends across the entire upper surface of the stone. Results from using a mano whose length approximates the width of the metate and that is moved across the entire grinding surface in a reciprocal motion. Both terms are not entirely satisfactory since all non-bedrock metates are slabs of stone and flat metates actually have concave, longitudinal cross sections, unless they are in the very early stages of use. Present throughout the prehistoric Southwest. [illustration adapted from Haury 1976:280, Figure 14.9a]

Metate, trough.

Tool type. Metate with a grinding surface that does not extend across the entire upper surface. Results from using a mano that is shorter than the metate is wide and is characterized by having sides that are higher than the grinding surface. Mano is used with a reciprocal motion. Present in all areas of the prehistoric Southwest and generally post-dates basin metates or grinding slabs and pre-dates slab or flat metates (Woodbury 1954:51-65). See **Metate, closed-end trough** and **Metate, Utah-type.**

Metate, Utah-type.

Tool type. Troughed metate with a shelf on the one closed end. Shelf is thought to have been used to hold mano while not in use, but it may have served other purposes. Closed end with shelf is toward the grinder. Apparently never used by the Hohokam. Appears to be present earliest in the Mogollon area and then spread into the Anasazi area (Woodbury 1954:59).



Microscopic use-wear.

Evidence of ground stone artifact use or manufacture, such as scratches or polish, that can be seen most clearly only by using a microscope.

Milling stone.

Tool type. Grinding tool kit consisting of hand-held top stone (mano or handstone) that was rubbed against a stationary bottom stone (metate or grinding slab) to process food, especially wild or domestic grains. According to Sayles (1983:68, 77), the term applies to stones with little to no intentional shaping and whose primary use was to process plant foods.

Mortar.

Tool type. Pieces of stone with various degrees of shaping that have a concavity pecked into one surface and that were used with a pestle or handstone for pounding and some grinding of materials (Woodbury 1954:116). Mortars may be reused metates (Woodbury 1954; Haury 1976). In Archaic period assemblages, distinguished from a deep-basin grinding stone by having a circular grinding area that is usually deeper than it is wide. Includes portable implements and bedrock features. See also **Basin-mortar, Bedrock mortar, Cupule.**

Muller or mueller.

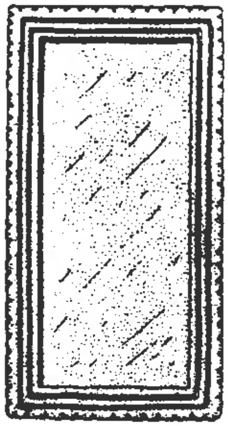
Tool type. Grinding stone. Most often refers to the hand-held top stone. See **Mano.**

Nether stone, nether milling stone.

(Archaic: Cochise culture). Large, stationary stone on which substances, particularly food stuffs, are processed by using a handstone or mano. Sayles (1983:69) refers to the following as nether stones: grinding slab, shallow and deep basin, basin-mortar, pebble-mortar, and lapstone or proto-palette. These types are distinguished on the basis of shape, grinding or working surface, and wear pattern. See also **Basin nether stone.**

Palette.

Tool type. According to Wheat's (1955:117) typology for Mogollon ground stone, these are "small flat stone slabs that sometimes have a shallow depression in one face and are frequently stained with pigment." Woodbury (1954:112) and Adams (1979:45-46) describe palettes in Anasazi assemblages as having concave grinding surfaces that are surrounded by a raised border and were used specifically to grind and mix pigments. Hohokam palettes are tabular objects with carved decoration that varies from simple to elaborate. Haury (1976:286) refers to them as one of the outstanding "hallmarks" of Hohokam culture. The use of Hohokam palettes is unknown, but the more finely and elaborately carved specimens have been assumed to be ceremonial in function (cf. Lowell 1990). [illustration adapted from Haury 1976:280, Figure 14.20e]

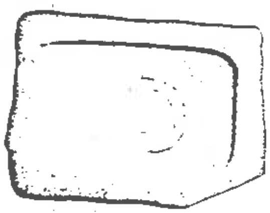


Palette, effigy.

Tool type. (Hohokam, Colonial and Sedentary periods). Hohokam stone palettes that are carved or have carved decoration in the form of animals or stylized humans (Haury 1976:286-289).

Palette, paint.

Tool type. Tabular stone slab exhibiting variable degrees of shaping that have evidence of paint pigment on one or more use surfaces (Woodbury 1954: 112; Adams 1979:45). Refers to implements used to grind or mix paint. Use surface contour ranges from flat to slightly concave to an oval depression. [illustration adapted from Woodbury 1954:Plate 34, Figure 23a]



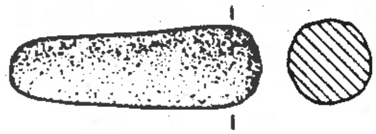
Pecking.

Manufacturing process. Occurs when a stone is struck with the point or edge of another hand-held stone of equal or greater hardness. The resulting pecked surface has numerous small, usually closely placed depressions (Fratt:1991). Microscopically, pecking leaves impact scars, cones, and dimples on the sand grains and cement (Adams 1986). Used to shape implements or to roughen grinding surfaces, especially on manos and metates.

Pecking stone.

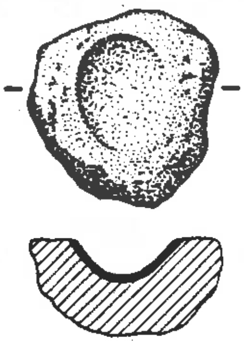
Tool type. Irregular, hand-held tool used to shape stone implements during manufacture. A jagged point or edge of the pecking stone is struck perpendicular to the implement being shaped, resulting in a roughened surface. Difficult to subtype due to the variability on form and size (Woodbury 1954:86).

Pestle.



Tool type. Broadly defined, refers to any implement used to crush or pound various food and nonfood substances. Term often restricted to relatively thin, elongated, cylindrical stones that exhibit some degree of shaping and whose blunt ends show evidence of use to crush or pound (Woodbury 1954:95). Sayles (1983:68) defines an Archaic (Cochise culture) pestle as a shaped handstone with one extended, heavily battered end that was used to crush or pound substances placed on a nether grinding stone (Sayles 1983:68). Present throughout the prehistoric Southwest.

Pebble-mortar.



Tool type. (Archaic: Cochise culture; Mogollon). Cobble-sized stones with a circular basin pecked and worn into one surface. Probably typological precursor of stone bowls (Sayles 1983:70). Also characteristic of Mogollon area where Wheat (1955:118-119) advocates calling them cobble-mortars. [illustration adapted from Sayles 1983:133, Figure 11.2d]

Pick.

Tool type. Elongated, thin implement with at least one relatively pointed end suitable for digging. May have origins in Mogollon culture area and spread west (Wheat 1955). Sayles (1937:199) describes the picks that appear on Hohokam Classic period sites as "cylindrical axe-like implements with a point in place of a cutting edge." Considered intrusive from Mogollon area.

Pigment.

"A powdered organic or mineral substance that when mixed with a vehicle produces paint" (Adams 1979:115). Ground stone implements that have pigment on one or more surfaces may have been used to grind or mix pigment or they may have been decorated with the pigment. Ground stone implements used to grind or mix pigment are called **Palettes.**

Piki stone.

Tool type. (Pueblo area, Pueblo III into Historic period). Carefully selected and prepared sandstone slabs upon which piki, a wafer-like corn bread, was cooked. Piki stones are made from well-cemented, very fine-grained sandstone and are distinguished by their extremely smooth cooking surface that is alternately rubbed with oil and heated until it develops a smooth, oily coating that prevents the thin corn gruel from sticking. O'Kane (1950) gives a detailed description accompanied with photographs of piki-stone manufacture and use. Piki stones are relatively recent additions to the prehistoric Pueblo tool kit, first appearing during the Pueblo

III-Pueblo IV transition period. They seem to have a southern origin and represent a new technique for preparing food. See **Cooking slab.**

Polishing stone or pebble.

Tool type. Small, water-worn pebbles that have one or more nearly flat surfaces (also referred to as facets) that show scratches, striations, or a sheen resulting from use. Modification of the surfaces, presumably due to polishing ceramics, ranges from ephemeral to distinct. One or more ends or projections may show evidence of battering (Woodbury 1954:96-97).

Pollen wash.

A analysis technique consisting of pouring a very weak solution of hydrochloric acid on the use surface of a ground stone implement, most commonly a mano or metate, and then collecting the acid for later analysis. The acid dissolves residue on the surface of the implement that may contain pollen from the plant material that was ground on the artifact's surface. This is a very effective technique for obtaining information about the material that the artifact was used to process, but care must be taken to minimize contaminating the artifact's use surface with modern pollen rain. This procedure does not appear to adversely effect microscopic traces of use-wear.

Preforms.

Artifact. Also referred to as **Blank.**

Proto-palette.

Tool type. See **Lapstone.**

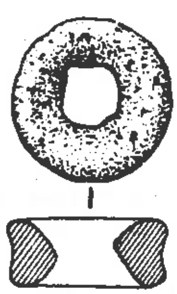
Rasping stone.

Tool type. See **Abrader.**

Resharpen.

Manufacturing process. Roughening the surface of an implement, especially a mano or metate, whose grinding efficiency has decreased due to extensive use. The smooth use surface is pecked, leaving small depressions and exposing sharp grains that increase the surface's abrasiveness and make grinding more efficient (Adams 1979:115).

Ring.



Doughnut-shaped implement made of stone whose use is unknown. Almost always made of a very rough stone such as vesicular basalt, pumice, or tuff. Recovered from the Hohokam and Mogollon culture areas (Haury 1976:290; Wheat 1955).

Rubbing stone.

Tool type. Hand-held tools exhibiting a wide range of shapes and sizes and shaped almost entirely by grinding. Degree of wear ranges from ephemeral to heavy. Tools may be multiple use or use specific. Floor polishers found in the Anasazi area may be an example of use-specific rubbing stones. May also be called handstones.

Scouring stone. Tool type. See **Abrader.**

Shaft straightener /smoother/polisher. Tool type. See **Abrader, grooved** and **Arrowshaft straightener/smoother/polisher.**

Sharpening. Manufacturing process. In the case of grinding tools, particularly manos and metates, refers to using a pecking stone to roughen a grinding surface that has been worn smooth, thereby improving the stone's grinding efficiency. In the cases of axes, hammers, hoes, and picks, refers to striking the blade or tip with a hammerstone in order to improve the tool's efficiency for cutting.

Stone Ball. Round stone object that has been intentionally shaped by flaking, pecking, and, occasionally, abrading. Size and regularity of shape vary. Function is unknown, but they are thought to have been used in a variety of games. Found throughout the Southwest (Adams 1979:90-91; Broms and Moriarty 1967; Woodbury 1954:171-173). May be misidentified as hammerstones, but usually are more regular in shape.

Surface fatigue. Type of use-wear. The wear mechanism that causes surface leveling as elevated pieces of material are crushed and worn down to the point that the load (compression stress) of the other surface can be born. This leveling of contacting surfaces is what causes grinding or abrading tools to loose their effectiveness by becoming too smooth and thereby, requiring periodic resharpening. Surface fatigue also causes cracks, pits, and loose particles to appear on contacting surfaces due to the repeated movement of the surfaces back and forth against each other. As this movement causes surfaces to crack, pieces of material, such as quartz grains, become loose and dislodge, producing pits in the surface and promoting further wear (Adams 1986:72-73, 1989b:261).

Tcamahia. (Anasazi, Pueblo III and later). According to Woodbury (1954:167), "ground or polished blades of hard, fine-grained stone, tapering from a narrow butt to a broad, thin cutting edge." May be intrusive from the San Juan-Mesa Verde area. Function unknown but artifacts found in the San Juan-Mesa Verde region are presumed to have been agricultural implements. By the time tcamahias appear in the Western Anasazi area, they seem to have had only a ceremonial use.

Transverse cross section. Technological attribute. See **Lateral cross section.**

Tribochemical wear. Type of use-wear. The wear mechanism that causes a build-up of reaction products on contacting surfaces that is often referred to as polish. Tribochemical wear is a continuous chemical process; however, other wear processes can breakdown the reaction products, and inhibit build-up (Adams 1989b:261).

Use life. The length of time an artifact can be used. Especially important for interpreting ratios of manos and metates found at a site. Major source of information comes from ethnographic of ethnoarchaeological studies, although experimentation is also yielding pertinent data (see Wright 1990).

Use surface. Technological attribute. Refers to the portion of the artifact that has been worn due to use, not manufacture. See **Grinding surface**.

Use-wear. Technological attribute. Alteration of an artifact's surface due to use. Traces of use-wear give clues about how the artifact was used, what substances were ground or abraded, the length or intensity of use, and whether the artifact was reused (Fratt: 1991; Adams 1986,1989a, 1989b). Can be microscopic or macroscopic. Microscopic use-wear studies are one of the most promising areas of recent research on ground stone tool use.

Whetstone. Tool type. See **Abrader**.

GLOSSARY C
GEOLOGICAL TERMS

Kirk Anderson

Aeroturbation. The mixing of sediments and soils as a result of air, wind, and gases, such as carbon dioxide being released from the soil (Wood and Johnson 1982).

Aggradation. A process of deposition, as in a floodplain building up due to continuous superimposed flood deposits.

Alluvium. Material deposited by water.

Andesite. An aphanitic, extrusive igneous rock of intermediate composition between granite and gabbro. Has less than 10 percent quartz. Diagnostic mineral associations are quartz, hornblende, potassium feldspar, biotite, sodic plagioclase, and pyroxene (Ernst 1969:102). This rock is the extrusive, fine-grained equivalent of diorite.

Aphanitic. Fine-grained texture of igneous rocks, indicating that the crystals are microscopic.

Aquaturbation. One of many pedoturbation processes, involving the mixing of the soil and sediments due to the pressure exerted by artesian water, and also by freeze and thaw activities (Wood and Johnson 1982:585).

Argilliturbation. One of many pedoturbation processes, involving the mixing of soils and sediments due to shrink and swelling of clays as a result of wetting and drying.

Basalt. An aphanitic extrusive igneous rock of mafic composition, usually dark in color and commonly vesicular. Has less than 10 percent quartz. Diagnostic mineral associations may include olivine, pyroxene, hornblende, and calcic plagioclase (Ernst 1969:102).

Bioturbation. Mixing of soil and sediments due to the activities of plants and animals. Can be very extensive in certain areas, and can destroy the integrity of cultural materials (Schiffer 1987).

Chalcedony. Biogenic sedimentary precipitate composed primarily of cryptocrystalline silica. Hand specimen generally differentiated from cherts based on the clear to translucent, white, appearance of chalcedony. Also referred to as opal (Jackson 1970).

Chert. Biogenic sedimentary precipitate composed primarily of microcrystalline silica. Hand specimen differentiated from chalcedony based on the translucent to opaque appearance and myriad of color combinations of chert, even within the same hand specimen (Jackson 1970).

Clastic (clast). Denotes individual grains in sedimentary rocks such as silt, sand, and boulders (Jackson 1970).

Clay. Term used to define a distinct grain size that is not visible to the naked eye (Fritz and Moore 1988: 46).

Claystone. Clastic sedimentary rock composed of clay-sized fragments that are not visible to the naked eye. May have a weak conchoidal fracture when massive. If it fractures along bedding planes, then it is termed a shale.

Cobble. Term used to define a distinct grain size (64-256 mm), but is commonly used to describe river-transported materials, such as river cobbles (Fritz and Moore 1988: 46). It is suggested, however, that this term should be used to define only those clasts that fall into that particular size fraction. Terms such as river pebbles and river boulders should be added to the vocabulary.

Colluvium. Generally coarse, angular gravel and sand fragments that are transported downslope under the force of gravity. It commonly develops at the foot of cliffs, as talus cones, and at the toe slope of hills and other rises.

Conglomerate. Sedimentary rock composed of gravel clasts (greater than 2 mm in diameter). Also referred to as a pebble conglomerate, quartzite conglomerate, etc. (Fritz and Moore 1988: 50).

Cryoturbation. Mixing of soils and sediment by the actions of freezing and thawing, which include such phenomena as ice and frost wedging, frost heaving, cracking, and sorting (Wood and Johnson 1982:562). This can be common in higher regions of Arizona, where seasonally frozen ground occurs.

Cryptocrystalline. Denotes a microscopic size for the crystals that occur within a specific rock type (Jackson 1970).

Crystalturbation. Mixing of soils and sediment by the actions of growing crystals such as calcium carbonate, calcium sulfate, sodium chloride, and silica dioxide. Mixing is caused by the growing and subsequent dissolution of the crystals (Wood and Johnson 1982). In the arid Southwest, the formation of calcium carbonate in older soils is very common (Gile and Grossman 1966) and can lead to the formation of rock-hard soils that totally destroy the primary sedimentary features of the original parent material.

Degradation. Same as erosion, although more suggestive of dissection and downcutting of an alluvial system.

Diorite. An intrusive igneous rock of intermediate composition between granite and gabbro. Has less than 10 percent quartz. This rock is phaneritic and is the coarse-grained equivalent of andesite (Ernst 1969:102). May have a "salt and pepper" appearance in which the white plagioclase crystals and the black pyroxene and/or hornblende crystals are approximately equal in volume. Other diagnostic minerals are potassium feldspar, quartz, biotite, and sodium plagioclase.

Eolian. Denotes wind transport and deposition of sedimentary particles.

Erosion. The process by which material is removed from its place of original deposition.

Gabbro. An intrusive igneous rock of mafic composition, generally dark in color, and containing olivine, hornblende, and pyroxene. This is the coarse grained equivalent of basalt (Ernst 1969:102). Also has less than 10 percent quartz.

Geomorphology. The study of the shape of the earth, landforms and landscapes of the past and present, and the processes by which the modern and ancient landscapes evolved.

Gneiss. A metamorphic rock with zones of light and dark colored minerals creating folded bands termed a banded gneiss (Jackson 1970).

Granite. An intrusive igneous rock of felsic composition, generally light in color, and containing quartz, hornblende, sodium plagioclase, biotite, and potassium feldspar (Ernst 1969:102). Has greater than 10 percent quartz. This rock type is the coarse grained intrusive equivalent of rhyolite.

Gravel. A distinct grain size in rocks or in unconsolidated sediments. This size includes all grain sizes greater than 2.0 mm, which includes pebbles (2-64 mm), cobbles (64-256 mm), and boulders (256-2048 mm) (Fritz and Moore 1988:46).

Graviturbation. The mixing of soils as a result of mass wasting, which does not require the presence of a medium of transport, but rather only requires the force of gravity (Wood and Johnson 1982). It includes such slow processes as soil creep, solifluction, and subsidence. Rapid mass wasting would include avalanches, slides, and flows, such as mudflows.

Microcrystalline. Microscopic crystals that have grown within an igneous or metamorphic rock (Jackson 1970).

Mudstone. Clastic sedimentary rock composed of both silt and clay-sized fraction, generally massive with a weak, conchoidal fracture (Fritz and Moore 1988: 48).

Obsidian. Extrusive igneous rock with little or no crystal formation, making the material very homogenous with respect to texture. Generally black, glassy material with excellent conchoidal fracture. May also be red, gray, or brown and have a lustrous to matted appearance. Also is generally translucent to transparent in light (Jackson 1970).

Orthoquartzite. A sedimentary quartz sandstone that has undergone cementation by influx of silica-rich solution, which has further cemented the grains. Such a process can create a rock with a weak conchoidal fracture. Generally not as hard or durable as true quartzite (Jackson 1970).

Paleosol. An old soil that represents a previous period of land surface stability. May be buried or exhumed and often can be associated with cultural material.

Pedology. The study of soils, their genesis, processes of formation, and environmental and agricultural importance.

Pedoturbation. The mixing of soils by various processes as enumerated in the text.

Phaneritic. Igneous texture in which individual crystals are visible to the naked eye (Jackson 1970).

Phenocrysts. Crystals that have grown within an igneous rock. Can be visible.

Porphyritic. Igneous texture in which two crystal sizes are present that are visible to the naked eye (Jackson 1970).

Quartzite. Metamorphosed quartz sandstone in which all grains are fused and sutured so that breakage occurs through the grains, rather than around them, which is the case for sandstone. This is a very hard and durable material that generally has a good conchoidal fracture (Jackson 1970).

Rhyolite. Intrusive igneous rock with is generally fined grained (microcrystalline) but may also be composed of two or more distinct grain sizes. Generally light in color, but may also be dark gray to black. Mineral associations may include quartz, muscovite, hornblende, potassium feldspar, and biotite. This rock is the extrusive equivalent of granite (Ernst 1969:102).

Sandstone. Clastic sedimentary rock composed of sand-sized grains (.06-2 mm) that are generally quartz, but may include other rock fragments (Fritz and Moore 1988: 46). Sand grains are visible and feel like sandpaper to the touch.

Schist. Metamorphic rock with characteristic foliations and micaceous mineralogy (Jackson 1970).

Sedimentary structures. Sedimentary structure that reflects the original depositional processes such as cross-bedding, ripples, and graded bedding. Such structures will be preserved in sediments that have not been modified by pedogenic processes (Fritz and Moore 1988).

Sedimentation. Deposition of sedimentary material by any one of many processes such as alluviation, eolian deposition, and infilling of lakes.

Seismiturbation. The mixing of soils and sediments by tectonic activity (Wood and Johnson 1982).

Shale. Clastic sedimentary rock composed of silt- and clay-sized grains that tend to fracture along bedding planes (Jackson 1970).

Siltstone. Clastic sedimentary rock composed of silt-sized grains (0.004-0.06 mm) that are not visible to the naked eye (Fritz and Moore 1988: 46). In the teeth, silt feels gritty, whereas clay is smooth. The rock is generally massive. If there is good cleavage along bedding planes, then the rock should be called a shale.

Site Formation Processes. The cultural and natural processes that have affected archaeological sites and have caused their present properties and characteristics (Schiffer 1987).

APPENDIX A
SELECTED LIST OF POTENTIAL NATIONAL REGISTER PROPERTIES

Mark C. Slaughter

One goal of this project is to identify ten "lithic" properties that should be given the highest priority for nomination to the National Register of Historic Places. National Register nomination of these sites would offer them a degree of protection, and it would affirm the importance of lithic sites. Two problems were encountered during this selection process: (1) lithic sites are often not preserved (avoidance recommended) for future study as frequently as other property types, such as prehistoric aggregated villages (structural remains), and (2) there are numerous sites that are potentially eligible for inclusion to the National Register. Although these two problems seemingly counter each other, they are imposing in the selection of eligible properties; for example, recent work and subsequent publications concerning aceramic sites are often the result of archaeological projects that are evaluating sites soon to be impacted by development of an area, and thus, these sites are not eligible, for inclusion to the National Register. The second problem is self explanatory in that many sites are potentially eligible, and to choose one site over another is a subjective process.

National Register standards, the fulfillment of either one or more of criteria A, B, C, and D, and that the property must have significance and integrity (cf. National Park Service 1982, 1986) were used for the selection of lithic properties for possible inclusion to the National Register of Historic Places. But, since this is a subjective selection of a few sites, other criteria and ranking were considered. The following table includes lithic sites selected on the basis of their past contribution to the field of archaeology and their potential for extending our knowledge of distinct geographical regions (e.g., chronology and functional differentiation).

	Site # / Name	Ownership / Managership	Primary References
1)	Murray Springs	BLM, Safford	Haynes 1974, 1976, 1978, 1979, 1980a, 1981; Haynes and Hemmings 1968
2)	Cienega Creek, AZ W:10:112 (ASM)	San Carlos Indian Reservation	Damon and Long 1962; Haury 1957; Crane and Griffin 1958
3)	JUA 80-50	Hopi Tribe	Marmaduke and Dechambre 1980
4)	Government Mountain[1]	Forest Service, Kaibab	Shackley 1988; Jennings 1971; Jack 1971
5)	Sitgreaves Mountain[1]	Forest Service, Kaibab	Shackley 1988; Jack 1971
6)	Groundstone Quarries near Bullhead City[2], AZ F:14:123 (ASM)	BLM, Kingman	Huckell 1986
7)	AZ H:9:13 (ASM), NA 20662	State of Arizona	Dan Landis (Soil Systems, Inc., Phoenix), personal communication 1991
8)	AZ EE:3:6 (ASM)	Forest Service, Coronado	Whalen 1971

9)	AZ D:7:2085 (ASM)	Navajo Tribe	Burgett et al 1985; Olszewski et al 1984
10)	Alamo Lake Sites[3]	State of Arizona, Corps of Engineers, Los Angles	Jones et al 1990; Gregory 1988; Stone 1977; Euler 1958

[1] These locations with the additions of RS Hill, Kendrick Peak, Slate Mountain, Fremont-Agassiz Saddle, and O'Leary Peak/Robinson Crater could be potentially eligible for inclusion to the National Historic Register of Historic Places as a district or multiple listing (see Shackley 1988:754-757 for additional data and locations on these localities).

[2] There are many more of the macroflake loci scattered in the Black Mountain Range, and only ten locus where chosen in the pioneering study by Huckell (1986). Although much of the property that comprises this site is privately owned, the State of Arizona manages several sections within the boundaries of this enormous site. Additionally, several of the loci are within an environmental resource nomination plan (ECEC) by the Bureau of Land Management (Pat Green, personal communication 1991).

[3] This general area contains a great diversity and quantity of lithic sites (>30), from rock shelters to lithic-procurement sites. As a whole, sites within and around this general area could be potentially eligible for inclusion to the National Historic Register of Historic Places as a district or multiple property listing (see Jones et al. 1990 for site-specific information).

APPENDIX B
ANNOTATED BIBLIOGRAPHY

Adams, Jenny L.
1979 Stone Implements, Miscellaneous Ground Stone, Miscellaneous Stone Artifacts, and Natural Objects. In Stone Artifacts from Walpi, pp. 1-220. Walpi Archaeological Project Phase II, Vol. 4, Part 1. Submitted to Heritage Conservation and Recreation Service, Interagency Archaeological Services, San Francisco. Museum of Northern Arizona, Flagstaff.

The Walpi assemblage dates from about A.D. 1640 to 1975, and this report is the most extensive and detailed study of a ground stone assemblage dating from the Contact and Historic periods written to date. The Walpi project presented a unique opportunity to apply ethnographic information to the interpretation of ground stone artifact use. This information changed some of Adams's preconceptions of ground stone artifact use and led to her studies of microscopic use-wear.

Adams, Jenny L.
1988 Use-wear Analyses on Manos and Hide-processing Stones. Journal of Field Archaeology 15:307-315.

Pioneering study in which Adams used replication experiments to study patterns of microscopic use-wear on sandstone implements used to grind corn and to rub hides. Adams found distinctive patterns of wear associated with the processing the two substances.

Adams, Jenny L.
1989 Methods for Improving Ground Stone Artifact Analysis: Experiments in Mano Wear Patterns. In Experiments in Lithic Technology, edited by Daniel S. Amick and Raymond P. Mauldin. BAR International Series No. 528. Oxford.

Details results of replication experiments designed by Adams and Fratt to simulate the wear associated with using sandstone implements to process a variety of different materials. Most distinctive wear patterns are those associated with stone-on-stone grinding, such as corn grinding, and those associated with processing more resilient material, such as wood, using only a single stone. These different wear patterns are described and illustrated by photomicrographs.

Bartlett, Katherine
1933 Pueblo Milling Stones of the Flagstaff Region and their Relation to Others in the Southwest. Museum of Northern Arizona Bulletin 3. Northern Arizona Society of Science and Art, Flagstaff.

Includes the most detailed and comprehensive discussion of corn-grinding techniques that Bartlett observed and their morphological characteristics on manos and metates. Also includes some initial temporal information on changes in Anasazi milling stones as a result of artifacts recovered from excavation. Her discussion of grinding methods initiated the debate about the nature of the variety of mano transverse cross sections that characterize assemblages recovered from the Pueblo II period and later.

Bostwick, Todd W.
1988 Projectile Point Analysis. In An Investigation of Archaic Subsistence and Settlement in the Harquahala Valley, Maricopa County, Arizona, assembled by Todd W. Bostwick, pp. 253-293. Submitted to the United States Bureau of Reclamation, Arizona Projects Office, Contract No. 3-PA-30-00740. Northland Research, Flagstaff.

This work encompasses the inadequately studied areas in western Arizona. It is a good companion volume to the earlier Granite Reef Project, and inferences concerning subsistence, settlement, and mobility are made. This work also illustrates the distances that mobil groups traveled in order to procure raw materials.

Broms, R. S. D., and James R. Moriarty
1967 The Antiquity and Inferred Use of Stone Spheroids in Southwestern Archaeology. The Masterkey 41(3):98-112.

Excellent example of using ethnographic and ethnohistoric information to create a typology of stone spheroids based on differences in size and to assign possible uses to these categories. Represents a morphologically based approach to inferring use of prehistoric artifacts in contrast to the experimental approach used by Adams.

Butzer, Karl W.
1982 Archaeology as Human Ecology. Cambridge University Press, Cambridge.

This text presents a fairly comprehensive overview of geoarchaeological problems and a method of inquiry for understanding them. The separation of archaeological sites into three levels (artifact, site, and region) proves to be a useful subdivision for detailed landscape investigations into archaeological problems.

Callahan, Erett
1979 The Basis of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flintknappers. Archaeology of Eastern North America 7:1-180.

This is the standard reference for understanding bifacial knapping. Many drawings illustrate the products that are produced during biface manufacture.

Christenson, Andrew L.
1987 Projectile Points: Eight Millennia of Projectile Change on the Colorado Plateau. In Prehistoric Stone Technology on Northern Black Mesa, Arizona, by William J. Parry and Andrew L. Christenson, pp. 143-198. Center for Archaeological Investigations Occasional Paper 12. Southern Illinois University, Carbondale.

One of the recent works on change and variation in projectile points. The focus of this work is Black Mesa, on the Colorado Plateau of Arizona. The discussion and subsequent photographs illustrate the variation and multiple use of projectile points.

Crabtree, Don E.
1972 An Introduction to Flintworking. Occasional Papers of the Idaho State University Museum No. 28. Pocatello.

The standard reference for all lithic analysts. This work illustrates the different reduction techniques, technologies, and tools used for flint knapping. Many drawings help the reader to recognize the different attributes of flakes and tools.

Formby, Don E.
1986 Pinto-Gypsum Complex Projectile Points from Arizona and New Mexico. The Kiva 51(2):99-127.

This work demonstrates the importance of past collectors publishing their data. Here Formby illustrates the many styles (called sub-types) of pinto points. With more publications or information from collectors our picture of point variation and styles could be changed.

Fratt, Lee
1991 Ground Stone. In Homol'ovi II: Archaeology of an Ancestral Hopi Village, Arizona, edited by E. Charles Adams and Kelley A. Hays, pp. 57-74. Anthropological Papers of the University of Arizona No. 55. University of Arizona Press, Tucson, in press.

Study of ground stone artifacts recovered from test excavations at Homol'ovi II that applies information obtained from replication experiments about distinctive patterns of microscopic use-wear to the analysis of a prehistoric ground stone assemblage. The technique proved very useful and revealed some discrepancies in morphological characteristics and use that sound a cautionary note for analyses that are based solely on morphology. However, Fratt found that Adams's use-wear categories had to be modified somewhat due to differences in granularity, raw materials, and the effect of post-depositional processes on the prehistoric artifacts.

Green, Margerie
1982 Chipped Stone Raw Materials and the Study of Interaction. Unpublished Ph.D. dissertation, Department of Anthropology, Arizona State University, Tempe.

This dissertation demonstrates the change in material acquisition on Black Mesa. This work uses cluster and factor analysis to infer trade and exchange of raw materials through time. Variation in later times (pueblo) is indicated, rather than the almost sole dependence on white-baked siltstone during the Basketmaker II period.

Green, Margerie
1985 Chipped Stone Raw Materials and the Study of Interaction on Black Mesa, Arizona. Center for Archaeological Investigations Occasional Paper 11. Southern Illinois University, Carbondale.

This comprehensive study contains maps of lithic quarries in the Black Mesa region and provides information about lithic resources outside of the region. The focus of the study is to evaluate the authors theory that lithic artifacts, perhaps more so than ceramics, can be used to evaluate the interaction of prehistoric groups with their environment and with other groups, both near and distant.

Haury, Emil W.
1975 The Stratigraphy and Archaeology of Ventana Cave. Originally published 1950. University of Arizona Press, Tucson.

A summary of the information from a stratified site in south central Arizona. The chronology from Ventana Cave is inferred to reach into the Paleo-Indian period and was used until recently. This work is a standard for the scholar who is examining material culture, temporal change, and data recovery from the man who pioneered southern Arizona archaeology.

Haury, Emil W.
1976 The Hohokam, Desert Farmers and Craftsmen: Excavations at Snaketown, 1964-1965. University of Arizona Press, Tucson.

Along with Sayles (1937), probably the most comprehensive study of Hohokam ground stone artifacts. Some details, such as artifact measurements, are omitted for some artifact types. Includes Haury's thoughts on Mesoamerican influences.

Hoffman, Teresa L., and David E. Doyel
1985 Ground Stone Tool Production in the New River Basin. In Hohokam Settlement and Economic Systems in the Central New River Drainage, Arizona, Vol. 2, edited by David E. Doyel and Mark D. Elson, pp. 521-564. Soil Systems Publications in Archaeology No. 4. Phoenix.

One of the two most extensive studies to date on ground stone quarries. Presents a detailed discussion of apparent reduction methods used to produce mano and metate blanks from the various andesite outcrops in the New River Basin. Also discusses the quarry sites in relation to regional Hohokam settlement and economics. Andesite from this area appears to have been used for some of the ground stone implements found at the site of Los Colinas in Phoenix, although the sourcing study has come under fire.

Huckell, Bruce B.
1982 The Distribution of Fluted Points in Arizona: A Review and Update. Arizona State Museum Archaeological Series No. 145. University of Arizona, Tucson.

This reexamination of the dispersion of fluted points, however descriptive, illustrates the lack of fluted points through most of the state. This manuscript, by use of maps, allows the reader to see the distribution of in situ fluted point deposits as well as isolated artifacts from Arizona. This is also a dated work and more materials have been identified, but the overall pattern that is present in Arizona remains, as of yet, unchanged.

Huckell, Bruce B.
1984 The Archaic Occupation of the Rosemont Area, Northern Santa Rita Mountains, Southeastern Arizona. Arizona State Museum Archaeological Series No. 147(1). University of Arizona, Tucson.

The Rosemont Area is the focus of the work, but the real importance is Huckell's examination and proposed reevaluation of the Archaic. Here he examines the regional concepts of the Archaic and convinces the reader that some real problems are encountered with the previous definitions of the Archaic. He proposes that the Archaic be broken into three different temporal categories, the Early Archaic, Middle Archaic, and Late Archaic.

Huckell, Bruce B.

1986 A Ground Stone Implement Quarry on the Lower Colorado River, Northwestern Arizona. United States Bureau of Land Management Cultural Resource Series No. 3. Phoenix.

Excellent, detailed study of ground stone quarry sites in western Arizona near Bullhead City. This study provides good descriptions enhanced by excellent illustrations of the reductive techniques used to manufacture metate blanks from the local andesite outcrops. Huckell also incorporates information from ethnographic accounts and interviews that supplement the information about ground stone implement production, use, exchange, and discard provided by the quarry assemblages.

Lesko, Lawrence

1989 A Reexamination Of Northern Arizona Obsidians. The Kiva 54:385-400.

This examination of obsidians presents a needed method for the macroscopic identification of obsidian types from several different locales in Northern Arizona.

Parry, William J., and Robert L. Kelly

1987 Expedient Core Technology and Sedentism. In The Organization of Core Technology, edited by Jay K. Johnson and Carol A. Marrow, pp. 285-304. Westview Special Studies in Archaeological Research, Westview Press, Boulder.

This brief chapter perhaps sums up the flaked stone manufacturing changes that occurred in the shift from the Archaic to the Ceramic Period cultures better than any other work. Here the authors show the change, from a couple of different areas in the Southwest, in the reductive technique used and quantity of formal tools associated with later cultures in contrast with earlier periods.

Sayles, E. B.

1937 Stone Implements and Bowls. In Excavations at Snaketown: Material Culture, by Harold S. Gladwin, Emil W. Haury, E. B. Sayles, and Nora Gladwin, pp. 101-134. Medallion Papers No. 25. Gila Pueblo, Globe, Az.

Along with Haury (1976), the most comprehensive report on Hohokam ground stone artifacts and a limited report on the flaked stone materials. Especially useful for the many charts illustrating morphological changes in major artifact groups.

Sayles, E. B.

1941 Archaeology of the Cochise Culture. In The Cochise Culture, by E.B. Sayles and Ernst Antevs. Medallion Papers No. 29. Pp. 1-30. Gila Pueblo, Globe.

Whether or not you buy into the phase sequences for the Archaic Period in southern Arizona, this source provides the most detailed information and illustrations of ground stone assemblages from this period. Illustrations show morphological changes in major artifact groups.

Schiffer, Michael B.
1987 Formation Processes of the Archaeological Record. University of New Mexico Press, Albuquerque.

This text presents a comprehensive evaluation of formation processes and how they effect site integrity and preservation. Both natural and cultural impacts are discussed as they relate to the transformation of sites from their original form.

Shackley, Steve
1988 Sources of Archaeological Obsidian in the Southwest: An Archaeological, Petrological, and Geochemical Study. American Antiquity 53:752-772.

This study contains a map of the Southwest with all known lithic obsidian sources located. Macroscopic, microscopic, and XRF descriptions are presented and discussed in detail.

Stone, Connie
1986 Deceptive Desolation: Prehistory of the Sonoran Desert in West Central Arizona. United States Bureau of Land Management Cultural Resource Series No. 1. Phoenix.

This portion of the state is discussed in general terms and with an overview of all resources. Although maps of lithic resources are not included, physiographic features and the resources found therein are discussed. An excellent discussion of site types found in the western parts of Arizona--through all periods. A standard reference for research within this area.

Sullivan, Alan P., III, and Kenneth C. Rozen
1985 Debitage Analysis and Archaeological Interpretation. American Antiquity 50:755-799.

This study contributes to the interpretation of debitage patterning. One of the contributions of this work is the quantifiable analysis method that is proposed. The debitage analysis method is noted both for its ease of use (introductory levels) and flexibility.

Wallace, Henry, and James P. Holmlund
1983 Mortars and Cupules. In "The Mortars, Petroglyphs, and Trincheras on Rillito Peak," by Henry Wallace. The Kiva 48(3):143-182.

Most detailed study of bedrock grinding features produced to date. Provides a start at distinguishing different kinds of mortars and other bedrock features based on size, location, and associated cultural and natural environment. Especially valuable for the discussion of measurement techniques.

Wheat, Joe Ben
1955 Mogollon Culture Prior to A.D. 1000. American Anthropologist Memoir No. 82.

Most comprehensive source of information on Mogollon ground stone assemblages, but illustrations and descriptions are basically unsatisfactory.

Wildesen, Leslie E.

1982 The Study of Impacts on Archaeological Sites. In Advances in Archaeological Method and Theory, Vol. 5, edited by Michael B. Schiffer, pp. 51-96. Academic Press, New York.

This paper presents several aspects of the impacts to sites. Historical studies, previous methods of evaluation, and case studies are presented.

Wood, W. Raymond, and Donald Lee Johnson

1982 A Survey of Disturbance Processes in Archaeological Site Formation. In Advances in Archaeological Method and Theory, Vol. 1, edited by Michael B. Schiffer, pp. 315-381. Academic Press, New York.

The complexities of soil-forming processes are given new light as they affect the preservation and destruction of archaeological sites. The many manifestations of pedoturbation and bioturbation are detailed.

Woodbury, Richard B.

1954 Prehistoric Stone Implements of Northeastern Arizona. Papers of the Peabody Museum of American Archaeology and Ethnology Vol. 24. Cambridge.

Probably the most useful source for flaked and ground stone artifacts recovered from prehistoric Southwestern sites, remarkable for both the descriptions of the ground stone assemblages recovered from Awatovi and other sites on Antelope Mesa and for the syntheses of major technological changes in Hohokam and Mogollon as well as Anasazi assemblages. Although some of the information presented is somewhat dated and interpretations are relatively lean, this is an absolutely essential source for analyzing ground stone assemblages.

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1955 Geologic-climatic Dating in the West. American Antiquity 20:317-335.

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1984 The Galaz Ruin: A Prehistoric Mimbres Village in Southwestern New Mexico. University of New Mexico Press, Albuquerque.

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1989 Arizona Road Map. Arizona Highways Magazine, Arizona Department of Transportation, Phoenix.

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1986 The Experimental Reproduction and Archaeological Occurrence of Biface Notching Flakes. Lithic Technology 15:96-100.

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1986 Technological Efficiency and Tool Curation. American Antiquity 51:38-50.

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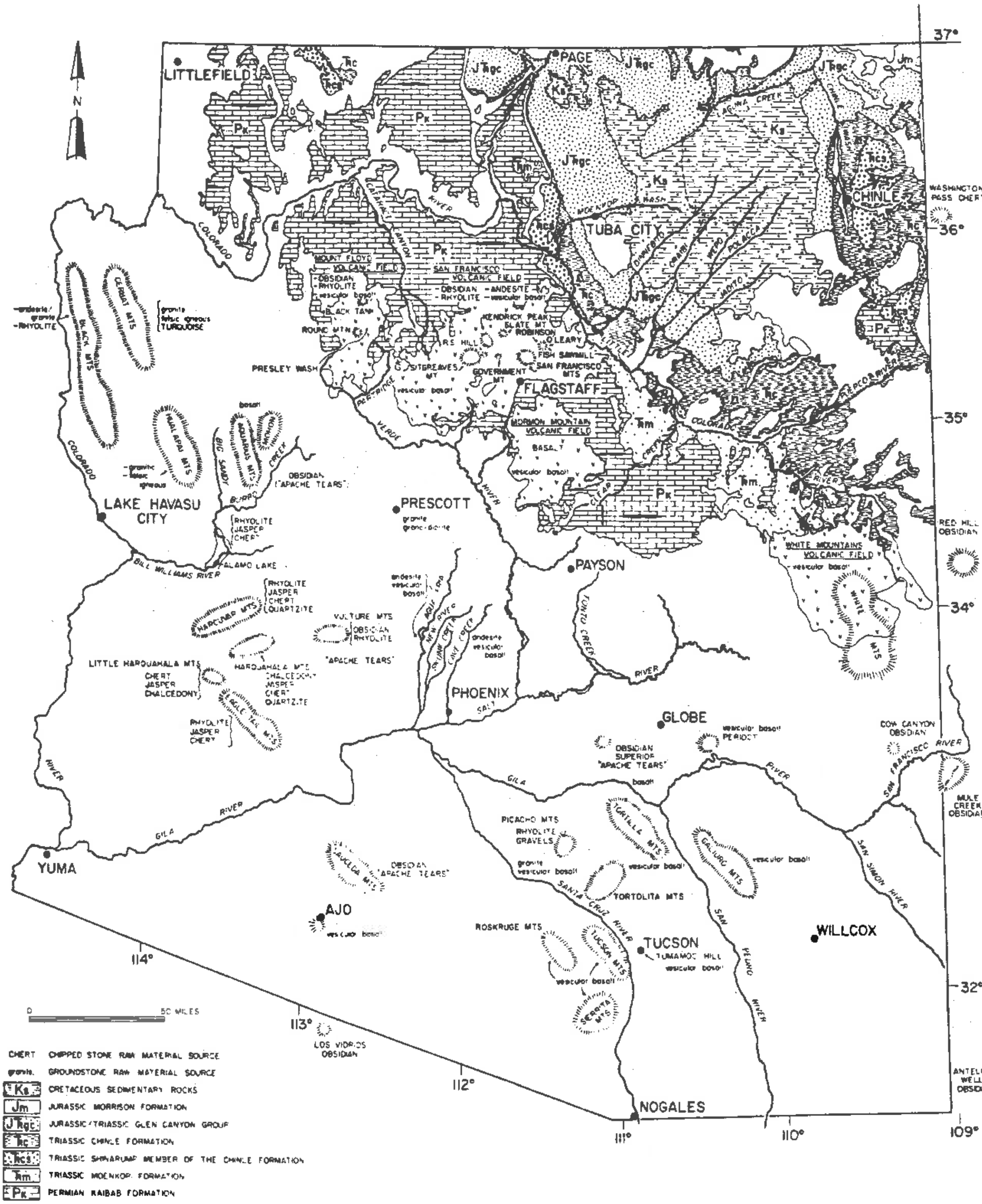
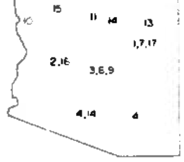


SELECTED LOCATIONS OF MAJOR LITHIC SOURCES IN ARIZONA

1 BERRY, CLAUDIA (1984)
2 BROWN AND STONE (1982)
3 BRUDER, SIMON (1983)
4 CALLAHAN, MARTHA (1988)
5 COOLEY MAURICE (1969)
6 DOYEL AND ELSON (1985)
7 DOSH, STEVE (1988)
8 GREEN, MARGERIE (1985)
9 GREEN, MARGERIE (1989)
10 MUCKELL, BRUCE (1988)
11 LESKO LAWRENCE (1989)
12 PARRY AND CHRISTENSON (1987)
13 REYNOLDS (1988)
14 SHACKLEY, STEVE (1985)
15 STONE, CONNIE (1987)
16 STONE, CONNIE (1986)
17 WESTFALL, DEBORAH (1986)
18 WESTFALL, DEBORAH (1987)



SWCA

K. ANDERSON
L. SHIFRIN

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