The Rye Creek Project: Archaeology in the Upper Tonto Basin

Volume 2: Artifact and Specific Analyses

Mark D. Elson
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Contributions by

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CHAPTER 11

THE INTERPRETATION OF ARCHAEOLOGICAL CONTEXT: THE ROLE OF FORMATION PROCESS STUDIES IN PREHISTORIC RESEARCH

Henry D. Wallace, Douglas B. Craig, Mark D. Elson, Miriam T. Stark, and James M. Heidke

Each archaeological site is the unique end-product of a series of processes that serve to remove or alter the excavated archaeological context (i.e., what the archaeologist finds) from its original systemic context (i.e., what was prehistorically deposited). These have been labeled formation processes by Schiffer (1972, 1976, 1987), although they have been recognized as potentially affecting archaeological deposits since the earliest days of the discipline. Both cultural and noncultural factors can alter archaeological deposits, and many of these have been identified and described in the archaeological and ethnoarchaeological literature (e.g., Binford 1978; Deal 1985; DeBoer 1983; Hammond et. al 1991; J. Hayden 1957; Hayden and Cannon 1984; Kramer 1985; Schiffer 1987; Sullivan 1978; Wood and Johnson 1978). For example, processes such as prehistoric scavenging, modern pothunting, animal and insect burrowing, prehistoric and modern construction activities, agricultural plowing, animal grazing, root disturbance, frost heaving, floodwater deposition, and even previous archaeological excavations, to name but a few, could all be included as potentially affecting archaeological deposits -- each of these serve to distance the excavated archaeological context from its original systemic depositional context. Furthermore, there is little disagreement among archaeologists that every site, no matter how pristine appearing, is influenced in some manner. As a result, one of the primary goals of archaeological research is to determine what prehistoric contexts have been altered, how and to what extent they have been affected, and the ways in which the prehistoric systemic context differs from (and has been transformed into) what is uncovered archaeologically.

There are numerous ways to operationalize this goal, some of which have been proposed in the archaeological literature (e.g., Bocek 1986; Hammond et al. 1991; Hull 1987; Johnson 1989; Lightfoot 1984; Odell and Cowan 1987; Schiffer 1987). The work of Wilk and Kosakowsky (1979; Wilk et al. 1980; Hammond et al. 1991) in the Mayan area, and to a certain extent Lightfoot (1984) in the Mogollon area, in particular, address a broad range of formation process issues, similar in some ways to what is proposed here. In general, however, most formation process studies are narrowly focused upon the effects of a specific formation process, such as rodent activity or agricultural plowing, and fail to broadly inform upon the deposit as a whole. Furthermore, although they allow for at least a partial reconstruction of the original systemic context through a more thorough understanding of the nature of the formation process(es) involved, these studies are often relatively time consuming, expensive to undertake, and can necessitate highly sophisticated and specialized analyses, often out of the reach of most archaeologists.

From a strictly analytical viewpoint, however, particularly when selecting samples for further excavation or analysis, the exact formation processes in operation may not always be overly important. From this perspective what is important is not so much the specifics of the particular formation processes that have altered a deposit, but that the deposit has been *transformed* in some manner. Once a deposit has been identified as having relatively little postdepositional alteration, a high degree of confidence can be placed in the interpretations of that deposit. Therefore, one of the goals of the Rye Creek analysis was to identify unmixed deposits that were temporally and behaviorally discrete. The identification of these deposits using the methods outlined below was a key factor in the selection of contexts and artifacts for more intensive analyses.

Ideally, the methods outlined here could be used to structure the in-field excavation strategy as well as the postfield analyses (see Doelle et al. 1991; Wallace and Heidke 1991). In this manner, depending on the nature of the site and the specific research questions, field strategies could be adjusted to ensure that the greatest levels of effort were placed on contexts that had the potential to offer the greatest return. On the Rye Creek Project, however, the analyses all occurred in a *post hoc* manner after the completion of the fieldwork and were used primarily for sample selection. This was due to the fact that the methods discussed here were still in the developmental stage during the Rye Creek fieldwork.

The discussion that follows is intended to provide background information on this approach. We begin with a brief summary of the types of refuse deposits that are typically encountered on archaeological sites. We then turn to a consideration of the approach as it has been developed for dealing with the most common class of artifacts, ceramics. These studies were instrumental in the selection of archaeological contexts for more intensive analyses. A similar analysis using the chipped stone data is presented by Craig in Chapter 14 of this volume. Although the focus of attention here is on how depositional variability is reflected in artifact variability, it should be kept in mind that these were not the only sources of information that were used to assess context during the Rye Creek Project. Other sources of information include field records and observations, knowledge of local environmental conditions, and knowledge gained from the study of other artifact classes.

It is believed that the consideration of these lines of evidence, along with the analytical methods proposed here, have allowed for the sample selection of artifacts for analysis that have high contextual integrity and interpretative value. Work on this research issue is still ongoing, and in fact much of what we propose here must be considered to be largely hypothetical and of an experimental nature. Furthermore, we realize that assumptions have been made, some of which we do not have the data to currently support. We expect that the methods and our interpretations will continue to be refined as more data are recovered.

TERMINOLOGY

The terminology adopted in this study is drawn largely from the field of behavioral archaeology. Schiffer (1987) provides a cogent summary in this regard. He identifies five general categories of cultural deposition processes: discard, loss, ritual caches, treatment of the dead, and abandonment. Of particular concern to us here are two of these processes, discard and abandonment, as the vast majority of the material culture examined by the archaeologist falls under these headings.

Discard Processes

Discard processes are operative during the cultural occupation of a site. Schiffer (1972:161, 1987:58-59) splits discarded material culture into two basic categories: primary and secondary refuse. Artifacts discarded at the location of use are considered *primary refuse*; artifacts discarded away from the area of use are considered *secondary refuse*. Archaeologists are typically concerned with the identification of both types of refuse, although the vast majority of material culture recovered in archaeological excavations was originally deposited in trash areas as secondary refuse. This is especially true for artifact classes such as ceramics that tend to have short use-lives, relatively rapid replacement rates, and relatively minimal reuse potential.

Abandonment Processes

Abandonment processes may produce primary and secondary refuse, but for most artifact classes all that can usually be recognized is *de facto refuse*. De facto refuse typically consists of artifacts left on living surfaces at the time of abandonment. Such assemblages may represent the complete inventory of artifacts in systemic use in cases of catastrophic abandonment, or, more commonly, assemblages that have been depleted in various ways, such as through later scavenging or the removal of material during the planned abandonment of a structure. On rare occasions, abandonment-stage primary or secondary refuse may also be present (although probably not overly recognizable), such as trash left in a house in anticipation of abandonment. Reoccupation or reuse of living surfaces may further cloud the issue by adding additional primary and de facto refuse. In other instances, artifacts that appear to be de facto refuse, because they represent whole or usable items on living surfaces, may actually represent what has been labeled "provisional discard" (Deal 1985; Hayden and Cannon 1983:131), that is, refuse that is retained for potential future use. In most cases, provisionally discarded artifacts will be difficult to distinguish from artifacts that remain from culturally depleted assemblages as both categories of artifacts have many of the same expected characteristics (e.g., broken or well-worn artifacts).

Transformations

Once an artifact is discarded as primary, secondary, or de facto refuse, various processes may disturb or *transform* the deposit. Transformations are critical to our understanding of archaeological deposits, since it is these processes that serve to remove material from the original systemic depositional context to the excavated archaeological context. These transformations may occur while the site is still in use or after its abandonment. Refuse that has been seriously churned or selectively depleted such that the deposit can no longer be treated as the product of a single behavioral event or a temporally limited series of behavioral processes is labeled here as *transformed refuse*. From a strict standpoint, all refuse undergoes some degree of transformation and mixing. In and of itself, this is no "big deal." Where it does become a big deal, though, is when a certain transformation "threshold" is crossed and the integrity of the deposits become seriously compromised. Some types of analyses may require more stringent controls over depositional mixing than others, just as the importance of these factors will depend to a large degree on the research questions being asked of the deposit. For example, a research question interested in long-term temporal trends in a particular artifact class that changed very slowly over time will be less worried about identifying a deposit with 50 years of mixed accumulated secondary refuse than will a research question that calls for the identification of the least mixed contexts for the temporal control of a ceramic microseriation. As stated earlier, our concern here is not so much with the specific processes that might have transformed the deposit (cf. Schiffer 1987; Wood and Johnson 1978), but with whether or not the deposit has been transformed beyond a certain critical point.

In practical terms, the archaeologist will often be able to identify transformed refuse in the field due to the relatively dramatic *traces* that are often present (after Sullivan 1978:194). The term traces is used here in its broadest sense to refer to "any perceptible consequence of an activity or process" (Schiffer 1987:15). For example, redeposited secondary refuse may be discernible from undisturbed secondary refuse due to a lack of clear stratigraphy or reverse stratigraphy. Pithouses or pits that are intentionally filled with refuse so that later occupation surfaces can be built atop them are another example. Oftentimes the transformations are not so obvious and we must turn to specific analyses, such as those discussed below, to assess the integrity of particular deposits. The identification of refuse deposits that have undergone minimal transformation (that is, deposits with a high level of depositional integrity) was a principal goal of the Rye Creek analysis sample selection process.

ANALYTICAL STRATEGIES

Our approach to formation processes takes as its minimal analytical unit the fill deposits associated with an individual feature. In most instances these deposits represent *naturally defined* strata, although in some instances we have further subdivided them into arbitrary levels for analytical purposes. Most notably in this regard, we have chosen to keep artifacts from the last 5 cm of fill above the floor of a structure (Stratum 19) separate from other fill artifacts (Strata 10 and 11); however, we make no assumptions about the association between these "lower fill" artifacts and those artifacts in direct contact with the floor (Stratum 20), a relatively common practice in Southwest archaeology (e.g., Rice 1987) (see Elson, Chapter 5, Volume 1, for a discussion of strata designations). Nor do we assume that all deposits at a site can be treated uniformly, or that all classes of artifacts from within a given deposit have been subjected to the same formation processes (cf. Reid and Montgomery 1990; Sullivan 1978). From our perspective, these issues are matters of empirical concern that need to be evaluated during the course of analysis.

In the discussion that follows, we review the specifics of the approach as it has been applied to the study of ceramic artifacts. As mentioned, a similar approach using the chipped stone data is discussed by Craig in Chapter 14 of this volume. Although other artifact classes, such as ground stone (see Craig and Eppley, Chapter 15, this volume), and faunal and molluscan remains (Wilk et al. 1980), can also be used to study formation processes, for the Rye Creek sites ceramics and chipped stone have the advantage of ubiquity; therefore, attention was focused on them. The ceramic assemblage was analyzed in the most detail since the methods used for the chipped stone assemblage were in a very rough formative stage during much of the analysis phase and in fact were developed specifically for this project. This brings us to an important point, however. Although the interpretation of the archaeological contexts presented here is based most strongly on the ceramic analyses, our approach to formation processes is not so much a single analytical technique as it is a set of related techniques. The goal is not to derive a single, absolute measure of "depositional integrity," but, rather, to be able to characterize different aspects of a feature's depositional history. Based on this information, in conjunction with the research questions being addressed, an informed decision can then be made about the suitability of the feature and the artifacts from that feature for further analysis.

Studying Ceramic Formation Processes

The Rye Creek Project sites posed a particularly difficult problem for the ceramic analysts. The sites contained relatively low frequencies of decorated ceramics (approximately 2.5 percent of the total assemblage), with the majority of sherds and vessels coming from very few of the excavated contexts. This meant that only minimal temporal control was available. Adding to the difficulties were what appeared to be associations of particular ceramic types not previously thought to co-occur. The apparent association of Gila Butte Red-on-buff with Kana-a Black-on-white at the Deer Creek site was one such case that had important implications for dating the Gila Butte phase and for the site in question (see Clark, Chapter 12, Volume 2 and Wallace, Chapter 24, Volume 3). In many cases, tree-ring-dated ceramic types were present that had overlapping known temporal ranges. A traditional analysis might have taken these cases, identified the point of overlap and assigned this overlap range to the context or site in general. Based on our previous experience in the Tucson Basin, however, this strategy was rejected because it does not consider site longevity, the potential for sequential reoccupation, and other sources of potential disturbances to the contexts involved. Were cultural and noncultural formation processes distorting these distributions or were the associations valid? Measures of contextual integrity that did not rely upon high frequencies of decorated ceramics and were independent of decorated ceramic studies were required to evaluate these cases. Several measures have been developed and applied in previous studies (Cable 1989; Lightfoot 1984; Heidke 1989a, 1989b, 1990, 1991; Wallace 1985, 1986a, 1986c; Wilk and Kosakowsky 1979; Wilk et. al 1980), but they have only received limited statistical evaluation. Part of the reason for this in previous studies by Heidke and Wallace has been the prevalence of decorated sherds that lend themselves admirably to contextual interpretations due to the temporal data they encode. The motivation to develop a more rigorous statistical approach evolved during the early stages of the Rye Creek Project when it was realized that the frequencies of decorated wares were dismally low and more intensive studies of the plainware would be required. An analysis that could use the plainware and redware from the sites was required not only for helping to date particular contexts and conducting the ceramic analysis, but also for developing models of site depositional histories. Though perhaps not immediately apparent given the preceding comments, dating many of the contexts with very low decorated frequencies became a realistic goal through the identification of contexts where even one or two decorated sherds could be said (with a relatively high degree of confidence) to be in association with a particular feature or deposit. Conversely, it was critical to determine whether one or two decorated temporally significant sherds should *not* be used for dating a context.

Ceramic density, sherd size, and sherd abrasion are all formation process traces that can help in assessing the depositional history of particular deposits. These measures have proven useful in previous archaeological investigations (Schiffer 1987; Wilk et al. 1980; Wilk and Kosakowsky 1990). In general, our concern for the present study is twofold: 1) to be able to quickly assess the integrity of particular deposits as they relate to specific research questions, and, 2) to be able to identify the most likely type or types of ceramic refuse represented by the deposit.

Our basic approach to ceramic formation processes is structured around the identification of relatively untransformed secondary refuse deposits. Although we also are concerned with intact de facto deposits, in most instances these are fairly easy to identify. The difficulty lies in distinguishing untransformed secondary trash deposits from those that have been moderately or severely transformed through cultural and/or natural processes. From our perspective, untransformed secondary refuse has the potential to address more of the project research issues than mixed or other transformed types of refuse. These research issues include investigations into chronology and other topics that require temporal control such as diachronic trends in ceramic (or other artifact class) exchange, subsistence systems, and paleoenvironmental reconstructions.

Another reason for focusing on untransformed secondary refuse deposits is that they provide a broader cross section of the total assemblage than most de facto assemblages, because de facto assemblages are often subject to depletion from curate behavior and scavenging. Secondary refuse is, however, expected to underrepresent some rare and exotic artifacts that do not commonly get discarded with other trash. An example of this might be ritual items that are only discarded in special places such as within burial pits or sacred sites.

Sherd Size

Aside from temporal data encoded in ceramic form and style of decoration, sherd size has been found to be the single most important archaeological trace in our previous investigations of Hohokam ceramics (Wallace 1986a, 1986c; Heidke 1990, 1991), as well as in other areas (Wilk and Kosakowsky 1979, 1990; Wilk et al. 1980). As pointed out by Schiffer (1987:267-269), there are many formation processes that can affect sherd size, all of which serve to reduce sherd size from the starting point of the whole vessel. Fortunately many of them can be readily controlled for or discounted in assessing particular deposits, thus allowing one to focus on specific processes or sets of processes appropriate to particular settings. Table 11.1 lists some of the more obvious technological, cultural, and environmental processes that can affect sherd size. In general, the technological factors are not a strong concern if the particular class of ceramics being investigated are relatively homogeneous for the attributes in question. Because some of the processes will be cumulative through time, though, deposits of vastly different ages might not be comparable. Although we have not undertaken empirical tests of many of these traits, we do not expect them to be a significant concern on the intrasite level because most of the Rye Creek sites (with the exception of Rye Creek Ruin) are either single component or of relatively short duration, lasting at most several generations. Comparisons drawn between sites must, however, proceed with caution. Moreover, a recent experimental investigation into the effects of trampling on sherds has determined that after the initial breakage event and initial trampling, and despite differences in ceramic hardness (encompassing a range exceeding that commonly thought to be present in the Rye Creek ceramics), the size-class frequency distributions produced were virtually identical (Neilsen 1991). This suggests that time serves more to homogenize assemblages than to introduce variability, and that ceramic breakage patterns, when measured in the manner used in this study, will produce comparable results even when differences in wares are not taken into account.

More important are the environmental and cultural processes that can reduce sherd size. In general, we can reasonably suppose that sherd size will be most heavily tied to specific environmental and cultural influences such as soil pressure, natural and biotic transport processes, trampling, cultural disturbance of deposits, discard behavior, reuse and curate behavior, and other postdepositional conditions such as fluvial transport and erosion. The length of time involved in the formation of a deposit is also a factor here, both in the duration of a particular formation process on a deposit, as well as in the increasing probability that a number of different postdepositional processes will occur. Because sherd size has the potential to inform on these processes, most of which can seriously compromise a deposit's integrity, it is a powerful tool for analysis. It can effectively direct one's attention to the particular formation processes that might be involved, which can then be evaluated using other traces.

When ceramic vessels break, they produce sherds of varying sizes. By looking at the sherds recovered from controlled excavations, percentages of certain size categories can be obtained. For the purposes of this analysis we have made the following assumptions, which we believe to be generally accurate, although admittedly in need of further testing and more detailed analysis. These are based for the most part on archaeological

Table 11.1. Factors influencing sherd size in the archaeological record.*

Technological Factors

Pot manufacturing techniques: vessel forms, vessel thickness, vessel size, firing techniques (duration, atmosphere, and temperature), surface finish.

Raw materials hardness: related to impurities present and microstructural features.

Raw material composition: directly related to hardness and strength - includes quality of clay, temper, and relationship between them. Includes factors such as pore space and particle size.

Environmental Factors

Soil conditions: pH, moisture content, chemical composition.

Temperature and temperature variability: freeze-thaw degradation.

Soil pressure and deformation processes: includes seismic activity, ground subsidence.

Natural (nonfaunal) transport processes: generally fluvial, possible aeolian; sherd erosion influenced by velocity, distance, grain density and size in associated deposits (i.e. is it moving in an abrasive medium?).

Faunal transport: generally related to rodent burrowing. This may be a secondary process in that animals may bring sherds to the surface, exposing them to other environmental or cultural impacts.

Faunal trampling.

Cultural Factors

Discard behavior: where discarded, how discarded.

Reuse and curate behavior: includes reuse as tools as well as by children for play.

Human trampling.

Loss behavior.

Postdepositional disturbances: includes modern impacts such as plowing and road construction.

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*Note that time could be considered a factor in that the greater the period of time involved, the more likely that one or more of the processes listed here may occur.

observations and research into the formation process, experimental archaeology, and ethnoarchaeological literature. For example, deposits with high percentages of very large sherds should represent something along the lines of de facto refuse. Generally, de facto vessels have been broken through various processes, in particular, the collapse of structures in which they were housed, and postabandonment soil pressure. This is essentially the most pristine and least transformed setting in most instances. The next size class would contain somewhat smaller sherds on the average, and would be behaviorally correlated to secondary refuse deposition that has been exposed to minimal levels of postdepositional transformations. Included under this heading would be rapidly deposited refuse in pits or structure depressions that are subsequently left undisturbed.

These deposits represent the backbone of many of our archaeological studies. Although they are altered in some identifiable and some as of yet unidentifiable ways (due to the current lack of data on vessel breakage patterns, see Wallace et al. 1991; Wilk et al. 1980), they are vastly superior analytically when compared to the third general category of deposits, which contain, on the average, very small sherds. Deposits of this sort are interpreted as transformed secondary refuse and they are considered to be of low depositional integrity, with a correspondingly low interpretive value. Our work suggests that contexts most commonly containing a majority of small sherds include surface and sheet-trash deposits.

A variety of measures may be chosen to measure sherd size; we chose to evaluate each rim via a comparison to size templates as described by Clark for the decorated wares in Chapter 12. The two size classes ultimately selected for statistical analysis consisted of sherds ranging between 5 and 16 cm^2 and those that were larger than 16 cm^2. Sherds smaller than 5 cm^2 were not included because this was the minimum size retained from some contexts. The six size classes used in the laboratory measurement of the plainware rims described by Stark and Heidke in Chapter 13 were selected to be comparable with previous analyses. The 16 cm^2 break point for the two lumped size classes actually used in the analysis was chosen based on the overall frequencies of rims so that as even a split as possible could be made. The median of the distribution is size class 2 and the average of the distribution places the division between size classes 2 and 3 (see Appendix E for the coding index). The rationale here is threefold. First, based on the ethnographic data supplied by DeBoer and Lathrap (1979:133, Figure 4.8) and the experimental evidence generated by Neilsen (1991), it is known that after the initial breakage, which can be variable, ceramics tend to break in a manner that produces consistently similar size distributions. Second, this observation is borne out in the archaeological record. The size patterning for the Rye Creek assemblage used in this analysis as well as the patterning within features at the West Branch site (Huntington 1986; unpublished data on file at Desert Archaeology), reveal that no matter where one assigns a size break point, the results obtained would be the same, provided sample size problems are taken into consideration for the categories chosen. Finally, the approximate median of the assemblage was the break point actually chosen in order to provide a clear display of the contexts with the highest frequencies of large sherds.

An alternative measuring technique that uses nested screens has been tested for a comparable analysis of a much larger assemblage of ceramics from the Los Morteros site (Wallace and Heidke 1991) and from the Schuk Toak sites (Allen Dart, personal communication, 1990). This method is also being used on the Roosevelt Community Development Study in the Lower Tonto Basin (Doelle et al. 1991). It produces results comparable in quality to those produced via the template approach and is considered more efficient for processing large assemblages. It may also provide results that are less subject to recording biases.

Ceramic Density (per unit volume)

Density is a useful indicator for several different reasons. First, sample size is always a consideration in ceramic studies and test excavations have the ability to predict the expected density (and therefore the productivity) of various deposits. Second, density is a measure of depositional processes in that it can help distinguish between behavioral patterns of refuse deposition and noncultural processes that redeposit refuse. Most often, relative density values will be utilized to aid in the interpretation of sequences of abandonment, operating under the assumption that in general (although not always), late-abandoned structures will have relatively lower density deposits than early-abandoned structures (e.g., Elson 1986; Reid 1973; and numerous others). Deposits with very low densities are commonly perceived as containing naturally transported sheet trash rather than culturally deposited secondary refuse, although in actuality this is not always the case, particularly at small, single-component sites, and multiple traces must be employed to make this interpretation (especially sherd size and abrasion); but density is an important clue. Particularly high densities tend to indicate trash middens and characteristic density-sherd size values are currently being identified for these types of deposits.

The use of ceramic density as an indicator of depositional integrity is based on the idea that the more a deposit becomes transformed, the lower the expected ceramic density. As sherds break, fewer and fewer will be larger than the recovery size (5 cm^2 in this study), thereby decreasing the recorded density (see also Neilsen

1991:Table 3). Also, churning of deposits will result in the greater likelihood that additional matrix will be mixed in with the sherds. In some instances where particularly dense refuse deposits are present, such as in some trash mounds in the Hohokam culture area, processes such as trampling and soil pressure may actually produce higher densities. This is thought to be a rare function of these particular circumstances, however, and not a concern for the present investigation, where much lower densities are the rule.

The fact that local conditions may make the measurement of density difficult (such as variably rocky soil or the presence of wall fall or rock fill), and that other factors such as variability in ceramic durability, soil conditions, site or feature function, and intensity and length of occupation, may influence the comparability of the measure, means that the use of density figures must be approached with caution. In this study, it was assumed that both soil conditions and ceramic durability (plainwares and redwares) were held constant. However, density is not thought, on average, to be as direct an indicator of depositional integrity as are measures such as sherd size and abrasion. There is the expectation that one cannot directly compare fine distinctions in ceramic density between two sites or even two features within a site (given varying feature and site functions) without considering other classes of information. Given the limited nature of this analysis, we chose to retain density on the plot (see Figure 11.1) for the information it provides on key reference points and the gross patterning it portrays. We did not use density, however, as a criteria for sample selection or for deleting certain contexts from consideration with the exception of the cases where sample sizes were too low to be analyzed in the first place. Future analysts may find it useful to partition large data sets in various ways (such as by site type, for example, instead of comparing density for all of the sites within the project area as done here) to help control for the biases that may be introduced into density calculations.

Density was calculated in this analysis from the total counts (bodies and rims; conjoins not taken into account) of plainwares and redwares (added together) in each structure's control unit(s) and dividing this number by the volume of the provenience. This combined redware and plainware measure was used for density because it was recognized that the absolute frequencies of the two wares vary over time. This was a particular concern for Classic period contexts where redwares comprise a higher relative percentage of the ceramic assemblage. If the absolute quantity of pottery used per capita remained the same over time, the increase in redware percentages would signal a decrease in the plainware discarded and density figures calculated on plainware alone would produce misleading values when compared over time. It is assumed that the density within the control units was representative for each of the features sampled.

Abrasion

Many processes damage ceramics in predictable ways, probably the most important of which is sherd breakage as discussed above. Running a close second is abrasion. Abrasion in prehistoric Southwestern ceramics has been investigated by Schiffer and Skibo (1989:101) and a sizable quantity of information exists in the material science literature on ceramics (see P. Rice 1987 for an archaeological review of some of these studies). The significance of abrasion to this investigation is the general principle that the more abraded a sherd is, the more likely it is to have been in some way disturbed from its original point of deposition. In other words, abrasion is a good marker for transformation processes that can affect secondary refuse. The identification of the precise processes resulting in various types of abrasion awaits further investigation. Processes may include fluvial transport, eolian sandblasting, and trampling.

Measuring abrasion on sherds may be accomplished through a variety of techniques. Miriam Stark developed a workable approach to the measurement of surface abrasion on plainware ceramics as part of the plainware and redware analysis (see Chapter 13, this volume), and additional studies were conducted as part of the Los Morteros analysis (Wallace and Heidke 1991). Together, these investigations reveal that markedly different frequencies of abrasion are present at different sites and depositional environments. Furthermore, in situations where severe abrasion is present on a significant number of sherds (greater than 10 percent for the Rye Creek sites), it can be useful for comparative purposes. In environments with relatively nonabrasive fine-grained soils, however, it may be less useful than it proved to be in the Rye Creek analysis.

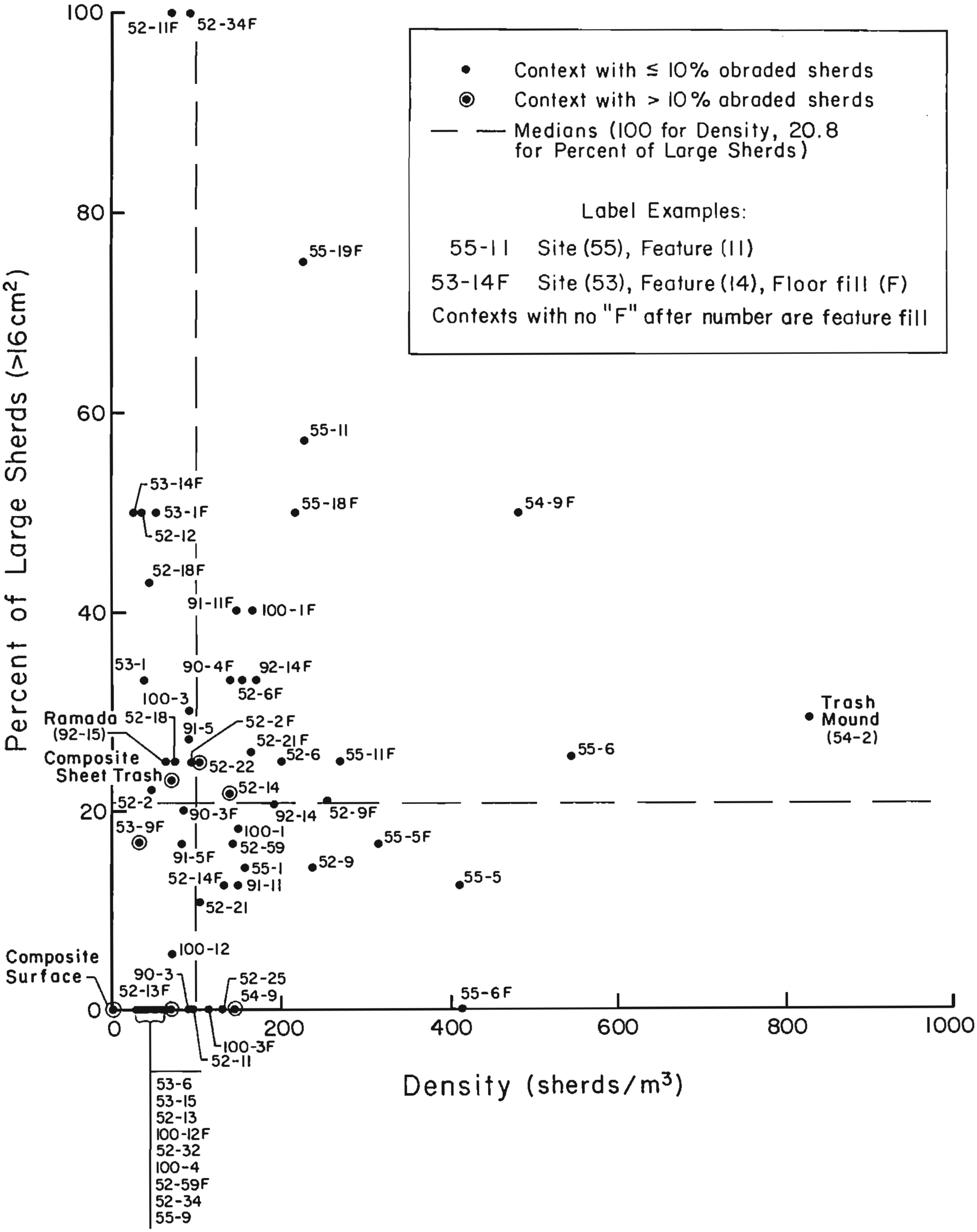

Figure 11.1. Plot of ceramic density by the percentage of sherds greater than 16 cm².

Application of Ceramic Formation Processes to the Rye Creek Project Sites

The goals of the ceramic formation process studies were to identify the contexts that contained the least disturbed secondary refuse (for assessing dating and to aid in the interpretation and analysis of other artifact classes) and to provide the ceramic analysts with recommendations for additional analysis based on these results.

After testing a variety of univariate, bivariate, and multivariate approaches to the problem, a bivariate plot was settled on for modeling and measuring ceramic formation processes. This involved plotting density in sherds/m^3 against the percentage of sherds larger than 16 cm^2 within a particular context. To aid in the interpretation of the resulting configuration, contexts with more than 10 percent of the sherds bearing heavy abrasion were demarcated and a series of other points were plotted that had known contextual integrity and interpretive value. These were used as calibrating points and included the following:

1. The trash midden deposit Feature 2 from the Cobble site (AZ O:15:54) was used as a known secondary refuse deposit that was expected to be relatively untransformed based on the lack of clear evidence for significant temporal mixing.

2. The sherds from the controlled surface collections at the Deer Creek (AZ O:15:52) and Hilltop (AZ O:15:53) sites were combined and measured for size and abrasion. A density value, though somewhat subjective in such a two-dimensional context, was taken via the number of sherds per square meter times 10 cm as an arbitrary maximum depth value. Clearly, the actual value would be lower than the resultant value which is less than 1. This point on the graph is expected to represent a severely transformed secondary refuse deposit by token of it being a surface scatter.

3. All contexts labeled as Stratum "9," the designation for "sheet trash," or trash found in the fill above feature pit boundaries, were lumped and plotted, expecting that this combined context would represent a composite assemblage of transformed household secondary refuse, some potential untransformed secondary refuse, and other mixed-in transformed secondary refuse deposits.

4. Feature 15, a probable ramada at the Rooted site (AZ O:15:92), was plotted as an example of a deposit likely to include transformed secondary refuse by token of its somewhat ephemeral and probable open-air function.

The analysis was run essentially "blind" by Henry Wallace and Miriam Stark (who performed the plainware analysis) prior to any input from field notes or familiarity with particular feature numbers and descriptions. The specific sherds selected for the sherd size and abrasion analysis, as noted earlier, were the plainware rims. Decorated wares were not included because of known significant differences in hardness, tensile strength, and breakage patterns. For the size and abrasion studies, redwares were excluded for the potential differences that might exist in breakage and abrasion patterns, although as noted above both plainwares and redwares were included in the density calculations. Rationales and procedures for sherd size and density measurements have been given above.

For the most part, only sherds from within structures were included in the analysis, because pits, burials, and most other features tended to have small sample sizes that we believed could best be dealt with separately. Strata within structures were combined so that Strata 19 and 20 were lumped as "floor fill" and 10, 11, and 12 were lumped as "fill." Stratum 30, the fill of secondary features within structures, was excluded because internal structure pits often differ in their depositional history from the structures as a whole. With the exception of the Stratum 9 and surface sherds noted above, no other strata were analyzed. All rims from each analytical unit were analyzed, including those from restorable or partially restorable vessels. When multiple sherds were present from a restorable vessel, they were lumped and counted only once with a size rating corresponding to the largest rim sherd. Other sherd conjoins were not counted because the method relies upon existing sherd size, not a reconstructed value. Rim sherds were selected to aid in the assessment of abrasion. In retrospect, this limited the analysis to sample sizes that were uncomfortably low in many instances. Minimum sample sizes required for inclusion in the analysis was two rims. The cases with particularly low sample sizes are considered suspect and interpretations drawn from these must be tempered with other lines of evidence.

The data from the analysis is seen in Table 11.2 and the resultant plot is presented in Figure 11.1. As a tool to aid in the interpretation of the array, median values for density and the percentage of large sherds were calculated and plotted. The contexts with known interpretations are seen to plot in predictable locations. For example, the composite surface collection, thought to be a prime example of a context with low depositional integrity, is seen to fall at the origin of the plot (very low density and all small sherds). The composite sheet trash point falls, as expected, at a moderate level for sherd size and is low in density. The relatively high placement on the sherd size scale is believed to relate to its mixed character (it probably includes secondary and transformed secondary refuse). The trash mound plots, as one would expect, as bearing a very high density and moderate sherd size. The abrasion measure provides additional clarification to the significance of the array. As expected, the composite surface and sheet-trash assemblages both bore high frequencies of heavily abraded sherds. What's more, all of the contexts with over 10 percent heavily abraded rims fall in the low density/small sherd portion of the plot, confirming the expectations for the behavior of the formation processes influencing the assemblages. Figure 11.2 presents a working model of our current perspective on the interpretation of this type of plot. Going by the standards seen in this model, and the "calibration" points plotted, it is apparent that very few of the analyzed Rye Creek contexts may be considered to be relatively untransformed secondary refuse. The majority fall in the domain of transformed deposits. Also apparent overall is that certain sites tend to plot in certain portions of the configuration. For example, the contexts from the Boone Moore site (AZ O:15:55) tend to have higher densities and to some extent more large sherds than virtually all other sites. This may relate to a number of factors not directly related to contextual integrity and it indicates that one must use caution in directly comparing the contexts between sites, as suggested above in the discussion of density measures.

The key to the utilization of this type of analysis lies in the ability one has to draw boundaries between the relevant interpretive categories, which in this case are different types of refuse and corresponding degrees of depositional integrity. Although such boundaries are necessarily imprecise and gradational, nevertheless with the data at hand, some suggestions are possible. First, all contexts that fall within the zone marked out by the contexts with more than 10 percent heavily abraded rim sherds are believed to be severely transformed and would be expected to have very low contextual integrity. Somewhere in the neighborhood of a large sherd percentage of 25, which falls above the ramada context which is thought to be another candidate for poor contextual integrity, one can reasonably conclude that most contexts will have at least moderate integrity. Support for this interpretation is drawn from a comparison with contexts containing enough decorated ceramics to assess temporal mixing. For example, the fill from Feature 5 at the Boone Moore site (AZ O:15:55) plots very low in terms of the percentage of large sherds on Figure 11.1, and the decorated ceramics within these strata are seen to be temporally mixed, ranging from Holbrook B Black-on-white (A.D. 1050-1150) to Pinto Polychrome (postdates A.D. 1250). Many other such cases where low contextual integrity can be correlated with temporal mixing are cited by Clark in the decorated ceramic analysis in Chapter 12. Decorated ceramic confirmation is also present for some cases where the contextual assessment indicated that the deposits were untransformed, although mixed temporal assemblages are present in a few of the supposedly untransformed deposits as well.

As noted above, density values were not used to aid in the identification of the "untransformed" deposits. This was largely due to the limited nature of this analysis and the potential difficulties in applying ceramic density as a measure, as discussed above. Another reason why it was not used relates to the fact that only a relatively gross level of meaningful interpretation could be drawn from it when comparing contexts. This was useful for initial pattern searching and exploratory data analysis, but it precluded the sort of partitioning in the data set needed at this stage of the analysis.

The inclusion of restorable vessels was intended during analysis to assist in the interpretation of the resultant array. Looking back on the study, this clouded the interpretation of some floor/floor fill contexts and the practice was discontinued in later investigations at Los Morteros (Wallace 1991), Schuk Toak (Dart 1992), and

Table 11.2. Data on sherd size, ceramic density, and abrasion used in the analysis.

Site	Feature	Context[a]	#Rims	%Lg. Sherds[b]	%Abraded[c]	Density[d]
52	02	Fill	9	22.22	0.60	49
52	02	Floor	8	25.00	1.00	93
52	06	Fill	8	25.00	1.00	202
52	06	Floor	3	33.33	1.00	156
52	09	Fill	21	14.29	0.94	239
52	09	Floor	19	21.05	0.86	255
52	11	Fill	15	0.00	0.91	93
52	11	Floor	2	100.00	1.00	75
52	12	Fill	2	50.00	1.00	37
52	13	Fill	3	0.00	0.00	32
52	13	Floor	3	0.00	0.67	69
52	14	Fill	23	21.74	0.68	141
52	14	Floor	8	12.50	1.00	134
52	18	Fill	16	25.00	0.93	75
52	18	Floor	7	42.86	1.00	47
52	21	Fill	28	10.71	0.96	103
52	21	Floor	23	26.09	0.95	165
52	22	Fill	4	25.00	0.50	103
52	25	Fill	6	0.00	1.00	130
52	32	Fill	2	0.00	1.00	41
52	34	Fill	2	0.00	1.00	61
52	34	Floor	2	100.00	1.00	97
52	59	Fill	6	16.67	0.80	144
52	59	Floor	4	0.00	1.00	56
53	01	Fill	3	33.33	0.33	40
53	01	Floor	2	50.00	1.00	55
53	06	Fill	2	0.00	1.00	29
53	09	Floor	6	16.67	0.60	33
53	14	Floor	2	50.00	1.00	29
53	15	Fill	4	0.00	1.00	30
54	09	Fill	4	0.00	0.67	144
54	09	Floor	2	50.00	1.00	484
55	01	Fill	7	14.29	1.00	159
55	05	Fill	8	12.50	1.00	412
55	05	Floor	6	16.67	1.00	317
55	06	Fill	55	25.45	1.00	546
55	06	Floor	9	0.00	1.00	416
55	09	Fill	2	0.00	0.00	62
55	11	Fill	7	57.14	1.00	231
55	11	Floor	8	25.00	1.00	271
55	18	Floor	8	50.00	0.88	222
55	19	Floor	4	75.00	1.00	230
90	03	Fill	4	0.00	1.00	90
90	03	Floor	5	20.00	1.00	85
90	04	Fill	3	33.33	1.00	142
91	05	Fill	11	27.27	1.00	94
91	05	Floor	6	16.67	1.00	83
91	11	Fill	24	12.50	0.90	149
91	11	Floor	20	40.00	0.95	149
92	14	Fill	34	20.59	1.00	194
92	14	Floor	9	33.33	1.00	172
92	15	Fill	4	25.00	0.75	65
100	01	Fill	11	18.18	1.00	150
100	01	Floor	5	40.00	1.00	169
100	03	Fill	10	30.00	0.88	92
100	03	Floor	3	0.00	1.00	114
100	04	Fill	4	0.00	1.00	50
100	12	Fill	18	5.56	0.93	72
100	12	Floor	4	0.00	1.00	38
54	2	Mound	34	29.41	0.97	828
Strash[e]	-	Composite	117	23.08	0.85	71
Surface[f]	-	Composite	19	0.00	0.14	0

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[a] Fill = combined strata 10 and 11; Floor = combined strata 19 and 20

[b] Percentage of analyzed rims larger than 16cm^2.

[c] Percent of total analyzed rims exhibiting severe abrasion (code 3 in Appendix E), defined as the presence of temper particle pedestaling and loss original surface on at least 75 percent of the sherd's exterior surface.

[d] Density calculated as (# plainwares and # redwares)/volume of the provenience.

[e] Sheet trash, Stratum 9.

[f] Surface sherds collected in grid units on sites O:15:52 and O:15:53.

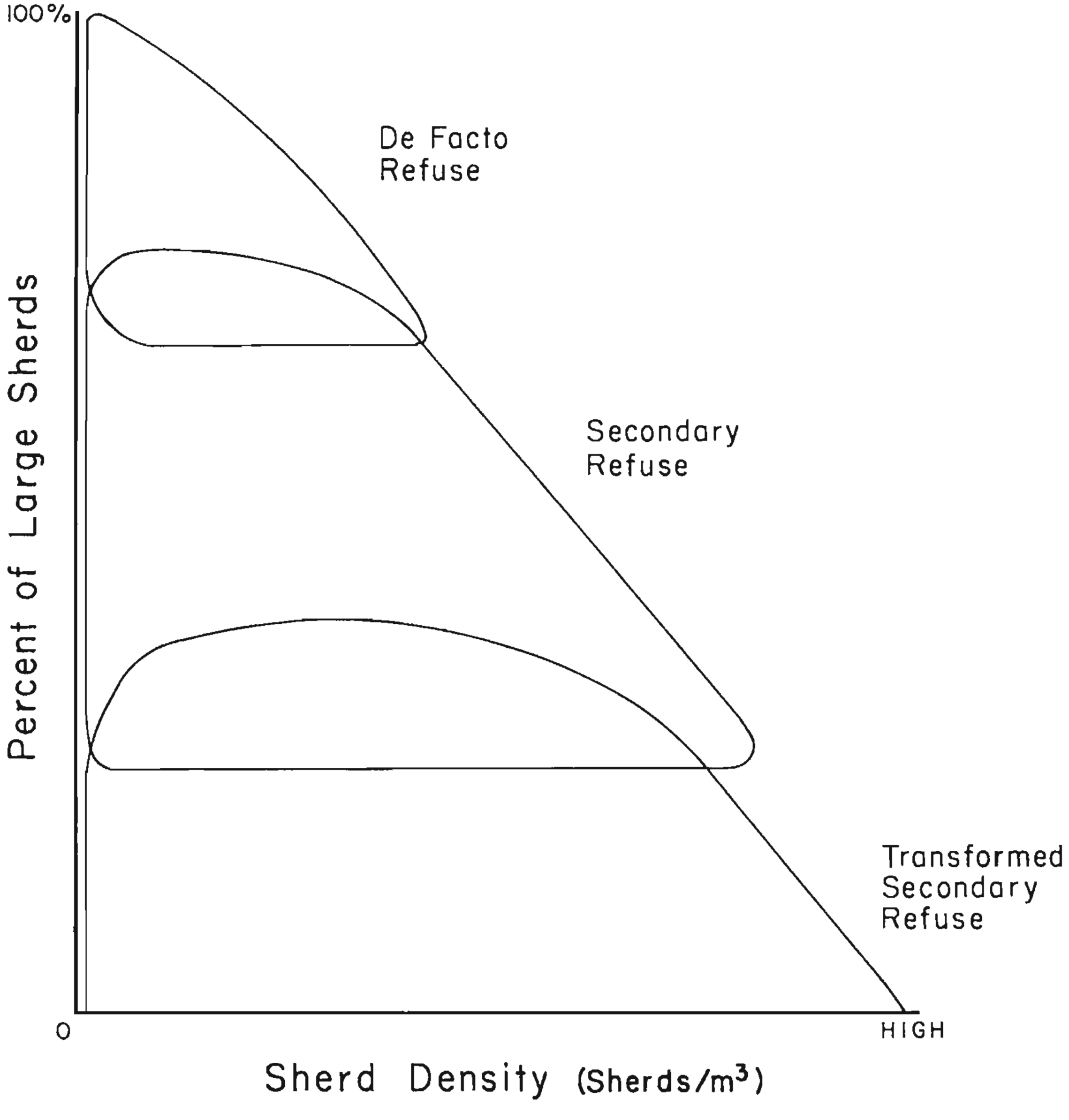

Figure 11.2. Proposed model correlating refuse type to sherd density and size.

the Roosevelt Community Development Study (Doelle et al. 1991). Their exclusion is now considered advantageous in that it is unnecessary to use this type of technique to recognize the presence of de facto refuse (i.e., a restorable vessel on a house floor), and it is more important to evaluate the integrity of the deposit that overlies and potentially is mixed in with the de facto floor artifacts.

It is important to recognize that the analysis presented here is intended to provide guidelines for interpretation, not absolute identifications of refuse type or utility for various analyses of other artifact classes. As mentioned, other lines of evidence are necessary in final interpretations. A feature-by-feature interpretation of the results of this analysis, which formed the basis for selecting the contexts used in the analysis of the plainware and redware ceramic assemblages, is presented in Appendix B and discussed in greater detail in the chapter on the plainware-redware analysis.

CONCLUSIONS

In conclusion, the analyses outlined above represent one method for dealing with the transformation of material from the systemic depositional context to the excavated archaeological context, thereby increasing confidence in the interpretation of archaeological data. We feel it is necessary to stress that the analyses presented here, particularly the size/density plots, are not meant to be used in a formulaic manner (i.e., where data are plugged in to generate readily interpretable answers). Many lines of evidence must be used in these interpretations, of which the size/density plot shown in Figure 11.1 is just one aspect. In addition, we realize that our research is still provisional, although suggestive, and that many of the assumptions used above are essentially untested. We are hopeful that additional research, such as that being conducted by Desert Archaeology on the Roosevelt Community Development Study in the Lower Tonto Basin (Doelle et al. 1991) and by Soil Systems, Inc., on the Pueblo Grande ceramic assemblage (David Abbott, personal communication, 1991), will serve to further refine these methods and increase our understanding of archaeological contexts.

More detailed consideration of formation process issues and the direct application of these data can be found elsewhere in this volume, particularly in the chapters on the decorated ceramic (Clark, Chapter 12), plainware and redware (Stark and Heidke, Chapter 13), lithics (Craig, Chapter 14), and ground and pecked stone (Craig and Eppley, Chapter 15) analyses and in the chapter on the Dating of the Gila Butte Phase (Wallace, Chapter 24). A feature-by-feature presentation and discussion of the results of the ceramic analyses outlined above are presented by Wallace in Appendix B because this played a critical role in sample and context selection.

CHAPTER 12

DECORATED CERAMIC ANALYSIS

Victoria H. Clark

The Rye Creek decorated ceramic assemblage consists of 1,063 sherds and seven reconstructible vessels, accounting for 2.6 percent of the total ceramic assemblage collected during the Rye Creek excavations. Decorated ceramics were recovered at 10 of the 13 excavated sites and Rye Creek Ruin (AZ O:15:1). Wares identified in the assemblage include Hohokam buffwares, Tusayan whitewares, Cibola whitewares, Little Colorado whitewares, Roosevelt redwares, White Mountain redwares, Hopi wares, Winslow orangewares, San Juan redwares, Tsegi orangewares, Tusayan graywares, and Mogollon brownwares. The decorated assemblage displayed a high diversity of diagnostic types. Thirty-five temporally sensitive ceramic types were identified within the project area assemblage (with the inclusion of the decorated sherds from the testing of Rye Creek Ruin, the number of identified diagnostic types rises to 46).

As can be seen in Tables 12.1 and 12.2, Hohokam buffwares were the most common decorated ceramic recovered from the project area. Buffwares comprise 44.6 percent of the decorated assemblage, with 77.1 percent of them occurring at a single site, the Deer Creek site (AZ O:15:52). Northern whitewares account for 41.8 percent of the decorated assemblage, with Tusayan whitewares comprising 19.7 percent, Cibola whitewares 11.2 percent, and Little Colorado whitewares 10.9 percent. The remaining 11.2 percent of the identifiable decorated assemblage is distributed in more or less equally low frequencies among the previously mentioned wares. An additional 3.4 percent of the decorated ceramic assemblage was not identifiable to the ware level.

RESEARCH GOALS

The primary goals of the decorated ceramic analysis were twofold. First, by identifying the decorated sherds to the type level, it was believed that some degree of temporal control could be gained over the individual features at the sites and the sites as a whole. Second, by comparing intrusive ware frequencies among sites, it was thought that ceramic exchange and interaction patterns over time could be assessed. Several secondary research questions were also investigated. These included a reassessment of the whiteware typology, particularly the Cibola whitewares, and the integration of the decorated ceramics into the framework developed for the contextual analysis as outlined in Chapter 11. With respect to context, the decorated ceramic assemblage was used as an independent test of the plainware data, being an indicator of the degree of temporal mixing. The primary reseach questions are discussed in greater detail below.

Temporal Control

The dating of the Rye Creek sites on the basis of decorated ceramics was undertaken with the assumption that ceramic cross-dating is a valid method for dating contexts with temporally sensitive intrusive ceramics. Although the validity of ceramic cross-dating has been questioned (Schiffer 1982), recent ethnoarchaeological and ethnographic data strongly suggest that, on the average, the use life of ceramic whole vessels is between 2 and 20 years (Arnold 1985; Kramer 1985). This implies that any lag between prehistoric ceramic production and ceramic exchange was probably minimal. Consequently, for this analysis it was assumed that the published dates for the intrusive ceramic types identified within the assemblage were applicable to the Rye Creek sites.

Table 12.1. Breakdown of number and frequency of decorated ceramic wares at the Rye Creek Project sites.

	Site Number (ASM)											
Ceramic Class	O:15:1	O:15: 52	O:15: 53	O:15: 54	O:15: 55	O:15: 89	O:15: 90	O:15: 91	O:15: 92	O:15: 99	O:15: 100	Total
Red-on-buff	4	368	13	0	0	0	6	22	46	0	18	477 (44.6%)
% Site Total	3.2%	88.7%	29.5%	0.0%	0.0%	0.0%	15.8%	15.6%	53.5%	0.0%	20.7%	
Tusayan Whiteware	0	36	13	5	1	0	13	80	16	1	46	211 (19.7%)
% Site Total	0.0%	8.7%	29.5%	7.8%	1.7%	0.0%	34.2%	56.7%	18.6%	10.0%	52.9%	
Little Colorado Whiteware	28	2	6	6	23	0	10	30	6	4	2	117 (10.9%)
% Site Total	22.6%	0.5%	13.6%	9.4%	38.3%	0.0%	26.3%	21.3%	7.0%	40.0%	2.3%	
Cibola Whiteware	27	0	7	37	23	0	3	7	5	4	7	120 (11.2%)
% Site Total	21.8%	0.0%	15.9%	57.8%	38.3%	0.0%	7.9%	5.0%	5.8%	40.0%	8.0%	
Tusayan or Little Colorado Whiteware	0	0	0	0	0	0	1	0	0	0	0	1 (0.1%)
% Site Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%	
Tusayan or Cibola Whiteware	0	0	0	2	0	1	0	1	4	0	8	16 (1.5%)
% Site Total	0.0%	0.0%	0.0%	3.1%	0.0%	100.0%	0.0%	0.7%	4.7%	0.0%	9.2%	
Cibola or Little Colorado Whiteware	3	0	0	0	0	0	0	0	0	0	0	3 (0.3%)
% Site Total	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Indeterminate Whiteware	1	0	0	0	0	0	0	1	0	0	3	5 (0.5%)
% Site Total	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	3.4%	
Roosevelt Redware	22	0	1	6	9	0	0	0	0	0	0	38 (3.6%)
% Site Total	17.7%	0.0%	2.3%	9.4%	15.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
White Mountain Redware	20	0	0	0	4	0	0	0	9	0	0	33 (3.1%)
% Site Total	16.1%	0.0%	0.0%	0.0%	6.7%	0.0%	0.0%	0.0%	10.5%	0.0%	0.0%	
San Juan Redware	0	0	1	0	0	0	2	0	0	0	3	6 (0.6%)
% Site Total	0.0%	0.0%	2.3%	0.0%	0.0%	0.0%	5.3%	0.0%	0.0%	0.0%	3.4%	
Tsegi Orangeware	0	0	0	4	0	0	1	0	0	0	0	5 (0.5%)
% Site Total	0.0%	0.0%	0.0%	6.3%	0.0%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%	
Hopi Ware	6	0	0	4	0	0	0	0	0	0	0	10 (0.9%)
% Site Total	4.8%	0.0%	0.0%	6.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Local Red-on-plain	0	7	0	0	0	0	0	0	0	0	0	7 (0.7%)
% Site Total	0.0%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Indeterminate Intrusive	7	2	1	0	0	0	1	0	0	0	0	11 (1.0%)
% Site Total	5.6%	0.5%	2.3%	0.0%	0.0%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%	
Winslow Orangeware	5	0	0	0	0	0	0	0	0	0	0	5 (0.5%)
% Site Total	4.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Tusayan Grayware	0	0	1	0	0	0	1	0	0	0	0	2 (0.2%)
% Site Total	0.0%	0.0%	2.3%	0.0%	0.0%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%	
Mogollon Brownware	1	0	1	0	0	0	0	0	0	1	0	3 (0.3%)
% Site Total	0.8%	0.0%	2.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.0%	0.0%	
Total	124	415	44	64	60	1	38	141	86	10	87	1070
% Site Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	

Table 12.2. Breakdown of number and frequency of decorated types at the Rye Creek sites.

	Site Number (ASM)											
Ceramic Type	O:15: 01	O:15: 52	O:15: 53	O:15: 54	O:15: 55	O:15: 89	O:15: 90	O:15: 91	O:15: 92	O:15: 99	O:15: 100	Total
Indeterminate	13	6	1	2	0	1	2	2	4	0	11	42
Snaketown Red-on-buff	0	12	0	0	0	0	0	0	0	0	0	12
Snaketown or Gila Butte Red-on-buff	0	13	0	0	0	0	0	0	0	0	0	13
Gila Butte Red-on-buff	0	131	0	0	0	0	1	0	0	0	3	135
Gila Butte/Santa Cruz Red-on-buff	0	1	0	0	0	0	0	0	0	0	0	1
Gila Butte or Santa Cruz Red-on-buff	0	50	0	0	0	0	0	0	0	0	1	51
Santa Cruz Red-on-buff	0	2	1	0	0	0	1	3	4	0	0	11
Santa Cruz or Sacaton Red-on-buff	1	0	0	0	0	0	1	3	3	0	0	8
Sacaton Red-on-buff	0	6	4	0	0	0	3	5	15	0	1	34
Indeterminate Red-on-buff	3	153	8	0	0	0	0	11	24	0	13	212
Indeterminate Tusayan Black-on-white	0	26	12	2	0	0	6	37	11	1	30	125
Kana-a Black-on-white	0	10	0	1	0	0	0	5	3	0	0	19
Kana-a or Black Mesa Black-on-white	0	0	0	0	0	0	4	0	1	0	0	5
Black Mesa Black-on-white	0	0	1	1	0	0	2	8	0	0	8	20
Black Mesa or Sosi Black-on-white	0	0	0	1	1	0	1	27	1	0	8	39
Sosi Black-on-white	0	0	0	0	0	0	0	3	0	0	0	3
Indet. Little Colorado Black-on-white	7	2	6	4	5	0	2	19	4	3	0	52
Holbrook A Black-on-white	0	0	0	0	0	0	3	5	0	0	0	8
Holbrook A/B Black-on-white	0	0	0	1	0	0	5	5	2	0	2	15
Holbrook B Black-on-white	0	0	0	0	8	0	0	0	0	0	0	8
Holbrook/Flagstaff Black-on-white	0	0	0	0	0	0	0	1	0	0	0	1
Walnut A Black-on-white	5	0	0	0	2	0	0	0	0	1	0	8
Walnut A/B Black-on-white	8	0	0	0	5	0	0	0	0	0	0	13
Walnut B Black-on-white	3	0	0	1	0	0	0	0	0	0	0	4
Padre Black-on-white	0	0	0	0	1	0	0	0	0	0	0	1
Leupp Black-on-white	0	0	0	0	1	0	0	0	0	0	0	1
Late Little Colorado Black-on-white	5	0	0	0	1	0	0	0	0	0	0	6
Indeterminate Cibola Black-on-white	19	0	5	35	14	0	1	1	3	4	2	84
Kiatuthlanna Black-on-white	0	0	2	0	0	0	0	1	0	0	0	3
Kiatuth. or Red Mesa Black-on-white	0	0	0	0	0	0	0	2	0	0	0	2
Red Mesa Black-on-white	0	0	0	0	0	0	2	3	1	0	1	7
Snowflake Black-on-white	3	0	0	0	4	0	0	0	0	0	0	7
Puerco Black-on-white	0	0	0	0	1	0	0	0	0	0	4	5
Reserve Black-on-white	0	0	0	0	0	0	0	0	1	0	0	1
Reserve/Tularosa Black-on-white	1	0	0	1	4	0	0	0	0	0	0	6
Tularosa Black-on-white	3	0	0	1	0	0	0	0	0	0	0	4
Pinedale Black-on-white	1	0	0	0	0	0	0	0	0	0	0	1

Table 12.2. Continued.

	Site Number (ASM)											
Ceramic Type	O:15: 01	O:15: 52	O:15: 53	O:15: 54	O:15: 55	O:15: 89	O:15: 90	O:15: 91	O:15: 92	O:15: 99	O:15: 100	Total
Pinto Black-on-red	3	0	0	4	6	0	0	0	0	0	0	13
Indeterminate Roosevelt Black-on-red	1	0	0	0	1	0	0	0	0	0	0	2
Indeterminate Roosevelt Red	1	0	0	0	0	0	0	0	0	0	0	1
Pinto Black-on-red	3	0	0	3	6	0	0	0	0	0	0	12
Pinto Polychrome	2	0	0	1	2	0	0	0	0	0	0	5
Pinto or Gila Polychrome	6	0	0	0	0	0	0	0	0	0	0	6
Gila Polychrome	9	0	1	0	0	0	0	0	0	0	0	10
Tonto Polychrome	0	0	0	1	0	0	0	0	0	0	0	1
Indeterminate White Mt. Polychrome	2	0	0	0	0	0	0	0	2	0	0	4
Indeterminate White Mt. Black-on-red	5	0	0	0	0	0	0	0	7	0	0	12
St. John's Black-on-red	0	0	0	0	4	0	0	0	0	0	0	4
Pinedale Black-on-red	2	0	0	0	0	0	0	0	0	0	0	2
Pinedale or 4mile Polychrome	1	0	0	0	0	0	0	0	0	0	0	1
Fourmile Polychrome	7	0	0	0	0	0	0	0	0	0	0	7
Cibecue Polychrome	3	0	0	0	0	0	0	0	0	0	0	3
Indeterminate San Juan Black-on-red	0	0	1	0	0	0	1	0	0	0	2	4
Deadmans Black-on-red	0	0	0	0	0	0	1	0	0	0	1	2
Indeterminate Tsegi Polychrome	0	0	0	1	0	0	0	0	0	0	0	1
Indeterminate Tsegi Black-on-red	0	0	0	0	0	0	1	0	0	0	0	1
Indeterminate Tsegi Orangeware	0	0	0	1	0	0	0	0	0	0	0	1
Tusayan Polychrome	0	0	0	1	0	0	0	0	0	0	0	1
Cameron Polychrome	0	0	0	1	0	0	0	0	0	0	0	1
Jeddito Yellow	1	0	0	0	0	0	0	0	0	0	0	1
Early Jeddito Black-on-yellow	2	0	0	0	0	0	0	0	0	0	0	2
Early or Late Jeddito	1	0	0	0	0	0	0	0	0	0	0	1
Bidahochi Polychrome	1	0	0	0	0	0	0	0	0	0	0	1
Bidahochi Black-on-white	1	0	0	0	0	0	0	0	0	0	0	1
Local Red-on-plain	0	2	0	0	0	0	0	0	0	0	0	2
Local Indeterminate	0	1	0	0	0	0	0	0	0	0	0	1
Homolovi Polychrome	3	0	0	0	0	0	0	0	0	0	0	3
Tuwiuca Black-on-orange	1	0	0	4	0	0	0	0	0	0	0	5
Chavez Pass Black-on-red	1	0	0	0	0	0	0	0	0	0	0	1
Tusayan Corrugated	0	0	1	0	0	0	1	0	0	0	0	2
Show Low Black-on-red	0	0	1	0	0	0	0	0	0	0	0	1
Show Low Black-on-red Corrugated	0	0	0	0	0	0	0	0	0	1	0	1
Maverick Mt. Polychrome	1	0	0	0	0	0	0	0	0	0	0	1
Total	124	415	44	64	60	1	38	141	86	10	87	1070

As is often the case, once the analysis was underway several factors came into play that limited the ability to establish tight temporal control. First, various difficulties were encountered in identifying the decorated sherds to the type level (Table 12.3). A primary factor here involved inconsistencies within some of the published ceramic typologies. This was particularly true when dealing with the literature on Cibola whiteware. Although there is an abundance of descriptive literature discussing a plethora of Cibola whiteware types, there is virtually no definitive literature on the topic. As a result, the typing of Cibola whiteware sherds was particularly problematic and likewise often unsuccessful; 70 percent of the Cibola whiteware sherds were coded as indeterminate at the type level.

A second reason for the difficulty in assigning type identifications can be traced to the particular formation processes that affected the project area sites. The decorated assemblage as a whole consisted of small and often abraded sherds. This is graphically shown in Figure 12.1, which breaks down the decorated assemblage on the basis of sherd size. The bias toward small sherd size is partially due to the fact that unlike the plainware assemblage, where only sherds larger than 2.5 cm (roughly the size of a quarter) were collected, all identifiable decorated sherds were recovered. Not surprisingly, success in identifying a decorated sherd to the type level appears to correlate directly with sherd size--the smaller the sherd, the less frequently it could be identified to the type level (Figure 12.2 and Table 12.3). Furthermore, although the decorated sherds were not coded for abrasion, as an aggregate they tend to be both small and abraded. Consequently, 22.5 percent of the decorated sherds, nearly a quarter of the assemblage, were coded at the type level as "indeterminate with no paint," indicating that the assemblage as a whole was deposited under conditions that were poorly suited for preservation. This conclusion is further supported by the results of the analysis of abrasion on the plainwares (Chapter 13).

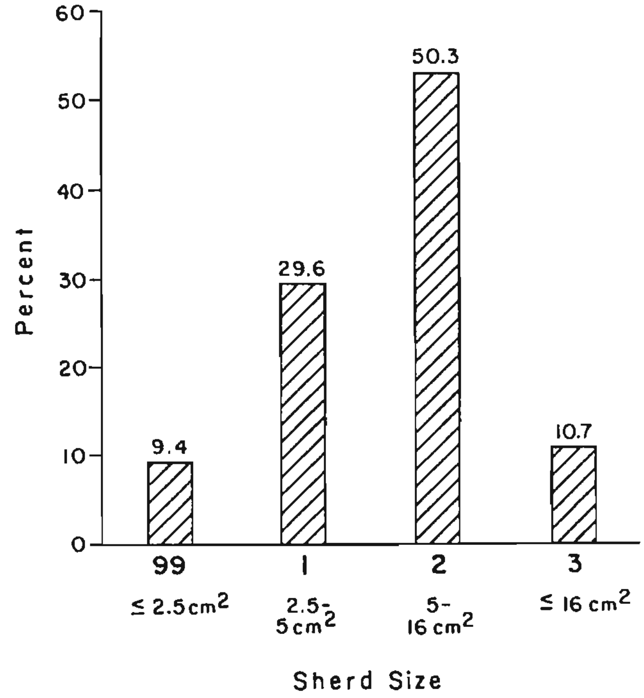

Figure 12.1. Decorated ceramic assemblage on the basis of sherd size.

Table 12.3. Assessment of success/failure in assigning type identifications.

Size	No. Typed	No. Either/Or	No. Indeterminate	Total
99 (≤ 2.5cm$^{2)}$	17 (16.8%)	7 (6.9%)	77 (76.2%)	101 (100%)
1 (2.5-5cm^2)	84 (26.5%)	38 (12.0%)	195 (61.5%)	317 (100%)
2 (5-16cm^2)	188 (34.9%)	111 (20.6%)	239 (44.4%)	538 (100%)
3 (≤ 16cm^2)	72 (63.2%)	11 (9.6%)	31 (27.2%)	114 (100%)
Total	361 (33.7%)	167 (15.6%)	542 (50.7%)	1070 (100%)

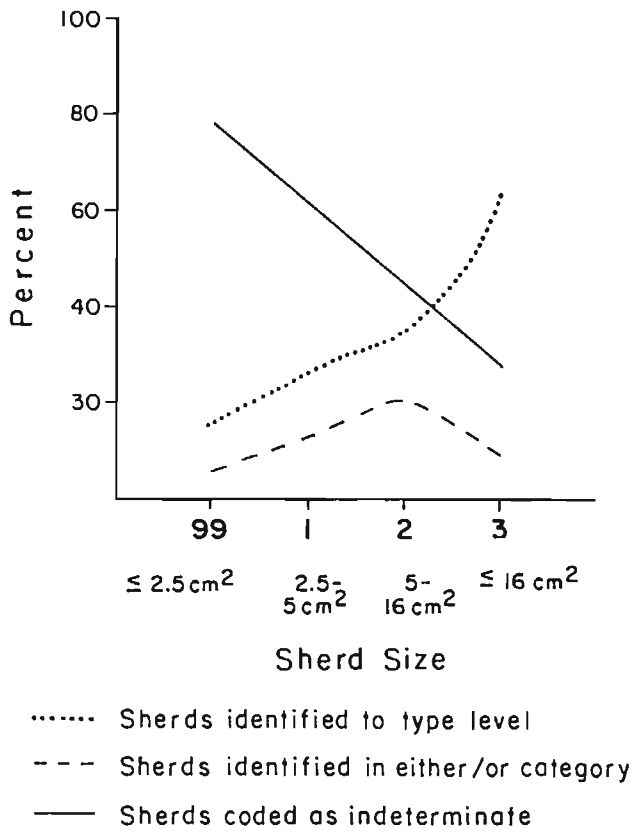

Figure 12.2. Sherd size versus success in assigning type.

Consequently, due to the various difficulties in assigning type identifications, only 49.3 percent of the decorated sherds provided any useful temporal information (528 sherds spread out over 11 sites). Therefore, expectations concerning the ceramic dating had to be readjusted and somewhat scaled down.

Furthermore, the actual dating of excavated contexts on the basis of the presence of temporally diagnostic ceramics became additionally problematic when the results of the contextual analysis were brought to bear on the issue of chronology. As is argued in Chapter 11, a relatively large number of excavated contexts from the Rye Creek Project are suggestive of sheetwash or transformed secondary trash deposits, thereby limiting the interpretative significance of the associated decorated sherds. Overall, the Rye Creek excavated contexts have low percentages of large sherds and low sherd densities, countered by high frequencies of abraded sherds. In addition, very few temporally diagnostic sherds were recovered from de facto floor contexts. As a result, with so many excavated contexts determined to be mixed, disturbed, and redeposited, limitations were placed on using diagnostic decorated ceramics to date specific features within a site. Although there was difficulty in dating individual features to specific time periods, particularly at multicomponent sites, the decorated assemblage did prove useful in determining general use dates for site areas.

Spatial Control: Diachronic Patterns in Ceramic Exchange

The second objective of the decorated ceramic analysis was to consider the question of variability in ceramic exchange and interaction networks over time. It was hoped that if the Rye Creek Project sites proved to have sufficient temporal depth then variation in intrusive ceramic ware frequencies would provide a means for assessing long-term trends in regional trade and interaction. This portion of the analysis was founded on ceramic-sourcing research that strongly suggests that specific wares have spatially restricted production zones (Shepard 1942; Heidke 1986, 1987; Douglass 1987; Bishop et al. 1988), thereby allowing the inference that a change in intrusive ware frequencies over time reflects a change in spatially distinct interaction spheres.

Indigenous Decorated Ceramics

At this point it is important to note that within the project area there appears to be no developed indigenous decorated ceramic tradition. Consequently, all decorated ceramics from the project area were considered intrusive. There are two possible exceptions:

First, there is the yet ambiguous origin of the decorated Roosevelt redwares, which includes the controversial Salado Polychromes. Historically, the production zone for decorated Roosevelt redwares has been designated as the Lower Tonto Basin, approximately 30 km downstream from the Rye Creek Project area (Doyel 1976; Gladwin and Gladwin 1930b; Haury 1945; Nelson and LeBlanc 1986). But, this scenario is currently subject to much debate, particularly with the results of recent clay- and temper-sourcing studies indicating that the production of Salado Polychromes was pursued in a number of different localities throughout the greater Southwest (Crown 1983; Crown and Bishop 1987; Nieves Zedeno, personal communication, 1990).

In the absence of clay- and temper-sourcing studies for the project's Roosevelt redwares it is impossible to determine whether these ceramics were intrusive or locally manufactured. It is worth noting, however, that during analysis the Roosevelt redwares could be macroscopically divided into three temper categories: sherd temper, sherd and unidentified sand temper, and unidentified sand temper and diabasic sand temper. The diabase tempering provisionally suggests some Salado Polychrome manufacture on the eastern side of the Tonto Basin, since this is the only area within the Tonto Basin where diabase is a common constituent of wash stream sands (Lombard 1989a:140,142).

Within the Rye Creek Project area, decorated Roosevelt redwares account for only 3.6 percent (38 sherds) of the decorated assemblage. Twenty-two of these 38 sherds (60.6 percent) were recovered from the trash mounds tested at Rye Creek Ruin. Notably, these 22 sherds represent only 17.7 percent of the decorated assemblage collected from the trash mounds, with Little Colorado whiteware assuming 22.6 percent of the whole, Cibola whiteware 21.8 percent, and White Mountain redware 16.1 percent. These low frequencies of Roosevelt Redware (0.3 percent of the entire Rye Creek ceramic assemblage) are not particularly favorable towards documenting local or exotic Roosevelt redware production.

Second, seven sherds and one reconstructible vessel, all recovered from the Deer Creek site (AZ O:15:52), were assigned to a local red-on-brown category. This decorated ware, of presumably local origin, was identified as being fired in an oxidizing atmosphere, having a coarse-grain mixed sand temper, having a slightly smoothed interior and exterior surface finish, and decorated with a semifugitive reddish pink pigment. Macroscopically speaking, this ware appears to be a decorated version of the plainware produced at AZ O:15:52. (See Figure 12.3 for illustrations of the local red-on-brown; note Gila Butte style design on the two illustrated sherds).

METHODOLOGY

This section describes how the analysis was structured and carried out in order to address the research questions. The first step in the analysis was to lay out the entire decorated assemblage, sorting the sherds first by site and then by feature in order of stratum and level. Included in the analysis were the decorated ceramics, except the buffwares, which were collected during the testing phase. The buffwares from the testing phase were identified by Henry Wallace of Desert Archaeology, Inc., who also identified the buffwares from the data recovery phase. The decorated assemblage from each site was laid out according to the plan view of that particular site; features adjacent to one another on the site map were placed adjacent to one another on the lay-out table. This was done in order to facilitate recording sherd matches within and among features.

Once the sherds were laid out, rough site-by-site counts of buffwares, whitewares, and remaining decorated sherds were made. These rough counts provided general overviews of the quantities present at each site. At this point it was decided that although the same variables would be quantified for all decorated sherds, the analysis would be carried out in three phases:

1) First, the buffwares were coded and typed. The actual identification of the buffwares to the type level was conducted by Henry Wallace of Desert Archaeology, Inc.

2) Next, the whitewares were coded and typed. Identification of the whitewares to the ware and type level was conducted by myself through consultation with Christian Downum of the Department of Anthropology, University of Arizona.

3) Last, the remaining decorated sherds were coded and typed. These sherds were identified to the ware and type level (when possible) by various consultants, with an attempt made to integrate and verify each consultant's opinion. Consultants used were Barbara Montgomery and Nieves Zedeno (Grasshopper Field School, University of Arizona) for White Mountain redwares and Roosevelt redwares; Kelley Hays and Louise Senior (Homol'ovi Project, University of Arizona) for Hopi wares and Winslow orangewares. Additional consultants included Barbara Mills (Northern Arizona University) and Peter Pilles (Coconino National Forest).

Variables Coded

A coding sheet was completed for every provenienced artifact bag that contained a decorated sherd. Because the analysis was divided into three phases, it was possible that up to three coding sheets might be filled out for a single bag, depending on the variety of wares present in the bag (if a bag contained buffwares, whitewares, and "remaining decorated sherds" then three coding sheets were completed for that particular bag). An example of a coding sheet and a summarized listing of the coding indexes can be found in Appendix E of this volume. All coded information was entered into a computer-based data file to facilitate subsequent analysis.

Twelve variables were coded for each sherd in the decorated assemblage. As mentioned above, the initial variable singled out for each sherd was provenience/bag number. This information was coded for cataloging and recall purposes; if the coding of a sherd needed to be reconsidered at any time during the analysis, or for that matter, any time following the analysis, then that sherd could be easily relocated by tracing it back to its provenience/bag number.

The remaining 11 variables coded for each sherd fall under three general analytical groupings: 1) contextual/formation process variables, 2) functional variables, and 3) spatial and temporal variables (an in-depth discussion concerning grouping 3 follows this section).

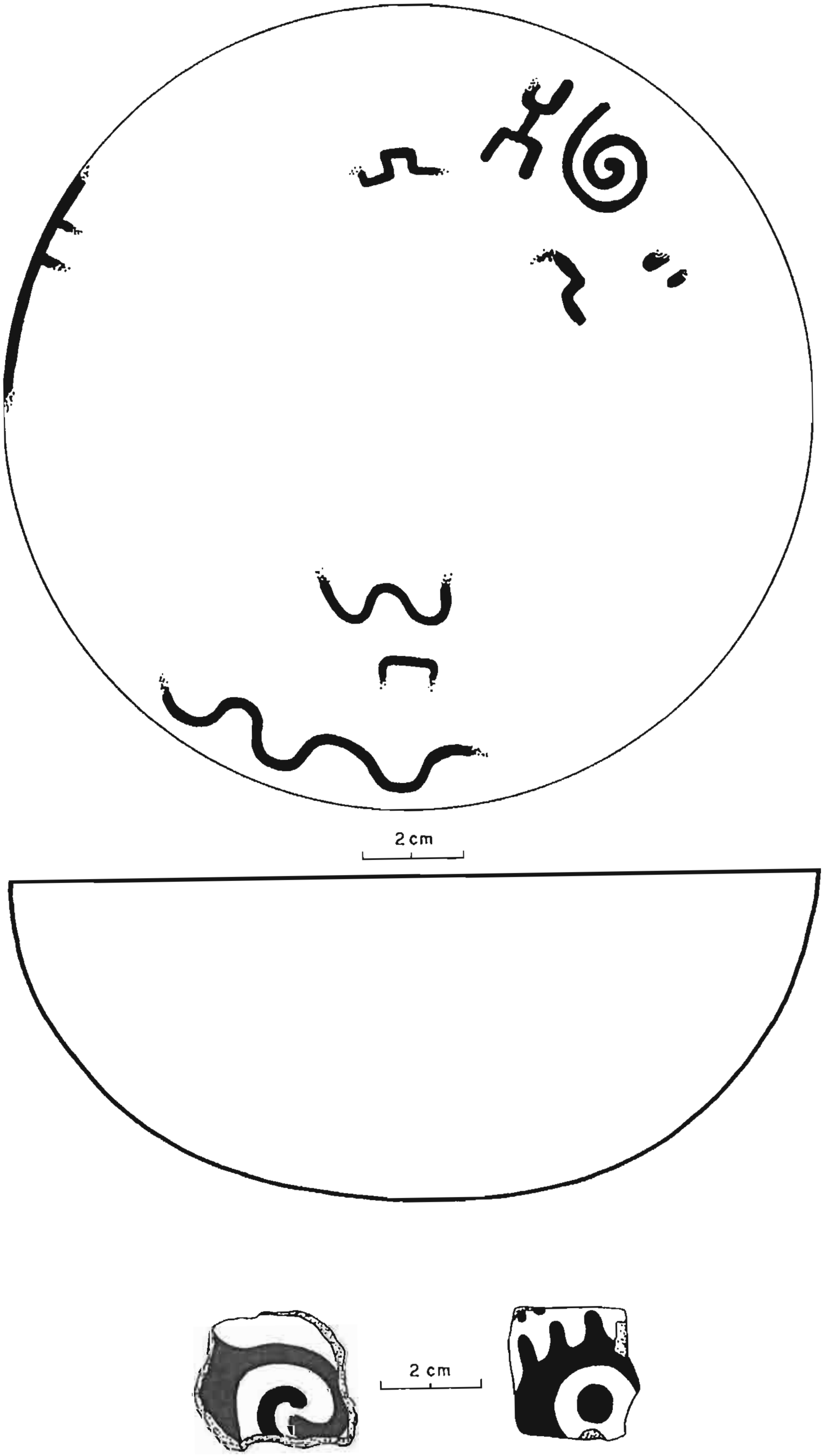

Figure 12.3. Illustration of local red-on-brown reconstructible vessel and two local red-on-brown sherds from the Deer Creek site, AZ O:15:52.

1) Contextual/formation process variables:

   a. Horizontal provenience information:
      (1) Site number
      (2) Feature number

   b. Vertical provenience information:
      (1) Stratum--a list of strata designations identified and used during the Rye Creek testing and mitigation phases can be found in Chapter 5.
      (2) Level--when a stratum warranted further division (judgment made in the field), level designations were assigned within the stratum.

   c. Sherd size--divisions coded were:
      (1) Less than 2.5 cm (dime size)
      (2) 2.5-5 cm (quarter size)
      (3) 5-16 cm
      (4) 16-49 cm
      (5) 49-100 cm
      (6) 100 cm-Reconstructible Vessel

   d. Evidence of secondary burning--divisions coded were:
      (1) Not burned
      (2) Burned
      (3) Possibly burned
      (4) Differentially burned

2) Functional variables included:

   a. Vessel part information--divisions coded were:
      (1) Body sherd
      (2) Rim sherd
      (3) Partial reconstructible vessel (1/4-3/4)
      (4) Partial reconstructible vessel (1/4-1/2)
      (5) Partial reconstructible vessel (1/2-3/4)
      (6) Reconstructible vessel (3/4 or more)
      (7) Indeterminate

   b. Vessel shape information--divisions coded were:
      (1) Bowl
      (2) Jar
      (3) Scoop
      (4) Other (listed in comments)
      (5) Indeterminate

   c. Worked sherd information--divisions coded were:
      (1) Mend hole present
      (2) One edge ground (straight)
      (3) One edge ground (round)
      (4) Unperforated disk
      (5) Semiperforated disk
      (6) Perforated disk
      (7) Other (listed in comments)
      (8) Not worked

3) <u>Spatial and temporal variables included</u>:

a. Ceramic class (analogous to ceramic ware)--divisions coded were:
(1) Buffware
(2) Tusayan whiteware
(3) Little Colorado whiteware
(4) Cibola whiteware
(5) Tusayan or Little Colorado whiteware
(6) Tusayan or Cibola whiteware
(7) Cibola or Little Colorado whiteware
(8) Indeterminate whiteware
(9) Roosevelt redware
(10) White Mountain redware
(11) San Juan redware
(12) Tsegi orangeware
(13) Winslow orangeware
(14) Hopi ware
(15) Tusayan grayware
(16) Mogollon brownware
(17) Local red-on-brown
(18) Indeterminate intrusive

b. Ceramic type--74 divisions were coded. See Appendix E for a complete listing of the coded ceramic types.

c. Incised--divisions coded were:
(1) Absent
(2) Present

Incising was recorded for buffware sherds due to the specific interest in the question of whether or not incising on Gila Butte Red-on-buff was temporally significant. Specifically, could it be determined if incised Gila Butte Red-on-buff sherds were occurring in earlier contexts than unincised Gila Butte Red-on-buff sherds?

Vessel count was the thirteenth variable, coded only for whitewares and "remaining decorated sherds." This variable was used as means of coding sherd matches. If a sherd match was found between sherds of a different provenience (i.e., from different features, from different strata, or from different excavation units within the same feature) then those sherds were given the same vessel-count number. Only sherds that matched exactly or had unquestionable technical and stylistic similarities were coded with the same vessel-count number. A separate tally of sherds that had probable or possible associations to one another was kept, though this information was not computer-coded. Vessel-count numbers ran from 1-n at each site. It should be noted that when sherd matches occurred among sherds with identical provenience information (sherds from the same artifact bag) then these sherds were coded only once, as a single sherd. It was thought that the relatively small and distinctive whiteware and "remaining decorated sherds" assemblages would provide a good testing ground for a variable that relied on identifying the maximum number of sherd refits.

The vessel-count variable was an experimental variable with two possible applications: 1) As a means of coding the distribution of pieces of the same vessel across space; and 2) As an attempt to control for the total number of vessels within an assemblage, as opposed to just sherd totals. The distribution of sherd refits, within features and between features, provided significant information on the contemporaneity of features and the degree of mixing; both important components and independent tests of the contextual analysis (see Chapter 11).

CERAMIC CLASS AND CERAMIC TYPE VARIABLES

This section presents an overview of the ceramic wares and types identified in the Rye Creek decorated ceramic assemblage. The discussion is divided into three parts: buffwares, whitewares, and remaining decorated sherds.

Buffwares

Sherds identified as buffware had a porous paste ranging from grey to buff to salmon in color. Temper was predominantly a mica-schist, though quartz and mixed-sand inclusions were not uncommon. Such inclusions made up the majority of the temper in the assemblage's Snaketown Red-on-buff sherds. Buffware identification was based on Haury's type descriptions from the Snaketown excavations (Haury 1965a, 1976).

Red-on-buff types identified within the buffware assemblage included: 1) Snaketown Red-on-buff, 2) Gila Butte Red-on-buff, 3) Santa Cruz Red-on-buff, and 4) Sacaton Red-on-buff. Type identifications were assigned by Henry Wallace. It should be noted that in typing Gila Butte Red-on-buff sherds, the occurrence of shallow exterior incising was considered a diagnostic attribute, although not the only diagnostic attribute; 84 of the 132 sherds typed as Gila Butte Red-on-buff (64 percent) exhibited exterior incising. The differentiation of Gila Butte Red-on-buff from Santa Cruz Red-on-buff, a distinction of some importance in the interpretations presented below, is discussed in detail by Wallace in Chapter 24. For illustrations of diagnostic red-on-buff sherds and reconstructible vessels from the Rye Creek assemblage see Figures 12.4, 12.5 12.6, and 12.7.

Three "either/or" categories were used to code buffware sherds that fell between two diagnostic type groupings and could represent either of the two defined types: 1) Snaketown or Gila Butte Red-on-buff, 2) Gila Butte or Santa Cruz Red-on-buff, and 3) Santa Cruz or Sacaton Red-on-buff. It is important to note that these (and other "either/or" categories used in the ceramic analysis) do not represent categories for transitional sherds. Rather, ceramics assigned to these categories reflect difficulties with the individual sherd, such as small size or nondiagnostic design elements. If the sherd were larger or better preserved, the typological placement would be more specific. These categories were recorded in an attempt to maximize the temporal information to be gained from the assemblage. Sherds that might otherwise have been lost in an indeterminate category, now had some, albeit more limited, temporal significance.

A single sherd was coded as truly transitional between Gila Butte Red-on-buff and Santa Cruz Red-on-buff.

Two final categories dealt with the buffware sherds that eluded typological classification: 1) indeterminate red-on-buff and 2) indeterminate buffware--no paint.

In summary, 10 ceramic types divisions were identified within the buffware ceramic class from the Rye Creek Project area sites: 1) Snaketown Red-on-buff, 2) Snaketown or Gila Butte Red-on-buff, 3) Gila Butte Red-on-buff, 4) Gila Butte or Santa Cruz Red-on-buff, 5) Gila Butte/Santa Cruz Red-on-buff, 6) Santa Cruz Red-on-buff, 7) Santa Cruz or Sacaton Red-on-buff, 8) Sacaton Red-on-buff, 9) indeterminate red-on-buff, and 10) indeterminate buffware.

Whitewares

Whitewares: Ceramic Class Variable

Three whiteware classes were present in the Rye Creek decorated assemblage: Tusayan whiteware, Little Colorado whiteware, and Cibola whiteware. The differential representation of each of the whiteware classes among the Rye Creek sites required, in order to standardize coding procedures, the isolation of particular technical attributes or groups of technical attributes that were diagnostic for each whiteware class. Distinction among the wares was made on the basis of macroscopically and microscropically observable differences in paint

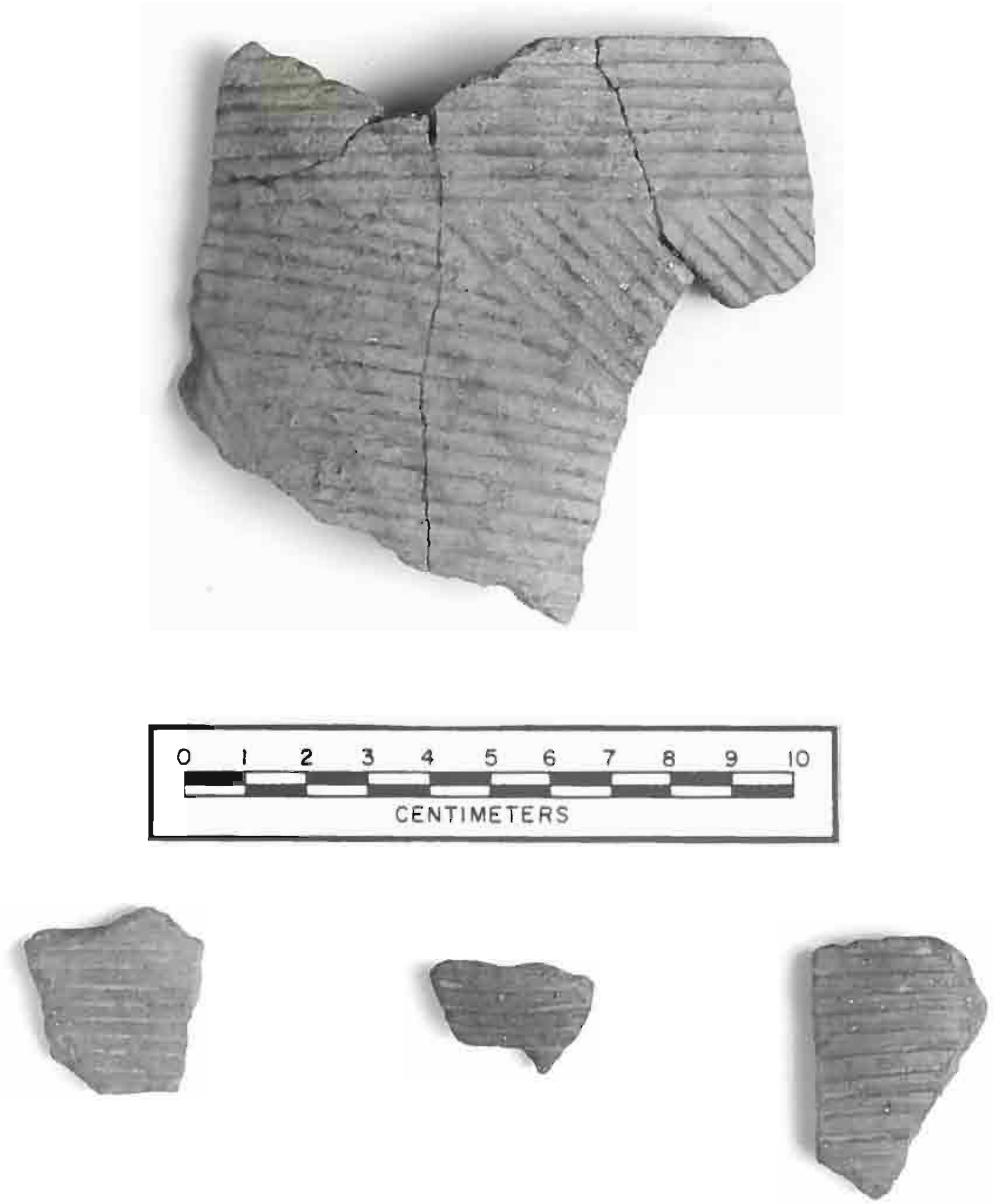

Figure 12.4. Snaketown Red-on-buff sherds from the Deer Creek site, AZ O:15:52.

composition, temper composition, paste color and texture, and slip variability. The definitive technical attributes isolated for the identification of each whiteware class were:

Tusayan whiteware

1) carbon-base paint
2) quartz sand temper
3) light gray to white paste, often with carbon streak
4) occasional thin white slip or wash on jar exteriors and bowl exteriors and interiors

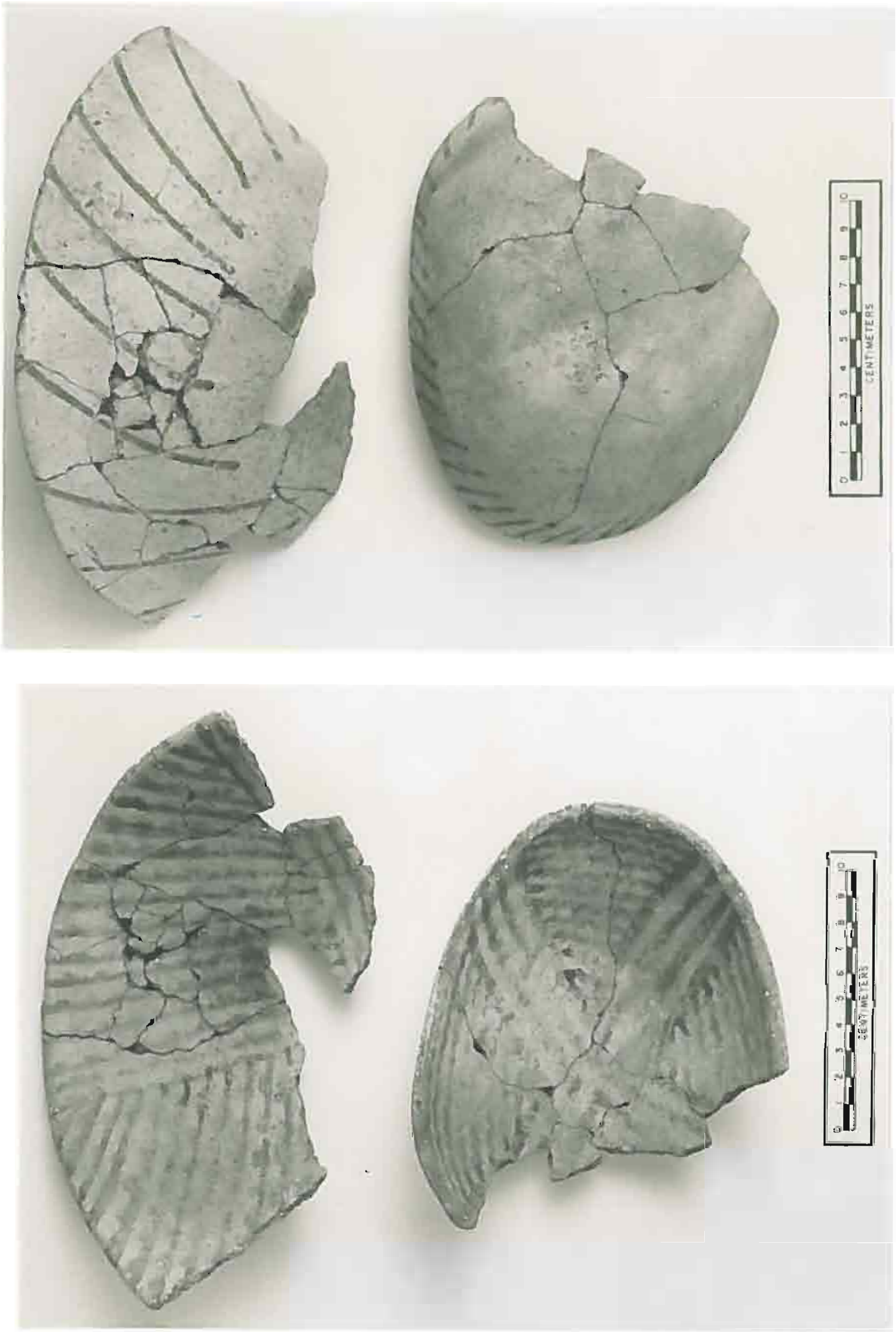

Figure 12.5. Gila Butte Red-on-buff reconstructible vessels from the Deer Creek site, AZ O:15:52.

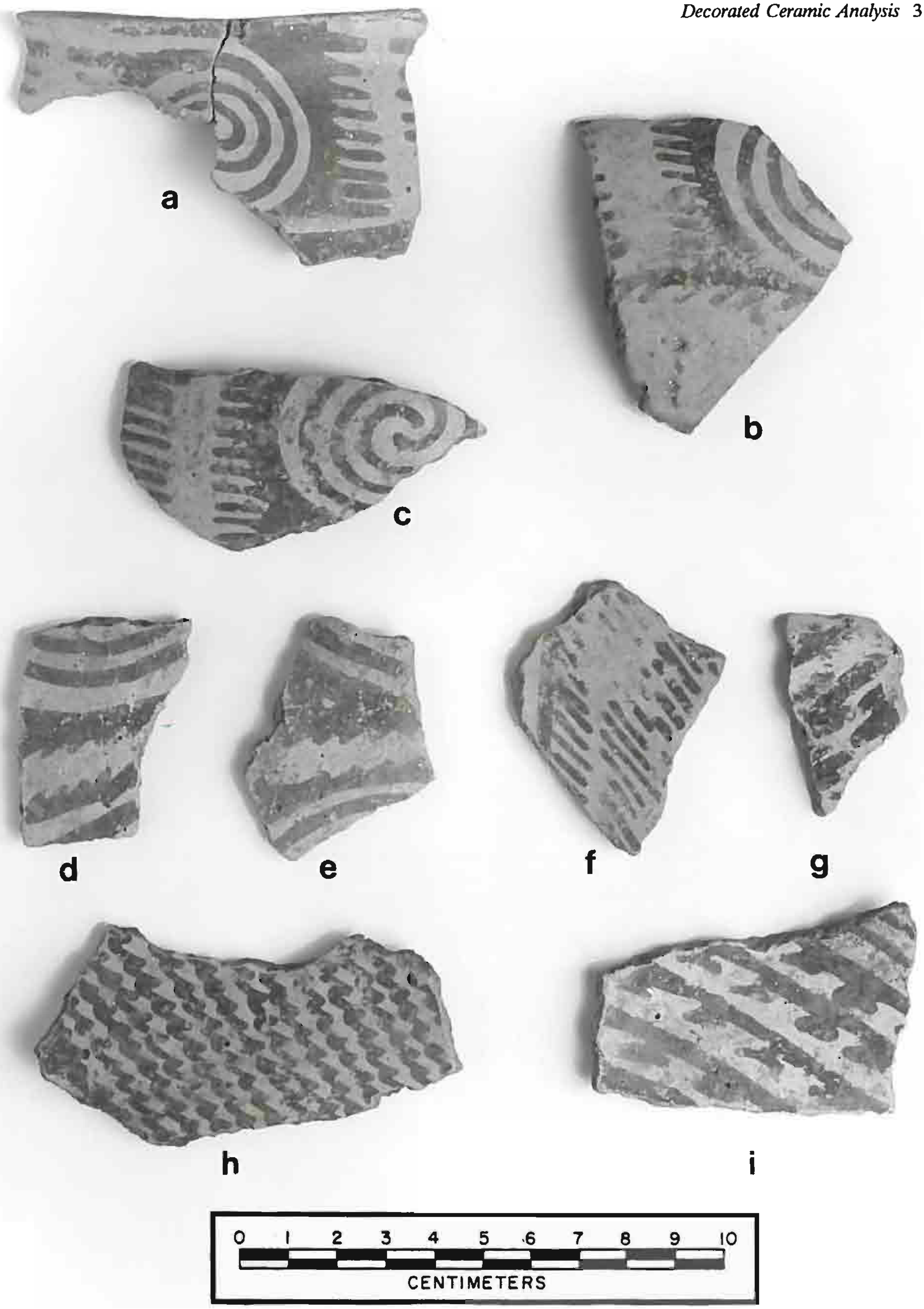

Figure 12.6. Gila Butte Red-on-buff sherds from the Deer Creek site AZ O:15:52: sherds from a single reconstructible vessel (a-c) and other examples of Gila Butte Red-on-buff sherds (d-i).

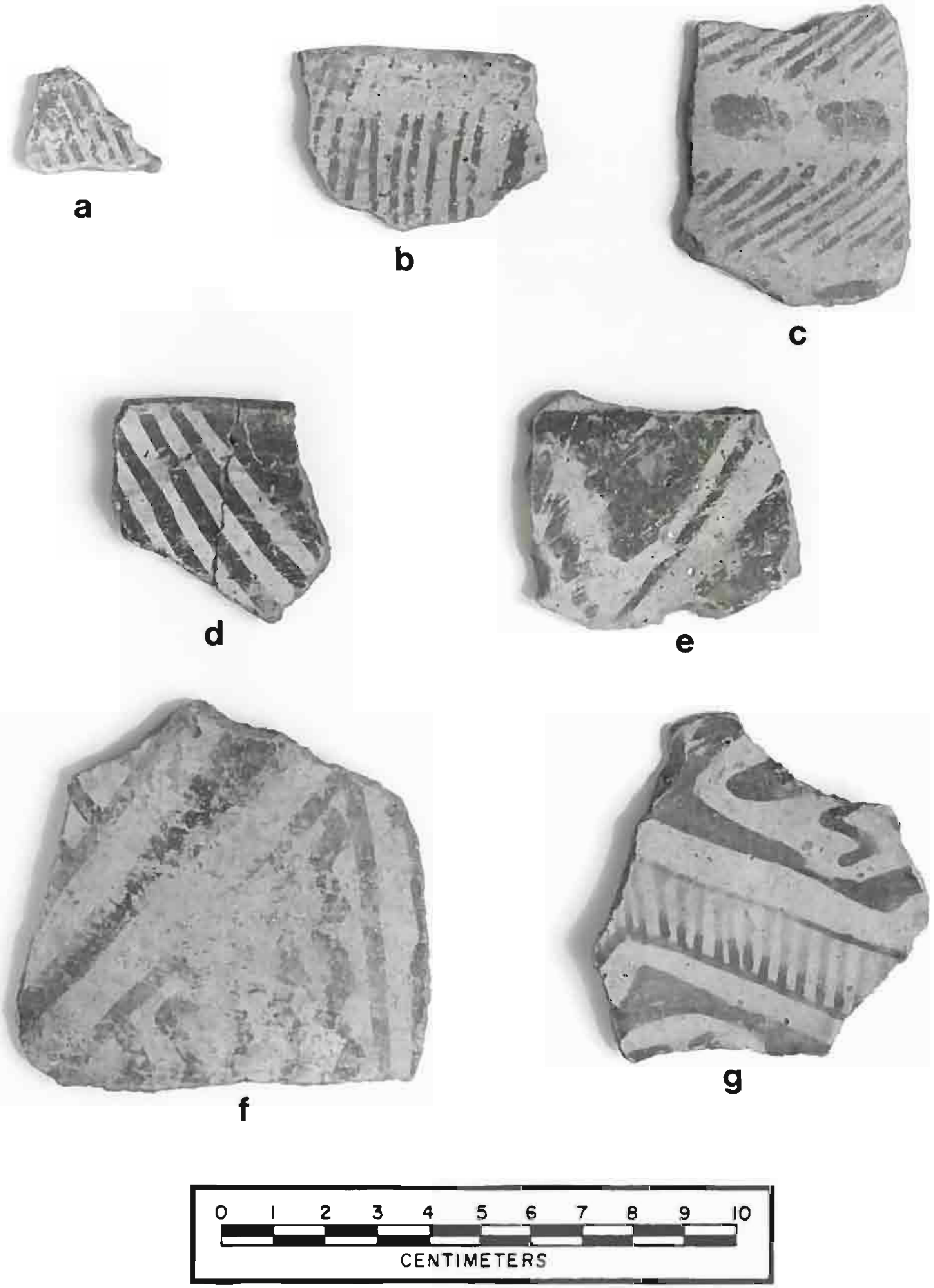

Figure 12.7. Santa Cruz Red-on-buff sherds (a-c) and Sacaton Red-on-buff sherds (d-g).

Little Colorado whiteware

1) carbon-base paint
2) white sherd, white sherd and quartz sand, or quartz sand temper
3) gray platey paste
4) decorated surfaces covered with thick white slip

Cibola whiteware

1) mineral-base paint
2) variable temper
    a. quartz sand
    b. sherd
    c. quartz sand and sherd
    d. mixed sand (coarse, medium, to fine-grain inclusions ranging from red to brown and gray to black in color)
    e. mixed sand and sherd
3) gray to white paste, occasionally with carbon streak
4) light gray to white slip of variable thickness on jar exteriors and bowl exteriors and interiors

(For a complete discussion of the technical attributes associated with each ware, see Colton and Hargrave 1937; Colton 1941, Colton 1955; Douglass 1987; Gladwin and Gladwin 1931; Gladwin 1945; W. Smith 1971).

Although this listing is gross in scope, because detailed compositional and technical data are not provided, such detail was not necessary to identify the Rye Creek whiteware sherds to the ware level. At this point in the analysis it was immaterial whether "mixed sand" was of an arkosic origin or a volcanic origin. What was important was that under the microscope "mixed sand" was visibly distinguishable from pure quartz sand and/or sherd temper and that "mixed sand" was a nonplastic inclusion unique to one of the three wares in question.

Therefore, given the above listing of attributes, indentification of whiteware sherds to the ware level was a process of elimination, with the initial cutoff being between decorated whiteware sherds and undecorated whiteware sherds.

Differentiating Among Decorated Whiteware Sherds

The most important technical attribute for distinguishing among decorated whiteware sherds concerned paint composition--that is, whether the paint was carbon- or mineral-based. The carbon versus mineral paint distinction was usually macroscopically observable. Carbon-based paint appeared to soak into the clay/slip, leaving an often indistinct or "fuzzy" line edge. Mineral-based paint appeared to rest on top of the clay/slip, leaving a distinct or "clean" line edge. If there was uncertainty as to a particular sherd's paint composition, a test for magnetism was carried out. This test, initially proposed by Colton (1941:13) and later applied by Doyel (1980:161-163), involved scraping off a bit of the questionable black paint (with a glass slide "to avoid electrostatic interference") onto a piece of clean white paper and then running a magnet under the paper to see if the paint particles were attracted to the magnet. If the majority of the paint particles were attracted to the magnet it was concluded that the paint was primarily of a mineral composition.

Whiteware sherds decorated with a mineral-based paint were coded automatically as Cibola whitewares; carbon-based painted sherds were either Tusayan or Little Colorado whitewares. Differentiating between decorated sherds of Tusayan whiteware and Little Colorado whiteware was fairly straightforward. The platey gray paste, predominantly sherd temper, and distinctive thick white slip of Little Colorado whiteware were a definitive combination of attributes which were distinguishable from the white paste, quartz sand temper, and thinly slipped surfaces of the Tusayan whiteware sherds.

Differentiating Among Undecorated Whiteware Sherds

Indentifying undecorated whiteware sherds to the ware level was problematic. Of the 95 undecorated whiteware sherds, 24 (25.3 per cent) were not identifiable to the ware level. In an attempt to maximize the information to be gained from the undecorated whiteware sherds, while still making a conscious effort not to force indeterminate sherds into a specific ware designation, four ceramic categories were added for the coding of undecorated whiteware sherds. As a result, there were seven possible ceramic class choices for undecorated whiteware sherds: 1) Tusayan whiteware, 2) Little Colorado whiteware, 3) Cibola whiteware, 4) Tusayan or Little Colorado whiteware, 5) Tusayan or Cibola whiteware, 6) Cibola or Little Colorado whiteware, and 7) indeterminate whiteware.

During the analysis of the undecorated whiteware sherds, the most ambiguous sherds were those that fell somewhere between Tusayan and Cibola whitewares. With white paste and quartz temper common to both, it was often difficult to distinguish between undecorated sherds of these two wares. When quartz temper was abundant and/or a thick carbon streak was present, however, the sherd was usually coded as a Tusayan whiteware. In contrast, the distinctive paste, temper, and slip of the Little Colorado whitewares made the coding of undecorated sherds of this ware fairly unambiguous. A summary of the results of the coding of undecorated whiteware sherds is presented in Table 12.4.

Table 12.4. Numbers and frequencies of identifiable undecorated whitewares and indeterminate whitewares.

Type	Numbers	Percent
Tusayan Whiteware	47	49
Little Colorado Whiteware	15	16
Cibola Whiteware	9	9
Tusayan or Little Colorado	1	1
Tusayan or Cibola	16	17
Cibola or Little Colorado	3	3
Indeterminate	5	5
Total	96	100

Whitewares: Ceramic Type Variable

The next step in coding the whitewares was assigning ceramic type designations. The types coded for each ware are discussed by ware below. It should be noted that due to the small size of the Rye Creek whiteware ceramic assemblage (an assemblage which becomes even smaller--for analytical purposes--when it is further divided into specific ware groupings), it was decided that the Rye Creek whiteware assemblage could not speak to the broader issues of refining whiteware typology. An attempt was made, however, to type the whiteware sherds according to the most current refinement of each of the specific ware taxonomies.

Tusayan Whitewares: Ceramic Type Variable

Tusayan whiteware types identified in the Rye Creek assemblage were: 1) Kana-a Black-on-white, 2) Black Mesa Black-on-white, and 3) Sosi Black-on-white. Identification of Tusayan whiteware types was based on the descriptions and illustrations found in Colton and Hargrave (1937), Colton (1952, 1955), and Beals et al. (1945). Additional reference literature (used mainly for illustrative purposes) included Downum (1988), Lindsay et al. (1968), Martin and Willis (1940), W. Smith (1971), and Wood (1987). It is noted that all the Rye Creek sherds typed as Sosi Black-on-white fell into Sosi Style I, as defined by Colton and Hargrave (1937). For illustrations of diagnostic Tusayan whitewares from the Rye Creek assemblage see Figure 12.8, 12.9, and 12.10.

Two categories were used for coding sherds that fell between diagnostic type groupings: 1) Kana-a or Black Mesa Black-on-white, and 2) Black Mesa or Sosi Black-on-white. Again these categories were initiated in order to maximize the temporal information to be gained from the assemblage. It is noted that sherds that were coded as Kana-a or Black Mesa Black-on-white could possibly have been identified as Wepo Black-on-white. Because I was unable to find a uniformly understood description of the stylistic attributes that would separate Wepo Black-on-white from Kana-a Black-on-white and Black Mesa Black-on-white, I was hesitant to identify sherds as Wepo Black-on-white. Consequently, the type was not used. The Black Mesa or Sosi Black-on-white category was primarily a grouping for Tusayan whiteware sherds that exhibited the broad linework characteristic of both Black Mesa Black-on-white and Sosi Black-on-white, yet failed to exhibit stylistic attributes diagnostic to one type in particular ("solid areas with large pendant dots": Black Mesa Black-on-white; "stripes or wide lines with large solid triangles, singly or in series": Sosi Black-on-white, Style II (Colton and Hargrave 1937)).

Two final categories were used to code sherds which were typologically insensitive: 1) Indeterminate Tusayan whiteware black-on-white and 2) Indeterminate Tusayan whiteware--no paint. For illustrations of Black Mesa or Sosi Black-on-white sherds see Figure 12.10.

In summary, there were seven ceramic type possibilities coded for Tusayan whiteware sherds: 1) Kana-a Black-on-white, 2) Kana-a or Black Mesa Black-on-white, 3) Black Mesa Black-on-white, 4) Black Mesa or Sosi Black-on-white, 5) Sosi Black-on-white, 6) Indeterminate Tusayan whiteware black-on-white, and 7) Indeterminate Tusayan whiteware--no paint.

Little Colorado Whitewares: Ceramic Type Variable

Little Colorado whiteware types identified in the Rye Creek assemblage included: 1) Holbrook Black-on-white Variety A (Black Mesa Style), 2) Holbrook Black-on-white Variety B (Sosi Style), 3) Walnut Black-on-white Variety A (Flagstaff Style), 4) Walnut Black-on-white Variety B (Walnut Style), 5) Padre Black-on-white, and 6) Leupp Black-on-white. Little Colorado whiteware types were assigned according to the recent stylistic work done by Douglass (1987), with reference to the original typologies published by Colton and Hargrave (1937) and Colton (1955), and to the illustrations and text found in Smith (1971). For illustrations of diagnostic Little Colorado whiteware sherds from the Rye Creek assemblage see Figure 12.11.

Three categories were used to code sherds which fell between diagnostic type groupings: 1) Holbrook Black-on-white Variety A or B, 2) Walnut Black-on-white Variety A or B, and 3) a general "Late" category. The Holbrook Black-on-white Variety A or B category was used to classify sherds that had broad linework but failed to exhibit specific stylistic attributes diagnostic to just one of the Holbrook types (analogous to the Tusayan whiteware category Black Mesa or Sosi Black-on-white). The Walnut Black-on-white Variety A or B category was used to code sherds that displayed the relatively tight and narrow linework common to both Walnut types but not diagnostic to one type in particular. This category also was used to type sherds that displayed stylistic attributes shared by both of the Walnut types, such as "plaited" linework and ticked lines (Douglass 1987). The final category, labeled "Late," was initiated in order to code sherds whose decoration was within the range of the Walnut, Padre, and Leupp types, but not diagnostic to one type over another, such

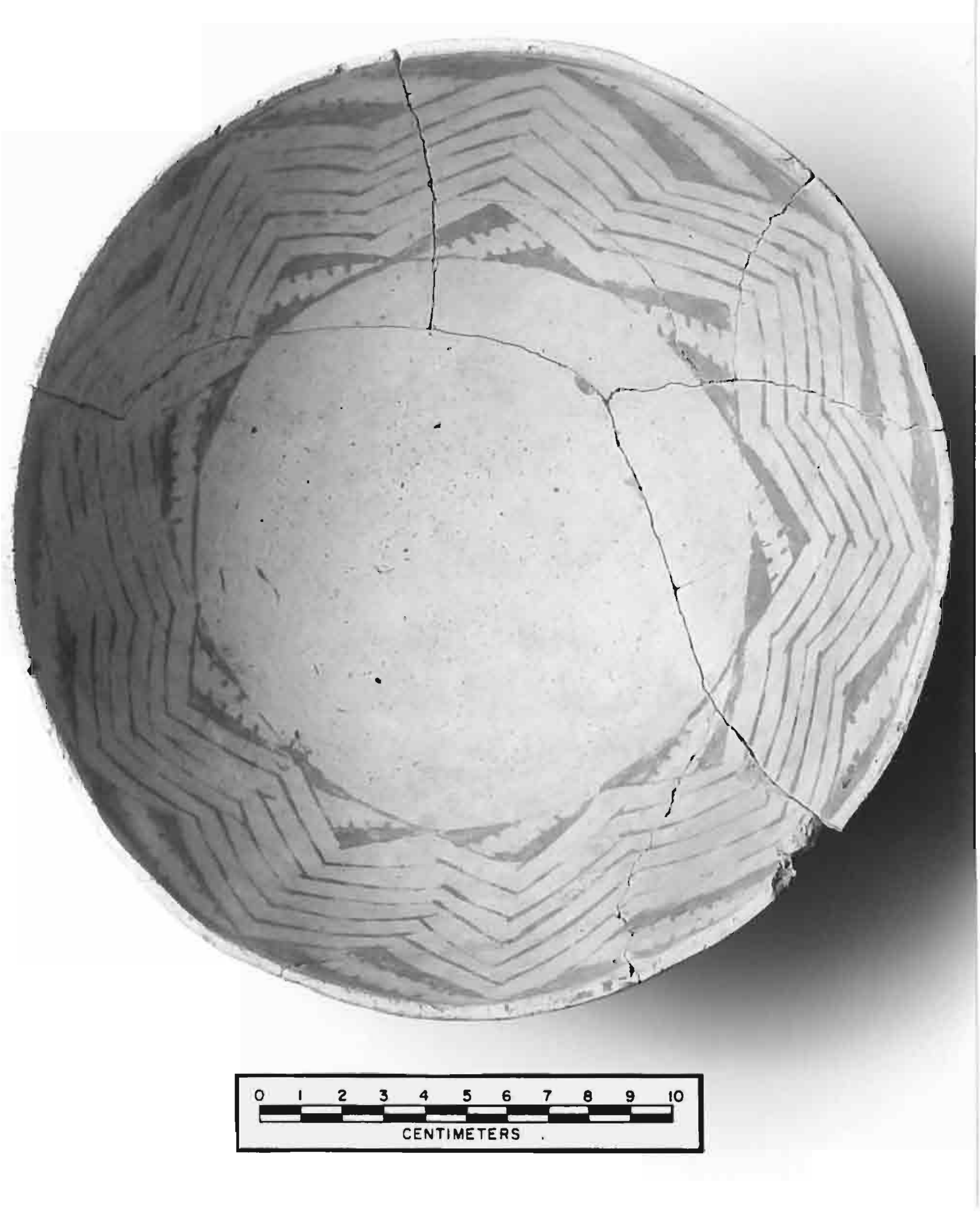

Figure 12.8. Interior of a Kana-a Black-on-white reconstructed bowl from the Deer Creek site, AZ O:15:52.

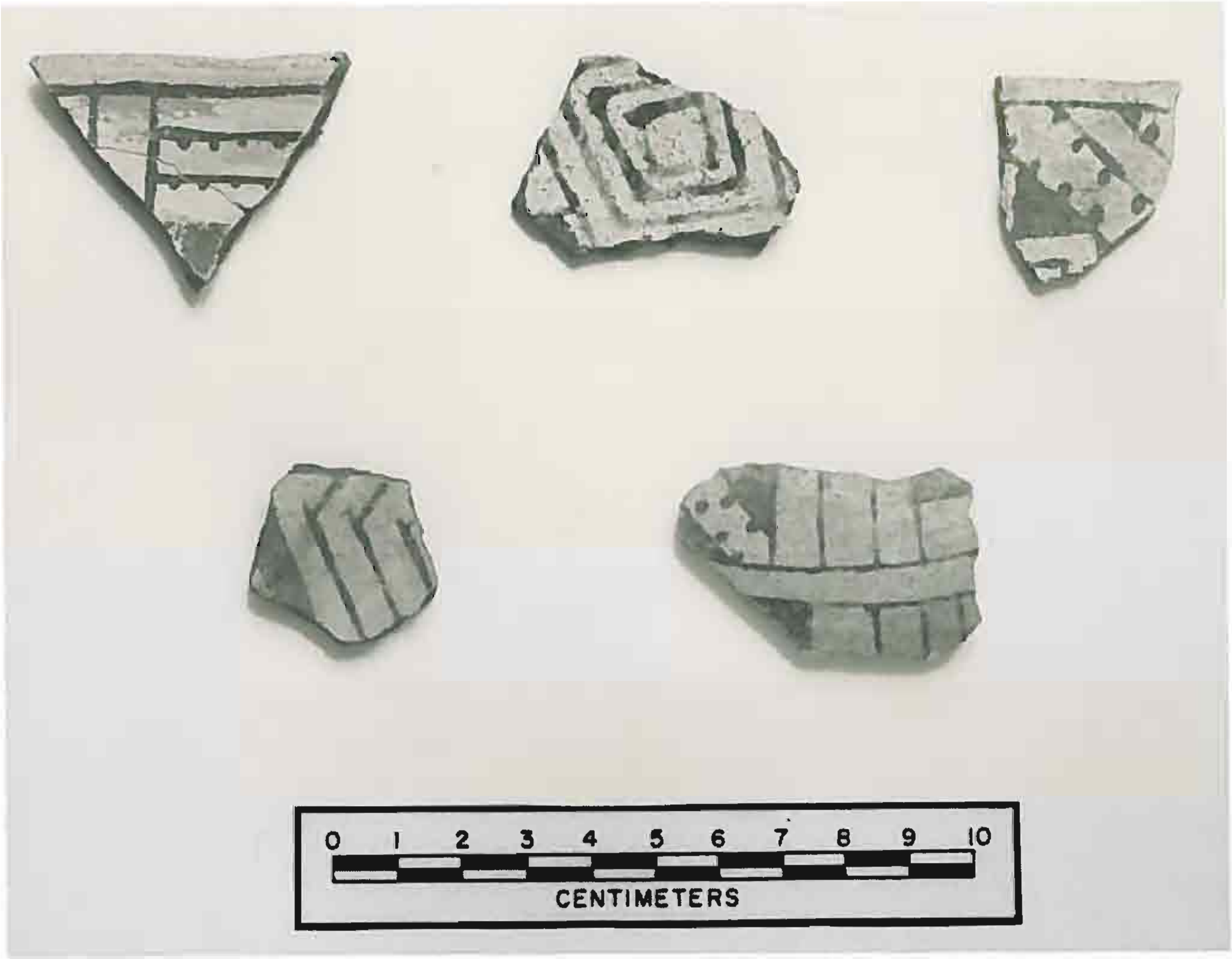

Figure 12.9. Kana-a Black-on-white sherds.

as cross-hatching filled with unappended dots (Douglass 1987). For illustrations of two Little Colorado whiteware sherds coded as "Late" see Figure 12.11.

Two categories were used to code Little Colorado whiteware sherds that eluded typological classification: 1) Indeterminate Little Colorado whiteware black-on-white, and 2) Indeterminate Little Colorado whiteware--no paint.

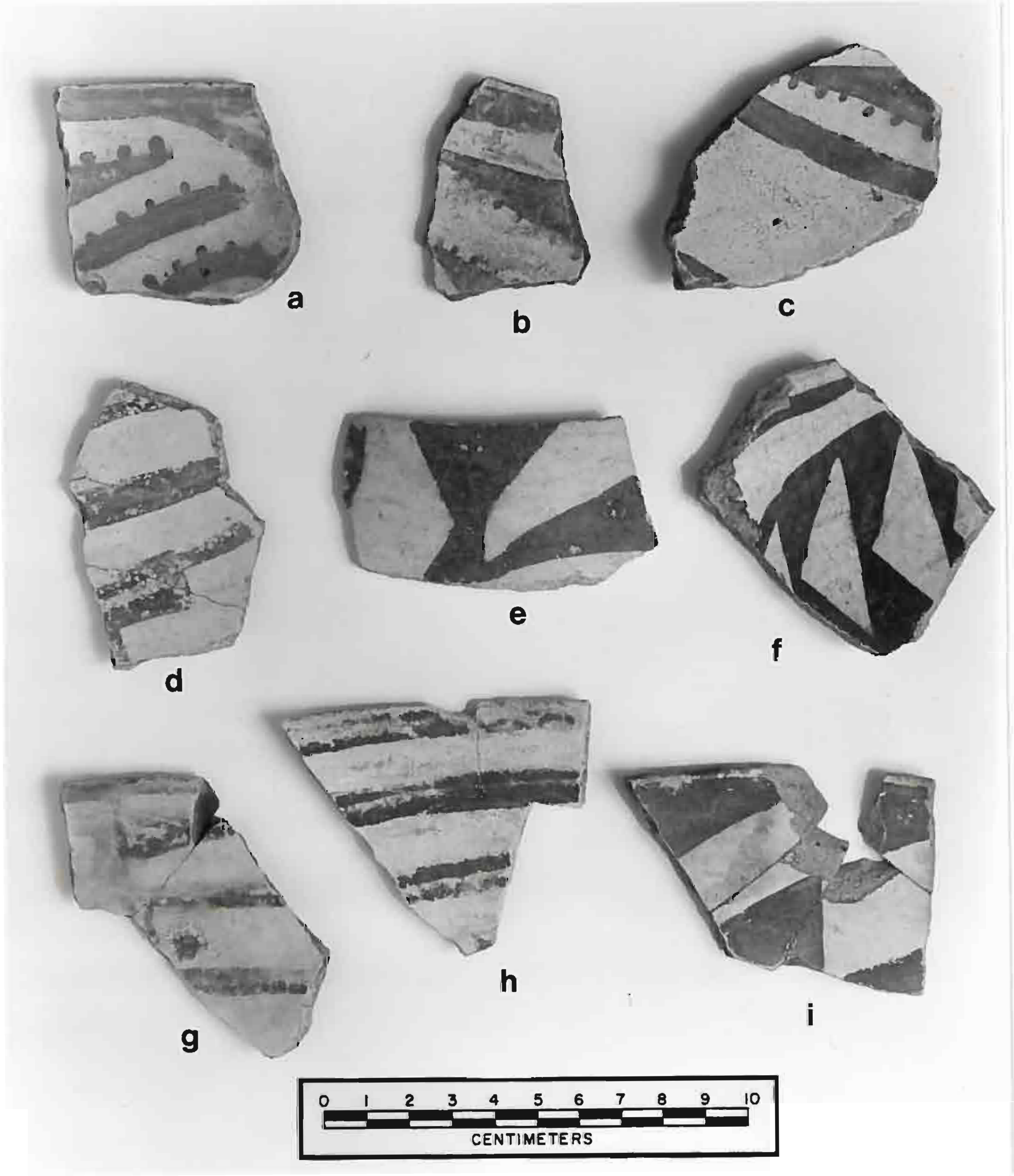

Figure 12.10. Black Mesa Black-on-white sherds (a-c), Sosi Black-on-white sherds (d, e), and Black Mesa or Sosi Black-on-white sherds (f-i).

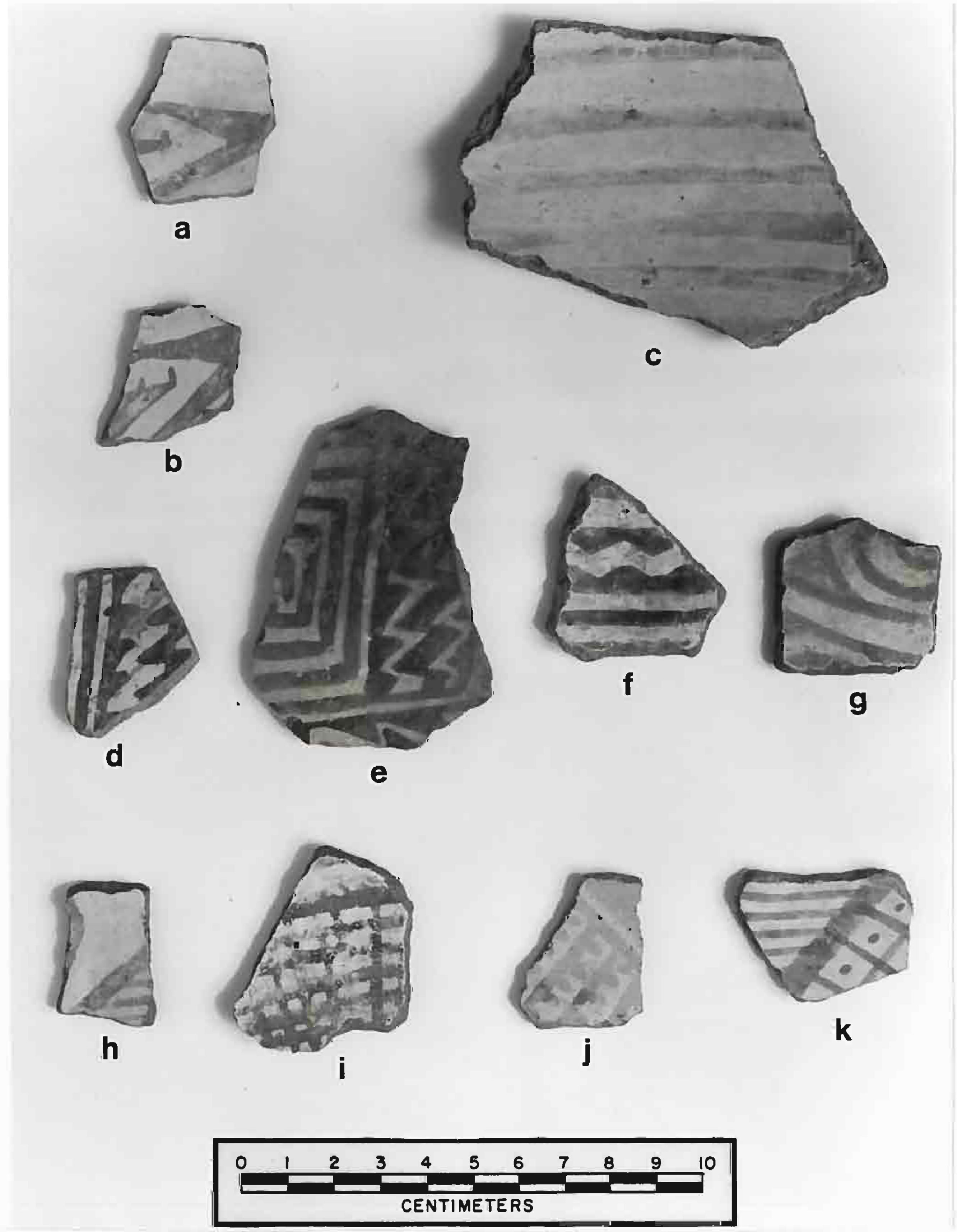

Figure 12.11. Holbrook Black-on-white Variety A sherds (a, b), Holbrook Black-on-white Variety B sherd (c), Walnut black-on-white Variety A sherds (d, e), Walnut Balck-on-white Variety B sherds (f, g), a Padre Black-on-white sherd (h), a Leupp Black-on-white (i), and "Late" Little Colorado whiteware sherds (j, k).

In summary, there were eleven ceramic types coded for Little Colorado whiteware sherds: 1) Holbrook Black-on-white Variety A, 2) Holbrook Black-on-white Variety A or B, 3) Holbrook Black-on-white Variety B, 4) Walnut Black-on-white Variety A, 5) Walnut Black-on-white Variety A or B, 6) Walnut Black-on-white Variety B 7) Padre Black-on-white, 8) Leupp Black-on-white, 9) "Late," 10) Indeterminate Little Colorado whiteware black-on-white, and 11) Indeterminate Little Colorado whiteware--no paint.

Cibola Whitewares: Ceramic Type Variables

There were seven Cibola whiteware types identified in the Rye Creek decorated assemblage: 1) Kiatuthlanna Black-on-white, 2) Red Mesa Black-on-white, 3) Snowflake Black-on-white, 4) Puerco Black-on-white, 5) Reserve Black-on-white, 6) Tularosa Black-on-white, and 6) Pinedale Black-on-white. As mentioned earlier in this chapter, there were particular difficulties in determining what the Cibola whiteware types actually were and what attributes were diagnostic of these types. Perhaps most disconcerting is the fact that there appears to be little agreement among those working with Cibola ceramics, either presently or in the past. After an extensive literature review (Colton and Hargrave 1937; Crown 1981b; Dosh 1988; Doyel 1980; Ferg 1978; Fowler 1989; Gladwin 1945; Gladwin and Gladwin 1931; Haury 1985; Longacre 1964; Martin and Rinaldo 1950; Martin et al. 1956; Martin and Willis 1940; Mills 1987; Reid et al. 1982; Sullivan and Hantman 1984; Swarthout and Dulaney 1982; Wasley 1959; Windes and McKenna 1989; Wood 1987), it was concluded that the type descriptions/discussions presented by Mills (1987) and Fowler (n.d., 1989) were the most comprehensive in scope and unambiguous and definitive in content.

Particularly noteworthy is a chart presented by Mills (1987:86, Figure 11.1) that illustrates a taxonomic hierarchy, based on stylistic variation, for classifying Cibola whiteware. In coding the Rye Creek Cibola whiteware sherds to the type level, an attempt was made to adhere to Mills' classification schema. It is noted that an exception was made when distinguishing Kiatuthlanna Black-on-white from Red Mesa Black-on-white. In differentiating between these two types a technological factor was also considered. As discussed by Fowler (1989:3), Kiatuthlanna Black-on-white (at least from the Zuni area) is "generally very smooth and well polished, with a good slip, and predominantly fine sand temper." These attributes also were observed in the Kiatuthlanna Black-on-white sherds from the Rye Creek assemblage. Consequently, the criteria for identifying Kiatuthlanna Black-on-white were both stylistic and technological.

A single sherd from the Rye Creek assemblage (from Rye Creek Ruin) was assigned to Pinedale Black-on-white, a type not discussed by Mills or Fowler. The assignment was based on descriptions found in Colton and Hargrave (1937), Carlson (1970), and Crown (1981b).

For illustrations of diagnostic Cibola whitewares from the Rye Creek assemblage see Figures 12.12, 12.13, and 12.14.

Two categories were used to code sherds that fell between diagnostic type groupings: 1) Kiatuthlanna or Red Mesa Black-on-white, and 2) Reserve or Tularosa Black-on-white. The Kiatuthlanna or Red Mesa Black-on-white category was used to code sherds that exhibited medium width linework but no other stylistic or technical attribute unique to one of the types in particular (such as pendant dots or ticks for Red Mesa Black-on-white (Mills 1987), or a well-polished surface and predominant sand temper for Kiatuthlanna Black-on-white (Fowler 1989:3)). The Reserve or Tularosa Black-on-white category was initiated in order to deal with sherds that, as Crown (1981b:240) states in reference to the manner of execution of hatching lines, "might either be considered well-painted Reserve or sloppy Tularosa Style."

Two final categories were used to code the indeterminate Cibola whiteware sherds: 1) Indeterminate Cibola whiteware black-on-white, and 2) Indeterminate Cibola whiteware--no paint. A single reconstructible vessel was coded in the "Indeterminate Cibola whiteware black-on-white" category (see Figure 12.14). This vessel fails to fit into any of the temporally sensitive type groupings as they are currently defined. Its banded layout and bold solids are reminiscent of Puerco Style, as defined by Doyel (1980). Or, in contrast, the "negative lightening" motif, according to Mills (personal communication, 1989), is suggestive of designs diagnostic to Escavada Black-on-white. Consequently, though this vessel is not diagnostic of a particular type, it does

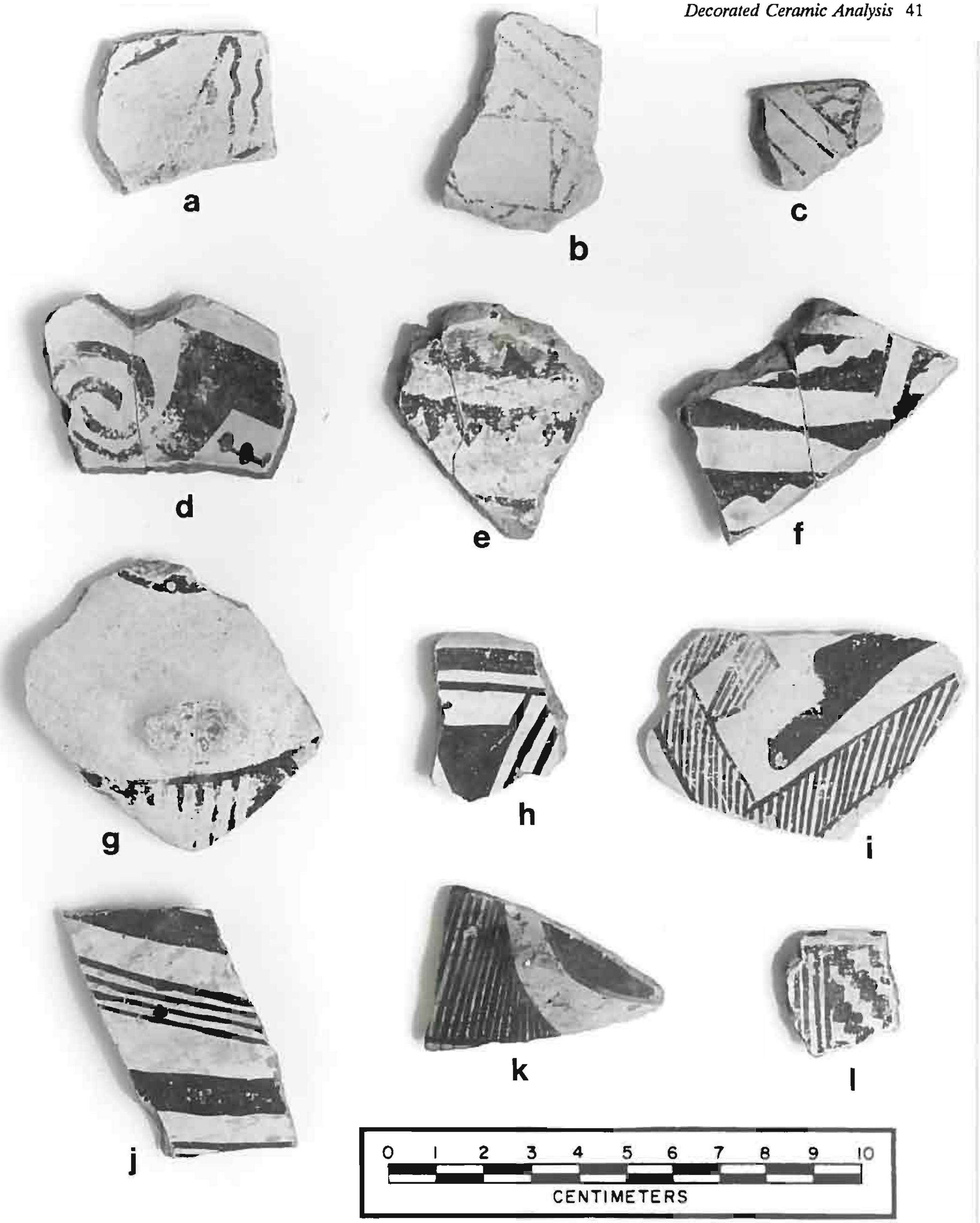

Figure 12.12. Kiatuthlanna Black-on-white sherds (a-c), Red Mesa Black-on-white sherds (d-f), Puerco Black-on-white sherds (g, h), Tularosa Black-on-white sherds (i-k), and a Pinedale Black-on-white sherd (l).

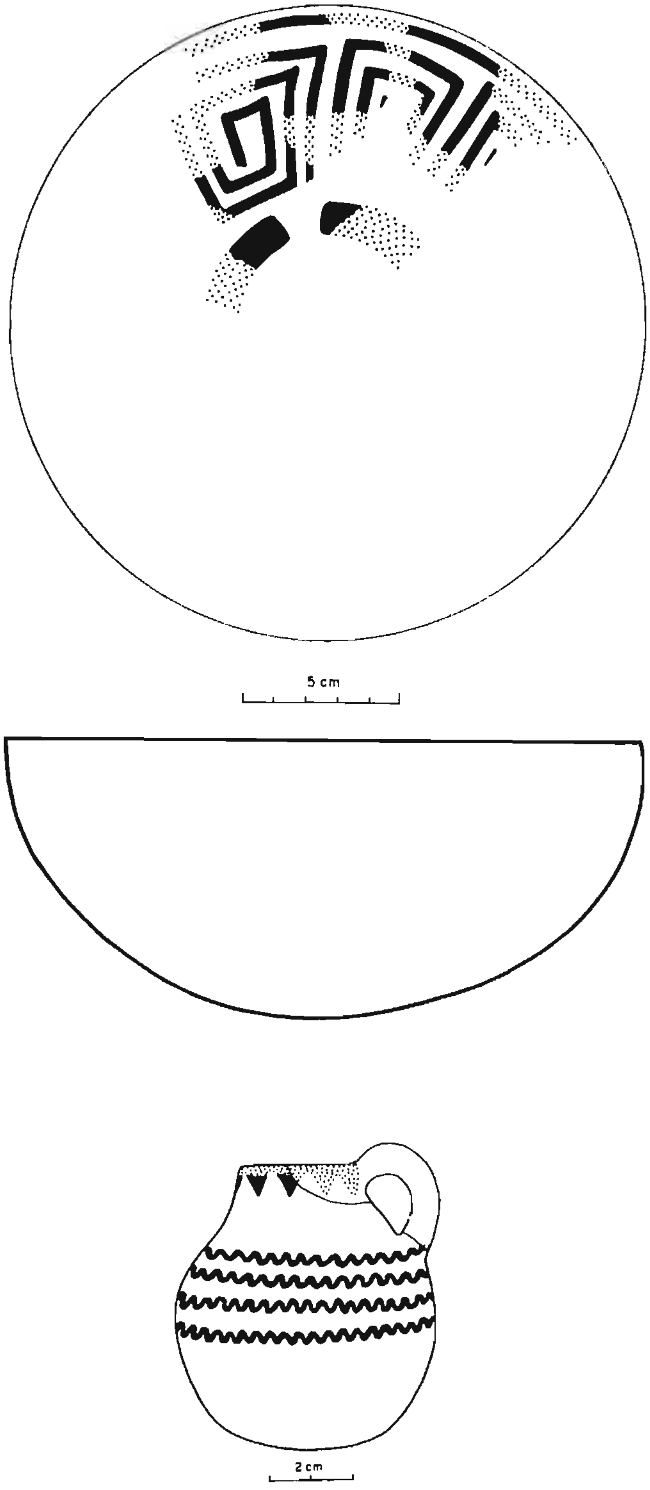

Figure 12.13. Illustration of a Snowflake Black-on-white partially reconstructible vessel from the Boone Moore site (AZ O:15:55) and a Red Mesa Black-on-white whole vessel from the Redstone site (AZ O:15:91).

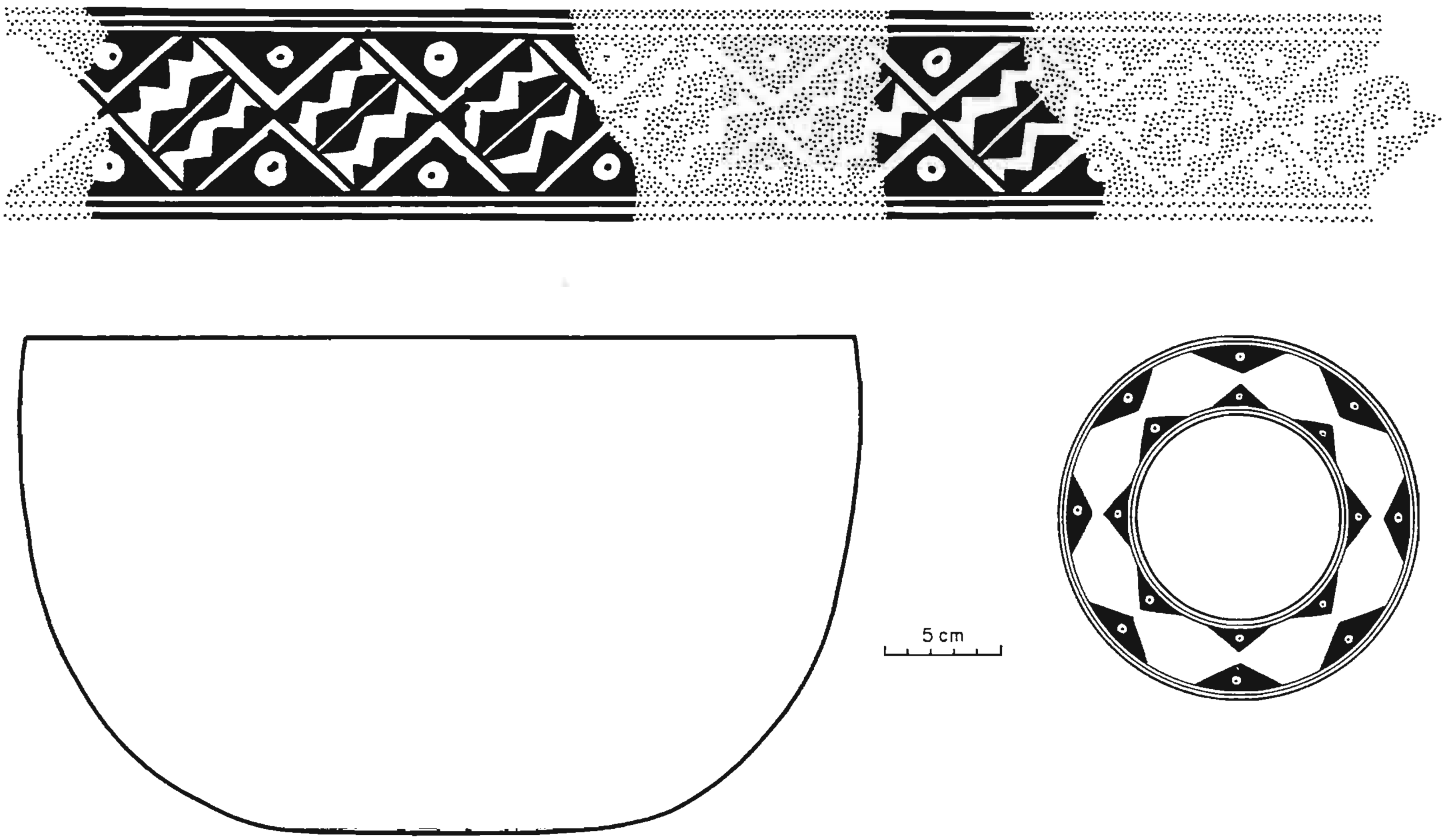

Figure 12.14. Illustration of an Indeterminate Cibola Whiteware (Puerco or Escavada Black-on-white) reconstructible vessel from the Boone Moore site (AZ O:15:55).

appear to be a product of a particular time. Therefore it was given temporal equivalence with Puerco and Escavada Black-on-white, two types of near contemporaneity.

In summary, eleven ceramic types were coded for Cibola whiteware sherds: 1) Kiatuthlanna Black-on-white, 2) Kiatuthlanna or Red Mesa Black-on-white, 3) Red Mesa Black-on-white, 4) Snowflake Black-on-white, 5) Puerco Black-on-white 6) Reserve Black-on-white, 7) Reserve or Tularosa Black-on-white, 8) Tularosa Black-on-white, 9) Pinedale Black-on-white, 10) Indeterminate Cibola whiteware black-on-white, and 11) Indeterminate Cibola whiteware--no paint.

Remaining Decorated Sherds: Ceramic Class and Ceramic Type Variables

The remaining decorated sherds were coded under ten ceramic classes: 1) Roosevelt redware, 2) White Mountain redware, 3) Hopi ware, 4) Winslow orangeware, 5) San Juan redware, 6) Tsegi orangeware, 7) Tusayan grayware, 8) Mogollon brownware, 9) Local red-on-brown, and 10) Indeterminate. As discussed in the previous section, these wares and their corresponding type designations were assigned according to the opinions of various consultants, with subsequent referral to relevant literature.

Roosevelt Redwares: Ceramic Type Variable

There were four Roosevelt redware types identified in the Rye Creek decorated assemblage: 1) Pinto Black-on-red, 2) Pinto Polychrome, 3) Gila Polychrome, and 4) Tonto Polychrome (for type discussions see Colton and Hargrave 1937; Lindsay and Jennings 1968; and Crown 1983). Diagnostic Roosevelt redwares from the Rye Creek assemblage are illustrated in Figure 12.15.

One category was used to code sherds which fell between the type descriptions for Pinto Polychrome and Gila Polychrome. Two categories were initiated to code sherds which eluded typological classification: 1) Indeterminate Roosevelt redware black-on-red, and 2) Indeterminate Roosevelt redware--no black paint and no white slip.

In summary, there were seven ceramic types coded for Roosevelt Redware: 1) Pinto Black-on-red, 2) Pinto Polychrome, 3) Pinto or Gila Polychrome, 4) Gila Polychrome, 5) Tonto Polychrome, 6) Indeterminate Roosevelt redware Black-on-red, and 7) Indeterminate Roosevelt redware--no black paint and no white slip.

White Mountain Redwares: Ceramic Type Variable

There were four White Mountain redware types identified in the Rye Creek decorated assemblage: 1) St. John's Black-on-red, 2) Pinedale Black-on-red, 3) Fourmile Polychrome (for type discussion see Carlson 1970), and 4) Cibecue Polychrome (for type discussion see Haury 1934). The placement of Cibecue Polychrome within the White Mountain redware class is questionable. Haury's (1934) original remarks are that Cibecue Polychrome is a "local" response to White Mountain redware and Mogollon brownware influences. By "local" Haury confines the type to east-central Arizona, primarily below the Mogollon Rim. Later references classify Cibecue Polychrome as a Roosevelt redware (Colton 1965) and a White Mountain redware (Wood 1987). It is noted that Carlson's (1970) comprehensive discussion of White Mountain redware never mentions Cibecue Polychrome. My decision here to include Cibecue Polychrome as a White Mountain redware is tentative. Yet, considering Cibecue Polychrome's suggested Mogollon Rim region origins (Haury 1934; Wood 1987), in conjunction with its White Mountain redware stylistic attributes (Haury 1934), this type for the moment is placed within the White Mountain redware tradition. Diagnostic White Mountain redware sherds from the Rye Creek assemblage are illustrated in Figure 12.16.

One category was used to code sherds that fell between the type descriptions for Pinedale Polychrome and Fourmile Polychrome. Two categories were initiated to code sherds that were not temporally sensitive: 1) Indeterminate White Mountain redware polychrome, and 2) Indeterminate White Mountain redware black-on-red.

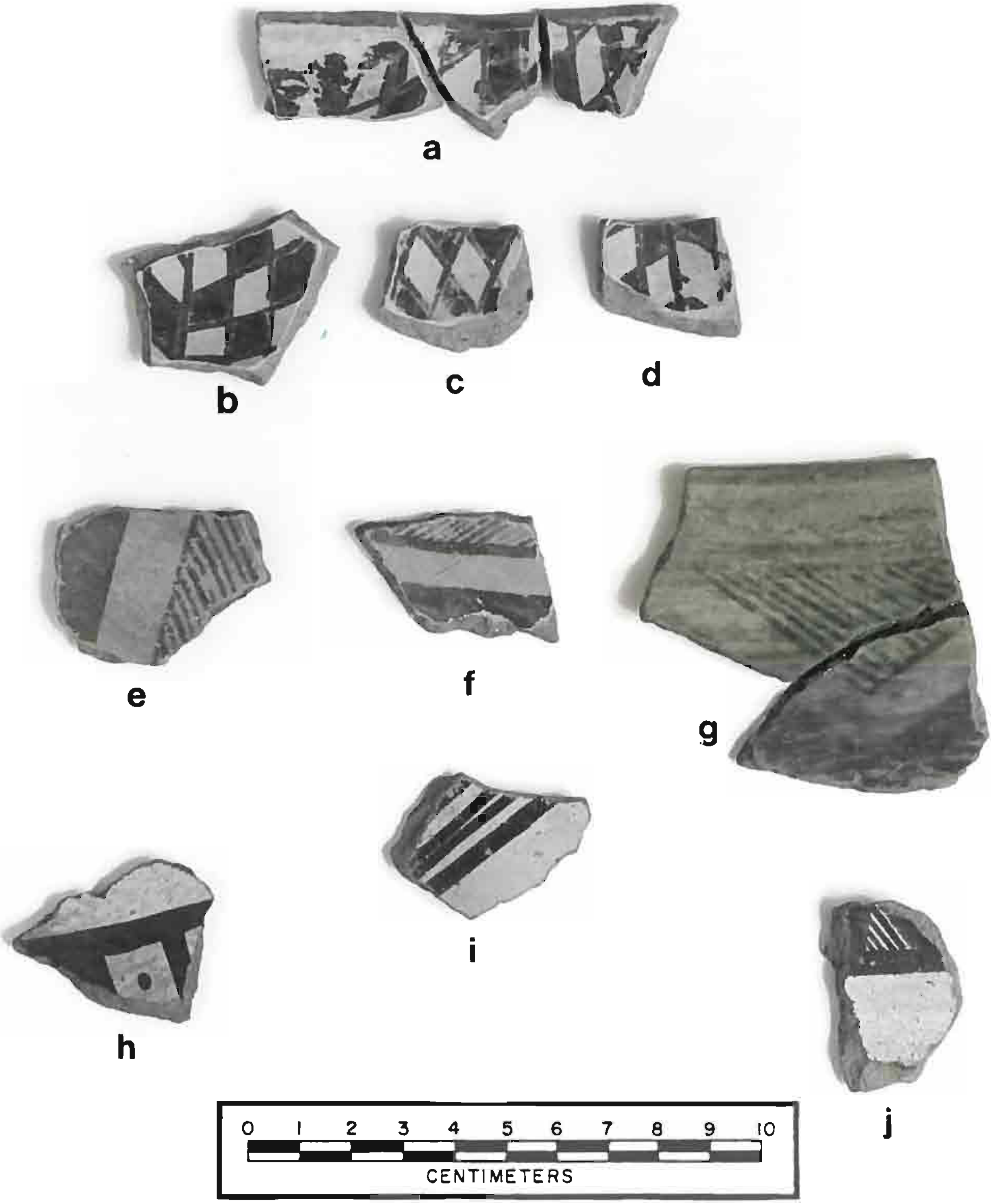

Figure 12.15. Sherds from a Pinto Polychrome partially reconstructible vessel (a-d), Pinto Black-on-red sherds (e-g), and Gila Polychrome sherds (h-j).

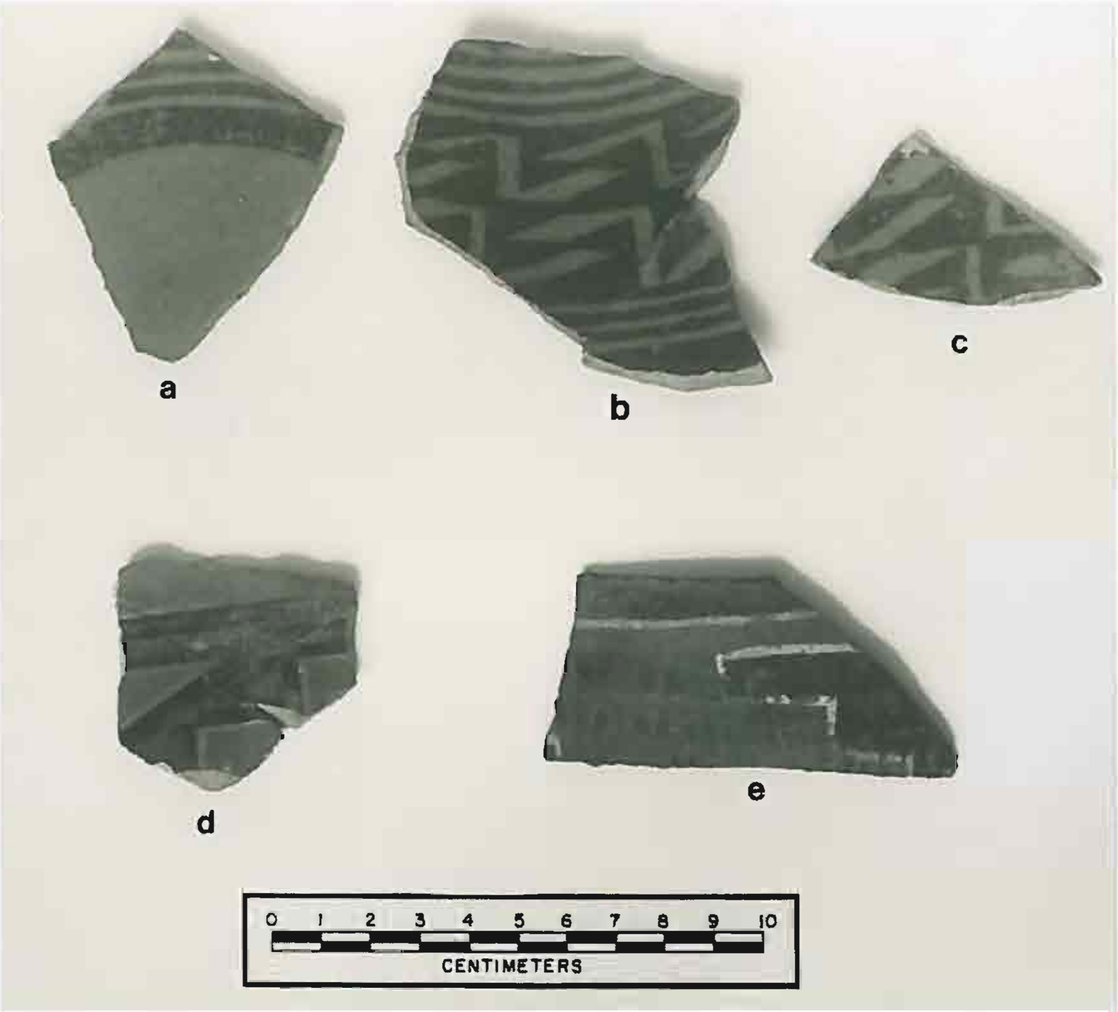

Figure 12.16. Sherds from a St. John's Black-on-red partially reconstructible vessel (a-c), a Fourmile Polychrome sherd (d), and a Cibecue Polychrome sherd (e).

In summary, seven ceramic types were coded for White Mountain redware: 1) St. John's Black-on-red, 2) Pinedale Black-on-red, 3) Pinedale or Fourmile Polychrome, 4) Fourmile Polychrome, 5) Cibecue Polychrome, 6) Indeterminate White Mountain redware polychrome, and 7) Indeterminate White Mountain redware black-on-red.

Hopi Wares: Ceramic Type Variable

The Hopi ware ceramic class included two separate ceramic wares: 1) Jeddito yellowware, and 2) Bidahochi Black-on-white (a single type that, according to Colton and Hargrave (1937) and W. Smith (1971), is a ware unto itself) (For in-depth discussions on these wares and their corresponding types see Smith (1971)).

Ceramic types coded for Jeddito yellowware included one diagnostic type: Awatovi Black-on-yellow; Awatovi or Jeddito Black-on-yellow; and one indeterminate type: Indeterminate Jeddito yellowware--no paint.

For illustrations of the diagnostic types coded within the Hopi ware ceramic class see Figure 12.17.

In summary, four ceramic types were coded for the Hopi ware ceramic class: 1) Awatovi Black-on-yellow, 2) Awatovi or Jeddito Black-on-yellow, 3) Indeterminate Jeddito yellowware--no paint, and 4) Bidahochi Black-on-white.

Winslow Orangewares: Ceramic Type Variable

There were three ceramic types coded for Winslow orangeware, all three were diagnostic types: 1) Tuwiuca Black-on-orange, 2) Homolovi Polychrome, and 3) Chavez Pass Black-on-red. Discussions concerning these types can be found in Colton and Hargrave (1937), Colton (1955), and Smith (1971). It is noted, however, that the identification of these types is in agreement with the current refinement of the Winslow orangeware typology by the Homolovi Research Project (University of Arizona). Notable Homolovi Project revisions include Chavez Pass Black-on-red being viewed as a slipped (red or orange) version of Tuwiuca Black-on-orange, and of Tuwiuca Black-on-orange being classified as the bichrome version of Homolovi Polychrome (Kelley Hays, personal communication, 1989). For illustrations of Winslow orangeware sherds from the Rye Creek excavations, see Figure 12.17.

San Juan Redwares: Ceramic Type Variable

Two ceramic types were coded for San Juan redware: Deadmans Black-on-red and Indeterminate San Juan Redware black-on-red. Discussions of San Juan redware can be found in Colton and Hargrave (1937), Abel (1955), and Breternitz et al. (1974).

Tsegi Orangewares: Ceramic Type Variable

There were five ceramic types coded for Tsegi orangeware, two diagnostic types: 1) Tusayan Polychrome variety A, and 2) Cameron Polychrome; and three indeterminate types: 1) Indeterminate Tsegi orangeware polychrome, 2) Indeterminate Tsegi orangeware black-on-red, and 3) Indeterminate Tsegi orangeware--no paint. Tsegi orangeware is defined by Colton and Hargrave (1937) and Abel (1956).

Tusayan Graywares: Ceramic Type Variable

There was one ceramic type coded for Tusayan grayware: 1) Tusayan corrugated, a type defined by Colton and Hargrave (1937), and Colton (1955).

Mogollon Brownwares: Ceramic Type Variable

There were three ceramic types coded for Mogollon brownware, all were diagnostic types: 1) Show Low Black-on-red, 2) Show Low Black-on-red Corrugated, and 3) Maverick Mountain Polychrome. The two Show Low types were originally recorded under the Homolovi Series by Colton and Hargrave (1937). Type descriptions have been refined and reworked by Fowler (1989), resulting in the inclusion of the Show Low Series with Mogollon brownware--Woodruff Series (as originally recommended by Colton and Hargrave 1937:79). A single Maverick Mountain Polychrome sherd was identified in the Rye Creek decorated assemblage. The identification was made by Lex Lindsey (Arizona State Museum, personal communication from Steve Lekson, 1989). Discussions on this type can be found in E. A. Morris (1957) and Wasley (1962).

Local Red-on-browns: Ceramic Type Variable

Two ceramic type divisions were coded for the Local red-on-brown category: 1) Local red-on-brown with possible Hohokam design element, and 2) Local red-on-brown with indeterminate design element. Discussion of this ceramic class can be found at the beginning of this chapter. For illustrations of Local red-on-brown sherds from the Rye Creek assemblage see Figure 12.3.

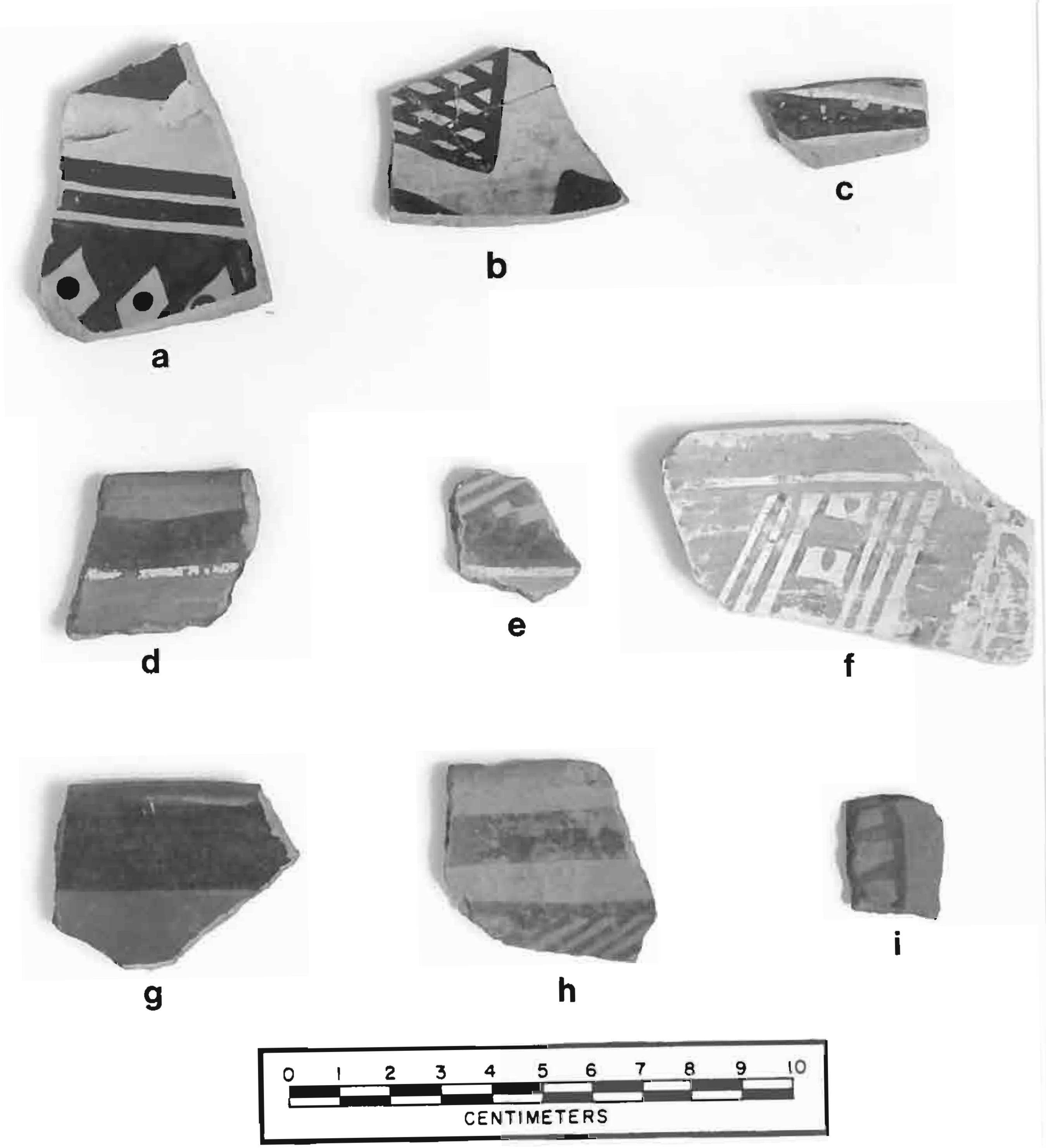

Figure 12.17. Awatovi Black-on-yellow sherds (a, b), Bidahochi Polychrome sherd (c), Homolovi Polychrome sherds (d, e), Bidahochi Black-on-white sherd (f), Tuwiuca Black-on-orange sherds (g, h), Chavez Pass Black-on-red sherd (i).

Indeterminate Ceramic Class: Ceramic Type Variable

All sherds coded in the indeterminate ceramic class category were similarly coded in an indeterminate ceramic type category.

SITE DATING

As discussed earlier, the temporal ordering of the Rye Creek sites and, more specifically, of individual loci, features, and fill episodes at these sites, was limited by the lack in quantity of diagnostic decorated sherds and by the large number of excavated contexts lacking good contextual integrity. Despite these problems, the relative ceramic ordering of the Rye Creek sites and site features was attempted, partly with the understanding that the co-occurrence of several temporally diagnostic types from a limited site area or a particular context would tighten the temporal resolution attainable for the site. Furthermore, because many of the sites were small, single-component occupations, the lack of contextual integrity was not considered a serious problem, since it is most probable that all of the recovered ceramics, regardless of context, date to the occupation of the site. The greatest weight, however, was placed on diagnostic ceramics recovered from contexts that the contextual analysis determined to be of higher integrity (see Chapter 11).

The methodology used in dating the sites was a "best fit" approach. The approach takes into account the frequency and context of the diagnostic decorated types present at the site, and assesses both the longest possible occupation span and a more refined period where the ceramics display the greatest temporal overlap. Each site was considered as its own case. Raw counts and relative frequencies for each coded ceramic type were totaled by site (or, when further refinement could be attempted, by particular locus, feature, or fill episode at the site). A plot was then made showing the temporal span for each of the temporally sensitive types identified at the particular site (or, again, when appropriate, for each of the singled-out contexts at the particular site). The plots in conjunction with the frequency data, the site/feature descriptions, and the results of the contextual analysis were considered, and a best-fit date was arrived at. The raw counts are presented below by site, feature, and stratum with a discussion of what dates were assigned, and why these dates appear to be the best fit. The sites are presented in chronological order (of the primary component), from earliest to latest.

A master list of absolute dates and their respective sources used for dating the ceramic types identified in the Rye Creek Project area was compiled for this portion of the analysis (Table 12.5). An attempt was made to seek out dates which represented the most current refinement within a specific typology. In cases where ceramic type dates are particularly subject to controversy, a listing of the conflicting possibilities was provided. For a more complete discussion of site chronology, including consideration of both the relative ceramic dates and the recovered absolute dates, see Chapter 25.

The Deer Creek Site (AZ O:15:52): A.D. 750-850; (950-1150)

The Deer Creek site is a small pithouse hamlet, the largest pithouse site in the project area. Features excavated at the site included 17 pithouses, 13 crematoriums, six secondary cremations, two inhumations, and numerous extramural pits. The decorated ceramic assemblage from the site is both the largest and the earliest of any of the decorated assemblages within the project area, and one of the earliest assemblages from the Tonto Basin in general. As can be seen in Tables 12.2 and 12.6, Gila Butte Red-on-buff overwhelmingly dominates the assemblage, strongly suggesting that the greatest intensity of occupation at the Deer Creek site was during the Gila Butte phase. The occurrence of 12 Snaketown Red-on-buff sherds and 13 Snaketown or Gila Butte Red-on-buff sherds is suggestive of an earlier occupation of the site area. Moreover, the presence of two Santa Cruz Red-on-buff sherds, 50 Gila Butte or Santa Cruz Red-on-buff sherds, 10 Kana-a Black-on-white sherds, and six Sacaton Red-on-buff sherds, indicates that there is a later component as well.

The dating of the Gila Butte phase is currently the subject of some debate (Cable and Doyel 1987; Ciolek-Torrello 1988; Dean 1990; Eighmy and McGuire 1988; Gladwin et al. 1965; Haury 1976; Plog 1980; Schiffer 1982; Wallace and Craig 1988; Wilcox and Shenk 1977). The dates used here are those recently compiled by Wallace (see Chapter 24), who conducted an extensive study of Gila Butte Red-on-buff ceramics in association with tree-ring dates or tree-ring-dated ceramics. Wallace suggests that the Gila Butte phase best dates between A.D. 750 and 850.

As to assigning particular contexts from the Deer Creek site to particular temporal components there was some success and much ambiguity. Table 12.6 presents the distribution of the diagnostic sherds at the site. In singling out first the floor contexts, it is noted that the floors/floor fills of Features 6, 11, and 18 have relatively high numbers of diagnostic Gila Butte Red-on-buff sherds, a uniformity in diagnostic types, and were considered to have a relatively high contextual integrity (particulary in the case of Features 6 and 18). Consequently, it is asserted that the abandonment of these three structures quite solidly dates to the Gila Butte phase. In addition, it is suggested that Feature 21 may be a candidate for a later Gila Butte phase abandonment. With a moderate- to high-contextual integrity and the presence of several Gila Butte Red-on-buff sherds (A.D. 750-850) on the floor and a Kana-a Black-on-white sherd (A.D. 825-1000) in Stratum 19, there is some evidence indicating the possibility for an early- to mid-800s abandonment of this structure. Regarding the remaining floor assemblages, nothing can be conclusively substantiated outside the fact that the majority of the structures probably date to sometime in the Gila Butte phase.

With regard to the dating of fill contexts, due to the evidence for temporal mixing and the generally small sample size, it appears that very little can be determined regarding the temporal ordering of the fill contexts at the Deer Creek site. It is suggested, however, that Feature 6, on the basis of its moderate- to high-contextual integrity and a dominating percentage of Gila Butte Red-on-buff sherds, was filled during the Gila Butte phase. In addition, the low contextual integrity of the ceramic deposits within the fills of Features 11, 14, and 21 (note, however, that the ground stone and lithic contextual analyses suggest secondary trash), along with the relatively high frequencies of Gila Butte Red-on-buff sherds and low incident of temporal mixing, suggests that these structures may have been at least partially filled by deflating Gila Butte phase trash middens. Although these contexts could therefore date later than the Gila Butte phase, additional lines of evidence, such as floor assemblages, suggest that they date to this phase, albeit, perhaps somewhat later in the site occupation.

As a final note on the dating of specific pithouse contexts at the Deer Creek site, it is mentioned that no context, neither floor nor fill, on the basis of diagnostic decorated ceramics, can be specifically or solely assigned to an early (Snaketown phase) or a late (Santa Cruz or Sacaton phase) occupation component. In all instances, diagnostic ceramics from these periods were intermixed with Gila Butte phase ceramics. The best candidate for a Snaketown phase house is Feature 32, in which a Snaketown Red-on-buff sherd was recovered from Stratum 19. Unfortunately, this sherd was partially resting on a large vertical root and its true provenience is unknown, although obviously displaced. All that can be conclusively stated is that several contexts do clearly date solely to the Gila Butte phase; however, the majority of the contexts are ambiguous as to a specific temporal component affiliation.

Next, the ceramic dating of the crematoriums, secondary interments, and inhumations at the Deer Creek site is considered. First, given the presence of two whole Gila Butte Red-on-buff vessels in Features 51 (secondary interment) and 52 (crematorium), these features are assumed to date between A.D. 750 and 850. Furthermore it is noted that these two features are intrusive into Feature 11, providing convincing evidence that this pithouse was filled during the Gila Butte phase. Also, the recovery of a complete Kana-a Black-on-white bowl from Feature 49 indicates that this burial dates to between A.D. 825 and 1000. Feature 49 is intrusive into pithouse Feature 9, indicating that Feature 9 predates the burial and may also date to the Gila Butte phase. Although diagnostic sherds were recovered from within the fill of three of the crematoriums and one of the secondary cremations nothing conclusive is asserted because the formation processes behind the filling of these features is unknown.

Table 12.5. Absolute dates used for ceramic types identified in the Rye Creek Project area.

Ware	Type	Date (A.D.)	Source
Hohokam buffware	Snaketown Red-on-buff	650-750	Dean (1990), Wallace and Craig (1988)
	Gila Butte Red-on-buff	750-850	Dean (1990), Wallace and Craig (1988)
	Santa Cruz Red-on-buff	850-950	Dean (1990), Wallace and Craig (1988)
	Sacaton Red-on-buff	950-1100	Dean (1990), Wallace and Craig (1988)
Tusayan whiteware	Kana-a Black-on-white	825-1000	Dean (p.c.), Downum (1988)
	Wepo Black-on-white	930-1050	Ambler (1985)
	Black Mesa Black-on-white	1000-1135	Dean (p.c.)
		1050-1120	Downum (1988)
	Sosi Black-on-white	1075-1150	Dean (p.c.), Downum (1988)
Little Colorado whiteware	Holbrook Black-on-white A	1050-1150	Douglass (1987)
	Holbrook Black-on-white B	1050-1150	Douglass (1987)
	Walnut Black-on-white A	1100-1250	Douglass (1987)
	Walnut Black-on-white B	1200-1250	Douglass (1987)
	Padre Black-on-white	1100-1250	Douglass (1987)
	Leupp Black-on-white	1200-1250	Douglass (1987)
Cibola whiteware	Kiatuthlanna Black-on-white	850-950	Mills (1987)
	Red Mesa Black-on-white	950-1050	Mills (1987)
	Puerco Black-on-white	990-1200	Mills (1987)
	Escavada Black-on-white	1050-1150	Fowler (1989)
	Snowflake Black-on-white	1100-1200	Dosh (1988)
	Reserve Black-on-white	1100-1200	Mills (1987)
	Tularosa Black-on-white	1200-1300	Mills (1987)
	Pinedale Black-on-white	1250-1350	Kintigh (1985)
San Juan redware	Deadmans Black-on-red	800-1000	Breternitz et al. (1974)
Tsegi orangeware	Tusayan Black-on-red (both varieties)	1000-1280/90	Ambler (1985)
	Tusayan Polychrome	1125-1280/90	Ambler (1985)
	Cameron Polychrome	1100-1280/90	Ambler (1985)
Tusayan grayware	Tusayan Corrugated	1030-1300+	Ambler (1985)
Mogollon brownware (Woodruff Series)	Show Low Black-on-red	1030-1200?	Fowler (1989)
	Show Low Black-on-red Corrugated	1050-1200?	Fowler (1989)
Mogollon brownware	Maverick Mountain Polychrome	1265-1290	Breternitz (1966), Wood (1987)
White Mountain redware	St. John's Black-on-red	1200-1275	Mills (1987)
		1175-1325	Kintigh (1985)
		1175-1250	Dosh (1988)
	Pinedale Black-on-red	1275-1325	Dosh (1988)
	Fourmile Polychrome	1325-1400	Dosh (1988)
		1325-1375	Reid (p.c.)
	Cibecue Polychrome	1275-1350	Reid (p.c.)
Roosevelt redware	Pinto Black-on-red and Polychrome	1263-1300	Montgomery and Reid (1990)
		1200-1300/1350	Doyel (1978), Wood (1987)
		1265-1350	Breternitz (1966)
	Gila Polychrome	1250-1400	Breternitz (1966)
		1300-1400?	Reid (p.c.)
	Tonto Polychrome	1250-1400+	?Breternitz (1966)
		1300-1400?	Reid (p.c.)
Winslow orangeware	Tuwiuca Black-on-orange	1275-1350	Adams et al. (in press)
	Homol'ovi Polychrome	1275-1350	Adams et al. (in press)
	Chavez Pass Black-on-red	1275-1350	Adams et al. (in press)
Hopi Wares	Awatovi Black-on-yellow	1300-1350	W. Smith (1971)
	Jeddito Black-on-yellow	1350-1450	W. Smith (1971)
	Bidahochi Polychrome	1320-1400	Colton (1956)
	Jeddito Black-on-orange	1250-1350	W. Smith (1971)
	Bidahochi Black-on-white	1325-1400	W. Smith (1971)

Table 12.6. Diagnostic sherd proveniences from the Deer Creek site, AZ O:15:52.

Site O:15:52

Feat. 0	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SNAKETOWN R/BF	1	0	0	0	0	0	0	0	0	1
SN OR GB R/BF	3 (3)	0	0	0	0	0	0	0	0	3
GILA BUTTE R/BF	12 (7)	0	0	0	0	0	0	0	0	12
GB OR SC R/BF	6	0	0	0	0	0	0	0	0	6
INDET. BUFF	21	0	0	0	0	0	0	0	0	21
INDET. T B/W	6	0	0	0	0	0	0	0	0	6
KANA-A B/W	1	0	0	0	0	0	0	0	0	1
INDET. LC B/W	2	0	0	0	0	0	0	0	0	2
Feature Total	52	0	0	0	0	0	0	0	0	52

Feat. 2	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GB OR SC R/BF	0	1	0	0	0	0	0	0	0	1
INDET. BUFF	0	2	1	0	0	0	0	0	2	5
Feature Total	0	3	1	0	0	0	0	0	2	6

Feat. 5	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	6 (5)	0	0	0	0	0	1	0	7
GB OR SC R/BF	0	1	0	0	0	0	0	1	0	2
INDET. BUFF	0	3	0	0	0	0	0	0	0	3
Feature Total	0	10	0	0	0	0	0	2	0	12

Feat. 6	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SNAKETOWN R/BF	0	0	1 (1)	0	0	0	0	0	0	1
GILA BUTTE R/BF	0	1 (1)	5 (4)	0	4 (4)	1 (1)	0	0	1 (1)	12
GB OR SC R/BF	0	0	1	0	1	0	0	0	1	3
INDET. BUFF	0	3	3	0	0	0	0	0	3	9
LOCAL R/PLN	0	0	1	0	0	0	0	0	0	1
Feature Total	0	4	11	0	5	1	0	0	5	26

Feat. 9	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SNAKETOWN R/BF	0	1 (1)	0	0	1	0	0	0	0	2
GILA BUTTE R/BF	0	0	6 (2)	0	1	0	1	0	0	8
GB OR SC R/BF	0	0	1	0	0	0	0	0	0	1
SACATON R/BF	0	2	0	0	1	0	0	0	0	3
INDET. BUFF	0	6	2	0	2	0	0	0	0	10
INDET. T B/W	0	0	1	0	1	0	0	0	0	2
KANA-A B/W	0	0	1	0	1	0	0	0	0	2
Feature Total	0	9	11	0	7	0	1	0	0	28

Feat. 11	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SN OR GB R/BF	0	0	0	1	0	0	0	0	0	1
GILA BUTTE R/BF	0	0	6 (6)	5 (5)	6 (6)	0	0	0	0	17
GB OR SC R/BF	0	0	1	2	0	0	0	0	0	3
INDET. BUFF	0	0	2	4	5	0	0	0	0	11
Feature Total	0	0	9	12	11	0	0	0	0	32

Feat. 12	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SNAKETOWN R/BF	0	1	0	0	0	0	0	0	0	1
GILA BUTTE R/BF	0	1	1	1	1	1	0	0	0	5
INDET. BUFF	0	0	1	0	1	1	0	0	0	3
Feature Total	0	2	2	1	2	2	0	0	0	9

Feat. 13	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GB OR SC R/BF	0	0	1	0	0	0	0	0	0	1
INDET. BUFF	0	1	1	2	0	0	0	0	0	4
INDET. T B/W	0	3	0	0	0	0	0	0	0	3
Feature Total	0	4	2	2	0	0	0	0	0	8

Table 12.6. Continued.

Site O:15:52

Feat. 14	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SNAKETOWN R/BF	0	1 (1)	0	0	1 (1)	0	0	0	0	2
SN OR GB R/BF	0	0	1	0	1	0	0	0	0	2
GILA BUTTE R/BF	0	2 (1)	5 (4)	2 (1)	3 (2)	0	0	0	0	12
GB OR SC R/BF	0	0	3	1	1	1	0	0	0	6
INDET. BUFF	0	1	0	1	0	0	0	0	0	2
INDET. T B/W	0	0	1	0	0	0	0	0	0	1
Feature Total	0	4	10	4	6	1	0	0	0	25

Feat. 18	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SNAKETOWN R/BF	0	0	2	0	0	0	0	0	0	2
SN OR GB R/BF	0	0	1	0	0	0	0	0	0	1
GILA BUTTE R/BF	0	1	7 (3)	0	8 (7)	0	0	0	0	16
GB/SC R/BF	0	0	1	0	0	0	0	0	0	1
GB OR SC R/BF	0	0	3	0	1	0	0	0	0	4
INDET. BUFF	0	2	6	0	7	0	0	0	0	15
INDET. T B/W	0	0	0	0	1	0	0	0	0	1
KANA-A B/W	0	0	1	0	0	0	0	0	0	1
Feature Total	0	3	21	0	17	0	0	0	0	41

Feat. 20	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	0	0	0	0	0	0	0	0	1	1
GILA BUTTE R/BF	0	0	0	0	0	0	0	0	2 (1)	2
GB OR SC R/BF	0	0	0	0	0	0	0	0	2	2
SANTA CRUZ R/BF	0	0	0	0	0	0	0	0	1	1
SACATON R/BF	0	0	0	0	0	0	0	0	2	2
INDET. BUFF	0	0	0	0	0	0	0	0	5	5
INDET. T B/W	0	0	0	0	0	0	0	0	1	1
Feature Total	0	0	0	0	0	0	0	0	14	14

Feat. 21	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SNAKETOWN R/BF	0	0	1 (1)	0	0	0	0	0	0	1
SN OR GB R/BF	0	0	1 (1)	0	0	0	0	0	1	2
GILA BUTTE R/BF	0	5 (3)	10 (7)	0	1 (1)	2 (2)	0	0	0	18
GB OR SC R/BF	0	3	4	0	1	0	0	0	0	8
SACATON R/BF	0	1	0	0	0	0	0	0	0	1
INDET. BUFF	0	6	7	0	2	2	0	0	0	17
KANA-A B/W	0	1	0	0	1	0	0	0	0	2
LOCAL R/PLN	0	0	1	0	0	0	0	0	0	1
Feature Total	0	16	24	0	5	4	0	0	1	50

Feat. 22	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SANTA CRUZ R/BF	0	0	0	0	1	0	0	0	0	1
INDET. BUFF	0	4	2	0	1	0	1	0	0	8
KANA-A B/W	0	0	1	0	0	0	0	0	0	1
Feature Total	0	4	3	0	2	0	1	0	0	10

Feat. 25	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	0	1	0	0	0	0	0	0	1
GB OR SC R/BF	0	0	1	0	1	0	0	0	0	2
INDET. BUFF	0	0	4	0	0	0	0	0	0	4
Feature Total	0	0	6	0	1	0	0	0	0	7

Feat. 32	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SNAKETOWN R/BF	0	0	0	0	1 (1)	0	0	0	0	1
SN OR GB R/BF	0	0	0	0	0	0	0	0	1	1
INDET. BUFF	0	0	0	2	1	0	0	0	0	3
INDET. T B/W	0	0	0	0	0	1	0	0	0	1
Feature Total	0	0	0	2	2	1	0	0	1	6

Table 12.6. Continued.

Site O:15:52

Feat. 34	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. T B/W	0	0	0	0	0	0	0	0	1	1
Feature Total	0	0	0	0	0	0	0	0	1	1

Feat. 36	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SN OR GB R/BF	0	0	0	0	1 (1)	0	0	0	1 (1)	2
GILA BUTTE R/BF	0	1 (1)	0	0	0	3 (1)	0	0	0	4
GB OR SC R/BF	0	0	0	0	0	1	0	0	0	1
INDET. BUFF	0	2	0	0	2	3	0	0	0	7
INDET. T B/W	0	2	0	0	0	0	0	0	1	3
LOCAL INDET.	0	0	1	0	0	0	0	0	0	1
Feature Total	0	5	1	0	3	7	0	0	2	18

Feat. 37	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	0	0	0	0	0	0	0	4	0	4
Feature Total	0	0	0	0	0	0	0	4	0	4

Feat. 43	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GB OR SC R/BF	0	0	0	0	0	0	0	2	0	2
Feature Total	0	0	0	0	0	0	0	2	0	2

Feat. 44	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	1	0	0	0	0	0	0	0	1
GB OR SC R/BF	0	1	0	0	0	0	0	0	0	1
INDET. BUFF	0	3	0	0	0	0	0	0	0	3
INDET. T B/W	0	1	0	0	0	0	0	0	0	1
Feature Total	0	6	0	0	0	0	0	0	0	6

Feat. 49	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GB OR SC R/BF	0	0	0	0	0	0	0	1	0	1
INDET. BUFF	0	0	0	0	0	0	0	2	0	2
KANA-A B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	4	0	4

Feat. 50	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. T B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1

Feat. 51	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	0	0	0	0	0	0	5 (1)	0	5
INDET. T B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	6	0	6

Feat. 52	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1

Feat. 54	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GB OR SC R/BF	0	0	0	0	0	0	0	1	0	1
INDET. BUFF	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	2	0	2

Table 12.6. Continued.

Feat. 59	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	0	0	0	0	0	0	0	0	1	1
SNAKETOWN R/BF	0	0	1	0	0	0	0	0	0	1
SN OR GB R/BF	0	0	1 (1)	0	0	0	0	0	0	1
GILA BUTTE R/BF	0	0	1 (1)	0	1	0	0	0	1 (1)	3
GB OR SC R/BF	0	0	3	0	1	0	0	0	1	5
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INDET. BUFF	0	0	3	0	0	0	0	0	10	13
INDET. T B/W	0	0	0	0	0	0	0	0	2	2
KANA-A B/W	0	0	0	0	0	0	0	0	1	1
Feature Total	0	0	9	0	2	0	0	0	16	27
Feat. 62	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	1 (1)	2 (1)	0	0	0	0	0	0	3
INDET. BUFF	0	2	0	0	1	0	0	0	0	3
INDET. T B/W	0	1	0	0	0	0	0	0	0	1
KANA-A B/W	0	0	1	0	0	0	0	0	0	1
Feature Total	0	4	3	0	1	0	0	0	0	8
Feat. 63	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	0	0	0	0	0	0	1	0	1
INDET. BUFF	0	0	0	0	0	0	0	2	0	2
Feature Total	0	0	0	0	0	0	0	3	0	3
Feat. 70	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. BUFF	0	0	0	0	0	0	0	0	1	1
INDET. T B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	1	2
Feat. 71	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	0	0	0	0	0	0	1 (1)	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1
Feat. 88	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. BUFF	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1
Feat. 117	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	0	0	0	0	0	0	2 (2)	0	2
Feature Total	0	0	0	0	0	0	0	2	0	2
Site Total	52	74	113	21	64	16	2	30	43	415

() Numbers in parentheses indicate incised sherds.

Gila Butte Red-on-buff and Kana-a Black-on-white: Assessing Contextual Co-occurrence

At the Deer Creek site there were seven cases in which Gila Butte Red-on-buff sherds and Kana-a Black-on-white sherds were recovered from the same excavated contexts. In addition, there were nine cases in which indeterminate Tusayan whiteware sherds were recovered in association with Gila Butte Red-on-buff sherds. These contextual associations suggested that the Deer Creek site's decorated ceramic assemblage might contribute new data concerning the possibility for Gila Butte Red-on-buff and Kana-a Black-on-white contemporaneity or, at least, temporal overlap. This in turn could aid in refining the absolute temporal range of Gila Butte Red-on-buff, as Kana-a Black-on-white is a relatively well-dated type.

With Kana-a Black-on-white being the only Tusayan whiteware type identified in the Deer Creek decorated ceramic assemblage, it is assumed, for the purposes of this discussion, that the indeterminate Tusayan whiteware sherds are most likely of Kana-a Black-on-white origin. Table 12.7 provides a listing of the proveniences (by feature and stratum) of each of the Kana-a Black-on-white and indeterminate Tusayan whiteware sherds from the Deer Creek site. In addition, Table 12.7 lists the diagnostic sherds found in association with each of these Tusayan whiteware sherds. Finally, Table 12.7 provides a rating for each of the contexts from which these sherds were recovered. It is noted that there are two rating columns. The first, "Initial Contextual Rating," filters out the contexts that are clearly of poor integrity--temporally mixed deposits (TM), transformed secondary trash or sheet-trash deposits (ST), and deposits noted by the excavator as disturbed/mixed (D). Also this column deletes the contexts that are not applicable to the discussion--contexts with no Gila Butte Red-on-buff sherds in association with Tusayan whiteware sherds (NA). Furthermore, it is noted that the fill of Feature 51, a secondary cremation, and Feature 49, an inhumation, also are considered "not applicable." These determinations were made on account of the unknown origin of the matrix used to fill these pits. The "Secondary Contextual Rating" column then deals with the remaining contexts, of which there are only four. This secondary rating is based on the findings of the contextual analysis, presented in Chapter 11. It is noted that both the fill of Feature 9 and the fill of Feature 62 are rated poorly, with the fill of Feature 9 possibly representative of a transformed secondary trash context (small sherds in high density) and possibly a later activity surface (as determined through the ground stone contextual analysis), and the fill of Feature 62 suggestive of a sheet-trash deposit (small sherds in low density). Two contexts remain, the fill of Feature 14 and the floor of Feature 21.

The fill of Feature 14 plots as having a moderate contextual integrity. The house burned, although probably when it was temporarily unoccupied, given the large number of useable (and upside down) ground stone on the floor and a single ceramic vessel. Following the burning of this structure, the depression was used as a trash dump; the contextual analysis suggests that it is likely that the structure filled with both washed-in sheet trash deposits and secondary trash deposits. Whether the filling of the pit occurred over a limited or lengthy temporal interval is unclear. Given the probable presence of sheet-wash deposits, however, it is likely that the structure was open for a certain duration of time. Consequently, although this context may be intact and the association between the Gila Butte Red-on-buff sherds and the indeterminate Tusayan whiteware sherd in the fill of the structure may be true, there is still ambiguity. Nothing conclusive can be asserted.

The last context to be evaluated is the floor of Feature 21. Out of the possible 16 incidences of Gila Butte Red-on-buff and Tusayan whiteware co-occurrence at the Deer Creek site, the floor of Feature 21 was the best case for a true association. Unfortunately, as with Feature 14, the data are ambiguous at best. Results of the contextual analysis suggest a possible secondary trash context for the floor and floor fill of Feature 21, although the feature description is clearly indicative of a floor de facto context; five reconstructible vessels, six manos, three tabular knives, a metate fragment, a chopper, a hammerstone, and a projectile point were provenienced on the floor and covered by 10 cm of burned roof fall containing burned daub and charcoal inclusions. The floor assemblage contained two Gila Butte Red-on-buff sherds, while a Gila Butte Red-on-buff, a Gila Butte or Santa Cruz Red-on-buff, and a Kana-a Black-on-white sherd were recovered from Stratum 19, which is within 5 cm of the floor. None of these sherds were burned, however, and all were relatively small. This, in conjunction with the contextual analysis which suggests that the upper fill contained mixed sheet trash and secondary trash deposits, makes the actual association of these sherds uncertain. It is possible that they are temporally associated, yet it is equally plausible that the sherds originated in the contextually mixed upper layers. As a result, the data for the contextual contemporaneity of Gila Butte Red-on-buff and Kana-a Black-on-white remain ambiguous.

In conclusion, although excavations at the Deer Creek site provide several incidences of Gila Butte Red-on-buff and Kana-a Black-on-white in stratigraphic co-occurrence, the problem of ambiguous contexts and conflicting interpretations leaves all of these associations questionable in integrity. The issue of temporal overlap between Kana-a Black-on-white and Gila Butte Red-on-buff can be neither proved nor disproved from the Deer Creek site data set (see also Chapter 24).

Incising on Gila Butte Red-on-buff: A Temporally Sensitive Attribute?

There were 131 sherds identified as Gila Butte Red-on-buff from the Deer Creek site. Eighty-four (64.1 percent) of these sherds were incised. During the course of the analysis the question arose as to whether the incised versus the unincised Gila Butte Red-on-buff sherds varied spatially across the site, and whether this variation could be attributed to temporal factors. A possible temporal relationship within the Gila Butte phase was suggested due to the fact that incising is known to be an early trait that follows a relatively straightforward pattern. Incising is present in the Estrella, Sweetwater, and Snaketown phases, where the grooves are deep and pronounced. It continues in a shallower form throughout the Gila Butte phase, and disappears entirely by the following Santa Cruz phase (Haury 1976). The relatively large but spatially discrete Gila Butte Red-on-buff sample from the Deer Creek site provided an opportunity to examine whether temporal factors could account for the differential distribution of incising on Gila Butte vessels.

Table 12.6 presents the distribution of incised Gila Butte Red-on-buff sherds, unincised Gila Butte Red-on-buff sherds, and sherds typed as Gila Butte or Santa Cruz Red-on-buff (which are, by definition, unincised). Sheet trash, fill, and floor contexts are singled out. Although the per-feature sample size is generally small and there are, as always, problems of contextual integrity, there are some gross trends which can be discerned. First of all, the majority of the Gila Butte Red-on-buff sherds are concentrated in the south and central portion of the site, suggestive of the areal focus of the Gila Butte phase occupation. The southern portion of the site also contains the most superposition of features, specifically Gila Butte phase mortuary features intruding into earlier Gila Butte phase pithouses, further suggesting that the earliest or initial occupation may have occurred here. The floors and floor fill levels of Features 6 and 11, in the southern portion of the site, and 18, in a more central position, have relatively large Gila Butte Red-on-buff assemblages. Moreover these assemblages are dominated clearly by incised Gila Butte Red-on-buff. It is added that the floor and Stratum 19 (floor fill) assemblage of Feature 21 contains only incised Gila Butte Red-on-buff; however, with only three sherds the problem of sample size is a consideration. The contextual analysis suggests that the floor/floor fill levels of all of these features, with the possible exception of Feature 21 (which may be mixed), are of relatively high integrity and therefore the associations are believed to be valid.

With regard to the fill of these four features, it is noted that: 1) the assemblages from the fill of Features 6 and 11 are relatively large and dominated by incised Gila Butte Red-on-buff; and 2) the assemblages from the fill of Features 18 and 21, which are both centrally located, are both relatively large and contain a lower percentage of incised Gila Butte Red-on-buff along with Gila Butte or Santa Cruz Red-on-buff. Although the evidence is far from conclusive, there is some suggestion that incising is less frequent over time since the pithouse fill, particularly from the more central site area, are expected to be later than the pithouse floors. Again, in considering the quality of these fill contexts it is noted that the fill of Features 6 and 18 appear to be secondary trash deposits, while the fill of Features 11 and 21 are more indicative of transformed secondary trash deposits or sheetwash deposits. As a result, although this contextual ambiguity does somewhat weaken the stratigraphic argument, since sheet-trash deposits may originate from any number of unrelated sources, the fact that the two contexts with high integrity follow the proposed temporal pattern is noteworthy.

Additional support for this pattern comes from the fact that the assemblages of two of the features intrusive into Feature 11 (Features 51 and 52) are dominated by unincised Gila Butte Red-on-buff. In particular, a whole vessel of unincised Gila Butte Red-on-buff was recovered from Feature 52. With both the floor and fill contexts of Feature 11 dominated by incised Gila Butte Red-on-buff, while the assemblages from the intrusive features are dominated by unincised Gila Butte Red-on-buff, again there is some stratigraphic evidence for a decrease in the frequency of incising on Gila Butte Red-on-buff over time.

Table 12.7. Assessment of Tusayan whiteware and Gila Butte Red-on-buff associations at the Deer Creek site (AZ O:15:52).

Feature Number	Feature Type	No. of Kana-a sherds	No. of Indeterminate Tusayan sherds	Stratum	Snaketown	Snaketown or Gila Butte	Gila Butte	Gila Butte/ Santa Cruz	Gila Butte or Santa Cruz	Santa Cruz	Sacaton	Total	Initial Contextual Rating	Secondary Contextual Rating
9	Pithouse	1	1	Fill			6		1			7	High	Low
9	Pithouse	1	1	Floor	1		1				1	3	TM	
13	Pithouse		3	Sheet trash								0	NA	
14	Pithouse		1	Fill		1	7		4			12	High	Mod
18	Pithouse	1		Fill	2	1	7	1	3			14	TM	
18	Pithouse		1	Floor (sealed)								0	NA	
20	Extramural Surface		1	Disturbed			2		2	1	2	7	D	
21	Pithouse	1		Sheet trash			5		3		1	9	ST	
21	Pithouse	1		Floor			3		1			4	High	High
22	Pithouse	1		Fill								0	NA	
32	Pithouse		1	Floor	1							1	TM	
34	Pithouse		1	Disturbed								0	NA	
36	Pithouse		2	Sheet trash			1					1	ST	
44	Roasting pit		1	Sheet trash			1		1			2	ST	
49	Inhumation	1		Fill					1			1	NA	
50	Crematorium		1	Fill								0	NA	
51	Secondary Cremation		1	Fill			5					5	NA	
59	Pithouse	1	2	Disturbed			1		1			2	D	
62	Pithouse		1	Sheet trash			1					1	ST	
62	Pithouse	1		Fill			2					2	High	Low
70	Crematorium		1	Fill								0	NA	
	Totals	9	19		4	2	42	1	17	1	4	71		

TM = Temporally mixed assemblage; ST = Sheet trash deposit; D = Noted by excavator as disturbed; NA = Not applicable

A few final observations from Table 12.6 include noting that only unincised sherds of Gila Butte Red-on-buff are associated with Feature 12, including a whole vessel of unincised Gila Butte Red-on-buff recovered from the fill of the structure. This may indicate a later Gila Butte phase use/filling of this structure. The sample size from Feature 12 is small, however, so conclusions are tentative at best. Finally it is observed that the Gila Butte Red-on-buff sherds from the northern portion of the site are predominantly unincised or typed as Gila Butte or Santa Cruz Red-on-buff. The suggestion here is that the use of this locus occurred at the later end of the Gila Butte phase, or at least at the later end of the Gila Butte occupation of the Deer Creek site.

Conclusions

In conclusion, it is reiterated that the primary occupation of the Deer Creek site is suspected to have spanned the entire range of the Gila Butte phase. This is suggested by the presence of typologically late Snaketown Red-on-buff sherds in conjuction with the occurrence of both incised and unincised Gila Butte Red-on-buff sherds. Whether occupation at the Deer Creek site during the Gila Butte phase was continual or periodic cannot be determined on the basis of the diagnostic decorated assemblage. Stratigraphically, at least several replacement episodes are suspected within the estimated 100-year time span of the Gila Butte phase, suggesting a more continuous occupation. Additionally, given the presence of low frequencies of Snaketown Red-on-buff, Kana-a Black-on-white, Santa Cruz Red-on-buff, and Sacaton Red-on-buff ceramics, it seems probable that there was use of the site area both prior to A.D. 750 and succeeding A.D. 850.

The Rooted Site (AZ O:15:92): A.D. 900-1000; (1100-1300)

AZ O:15:92 is divided into two, temporally and spatially distinct loci. Locus A, which includes excavated Features 13, 14, 15, and 16, is a (presumed) large Preclassic period occupation that has been almost entirely destroyed through root-plowing. Features 13, 14, 15, and 16 escaped root-plowing due to their location within the original State Route 87 right-of-way. Locus B, which contains Feature 1, is separated from Locus A by approximately 100 m of nonsite area. Feature 1 is a Classic period masonry structure, again, destroyed by root-plowing. This feature was investigated only briefly during the testing phase and subsequently not returned to during the mitigation.

Features 13, 14, 15, and 16

Features 13, 14, 15, and 16 are clustered together in the southwestern quarter of Locus A at AZ O:15:92, and are, respectively, an infant inhumation, a pithouse, a ramada, and another infant inhumation. Table 12.8 provides counts of the decorated ceramics recovered from this locus. It is noted that the majority of the diagnostic decorated sherds from this area were found in association with Feature 14, the pithouse. Fourteen Sacaton Red-on-buff sherds, 2 Santa Cruz Red-on-buff sherds, 3 Santa Cruz or Sacaton Red-on-buff sherds, 3 Kana-a Black-on-white sherds, 1 Kana-a or Black Mesa Black-on-white sherd, and 1 Red Mesa Black-on-white sherd were recovered from the fill of the pithouse. Two Santa Cruz Red-on-buff sherds were provenienced to Stratum 19 of the pithouse. One Sacaton Red-on-buff sherd was recovered from the sheet trash overlying Feature 16, the infant burial. No decorated sherds were associated with either the ramada or the other infant burial.

Results of the contextual analysis suggest that the fill of the pithouse is of moderate integrity. Only 21 percent of the plainware rim sherds were larger than 16 cm^2, and sherd density was moderate to high, numbering about 200 sherds per cubic meter. This suggests that both secondary trash and transformed secondary trash deposits may be present, which is supported by a review of the feature description which indicates that the filling of the pithouse was perhaps episodic, marked by several localized periods of trash dumping. Alternatively, both the contextual analysis and the feature description suggest that the artifacts provenienced to the floor and floor fill of the pithouse are in good contextual association.

Table 12.8. Diagnostic sherd proveniences from the Rooted site, AZ O:15:92.

Site 0:15:92

Feat. 0	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	2	0	0	0	0	0	0	0	0	2
INDET. T B/W	10	0	0	0	0	0	0	0	0	10
INDET. LC B/W	4	0	0	0	0	0	0	0	0	4
HOLBRK A/B B/W	2	0	0	0	0	0	0	0	0	2
INDET. C B/W	3	0	0	0	0	0	0	0	0	3
Feature Total	21	0	0	0	0	0	0	0	0	21
Feat. 1	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
BM OR SOSI B/W	0	0	0	0	0	0	0	0	1	1
RESERVE B/W	1	0	0	0	0	0	0	0	0	1
INDET. WM POLY	1	0	0	0	0	0	0	0	1	2
INDET. WM B/R	3	0	0	2	0	0	0	0	2	7
Feature Total	5	0	0	2	0	0	0	0	4	11
Feat. 14	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	0	0	2	0	0	0	0	0	0	2
SANTA CRUZ R/BF	0	0	2	0	2	0	0	0	0	4
SC OR SAC R/BF	0	0	3	0	0	0	0	0	0	3
SACATON R/BF	0	0	14	0	0	0	0	0	0	14
INDET. BUFF	0	0	17	0	4	1	0	0	0	22
INDET. T B/W	0	0	1	0	0	0	0	0	0	1
KANA-A B/W	0	0	3	0	0	0	0	0	0	3
KANA-A OR BM B/	0	0	1	0	0	0	0	0	0	1
RED MESA B/W	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	44	0	6	1	0	0	0	51
Feat. 15	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. BUFF	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	1	0	0	0	0	0	0	1
Feat. 16	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SACATON R/BF	0	1	0	0	0	0	0	0	0	1
INDET. BUFF	0	1	0	0	0	0	0	0	0	1
Feature Total	0	2	0	0	0	0	0	0	0	2
Site Total	26	2	45	2	6	1	0	0	4	86

Unfortunately, no diagnostic decorated ceramics were recovered from the floor, although two Santa Cruz Red-on-buff sherds were recovered from Stratum 19 within 5 cm of the floor. Consequently, considering this information, and realizing that it is based on only two sherds, it is tentatively suggested that the final occupation of Feature 14 falls somewhere within the date range expected for Santa Cruz Red-on-buff (A.D. 850-950), perhaps at the late end of the Santa Cruz phase, given the preponderance of Sacaton Red-on-buff and Santa Cruz or Sacaton Red-on-buff in the fill. Furthermore, while the filling of Feature 14 may potentially span from A.D. 850 to 1100+, it is tentatively argued, on the basis of negative evidence, that the filling of Feature 14 could be more tightly temporally restricted to the period between A.D. 850 and 1000/1050. This narrowing of the temporal range is hazarded on account of the absence of Black Mesa Black-on-white (A.D. 1000-1135) from the decorated assemblage. Reviewing the observation that Black Mesa Black-on-white is a prevalent type within the Rye Creek decorated assemblage as a whole and, moreover, noting that it is frequently found in association with Sacaton Red-on-buff, its absence within this subset of the assemblage is tentatively suggested to be temporally significant. These data in combination suggest a possible best-fit date range of approximately A.D. 900-1000 for the feature.

As to the dating of Features 13, 15, and 16 on the basis of associated diagnostic decorated sherds nothing can be said. The proximity of these features to Feature 14 tentatively suggests a date somewhere within the A.D. 850 to 1050 temporal range.

Feature 1

As can be seen in Table 12.8, 11 decorated sherds were recovered in association with Feature 1, a disturbed masonry structure. Five of the sherds were collected off the surface, four were noted as coming from disturbed fill, and two were provenienced to Stratum 11 (though excavator comments indicate that this stratum assignment is tenuous at best and that a more accurate assessment would be to consider Statum 11 also a disturbed fill). Consequently, although all 11 of the decorated sherds recovered in association with this feature provide some temporal information, the question of contextual integrity leaves the dating of this feature on the basis of the associated decorated ceramics problematical. It is unclear as to at what point in the life of the structure the sherds were deposited. In addition, it is unclear as to how the various decorated types recovered from the feature relate depositionally to one another; recovered diagnostics include Black Mesa or Sosi Black-on-white, Reserve Black-on-white, Pinedale Black-on-white, and Pinedale or Fourmile Polychrome. Therefore, the diagnostic decorated assemblage from Feature 1 can suggest no more than that there was probable use of the area in and around Feature 1 sometime between A.D. 1000 and 1200+. With the exception of Rye Creek Ruin, this locus contained the largest collection of White Mountain redwares of any site within the project area.

The Clover Wash Site (AZ O:15:100): A.D. 1000-1100; (750-850)

The Clover Wash site consists of five pithouses, an inhumation, 11 extramural pits (including two roasting pits), a rock cluster, and a large amorphous extramural pit/disturbance. The decorated ceramic assemblage at the Clover Wash site runs the temporal spectrum from Gila Butte Red-on-buff (A.D. 750-850) to Puerco Black-on-white (A.D. 990-1200), with Black Mesa Black-on-white (A.D. 1000-1135) dominating the assemblage (see Tables 12.2 and 12.9). In considering the range of dates for the diagnostic types in the Clover Wash assemblage, it can be suggested that there were two periods of occupation at the site: one period associated with the types Gila Butte Red-on-buff, Gila Butte or Santa Cruz Red-on-buff, and Deadmans Black-on-red, the other associated with the types Sacaton Red-on-buff, Black Mesa Black-on-white, Black Mesa or Sosi Black-on-white, Holbrook Black-on-white Variety A or B, Red Mesa Black-on-white, and Puerco Black-on-white. Unfortunately, the vertical and horizontal spatial distribution of the diagnostic sherds at the Clover Wash site was fairly well mixed (see Table 12.9). The mixing may be partially a result of the root-plowing, which severely disturbed the upper 20 to 40 cm of the site. For example, the Deadmans Black-on-red sherd was found in the fill of Feature 4 along with two Black Mesa Black-on-white sherds and a Holbrook Black-on-white Variety A or B sherd. The Gila Butte or Santa Cruz Red-on-buff sherd was located in the fill of Feature 1, along with a Black Mesa Black-on-white sherd, a Black Mesa or Sosi Black-on-white sherd, and a Puerco Black-on-white sherd. One of the Gila Butte sherds was provenienced to the sheet trash above Feature 12, another was recovered from the fill of Feature 12 in conjunction with two Black Mesa Black-on-white sherds and two Black Mesa or Sosi Black-on-white sherds. Only one of the "early" diagnostic sherds was in an isolated context--a Gila Butte Red-on-buff sherd along with an indeterminate buffware and an indeterminate Tusayan whiteware were all collected within 5 cm of the floor (Stratum 19) of Feature 6. Unfortunately, Feature 6 had been severely disturbed through root-plowing and only 5 cm to 10 cm of fill remained, making this context somewhat ambiguous.

Furthermore, the contextual analysis of AZ O:15:100 suggests that a majority of the contexts are dominated by small sherds and low sherd densities, suggestive of transformed secondary refuse of dubious quality. In light of the temporal mixing of the decorated ceramics, such a conclusion is not surprising. There were two contexts, however, which did contain a relatively higher integrity. One was the floor/floor fill of Feature 1, from which a Sacaton Red-on-buff sherd and a Puerco Black-on-white sherd were recovered, suggesting a final

Table 12.9. Diagnostic sherd proveniences from the Clover Wash site, AZ O:15:100.

Site O:15:100

Feat. 0	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	5	0	0	0	0	0	0	0	0	5
INDET. T B/W	7	0	0	0	0	0	0	0	0	7
BLACK MESA B/W	1	0	0	0	0	0	0	0	0	1
INDET. C B/W	1	0	0	0	0	0	0	0	0	1
Feature Total	14	0	0	0	0	0	0	0	0	14

Feat. 1	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	0	0	2	0	0	0	0	0	0	2
GB OR SC R/BF	0	0	1	0	0	0	0	0	0	1
SACATON R/BF	0	0	0	0	1	0	0	0	0	1
INDET. BUFF	0	0	1	0	0	0	0	0	3	4
INDET. T B/W	0	0	1	0	0	1	0	0	1	3
BLACK MESA B/W	0	0	1	0	0	0	0	0	1	2
BM OR SOSI B/W	0	0	1	0	0	0	0	0	0	1
INDET. C B/W	0	0	1	0	0	0	0	0	0	1
PUERCO B/W	0	0	1	0	1	0	0	0	1	3
Feature Total	0	0	9	0	2	1	0	0	6	18

Feat. 2	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. BUFF	0	0	0	0	0	0	0	2	0	2
INDET. T B/W	0	0	0	0	0	0	0	4	1	5
Feature Total	0	0	0	0	0	0	0	6	1	7

Feat. 3	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. T B/W	0	0	2	2	0	0	0	0	0	4
BM OR SOSI B/W	0	0	3	0	0	0	0	0	0	3
RED MESA B/W	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	6	2	0	0	0	0	0	8

Feat. 4	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	0	0	1	0	0	0	0	0	0	1
INDET. T B/W	0	0	0	0	1	0	0	0	0	1
BLACK MESA B/W	0	0	2	0	0	0	0	0	0	2
HOLBRK A/B B/W	0	0	1	0	0	0	0	0	0	1
DEADMAN'S B/R	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	5	0	1	0	0	0	0	6

Feat. 6	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	0	0	0	1	0	0	0	0	1
INDET. BUFF	0	0	0	0	1	0	0	0	0	1
INDET. T B/W	0	0	0	0	1	0	0	0	0	1
Feature Total	0	0	0	0	3	0	0	0	0	3

Feat. 12	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	0	0	3	0	0	0	0	0	0	3
GILA BUTTE R/BF	0	1	1	0	0	0	0	0	0	2
INDET. BUFF	0	0	4	0	0	0	0	0	0	4
INDET. T B/W	0	0	7	0	1	0	0	0	0	8
BLACK MESA B/W	0	0	2	0	0	0	0	0	0	2
BM OR SOSI B/W	0	0	2	0	0	0	0	0	0	2
INDET. SJ B/R	0	0	1	0	1	0	0	0	0	2
Feature Total	0	1	20	0	2	0	0	0	0	23

Feat. 14	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. BUFF	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1

Feat. 16	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
HOLBRK A/B B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1

Table 12.9. Continued.

Site O:15:100

Feat. 17	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
BLACK MESA B/W	0	0	0	0	0	0	0	1	0	1
BM OR SOSI B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	2	0	2
Feat. 22	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
BM OR SOSI B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1
Feat. 27	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
PUERCO B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1
Feat. 28	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. BUFF	0	0	0	0	0	0	0	1	0	1
INDET. T B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	2	0	2
Site Total	14	1	40	2	8	1	0	14	7	87

occupation date for this feature to fall between A.D. 1000 and 1100. The second was the fill of Feature 3, from which three Black Mesa or Sosi Black-on-white sherds and one Red Mesa Black-on-white sherd were collected, indicating perhaps a fill date sometime during the first half of the A.D. 1000s.

Feature 6 was not included in the contextual analysis due to its small sample size and potential root-plowed disturbance. The feature description indicates, however, that although the fill of the pithouse was severely disturbed by root-plowing, portions of the floor did appear to be intact. The floor assemblage included a single plainware sherd cluster and several pieces of groundstone. There was also evidence that the structure had burned. Consequently, it is possible that the single Gila Butte Red-on-buff sherd in Stratum 19 may be significant, and that this feature may indeed date to the earlier component at this site, although there is no way to conclusively determine this. The fact that Feature 6 does not appear to be grouped into a house cluster, as are the other structures at the site, somewhat supports this assertion.

In conclusion, the decorated ceramic assemblage from the Clover Wash site is tentatively suggestive of two occupation phases: the first phase dating at some point between A.D. 750 and 850+, the second and perhaps primary phase falling some time between A.D. 1000 and 1100+. Due to the apparent contextual mixing it seems imprudent to assign particular features to particular dates or phases; however, it is suggested that Feature 6 may date to the earlier occupation phase, while the final use of Feature 1 and the fill of Feature 3 probably date to the later occupation phase.

The Redstone Site (AZ O:15:91): A.D. 1000-1150; (850-950)

One hundred and forty-one decorated sherds were collected from the Redstone site, placing this site second only to the Deer Creek site in frequency of decorated sherds for the project area. The site also contains one of the highest frequencies of whiteware ceramics of any site in the project area. The site consists of two pithouses, one of which underwent substantial remodeling, a possible ramada, a possible brush kitchen, two roasting pits, two ephemeral rock alignments, and various extramural and instrusive pits. Several possible masonry structures lie adjacent to the site area just outside of the right-of-way. The majority of the decorated sherds were found in association with the two pithouses and the possible ramada, Features 5, 11, and 3 respectively (see Table 12.10). The diagnostic decorated ceramics suggest that there are potentially two, and possibly three, temporally distinct phases of occupation. First, there may be an occupation associated with the presence of a few Santa Cruz Red-on-buff, Kana-a Black-on-white, and Kiatuthlanna Black-on-white sherds. The occupation associated with these types might be expected to date sometime betweeen A.D. 850 and 950. Second, it is suggested that there is an occupation phase associated with the presence of Sacaton Red-on-buff, Black Mesa Black-on-white, Sosi Black-on-white, Holbrook Black-on-white Variety A, Holbrook Black-on-white Variety A or B, and Red Mesa Black-on-white. The occupation associated with these types, which appears to be the most intensive and related to the two pithouses, dates sometime between A.D. 1000 and 1150, with perhaps the mid- to late-1000s being the best fit. Finally, judging from the redware frequency (see Chapter 13), and the presence of masonry architecture just outside the excavated right-of-way, there appears to be a small Classic period component, perhaps dating sometime after A.D. 1150.

It is emphasized that the discreteness of the suggested occupation phases are at best speculative. It is possible that the occupation was continuous, because several ceramic types bridge the gap between the periods. Furthermore, given the fact that the site contained only two structures, which appear to be architecturally related and perhaps sequential, it is probable that the primary occupation was relatively short-term and not continuous throughout the entire ceramic span. Unfortunately, the spatial distribution of the diagnostic types across the site is not conclusive of two or three discrete temporal components. The earlier sherds are in every instance mixed with later sherds.

The contextual analysis indicates that only two of the excavated contexts from the site are considered to be of relatively high integrity. The first is the floor and Stratum 19 of pithouse Feature 11, from which one Black Mesa Black-on-white sherd (floor contact), two Black Mesa or Sosi Black-on-white sherds, and one Holbrook Black-on-white Variety A sherds were collected. These associations suggest that the final occupation of Feature 11 dated sometime between A.D. 1050 and 1150. The second potentially good context, which is actually borderline on the contextual analysis plots, is the fill of pithouse Feature 5, from which one Santa Cruz Red-on-buff sherd, one Kana-a Black-on-white sherd, three Black Mesa or Sosi Black-on-white sherds, and one Holbrook Black-on-white Variety A sherd were recovered. Despite the somewhat satisfactory rating from the contextual analysis, this context from the decorated ceramic viewpoint appears hopelessly temporally mixed. Consequently no comment is asserted concerning the dating of this fill.

In conclusion, the diagnostic decorated ceramic assemblage at AZ O:15:91 is suggestive of two occupational phases, the first perhaps dating between A.D. 850 and 950, the second dating between A.D. 1000 and 1150. While Feature 11 probably dates to the later period, due to contextual mixing no further conclusions are offered concerning which features or fill episodes are associated with which occupational sequences.

Finally, the site's two roasting pits and two ephemeral rock alignments are believed to be possible evidence of a post-A.D. 1150 Classic period use of the site area. Although no decorated sherds dating to this period were recovered from the site, stratigraphic evidence (the two roasting pits were intrusive over the pithouses), the redware frequency, and architectural evidence suggest that these features may be of Classic period origin.

The Compact Site (AZ O:15:90): A.D. 1000-1150 (750-950)

The Compact site is a cluster of four pithouses, two extramural roasting pits, and one intrusive horno. Thirty-eight decorated sherds were recovered during the excavation of the site. The temporal span of the diagnostic types is great, ranging from Gila Butte Red-on-buff (A.D. 750-850) to Holbrook Black-on-white Variety A (A.D. 1050-1150). The majority (88 percent) of the temporally sensitive sherds from AZ O:15:90 fall within the A.D. 1000-1100+ range, with the best fit perhaps being the mid-1000s. Again, due to the temporal diversity of the types present in the assemblage, it is tentatively suggested that the decorated ceramic assemblage represents two periods of occupation. With only one sherd (the Gila Butte Red-on-buff sherd) clearly dating earlier than the majority of the assemblage, and only two other sherds suggesting a pre-A.D.

Table 12.10. Diagnostic sherd proveniences from the Redstone site, AZ O:15:91.

Site O:15:91

Feat. 0	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	1	0	0	0	0	0	0	0	0	1
SANTA CRUZ R/BF	1	0	0	0	0	0	0	0	0	1
SC OR SAC R/BF	1	0	0	0	0	0	0	0	0	1
SACATON R/BF	2	0	0	0	0	0	0	0	0	2
INDET. BUFF	1	0	0	0	0	0	0	0	0	1
INDET. T B/W	12	0	0	0	0	0	0	0	0	12
BLACK MESA B/W	2	0	0	0	0	0	0	0	0	2
BM OR SOSI B/W	6	0	0	0	0	0	0	0	0	6
SOSI B/W	1	0	0	0	0	0	0	0	0	1
INDET. LC B/W	8	0	0	0	0	0	0	0	0	8
HOLBROOK A B/W	1	0	0	0	0	0	0	0	0	1
HOLBRK A/B B/W	2	0	0	0	0	0	0	0	0	2
INDET. C B/W	1	0	0	0	0	0	0	0	0	1
KIAT OR RM B/W	1	0	0	0	0	0	0	0	0	1
Feature Total	40	0	0	0	0	0	0	0	0	40
Feat. 3	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SC OR SAC R/BF	0	0	1	0	0	0	0	0	0	1
SACATON R/BF	0	0	1	0	0	0	0	0	0	1
INDET. T B/W	0	0	1	0	0	0	0	0	1	2
BM OR SOSI B/W	0	4	0	0	0	0	0	0	0	4
HOLBRK A/B B/W	0	1	0	0	0	0	0	0	0	1
Feature Total	0	5	3	0	0	0	0	0	1	9
Feat. 5	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SANTA CRUZ R/BF	0	0	1	0	1	0	0	0	0	2
SC OR SAC R/BF	0	0	0	0	1	0	0	0	0	1
INDET. BUFF	0	0	2	0	1	0	0	0	0	3
INDET. T B/W	0	2	0	0	2	0	0	0	2	6
KANA-A B/W	0	0	1	0	1	0	1	0	1	4
BLACK MESA B/W	0	1	0	0	1	0	0	0	2	4
BM OR SOSI B/W	0	0	3	0	2	0	0	0	4	9
SOSI B/W	0	0	0	0	1	0	0	0	0	1
INDET. LC B/W	0	2	0	0	3	0	0	0	1	6
HOLBROOK A B/W	0	1	0	0	1	0	0	0	0	2
HOLBRK A/B B/W	0	1	1	0	0	0	0	0	0	2
HOLB/FLAG B/W	0	0	0	0	1	0	0	0	0	1
Feature Total	0	7	8	0	15	0	1	0	10	41
Feat. 11	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	0	0	0	0	1	0	0	0	0	1
SACATON R/BF	0	0	1	0	0	0	0	0	0	1
INDET. BUFF	0	2	2	0	2	0	0	0	0	6
INDET. T B/W	0	4	5	0	6	0	0	0	0	15
KANA-A B/W	0	0	1	0	0	0	0	0	0	1
BLACK MESA B/W	0	1	0	0	0	1	0	0	0	2
BM OR SOSI B/W	0	1	4	0	2	0	0	0	0	7
INDET. LC B/W	0	1	4	0	0	0	0	0	0	5
HOLBROOK A B/W	0	0	1	0	1	0	0	0	0	2
KIATUTH. B/W	0	1	0	0	0	0	0	0	0	1
KIAT OR RM B/W	0	0	1	0	0	0	0	0	0	1
RED MESA B/W	0	0	3	0	0	0	0	0	0	3
Feature Total	0	10	22	0	12	1	0	0	0	45
Feat. 16	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. T B/W	0	0	0	1	0	0	0	0	0	1
Feature Total	0	0	0	1	0	0	0	0	0	1
Feat. 17	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. T B/W	0	0	0	0	0	0	0	1	0	1
SOSI B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	2	0	2

Table 12.10. Continued.

Site 0:15:91

Feat. 18	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
BM OR SOSI B/W	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1
Feat. 23	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SACATON R/BF	0	0	0	0	0	0	0	1	0	1
INDET. BUFF	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	2	0	2
Site Total	40	22	33	1	27	1	1	5	11	141

1000 use of the area (a Santa Cruz Red-on-buff sherd and a Deadmans Black-on-red sherd), however, the ceramic evidence for an earlier component is not overly convincing. Moreover, as shown in Table 12.11, the three earlier sherds are invariably mixed with the later types. The Gila Butte Red-on-buff sherd occurred in the fill of Feature 2 with a Holbrook Black-on-white Variety A sherd provenienced to Stratum 19 of the same feature. The Santa Cruz Red-on-buff sherd was located in Stratum 10 of Feature 4 in association with a Sacaton Red-on-buff sherd, a Holbrook Black-on-white Variety A or B sherd, and a Red Mesa Black-on-white sherd. The Deadmans Black-on-red sherd was found in a disturbed sheetwash context above Features 4, 5, and 6.

Furthermore, results of the contextual analysis suggest that there are no contexts with high integrity at the site. All contexts are representative of either sheetwash deposits or transformed secondary trash deposits of dubious quality. Or, as in the case of Feature 4, the data set for the contextual analysis was so small, only one sherd, that the context was dismissed automatically from further consideration. Consequently, assigning specific dates to specific features or fill episodes cannot be justified.

In conclusion, the decorated ceramic assemblage from the Compact site indicates that occupation of the site area most likely occurred sometime between A.D. 1000 and 1150, with perhaps the mid-1000s being the "best fit." The presence of a Gila Butte Red-on-buff sherd, a Santa Cruz Red-on-buff sherd, and a Deadmans Black-on-red sherd suggest a limited pre-A.D. 1000 use of the site area.

As a final note, it is worth mentioning that the Compact site was highly disturbed during the initial construction of State Route 87. Consequently, the dearth of quality contexts at the site is not surprising. Moreover, it is plausible that an earlier component to the site may have been removed as a consequence of the road construction.

The Hilltop Site (AZ O:15:53): A.D. 1000-1150; (850-950); (1150-1300)

All Features (Except Feature 5)

The Hilltop site is comprised of a cluster of five pithouses, five possible crematoriums, and several extramural pits. The site is believed to have been used on a limited or temporary basis, with no two structures being occupied at the same time. Temporally sensitive sherds from the Hilltop site total only 10 in number and are distributed across the site with no apparent temporal patterning (see Table 12.12 for diagnostic sherd proveniences). Sacaton Red-on-buff was the dominant decorated type, comprising 40 percent of the diagnostic decorated assemblage. With so few diagnostic sherds, however, such a high temporal diversity, and no clear spatial patterning, it is difficult to conclude much of anything from the decorated assemblage. Furthermore,

Table 12.11. Diagnostic sherd proveniences from the Compact site, AZ O:15:90.

Site 0:15:90

Feat. 0	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SC OR SAC R/BF	1	0	0	0	0	0	0	0	0	1
INDET. T B/W	2	0	0	0	0	0	0	0	0	2
BLACK MESA B/W	1	0	0	0	0	0	0	0	0	1
BM OR SOSI B/W	1	0	0	0	0	0	0	0	0	1
INDET. LC B/W	1	0	0	0	0	0	0	0	0	1
HOLBROOK A B/W	1	0	0	0	0	0	0	0	0	1
HOLBRK A/B B/W	2	0	0	0	0	0	0	0	0	2
INDET. C B/W	1	0	0	0	0	0	0	0	0	1
DEADMAN'S B/R	1	0	0	0	0	0	0	0	0	1
INDET. TSG B/R	1	0	0	0	0	0	0	0	0	1
TUSAYAN CORR.	1	0	0	0	0	0	0	0	0	1
Feature Total	13	0	0	0	0	0	0	0	0	13
Feat. 2	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
GILA BUTTE R/BF	0	0	1	0	0	0	0	0	0	1
HOLBROOK A B/W	0	0	0	0	1	0	0	0	0	1
Feature Total	0	0	1	0	1	0	0	0	0	2
Feat. 3	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SACATON R/BF	0	0	2	0	0	0	0	0	0	2
INDET. T B/W	0	0	2	0	2	0	0	0	0	4
KANA-A OR BM B/	0	0	0	0	2	0	0	0	0	2
BLACK MESA B/W	0	0	0	0	1	0	0	0	0	1
INDET. LC B/W	0	0	1	0	0	0	0	0	0	1
HOLBROOK A B/W	0	0	1	0	0	0	0	0	0	1
RED MESA B/W	0	0	1	0	0	0	0	0	0	1
INDET. SJ B/R	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	8	0	5	0	0	0	0	13
Feat. 4	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	0	0	0	0	0	0	2	0	0	2
SANTA CRUZ R/BF	0	0	1	0	0	0	0	0	0	1
SACATON R/BF	0	0	1	0	0	0	0	0	0	1
KANA-A OR BM B/	0	2	0	0	0	0	0	0	0	2
HOLBRK A/B B/W	0	0	1	0	1	0	1	0	0	3
RED MESA B/W	0	0	1	0	0	0	0	0	0	1
Feature Total	0	2	4	0	1	0	3	0	0	10
Site Total	13	2	13	0	7	0	3	0	0	38

all contexts from the Hilltop site, excepting one, were dismissed from the contextual analysis due to their small sample sizes; only one or two sherds were present from each context (see Chapter 11). The one exception was the floor of Feature 9. This context fell into a transformed secondary trash determination which is suggestive of a disturbed or mixed context. Moreover, there were no diagnostic decorated ceramics collected from the floor of Feature 9.

Consequently, solely on the basis of the frequencies and the date ranges of the diagnostic types present, it is suggested that occupation of the Hilltop site occurred primarily in the A.D. 1000s. This is supported by the four recovered Sacaton Red-on-buff and the one recovered Black Mesa Black-on-white sherds. The presence of a Santa Cruz Red-on-buff sherd and two Kiatuthlanna Black-on-white sherds may suggest use of the site area sometime between A.D. 850 and 950. In addition, a single Deadmans Black-on-red sherd was recovered from the surface of the site during the testing phase, also suggestive of an earlier occupation (Elson and Swartz 1989:42). Finally, the occurrence of a Gila Polychrome sherd indicates a possible 14th-century visitation or perhaps usage of the site area. This may be related to the occupation of Feature 5.

Table 12.12. Diagnostic sherd proveniences from the Hilltop site, AZ O:15:53.

Site O:15:53

Feat. 0	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET.	1	0	0	0	0	0	0	0	0	1
SACATON R/BF	1	0	0	0	0	0	0	0	0	1
INDET. BUFF	1	0	0	0	0	0	0	0	0	1
INDET. T B/W	11	0	0	0	0	0	0	0	0	11
BLACK MESA B/W	1	0	0	0	0	0	0	0	0	1
INDET. LC B/W	4	0	0	0	0	0	0	0	0	4
INDET. C B/W	3	0	0	0	0	0	0	0	0	3
KIATUTH. B/W	2	0	0	0	0	0	0	0	0	2
INDET. SJ B/R	1	0	0	0	0	0	0	0	0	1
TUSAYAN CORR.	1	0	0	0	0	0	0	0	0	1
Feature Total	26	0	0	0	0	0	0	0	0	26

Feat. 1	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SANTA CRUZ R/BF	0	0	0	0	0	0	0	0	1	1
SACATON R/BF	0	2	0	0	0	0	0	0	0	2
INDET. BUFF	0	2	3	0	0	0	0	0	0	5
INDET. LC B/W	0	0	1	0	0	0	0	0	0	1
INDET. C B/W	0	1	0	0	0	0	0	0	0	1
GILA POLY	0	1	0	0	0	0	0	0	0	1
Feature Total	0	6	4	0	0	0	0	0	1	11

Feat. 5	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SHOW LOW B/R	0	1	0	0	0	0	0	0	0	1
Feature Total	0	1	0	0	0	0	0	0	0	1

Feat. 8	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
SACATON R/BF	0	1	0	0	0	0	0	0	0	1
INDET. BUFF	0	0	1	0	0	0	0	0	0	1
INDET. LC B/W	0	1	0	0	0	0	0	0	0	1
Feature Total	0	2	1	0	0	0	0	0	0	3

Feat. 9	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. BUFF	0	0	0	0	1	0	0	0	0	1
Feature Total	0	0	0	0	1	0	0	0	0	1

Feat. 15	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. T B/W	0	0	0	0	1	0	0	0	0	1
INDET. C B/W	0	0	0	0	1	0	0	0	0	1
Feature Total	0	0	0	0	2	0	0	0	0	2
Site Total	26	9	5	0	3	0	0	0	1	44

Feature 5

A single decorated sherd was recovered from Feature 5, a three-sided masonry structure located approximately 50 m downslope from the primary locus of AZ O:15:53. The sherd was identified as Show Low Black-on-red, which is dated provisionally between A.D. 1030 and 1200. The sherd was worked, having been ground into a disk shape. The sherd is provenienced to Stratum 9, overlying the fill of Feature 5, and therefore cannot be directly related to the occupation of the structure. Although it is impossible to make any strong temporal estimations on the basis of this one sherd, the fact that the structure is isolated from the main site locus and contains a relatively discrete artifact scatter, suggests a possible association. Furthermore, the masonry architecture and the presence of redware ceramics from the floor of Feature 5 do suggest a Classic period occupation, which would fit with the later end of the Show Low Black-on-red range.

The Arby's Site (AZ O:15:99): A.D. 1100-1200

The Arby's site consists of two distinct masonry structures (one of which was later remodeled into a cobble-lined windbreak or brush structure), a cobble alignment, and a single extramural hearth. The structures were located on either side of State Route 87 and their association is unclear, although a sherd match between the fills of the two structures suggests that the two sides of the road were related. Ten decorated sherds were recovered from the site. Of these only two are temporally significant (Table 12.13): a Show Low Black-on-red Corrugated sherd was provenienced to the fill of Feature 3, the masonry structure situated east of the highway; and a Walnut Variety A Black-on-white sherd was collected from the surface of the site also on the east side of the highway. It is noted that the fill of Feature 3 was dismissed from the contextual analysis because the sample size consisted of only two sherds. Consequently, with only two temporally sensitive sherds, both recovered from ambiguous contexts, nothing conclusive can be asserted regarding an absolute date range for the site's occupation or for the use/fill of the particular features. It is tentatively suggested, solely on the basis of the range of dates for the two diagnostic types present at the site, that occupation of the site occurred sometime between A.D. 1100 and 1200 (Table 12.5).

As a cursory note, it is of interest to reiterate that the Show Low Black-on-red Corrugated sherd came from the fill of Feature 3, a slab-lined pitroom (though as discussed above, this sherd's relationship with the use/filling of Feature 3 is uncertain). What is noteworthy about this association is that Feature 3 at AZ O:15:99 is somewhat similar in design to Feature 5 at the Hilltop site (AZ O:15:53), which also had a Show Low Black-on-red sherd in (possible) association. Whether this connection is significant or coincidental is uncertain, however, it seemed worthy of comment.

The Boone Moore Site (AZ O:15:55): A.D. 1100-1300

The Boone Moore site is comprised of three pithouses, two cobble-lined adobe pitrooms, two masonry structures, five inhumations, and various extramural pits. Sixty decorated sherds and one whole vessel were recovered from the site. Forty of these sherds and the vessel provide some temporal information (Tables 12.2 and 12.14). The date ranges for the temporally sensitive sherds identified at the Boone Moore site cluster between A.D. 1100 and 1300, with ceramic evidence possibly suggesting occupation into the first half of the 14th century.

Table 12.13. Diagnostic sherd proveniences from the Arby'a site, AZ O:15:99.

Site 0:15:99

Feat. 0	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. T B/W	1	0	0	0	0	0	0	0	0	1
INDET. LC B/W	3	0	0	0	0	0	0	0	0	3
WALNUT A	1	0	0	0	0	0	0	0	0	1
INDET. C B/W	2	0	0	0	0	0	0	0	0	2
Feature Total	7	0	0	0	0	0	0	0	0	7
Feat. 3	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. C B/W	0	0	1	0	0	0	0	0	0	1
SHOW. B/R COR.	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	2	0	0	0	0	0	0	2
Feat. 5	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. C B/W	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	1	0	0	0	0	0	0	1
Site Total	7	0	3	0	0	0	0	0	0	10

Table 12.14. Diagnostic sherd proveniences from the Boone Moore site, AZ O:15:55.

Site O:15:55

Feat. 0	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. LC B/W	1	0	0	0	0	0	0	0	0	1
WALNUT A	1	0	0	0	0	0	0	0	0	1
WALNUT A/B	2	0	0	0	0	0	0	0	0	2
INDET. C B/W	2	0	0	0	0	0	0	0	0	2
RESRV/TULA B/W	2	0	0	0	0	0	0	0	0	2
Feature Total	8	0	0	0	0	0	0	0	0	8
Feat. 1	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
HOLBROOK B B/W	0	0	0	2	0	0	0	0	0	2
Feature Total	0	0	0	2	0	0	0	0	0	2
Feat. 5	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
HOLBROOK B B/W	0	0	0	0	2	0	0	0	0	2
INDET. C B/W	0	2	2	0	2	0	0	0	0	6
SNOWFLAKE B/W	0	0	1	0	0	0	0	0	0	1
PUERCO B/W	0	0	0	0	0	0	1	0	0	1
PINTO B/R	0	1	1	0	0	0	0	0	0	2
PINTO POLY	0	0	0	0	1	0	0	0	0	1
ST. JOHN'S B/R	0	0	0	0	2	1	0	0	0	3
Feature Total	0	3	4	0	7	1	1	0	0	16
Feat. 6	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
HOLBROOK B B/W	0	0	2	0	0	0	0	0	0	2
WALNUT A	0	0	1	0	0	0	0	0	0	1
WALNUT A/B	0	0	1	0	0	0	0	0	0	1
PADRE B/W	0	0	1	0	0	0	0	0	0	1
INDET. C B/W	0	0	2	0	1	0	0	0	0	3
INDET. RSV B/R	0	0	0	1	0	0	0	0	0	1
PINTO POLY	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	8	1	1	0	0	0	0	10
Feat. 7	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. C B/W	0	0	0	0	0	0	0	1	0	1
PINTO B/R	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	2	0	2
Feat. 8	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. LC B/W	0	2	0	0	0	0	0	0	0	2
HOLBROOK B B/W	0	2	0	0	0	0	0	0	0	2
LEUPP B/W	0	1	0	0	0	0	0	0	0	1
PINTO B/R	0	2	0	0	0	0	0	0	0	2
Feature Total	0	7	0	0	0	0	0	0	0	7
Feat. 9	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
LATE LC B/W	0	0	1	0	0	0	0	0	0	1
PINTO B/R	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	2	0	0	0	0	0	0	2
Feat. 11	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
BM OR SOSI B/W	0	0	1	0	0	0	0	0	0	1
WALNUT A/B	0	0	0	0	0	0	0	0	1	1
INDET. C B/W	0	0	1	0	1	0	0	0	0	2
SNOWFLAKE B/W	0	0	0	0	2	1	0	0	0	3
Feature Total	0	0	2	0	3	1	0	0	1	7

Table 12.14. Continued.

Site O:15:55

Feat. 18	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. LC B/W	0	0	0	0	1	0	0	0	1	2
WALNUT A/B	0	0	0	0	0	1	0	0	0	1
RESRV/TULA B/W	0	0	0	0	1	0	0	0	0	1
Feature Total	0	0	0	0	2	1	0	0	1	4
Feat. 19	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
RESRV/TULA B/W	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	1	0	0	0	0	0	0	1
Feat. 22	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
ST. JOHN'S B/R	0	0	0	0	0	0	0	1	0	1
Feature Total	0	0	0	0	0	0	0	1	0	1
Site Total	8	10	17	3	13	3	1	3	2	60

Again, there is difficulty in assigning particular features to particular dates. It has been tentatively suggested, on the basis of architectural evidence, that the pithouses and cobble-lined adobe pitrooms predate the masonry structures. The ceramic evidence for this patterning is not conclusive. There are diagnostic sherds provenienced to the floors or Stratum 19 of three of the structures: Feature 11 (pithouse), which contains a partially reconstructible Snowflake Black-on-white vessel (A.D. 1100-1200); Feature 5 (cobble-lined adobe pitroom), which contains one sherd of Pinto Polychrome (A.D. 1250-1350), two sherds of Holbrook B Black-on-white (1050-1150), and three sherds of St. John's Black-on-red (1175-1325); and Feature 18 (disturbed masonry structure), which contains one sherd of Walnut Black-on-white Variety A or B (A.D. 1100-1250) and one sherd of Reserve or Tularosa Black-on-white (A.D. 1100-1300). The ceramic assemblages on these floors do not contradict the temporal architectural inferences, but they are not substantiative and, given the dating, it is possible that all three architectural types were roughly contemporaneous. The floor/floor fill deposits of Features 11 and 18 were recognized as deposits containing a high degree of integrity in the contextual analysis, both containing good secondary trash deposits, while Feature 5 was somewhat borderline between secondary trash and transformed secondary trash. Unfortunately, Feature 18, and possibly Features 5 and 6, were disturbed by road construction, although the floors (and Stratum 19) were not believed to be severely disturbed.

In considering the dating of fill deposits again there is uncertainty. The mixing of temporally distinct types is fairly complete. The "later" types within the assemblage, namely Pinto Black-on-red, Pinto Polychrome, and St. John's Black-on-red, consistently co-occurred with earlier types (note in particular Feature 9/Stratum 10, Feature 5/Stratum 10, Feature 5/Stratum 19, and Feature 6/Stratum 10). Consequently, these contexts are suggested to be mixed, and therefore, not accurately datable. This assessment is in only partial agreement with the results of the contextual analysis. Whereas the contextual analysis recognized the fill of Feature 6 to be potentially of high integrity based on sherd size and density, it is suggested here, on account of the co-occurrence of a Holbrook Black-on-white Variety B sherd (A.D. 1050-1150) and a Pinto Polychrome sherd (A.D. 1250-1350), that this context is temporally mixed. The contextual analysis did determine the fills of Features 5 and 9 to be of lower integrity.

It is important to note here that there is a fair amount of controversy regarding the dating of Pinto Polychrome (see Table 12.5). This is due to Montgomery and Reid's (1990:88-97) recent tree-ring dating of this type to no earlier than A.D. 1263 in the Grasshopper region of central Arizona, as compared to other dates as early as A.D. 1200 (Steen 1962; Wood 1987). Therefore the dating of this type and Features 5 and 6 are problematic. Given Breternitz's (1966) and Montgomery and Reid's (1990) tree-ring appraisals, however, a start date of around A.D. 1250 appears to be more realistic, and is the date used here.

Finally, it is noted that a whole vessel, typed as Puerco or Escavada Black-on-white (refer back to the discussion on indeterminate Cibola whitewares for details concerning this particular vessel), was recovered from Feature 7, an adult inhumation. The vessel is believed to date between A.D. 1000-1200, with a tightening of the temporal span (A.D. 1050-1150) suggested if the vessel is considered to be Escavada Black-on-white. Based on this date, it is speculated that Feature 7 is associated with the earlier component of the Boone Moore site.

In conclusion, ceramic evidence suggests an occupation span for the Boone Moore site from between A.D. 1100 to 1300. Although it is hypothesized that the pithouses and perhaps the cobble-lined adobe pit rooms predate the masonry structures, the ceramic evidence is inconclusive (but see Chapter 9, Volume 1).

Furthermore, the decorated ceramic assemblage cannot unequivocally determine whether or not occupation of the site was continous or periodic. With no obvious gap in the date ranges for the diagnostic ceramic types identified at the site, however, it is possible that the occupation of the site was continuous.

The Cobble Site (AZ O:15:54): A.D. 1100-1300; (850-1100); (1300-1450)

The Cobble site was originally a small masonry pueblo village. The site was divided into three loci for logistical purposes. Locus A consists of a large area of heavily root-plowed masonry rubble and a relatively undisturbed trash mound (Feature 2). The masonry remains, which exhibit no intact deposits, are estimated to have contained from 5 to 15 continguous masonry rooms. Locus B is approximately 20 m west, across State Route 87 from Locus A. Three noncontiguous masonry structures and an infant inhumation were excavated at Locus B. The relationship between Loci A and B is believed to have been spatially continuous prior to the construction of State Route 87. Locus C is an area of high surface artifact density situated approximately 90 m northeast of Locus A. No surface or subsurface features were recorded here.

Locus A: Feature 2

Feature 2 is a broad, low-lying trash mound (22 m north to south, 16 m east to west, and approximately 85 cm in height) associated with the disturbed masonry pueblo. Three 1-m by 2-m test units were placed within the mound. Two units, connected to one another in an "L"-shaped configuration, were located over the center of the mound. The third unit was placed a meter to the east of the other two units. All units were excavated in 10-cm arbitrary levels and screened through quarter-inch mesh. This was undertaken in an attempt to provide stratigraphic data to reconstruct the formation of the trash mound and perhaps the occupational history of the site. Table 12.15 provides a listing of the decorated ceramic types that were recovered from each of the units by level. Unfortunately, only 7 of the 37 decorated sherds collected from the three units provide any temporal information. Furthermore the vertical and horizontal distribution of these few sherds is not indicative of any clear temporal patterning. Consequently, nothing conclusive on the basis of the decorated ceramic assemblage can be asserted regarding the possibility of stratified deposits within the mound. The decorated assemblage as a whole, given the presence of Pinto Black-on-red, Pinto Polychrome, and Tusayan Polychrome suggests that formation of the mound took place sometime between A.D. 1125/1150 and 1300, with the period between A.D. 1250 and 1300 being the most probable, given the temporal overlap between Tusayan Polychrome and Pinto Polychrome.

Locus B: Features 5, 6, 8, and 9

Ten temporally sensitive sherds were recovered from Features 5, 6, 8, and 9 within Locus B (Table 12.15). These features are, respectively, a possible cobble pitroom, a cobble concentration (possibly a disturbed structure), remnants of a cobble structure, and a "D"-shaped slab-lined pitroom. Features 5 and 8 were severely disturbed during the construction of State Route 87 and only partially excavated. Feature 6 also was disturbed though the extent of the disturbance could not be defined clearly during excavation. Four diagnostic sherds were recovered in association with Feature 5, three from the fill: a Black Mesa or Sosi Black-on-white

Table 12.15. Diagnostic sherd proveniences from the Cobble site, AZ O:15:54.

Site O:15:54

Feat. 0	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
INDET. T B/W	2	0	0	0	0	0	0	0	0	2
INDET. LC B/W	3	0	0	0	0	0	0	0	0	3
WALNUT B	1	0	0	0	0	0	0	0	0	1
INDET. C B/W	9	0	0	0	0	0	0	0	0	9
INDET. TSG	1	0	0	0	0	0	0	0	0	1
CAMERON POLY	1	0	0	0	0	0	0	0	0	1
Feature Total	17	0	0	0	0	0	0	0	0	17

Feat. 2 Stratum 50	Level 0	Level 1	Level 2	Level 3	Level 4	Total
Test Unit 1 (Testing Phase):						
INDET.	2	0	0	0	0	2
INDET. C B/W	11	7	0	1	0	19
INDET. LC B/W	1	0	0	0	0	1
PINTO B/R	0	0	0	1	0	1
PINTO POLY	1	0	0	0	0	1
TUSAYAN POLY	1	0	0	0	0	1
Test Unit Total	16	7	0	2	0	25

Feat. 2 Stratum 50	Level 0	Level 1	Level 2	Level 3	Level 4	Total
Test Unit 2:						
INDET. C B/W	4	1	2	0	0	7
PINTO B/R	0	0	0	1	0	1
INDET. TSG. POLY	0	0	0	0	1	1
Test Unit Total	4	1	2	1	1	9

Feat. 2 Stratum 50	Level 0	Level 1	Level 2	Level 3	Level 4	Total
Test Unit 3:						
RES./TULAROSA B/W	0	1	0	0	0	1
TULAROSA B/W	0	0	0	1	0	1
PINTO B/R	0	0	0	0	1	1
Test Unit Total	0	1	0	1	1	3

Feat. 5	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
BM OR SOSI B/W	0	0	0	1	0	0	0	0	0	1
PINTO B/R	0	0	0	1	0	0	0	0	0	1
TONTO POLY	0	0	0	0	1	0	0	0	0	1
TUWIUCA BKL/ORG	0	0	0	0	0	0	0	0	1	1
Feature Total	0	0	0	2	1	0	0	0	1	4

Feat. 6	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
TUWIUCA BLK/ORG	0	0	0	0	0	0	0	0	1	1
Feature Total	0	0	0	0	0	0	0	0	1	1

Feat. 8	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
BLACK MESA B/W	0	0	1	0	0	0	0	0	0	1
TUWIUCA BLK/ORG	1	0	0	0	0	0	0	0	0	1
Feature Total	1	0	1	0	0	0	0	0	0	2

Feat. 9	Str. 0	Str. 09	Str. 10	Str.11	Str. 19	Str. 20	Str. 30	Str. 50	Str. 99	Total
KANA-A B/W	0	0	1	0	0	0	0	0	0	1
HOLBRK A/B B/W	0	0	0	0	1	0	0	0	0	1
TUWIUCA BLK/ORG	0	0	1	0	0	0	0	0	0	1
Feature Total	0	0	2	0	1	0	0	0	0	3
Site Total	46	0	3	2	2	0	0	37	2	64

sherd, a Pinto Black-on-red sherd, and a Tonto Polychrome sherd; and one from the surface: a Tuwiuca Black-on-orange sherd. One diagnostic sherd was collected from the surface of Feature 6, again a Tuwiuca Black-on-orange sherd. Two diagnostic sherds were recovered in association with Feature 8, a Black Mesa Black-on-white sherd from the fill, and a Tuwiuca Black-on-orange sherd from the surface. Three diagnostic sherds were collected in association with Feature 9, two from the fill: one Kana-a Black-on-white sherd and one Tuwiuca Black-on-orange sherd; and one from Stratum 19: a Holbrook Black-on-white Variey A or B sherd.

The contextual analysis dismissed all contexts from this locus, save two, from further consideration due to small sample size. The two contexts with enough sherds to warrant analysis were the fill and floor of Feature 9. The fill was ranked as transformed secondary trash, perhaps sheet trash; this is not surprising given the association of Kana-a Black-on-white and Tuwiuca Black-on-orange in the fill. The floor, on the other hand, was determined to be of high contextual integrity indicative of good secondary trash deposits. Therefore it is possible that the Holbrook Black-on-white Variety A or B sherd recovered from Stratum 19 is in good association and dates the last use or earliest fill of the structure to around A.D. 1050 to 1150. Unfortunately, outside of Feature 9, the varied horizontal and vertical mixing of temporally distinct types makes it imprudent to assign a ceramically based date to any other features.

In conclusion, due to depositional mixing and the low numbers of diagnostic sherds, all that is tentatively suggested from the decorated assemblage at Locus B is that there may have been a long-term periodic use of the site area, perhaps beginning in the mid-A.D. 800s and lasting through to the fourteenth century. The mid-A.D. 800s date comes from the early end of Kana-a Black-on-white. A single Santa Cruz or Sacaton Red-on-buff (A.D. 850-1150) also was recovered during the testing phase, from the surface of Locus A, suggesting a possible earlier occupation (Elson and Swartz 1989:76). The presence of Tonto Polychrome and Tuwiuca Black-on-orange suggests a possible late component between A.D. 1250 and 1400. Feature 9, the only structure that could be dated, appears to have been occupied between A.D. 1050 and 1150.

Conclusions

Based on the decorated ceramic assemblage, the Cobble site appears to have been occupied sporadically from sometime around A.D. 850 or 900 through the early fourteenth century. The primary occupation, however, taking into account all three loci, appears to have been in the period between A.D. 1100 and 1300 when it is speculated the majority of the masonry rooms and the trash mound were in use. Earlier use of the site area may be related to the Preclassic occupation at AZ O:15:92--situated across a wash less than 50 m south of the Cobble site is Locus A. AZ O:15:92, which may have represented a pithouse village, is estimated to have been primarily inhabited between A.D. 900-1000.

Rye Creek Ruin (AZ O:15:1): A.D. 1200-1350

Rye Creek Ruin, located approximately 500 m east of the project area, is a 200+ room masonry pueblo with an associated platform mound. This is the largest site in the Upper Tonto Basin, and appears to be the focus of the Classic period settlement within the project area. Although the site was already believed to date primarily to the late Classic period, stratigraphic tests of three trash mounds were undertaken to ascertain whether earlier Classic or Preclassic period components were present. The trash mounds that were tested were all located outside of the main compound. Test excavations consisted of 1-m by 2-m units dug in 20-cm levels situated in the center of each of the mounds.

Feature 1

Ninety-seven decorated sherds, representing 20 temporally sensitive types and five indeterminate ware categories, were recovered from the 1-m by 2-m test unit placed in Feature 1, the largest of the trash mounds tested at Rye Creek Ruin (Table 12.16). The date ranges for the types identified in the assemblage as a whole

Table 12.16. Diagnostic sherd proveniences from Rye Creek Ruin, AZ O:15:1.

Site O:15:1

Feat. 1	Level 1	Level 2	Level 3	Level 4	Level 5	Total
INDET.	2	1	2	2	1	8
SC OR SAC R/BF	0	0	0	0	1	1
INDET. BUFF	0	0	1	1	1	3
INDET. LC B/W	2	1	1	1	1	6
WALNUT A	1	0	1	1	0	3
WALNUT A/B	1	1	1	0	0	3
LATE LC B/W	2	1	0	1	0	4
INDET. C B/W	0	4	1	3	7	15
SNOWFLAKE B/W	0	0	1	0	0	1
TULAROSA B/W	0	1	0	0	2	3
PINEDALE B/W	0	0	0	1	0	1
INDET. RSV	0	0	0	1	0	1
PINTO B/R	0	0	0	0	1	1
PINTO POLY	0	0	1	0	1	2
PINTO/GILA POLY	3	1	1	0	1	6
GILA POLY	2	5	2	0	0	9
INDET. WM POLY	1	1	0	0	0	2
INDET. WM B/R	2	0	0	0	2	4
PINEDALE B/R	1	0	1	0	0	2
PINE/4MILE POLY	1	0	0	0	0	1
FOURMILE POLY	3	1	1	1	1	7
CIBECUE POLY	1	1	1	0	0	3
JEDDITO YELLOW	0	1	0	0	0	1
E. JEDDITO B/Y	2	0	0	0	0	2
E/L JEDDITO B/Y	1	0	0	0	0	1
BIDAHOCHI POLY	1	0	0	0	0	1
HOMOL. POLY	1	1	1	0	0	3
TUWIUCA BLK/ORG	0	0	0	0	1	1
CHAVEZ B/R	0	0	0	0	1	1
MAVRK MT. POLY	0	1	0	0	0	1
Feature Total	27	21	16	12	21	97

Feat. 2	Level 1	Level 2	Level 3	Total
INDET.	1	2	0	3
INDET. LC B/W	1	0	0	1
WALNUT A	0	0	1	1
WALNUT A/B	0	5	0	5
WALNUT B	2	0	0	2
LATE LC B/W	0	0	1	1
INDET. C B/W	1	1	1	3
SNOWFLAKE B/W	0	0	1	1
INDET. RSV B/R	0	1	0	1
PINTO B/R	0	0	1	1
INDET. WM B/R	0	1	0	1
BIDAHOCHI B/W	1	0	0	1
Feature Total	6	10	5	21

Feat. 3	Level 1	Level 2	Level 3	Total
WALNUT A	0	0	1	1
WALNUT B	1	0	0	1
INDET. C B/W	1	0	0	1
SNOWFLAKE B/W	0	1	0	1
RESRV/TULA B/W	0	0	1	1
PINTO B/R	0	0	1	1
Feature Total	2	1	3	6
Site Total	0	0	0	124

best cluster in the first half of the A.D. 1300s, though a second smaller cluster is also noted in the first half of the A.D. 1200s (associated with the presence of Little Colorado whitewares). Consequently a broad date range for the deposit could span from A.D. 1200 to 1400.

Again, stratigraphic mixing of the temporally sensitive types made a rigorous internal seriation of the deposit impossible (Table 12.17). As stated above, it seems that the trash mound was deposited primarily around or after A.D. 1300; 76.3 percent of the diagnostic decorated ceramics potentially postdate this time. Some stratigraphic information is still available, however, Levels 1, 2, and 3, the uppermost 60 cm of the deposit, contain the cleanest late Classic period assemblage from the project area, although some temporal mixing is present; 80 percent of the diagnostic decorated ceramics recovered from these levels postdate A.D. 1300. This is in contrast to Levels 4 and 5, the bottom 40 cm, where only 64.3 percent of the diagnostic ceramics postdate A.D. 1300. Perhaps also significant is the variation in whiteware to polychrome frequencies with respect to depth (Table 12.17). Whiteware ceramics, including indeterminate wares, comprise the majority of the decorated assemblage in Levels 4 and 5 (59.3 percent whitewares versus 40.7 percent polychromes), but are replaced by polychromes in Levels 1, 2, and 3 (34.5 percent whitewares versus 65.5 percent polychromes). This relationship is statistically significant (Pearson Chi-square = 12.56, DF=1 p =.0001). Consequently, it is asserted that within Feature 1 the occurrence of polychrome ceramics increases over time with a subsequent decrease in the occurrence of whiteware ceramics.

The earliest ceramic in the assemblage was a Santa Cruz or Sacaton Red-on-buff (A.D. 850-1150) sherd, recovered from Level 5 of the test unit. Also recovered from this level were two Tularosa Black-on-white sherds, one Fourmile Polychrome sherd, one Pinto Black-on-red sherd, one Pinto Polychrome sherd, one Pinto or Gila Polychrome sherd, one Chavez Pass Black-on-red sherd, and one Tuwiuca Black-on-orange sherd. Consequently, to argue that the earliest dumping episode associated with Feature 1 occurred in Santa Cruz or Sacaton times seems imprudent (three indeterminate buffware sherds also were recovered from Feature 1: one in level 5, one in level 4, and one in level 3). Of course, this does not belie the possibility of an early component at Rye Creek Ruin. All that can be stated at the present time, however, is that the presence of these buffware sherds, while suggestive, is not conclusive of an early Preclassic period occupation of the immediate site area.

Feature 2

Twenty-one decorated sherds were recovered from the two levels within the 1-by 2-m test unit placed in Feature 2, a small trash mound. Twelve of the decorated sherds provide temporal information. Again, due to the interlevel mixing of the diagnostic types, no internal seriation for the mound could be worked out; the two latest sherds from the assemblage, a Bidahochi Black-on-white sherd and a Pinto Black-on-red sherd, come, respectively, from the top and bottom levels of the test unit. Despite this mixing, however, the remaining sherds cluster within the A.D. 1100-1250 period. The best date for the trash mound as a whole would appear to be between A.D. 1200 and 1250. Although the sample size is small, 83.3 percent of the diagnostic ceramics predate A.D. 1300. This is considerably earlier than Feature 1 and documents an early

Classic period component at the site. Although the Bidahochi Black-on-white sherd dates considerably later than the suggested date range for the mound, this sherd was recovered from the uppermost level and its presence may be attributable to a later use of the area.

Feature 3

There were only five temporally sensitive sherds recovered from the 1-m by 2-m test unit placed in Feature 3, a small trash mound. Stratigraphic mixing of the temporally sensitive types made internal seriation of the deposit impossible. The assemblage does indicate that, like Feature 2, the trash as a whole dates between A.D. 1100 and 1250, with perhaps a best-fit date between A.D. 1200 and 1250.

Table 12.17. Whiteware and polychrome frequencies through time at Rye Creek Ruin.

Level	Pre A.D. 1300	Post A.D. 1300	Whiteware	Polychrome
Level 1	20.0%	80.0%	27.3%	72.7%
Level 2	14.3%	85.7%	40.0%	60.0%
Level 3	27.3%	72.7%	38.5%	61.5%
Level 4	50.0%	50.0%	70.0%	30.0%
Level 5	33.3%	66.6%	52.9%	47.1%

Conclusion

A wide diversity of ceramic wares and types was recovered from Rye Creek Ruin. Identified ceramics included eight wares with 20 distinct types. The ceramics stemmed from all areas of the greater Southwest, suggesting the importance of Rye Creek Ruin at both the regional and interregional level.

It is interesting to note that only 22 Roosevelt Redware sherds were recovered from the three tested trash mounds. These sherds represent only 17.7 percent of the recovered decorated assemblage; Little Colorado whiteware comprised 22.6 percent, Cibola whiteware 21.8 percent, and White Mountain redware 16.1 percent. Furthermore, it is noted that decorated sherds overall account for only 1.7 percent of the 7613 sherds recovered from the trash mounds (see Table 13.1). Consequently, at Rye Creek Ruin, Roosevelt Redwares make up only 0.3 percent of the entire assemblage.

The low frequency of Roosevelt Redwares at Rye Creek Ruin may be due to several factors. For one, Roosevelt Redwares may be primarily, although not exclusively, a mortuary ware, and therefore may not be found in great frequencies in the trash mounds. This is somewhat supported by research at the Grasshopper pueblo (Mayro et. al 1976) and by a recent analysis of the Rye Creek Ruin burial collections (John Ravesloot, personal communication, 1990), although these data are far from conclusive. Another possible explanation is that Roosevelt Redwares may simply not have been produced in the Upper Tonto Basin. Given the great diversity but relatively low frequency of intrusive ceramic wares at the Rye Creek Ruin trash mounds, the comparable low frequency of the Roosevelt Redwares suggests that this ware may also be an intrusive ceramic.

Summary of Ceramic-based Site Chronology

Table 12.18 summarizes the conclusions of the above discussion. As can be seen from the table, the temporal ranges of the decorated ceramics from the project area sites suggest more or less continuous occupation of the Lower Rye Creek drainage beginning perhaps as early as the eighth century (Snaketown phase) and lasting through to the early fifteenth century (Gila phase). The most probable occupation span, taking all factors into account, is from A.D. 750 through 1350. It is important to note, however, that due to the limitations of ceramic temporal resolution, a ceramically continuous occupation (i.e. one where the ceramic types overlap) does not necessarily mean that the occupation was permanent or even that the area was continuously inhabited throughout the represented time span. It simply means that there is a progression of temporally overlapping ceramic types.

For example, no site in the project area was dated primarily between A.D. 850 and 900, although the few Santa Cruz Red-on-buff and more numerous Kana-a Black-on-white sherds recovered from several of the sites suggest the possibility of occupation during this time. Whether this lack of a primary occupation is due to an actual mid ninth- to tenth-century abandonment of the area, or if it is simply a reflection of a limited site sample is unclear. Further survey and excavation in the Rye Creek area is needed before such a question can be evaluated fully, although the fact that Roosevelt 9:6 (Haury 1932), a large pithouse village in the Lower Tonto Basin, contains a strong Santa Cruz component is suggestive of a sampling problem. Therefore, although the Santa Cruz phase hiatus may be due to sampling, the question of continuous or intermittent occupation can be asked for every time period and site investigated, because the 100 or 200 year time spans generally represented by each decorated ceramic type is at too gross a level for making this determination. This and other problems are dealt with in greater detail in Chapters 25, 26 and 28, Volume 3.

Table 12.18 Ceramic-based site chronology for the Rye Creek Project sites.

Site Number	Feature Specific	Primary Temporal Span (A.D.)	Secondary Component
AZ O:15:52		750-850	950-1150
AZ O:15:92	Features 14, 15, 16	850-1050	
	Feature 1	1000-1200+	
AZ O:15:100		1000-1100+	750-850+
AZ O:15:91		1000-1150	850-950
AZ O:15:90		1000-1150	750-950
AZ O:15:53	Except Feature 5	1000-1150	850-950 1300s
	Feature 5	1150-1300	
AZ O:15:99		1100-1200	
AZ O:15:55		1100-1300	
AZ O:15:54	Feature 2	1125/1150-1300	
	Features 5, 6, 8, 9	850-1300	
AZ O:15:1	Feature 3	1200-1250	
	Feature 2	1200-1250	
	Feature 1	1200-1400+	

As a means of summarizing the above presentation, a cumulative percentage graph was prepared illustrating the temporal clustering of the Rye Creek Project sites on the basis of the frequencies of groupings of contemporaneous ceramic types (Figures 12.18 and 12.19). The rationale for the placement of particular ceramic types in particular ceramic groups is based on the published dates compiled in Table 12.5. Looking at Figure 12.18, it is noted that the Deer Creek site (AZ O:15:52) stands alone as having the earliest decorated ceramic assemblage. Next, it is seen that there is a clustering of sites (AZ O:15:53, 90, 91, 92, and 100) whose diagnostic decorated ceramic assemblages primarily fall into ceramic groups three, four, and five. Following this temporal cluster is the Boone Moore site (AZ O:15:55), whose assemblage is marked by ceramic groups five, six, and seven. Then there is AZ O:15:1, Rye Creek Ruin, with the latest assemblage, dominated by ceramic groups six, seven, eight, and nine. Finally, it is noted that AZ O:15:54 is the one site from the project area whose decorated ceramic assemblage spans the entire temporal range, having ceramic types present from ceramic groups three through nine.

In addition to Figure 12.18, Table 12.18 provides a summarized listing of the absolute temporal ranges suggested for each of the Rye Creek Project sites (or when specified for particular loci or features) on the basis of diagnostic decorated ceramics. Table 12.18 includes both the suggested primary occupation span and, when relevant, dates for additional occupation components.

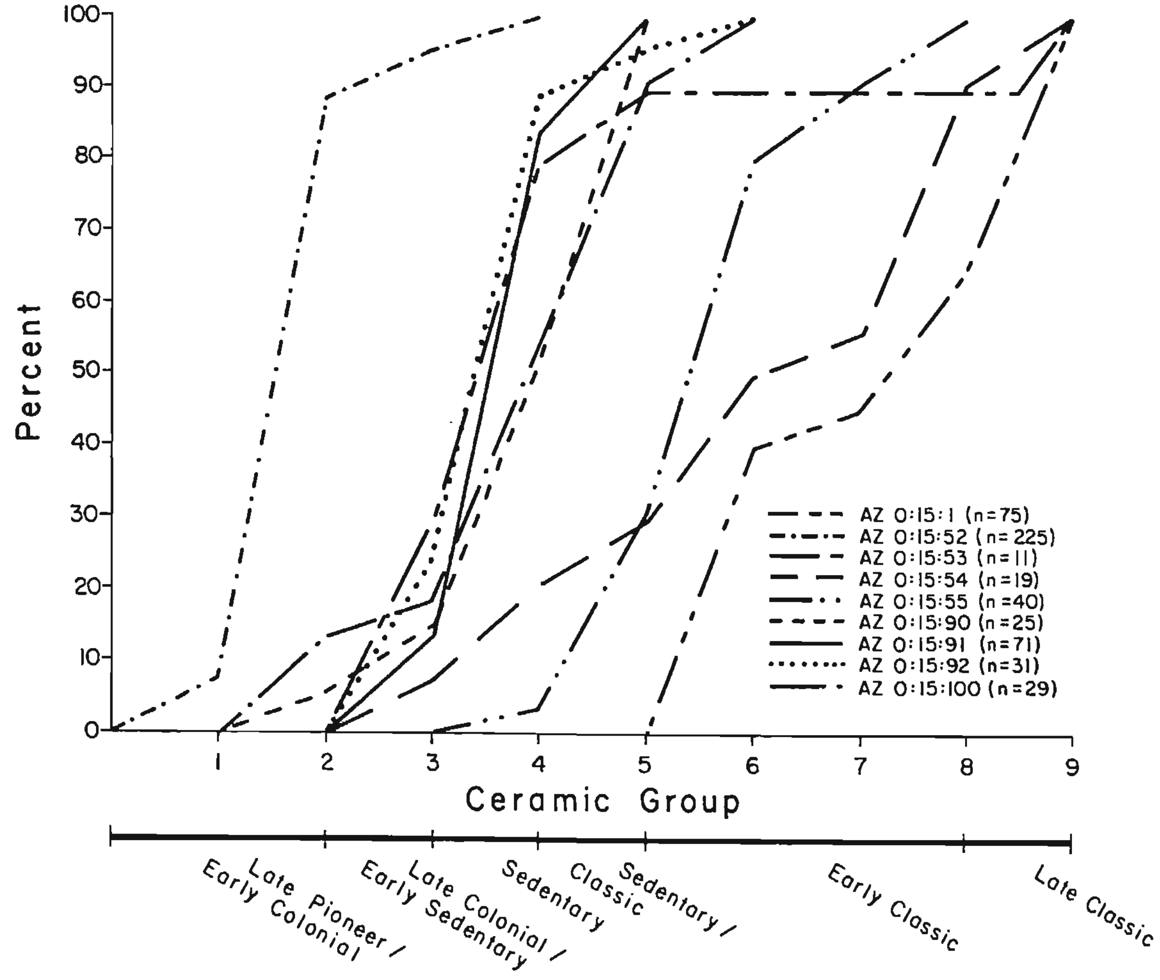

Figure 12.18. Cumulative percentage graph of the temporal clustering of the Rye Creek Project sites.

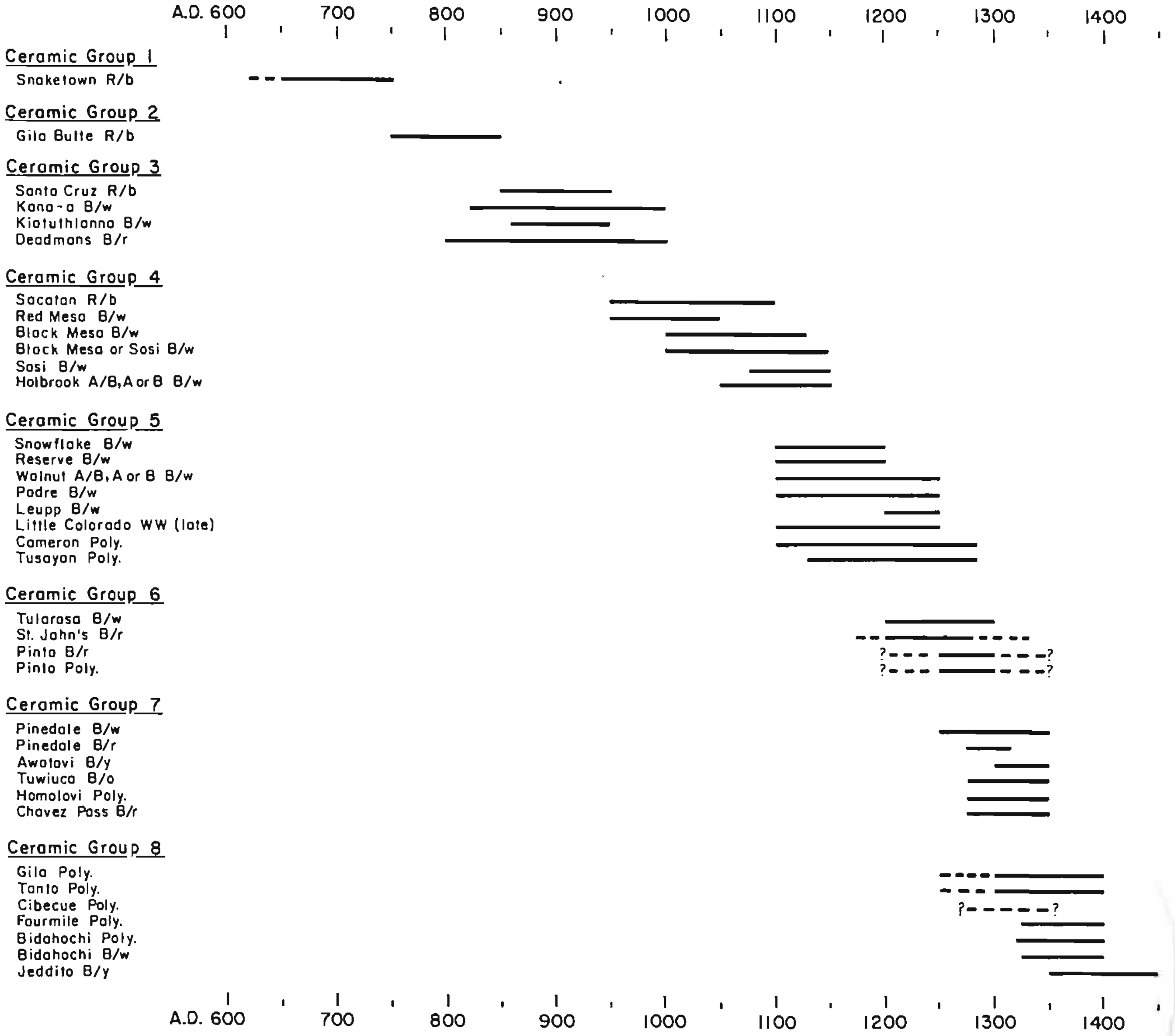

Figure 12.19. Ceramic types listed by group with date range plots.

DIACHRONIC PATTERNS IN REGIONAL INTERACTION

With the results of the temporal analysis indicating that the Rye Creek Project sites have significant temporal depth, the next issue is that of diachronic patterns in ceramic exchange and interaction. Specifically, can variability in decorated ceramic ware frequencies over time provide insights concerning the nature of nonlocal ceramic interaction networks in the Lower Rye Creek community? It is important to note that the following discussion is concerned solely with patterns of regional interaction, and makes no assumptions concerning whether decorated ceramics are entering the project area through trade and exchange networks or through actual movement of populations. Both processes may be occurring, although trade and exchange are considered to be the most likely source for the majority of the decorated assemblage.

Table 12.19 provides a listing of the decorated ceramic wares and the decorated ceramic ware frequencies associated with each site (or with specific features, when a site appears to be multicomponent). The sites and features are listed in chronological order according to the chronology discussed in the previous section. The decorated ceramic wares are grouped together by general geographic area of origin (Abel 1955; Breternitz, et. al. 1974; Carlson 1970; Colton 1952; Colton and Hargrave 1937; Fowler 1989; Haury 1976; W. Smith 1971; Sullivan and Hantmann 1984).

As Table 12.19 illustrates, there does appear to be significant diachronic variability in decorated ceramic ware frequencies for the Rye Creek Project sites. General trends suggested are:

1) A.D. 700-900: Hohokam buffwares dominate the decorated assemblage, though Tusayan whitewares are consistently present in low frequencies. An occasional Cibola whiteware occurs. The Hohokam buffwares, judging from style, paste, and temper, are identical to buffwares manufactured in the Hohokam core area to the south, and are assumed to have been manufactured in this area. Several plainware sherds of Gila Plain, Gila Variety, with a nonlocal micaceous schist temper, were also recovered from this time period, suggesting exchange in Hohokam plainware ceramics as well.

2) A.D. 900-1000: This is a transitional period, with neither Hohokam buffwares nor Tusayan whitewares clearly dominant. Although buffwares appear to be slightly more prevalent, interaction is clearly occurring to a significant degree with the Tusayan whiteware area. A few Cibola whitewares also are present.

3) A.D. 1000-1050: Tusayan whitewares replace Hohokam buffwares as the dominant decorated ware, though Hohokam buffwares are still present. Cibola whitewares occur in higher frequencies than in earlier assemblages, although their presence is still relatively minimal. There is the occasional appearance of a late San Juan redware or an early Tsegi orangeware.

4) A.D. 1050-1100: Tusayan whitewares and Little Colorado whitewares dominate the decorated assemblage with Hohokam buffwares the third most frequent ware. Cibola whitewares are present, though still in low frequencies. There is the occurrence of a single sherd of Tusayan grayware.

5) A.D. 1100-1250: Tusayan whitewares and Hohokam buffwares are no longer present. Little Colorado whitewares dominate the decorated assemblage, although Cibola whitewares are present in significant amounts. White Mountain redwares and Roosevelt redwares start appearing, respectively, by the late A.D. 1100s and early- to mid-A.D. 1200s. There is the occasional occurrence of a Mogollon brownware (Show Low Black-on-red).

6) A.D. 1250+: Cibola whitewares, White Mountain redwares, and Roosevelt redwares occur in the highest frequencies. Hopi wares and Winslow orangewares (replacing Little Colorado whitewares, which are no longer produced after the mid-A.D. 1200s (Douglass 1987)) are present in low frequencies. Occasional Mogollon brownwares (Maverick Mountain Polychrome) occur.

Table 12.19. Decorated ceramic ware counts and frequencies for the Rye Creek Project sites/features (sites/features arranged chronologically).

Site No.	Feat No.	Prim. Temp. Span	Salt Gila Buff		Kayenta								Hopi Buttes/ Hopi Mesas						East Central AZ/ West Central N.M.						?		Upper Tonto Basin		Indeterminates											
					TWW		SJRW		TOW		TGW		LCWW		WOW		HW		CWW		WMRW		MBW		RRW		LR/B		TorLC		TorC		CorLC		IWW		II		Total	
			#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
52		750-850	368	89	36	9	-	-	-	N	-	N	2	.5	-	N	-	N	-	-	-	N	-	-	-	N	7	2	-	-	-	-	-	-	-	-	2	.5	415	100
92	14, 15, 16	850-1050	46	88	5	10	-	-	-	N	-	N	-	N	-	N	-	N	1	2	-	N	-	-	-	N	-	-	-	-	-	-	-	-	-	-	-	-	52	100
100		1000-1100+	18	21	46	53	3	3	-	-	-	-	2	2	-	N	-	N	7	8	-	-	-	-	-	N	-	-	-	-	8	9	-	-	3	3	-	-	87	100
91		1000-1150	22	16	80	57	-	-	-	-	-	-	30	21	-	N	-	N	7	5	-	-	-	-	-	N	-	-	-	-	1	1	-	-	1	1	-	-	141	100
90		1000-1150	6	16	13	34	2	5	1	3	1	3	10	26	-	N	-	N	3	8	-	-	-	-	-	N	-	-	1	3	-	-	-	-	-	-	1	3	38	100
53		1000-1150	13	30	13	30	1	2	-	-	1	2	6	14	-	N	-	N	7	16	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	1	2	43	100
92	1	1000-1200	-	-	1	9	-	N	-	-	-	-	-	-	-	N	-	N	1	9	-	-	9	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	100
53	5	1150-1300	-	-	-	-	-	N	-	-	-	-	-	-	-	N	-	N	-	-	-	-	1	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	100
99		1100-1200	-	-	1	10	-	N	-	-	-	-	4	40	-	N	-	N	4	40	-	-	1	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	100
55		1100-1300	-	-	1	2	-	N	-	-	-	-	23	38	-	N	-	N	23	38	4	7	-	-	9	15	-	-	-	-	-	-	-	-	-	-	-	-	60	100
1	3	1200-1250	-	-	-	-	-	N	-	-	-	-	2	33	-	N	-	N	3	50	-	-	-	-	1	17	-	-	-	-	-	-	-	-	-	-	-	-	6	100
1	2	1200-1250	-	-	-	-	-	N	-	-	-	-	10	48	-	-	1	5	4	19	1	5	-	-	2	10	-	-	-	-	-	-	1	5	1	5	1	5	21	100
54	2	1150-1300	-	-	-	-	-	N	2	5	-	-	1	3	-	-	-	-	28	76	-	-	-	-	4	11	-	-	-	-	2	5	-	-	-	-	-	-	37	100
1	1	1200-1400	4	4	-	-	-	N	-	-	-	-	16	16	5	5	5	5	20	21	19	20	1	1	19	20	-	-	-	-	-	-	2	2	-	-	6	6	97	100
54	5, 6, 8, 9	800-1300	-	-	3	30	-	-	-	-	-	-	1	10	4	40	-	-	-	-	-	-	-	-	2	20	-	-	-	-	-	-	-	-	-	-	-	-	10	100
Total			477	46.4	199	19.3	6	0.6	3	0.3	2	0.2	107	10.4	9	0.9	6	0.6	108	10.5	24	2.3	12	1.2	38	3.7	7	0.7	1	0.1	11	1.1	3	0.3	5	0.5	11	1.1	1029	100

N = Ware not produced during the proposed temporal span for the site/feature; TWW = Tusayan Whiteware; SJRW = San Juan Redware; TOW = Tsegi Orangeware; TGW = Tusayan Grayware; LCWW = Little Colorado Whiteware; WOW = Winslow Orangeware; HW = Hopi Ware; CWW = Cibola WHiteware; WMRW = White Mountain Redware; MBR = Mogollon Brownware; RRW = Roosevelt Redware; TorLC = Tusayan or Little Colorado; TorC = Tusayan or Cibola Whiteware; CorLC = Cibola or Little Colorado Whiteware; IWW = Indeterminate Whiteware; II = Indeterminate Intrusive.

In summary, for the project area the earliest decorated ceramic assemblages are dominated by Hohokam buffwares. By A.D. 1000 Tusayan whitewares predominate. By A.D. 1100 Little Colorado whitewares predominate, although a significant number of Cibola whitewares are present; Hohokam buffwares and Tusayan whitewares cease to be present. By A.D. 1250 the assemblages become particularly variable with Cibola whitewares, White Mountain redwares, Roosevelt redwares, Winslow orangewares, and Hopi wares all present. These trends are shown graphically in Figure 12.20.

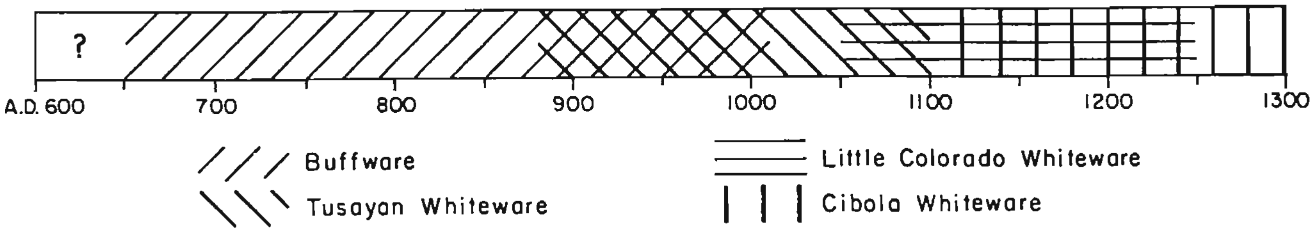

Figure 12.20. Graph of trends in presence of decorated wares through time.

Consequently, it does appear that significant diachronic patterns can be delineated from the decorated ceramic ware frequencies. Of course, some of the diachronic patterning is to be anticipated due to the given life span of certain wares. That is to say, White Mountain redwares would not be expected in an assemblage predating A.D. 1000, because production of White Mountain redwares did not commence until the eleventh century (Carlson 1970) (see Table 12.19: "N" denotes that the frequency most likely equals zero on account of the ware not being produced during the proposed temporal span for the given site or feature). Not all of the suggested temporal trends are attributable to the life span of a ware. Notably, the production lives of Hohokam buffwares, Tusayan whitewares, and Cibola whitewares span nearly the entire temporal range suggested for the project area sites, but frequencies of these wares within the project area vary significantly over time. From the above discussions there appear to be at least three diachronic trends in decorated ceramic ware frequencies that are potentially indicative of changes over time in the Rye Creek community's nonlocal ceramic exchange and interaction networks.

First, there is the shift from buffware dominance of the decorated assemblage to Tusayan whiteware dominance of the assemblage, a shift suggested to occur completely by about A.D. 1000 (with the advent of the type Black Mesa Black-on-white). This shift is reflective of a change in the relative intensity of northern versus southern ceramic trade and interaction ties for the Lower Rye Creek area. This is perhaps even more interesting when distance factors are considered. The approximate zone for Tusayan whiteware production (the Kayenta region) is about 100 miles northeast of the project area (Colton 1952) while the zone for Hohokam buffware production within the Gila-Salt basin is about 45 miles to the south (Haury 1976; Abbott 1991). These figures then indicate that simple distance factors cannot explain the apparent reorientation of the ceramic networks.

Second, there is the almost complete cessation of Tusayan whitewares and Hohokam buffwares after ca. A.D. 1100. This trend is further substantiated by noting that no Tusayan whiteware types postdating Sosi Black-on-white (ca. A.D. 1070-1180) were identified in the Rye Creek assemblage. Furthermore, only three sherds of Tusayan whiteware were typed as Sosi Black-on-white, all of which were recognized as Sosi Style I, the earlier of the two proposed design styles on Sosi Black-on-white (Colton and Hargrave 1937). In addition, no post-Sacaton phase buffwares were identified in the decorated assemblage. Granted, that buffwares later than Sacaton Red-on-buff (e.g., Casa Grande Red-on-buff) are rare outside of the Hohokam core area, the clear pattern of decreasing buffware frequency from Gila Butte through Santa Cruz through Sacaton Red-on-buff, supports this assertion. Furthermore, no Tanque Verde Red-on-brown, a widespread Hohokam Classic period ware, was found within the assemblage. These data strongly indicate that during this time ceramic networks to the south were almost completely broken while reorganization of the northern ceramic network was occurring. The trend in the buffware network parallels patterns seen in other areas outside the Hohokam core area, most notably the Tucson Basin, where the importation of buffware ceramics is estimated to end around A.D. 1050 (Heidke 1990). These data suggest that the Hohokam core area interaction network was significantly retracting at this time, at least from established networks to the north and south.

Subsequently, with the cessation of these two wares after A.D. 1100, there is a rise in the frequencies of Little Colorado and Cibola whitewares. Little Colorado whitewares initially dominate the assemblage. This is particularly clear from the data from the trash mounds at Rye Creek Ruin (see Table 12.16). Features 2 and 3, the two early trash mounds dating to A.D. 1100 to 1250, with a best-fit date between A.D. 1200 and 1250, are clearly dominated by Little Colorado whitewares (63.2 percent Little Colorado whitewares versus 36.8 percent Cibola whitewares). This contrasts with Feature 1, which is believed to primarily postdate A.D. 1300, although it is mixed with a low percentage of earlier trash. Here Cibola whitewares dominate the assemblage, comprising 55.9 percent versus 44.1 percent for the Little Colorado whitewares. This relationship is statistically significant (Pearson Chi-square = 7.26, DF=1, p =.007).

It is noted that Little Colorado whitewares, which have a suggested production life ranging from about A.D. 1050 to 1250 (Douglass 1987), are represented consistently in the Rye Creek decorated assemblage throughout their projected temporal existence. Consequently it is surmised that with the advent of the Little Colorado whitewares, Rye Creek's northern ceramic interaction network, formally dominated by Tusayan whitewares, shifts to favor Little Colorado whitewares. With the Little Colorado whiteware production zone geographically closer to the Rye Creek area than the Tusayan whiteware production zone (Hopi Buttes area versus Kayenta area, a difference of approximately 80 miles), it is perhaps not surprising to see an eclipse of Tusayan whitewares in conjunction with the rise of Little Colorado whitewares, given a directional scenario.

Third, at around this same point in time, perhaps partially corresponding with the dramatic demise in the occurrence of Hohokam buffwares, the eastern ceramic interaction network, already ongoing, is more firmly established. This is illustrated by the increases in Cibola whiteware frequencies (and of accompanying wares such as White Mountain redwares and decorated Mogollon brownwares) during the twelfth and thirteenth centuries. Although the source areas for Cibola whitewares have yet to be precisely determined, all indications suggest they are being manufactured east of the project area, and perhaps as close as the Chevlon drainage, approximately 40 to 50 miles to the northeast (Nieves Zendeno, personal communication, 1990). Moreover, the importance of the Cibola network appears to increase through time, particularly with the cessation of production of Little Colorado whiteware ceramics around A.D. 1250. Interaction with northern groups continued after this time, as indicated by the increase in Hopi wares and Winslow orangewares.

It is noted that with the production zone(s) for the Rye Creek Roosevelt redwares still uncertain, speculations concerning the ceramic interaction networks associated with these wares are not possible.

In summary, variability in ceramic ware frequencies over time suggest that nonlocal ceramic exchange and interaction networks associated with the project area initially were focused south to the Salt-Gila Basin or perhaps intervening Hohokam populations. By ca. A.D. 1000, attention turned north, first for the procurement of Tusayan whitewares, then for the procurement of Little Colorado whitewares, and finally for the procurement of Winslow orangewares and Hopi wares. Likewise, as the actual distances in northern networks were decreasing (ca. A.D. 1100), eastern networks became more firmly established, particularly noted by a rise in the frequencies of Cibola whitewares and White Mountain redwares.

It must be stressed that these trends are drawn from a very limited database. Furthermore, with no other excavation data available from the Lower Rye Creek area there is no comparable basis for confirming or negating these conclusions. The few decorated sherds (n = 60) recovered from the Ord Mine Project (Ciolek-Torrello 1987), situated in the Upper Tonto Basin just south of the project area, somewhat support the late dominance of Cibola whitewares and White Mountain redwares. Although the absolute dates from this project are inconclusive, all of the sites with architecture contained masonry structures, suggestive of a Classic period occupation. The whiteware assemblage (n = 36) was clearly dominated by Cibola whitewares; 94.4 percent of the whitewares were typed as Cibola versus 5.6 percent as Little Colorado. The polychrome or redware assemblage (n = 22) contained only Roosevelt redwares (72.7 percent) and White Mountain redwares (27.3 percent) (Bruder and Ciolek-Torrello 1987:93).

As a final note, it is important to point out that the conclusions drawn from the Ash Creek Project ceramic data (Hohmann 1985:346), are in disagreement with the conclusions drawn here. Hohmann suggests that for the Ash Creek sites (which are located in the Lower Tonto Basin, about 30 miles south of the Rye Creek Project area, and include both Preclassic and Classic period sites) Tusayan whiteware "tends to increase in frequency with time." Hohmann states that "this may reflect either an increased level of exchange or the development of more formal trade networks between these two loci." Because the general trends noted in the Rye Creek decorated ceramic analysis were the antithesis to Hohmann's conclusions, it was thought that a review of Hohmann's raw data might be instructive. For various reasons, however, such a review proved impossible. As can be seen from Table 12.20, a search of the ASU collections produced only 16 of the 157 whiteware sherds collected during the testing and mitigation of the Ash Creek sites. Of the 16 whiteware sherds located, two were identified as Little Colorado whiteware, 10 as Cibola whiteware, two as Tusayan or Cibola whiteware, one as Cibola or Little Colorado whiteware, and one as indeterminate whiteware. These data, with Cibola (83.3 percent) dominating those sherds that could be found and typed, support our expectations, because the majority of the Ash Creek sites were generally late, spanning the Sacaton through Gila phases. The fact that not a single sherd could be conclusively identified as a Tusayan whiteware also may be significant. This suggests that either this sample (which was randomly based on bags that could be relocated) is not representative of the collections as a whole, or that serious discrepencies are present in the way the Ash Creek Project sherds were typologically identified. Due to these problems, no comment can be made concerning Hohmann's interpretations.

Table 12.20. Counts of whitewares recorded for the Ash Creek project sites versus counts of whitewares located during an archival search of the Ash Creek material.

Site Number	No. of subsurface whiteware sherds recorded	No. of subsurface whiteware sherds relocated	No. of surface whiteware sherds recorded	No. of surface whiteware sherds relocated	Total whiteware sherds recorded	Total whiteware sherds relocated
AZ U:4:13	3	3	3	0	6	3
AZ U:3:44	3	4	11	0	14	4
AZ U:3:46	12	1	2	0	14	1
AZ U:3:49	27	2	37	1	64	3
AZ U:3:50	40	0	12	1	52	1
AZ U:3:51	4	3	1	0	5	3
AZ U:3:86	2	1	0	0	2	1
Total	91	14	66	2	157	16
Percent		15%		3%		10%

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Of course, in the end, I take sole responsibility and can thank only myself for the faults and fallacies within.

CHAPTER 13

THE PLAINWARE AND REDWARE CERAMIC ASSEMBLAGES

Miriam T. Stark and James Heidke

This chapter evaluates the plainware and redware ceramics recovered during the Rye Creek Project. The attribute-based analysis described in this chapter focuses on petrographic and technological approaches to characterize the assemblage under study. The plainware-redware analysis focused its efforts on examining variability in ceramic technology, function, and use through time in the Upper Tonto Basin. This chapter has two objectives. The first is to provide basic information on plainware and redware ceramics from the Upper Tonto Basin. The second is to identify important research questions to be explored in future analysis of plainware and redware assemblages from the Tonto Basin as a whole.

Excavations at the 13 Rye Creek Project sites produced a collection of ceramics spanning the time period from A.D. 750 to 1400. Approximately 42,000 ceramics were recovered from the 13 mitigated sites (Table 13.1). Decorated ceramics accounted for 1,056 sherds in the assemblage, or 2.5 percent of the entire ceramic collection (see Clark, Chapter 12, this volume). Within the plainware-redware assemblage, 22.2 percent (8,981) of the sherds are redwares. Both the plainware-brownware and red-slipped sherds (the latter hereafter referred to as redwares) have been classified in previous research as belonging to the Tonto-Verde Series (Wood 1987). Most of the plainwares and redwares in the RCM assemblage are subsumed under the Central Arizona Ceramic Tradition as described by Wood (1987). The plethora of types and varieties that he describes underscores the diversity of utility ceramic traditions throughout the Tonto Basin. For purposes of inter-analyst consistency, we have avoided the type-variety approach while classifying the plainwares and redwares. The section describing our actualistic study of sand-tempered ceramics later in this chapter discusses links between petrologically-identified source groups and previously defined types and varieties that have been described by Wood (1987). Here we only note that many of the plainware sherds analyzed fall into the Tonto Plain, Tonto variety category as described by Wood (1987), while many others represent an unnamed local variety of Tonto Plain. Through our attribute-based analysis, we have begun to refine subgroups within the Tonto Plain series that are based on petrological criteria. In theory, these geologically identified groups are highly consistent and therefore more easily replicable than is the present system described in Wood (1987). Through continued ceramic research in the Tonto Basin, we hope to link our petrologically identified groups to previously described ceramic types and varieties, and some of these translations are explored in a section of our chapter. A primary goal of Tonto Basin ceramic studies at this point is a consistent typology that can be successfully used by a variety of analysts. How many of these groups will be identifiable at the macroscopic level (for purposes of in-field investigation) is not yet clear. The analysis for the plainware and redware sherds differed slightly to accommodate ware-specific variables, and each analysis is addressed in turn.

Volume 1 of the Rye Creek Project report presents information on artifact assemblages by site. Repeated in Table 13.1 is information on plainware, redware, and decorated ceramics by site. The number of analyzed plainware and redware sherds from each site is also included. Concern for contextual integrity, discussed in Chapter 11, Appendix B, and in the following sections, severely restricted the number of sherds sampled from each site for in-depth analysis. The size of the analyzed sample initially appears low relative to the total assemblages presented in Table 13.1; however, sherds within the small sample are believed to have exceptionally high contextual integrity and should produce reliable and replicable patterns regarding temporal change and site function.

Table 13.1. Composition of the Rye Creek Project ceramic assemblage by site and ware. Plainware and redware rim sherd figures include partial or complete restorable vessels, each counted as a single observation.

	Plainware			Redware			Decorated			Corrugated			
ASM Site	Rim[1]	Body	Total	Rim[1]	Body	Total	Rim[1]	Body	Total	Rim[1]	Body	Total	Site Total
O:15:001	239 [52]	4519 [0]	4758 [52]	208 [54]	2496 [0]	2704 [54]	23 [23]	101 [101]	124 [124]	16 [0]	576 [0]	592 [0]	8178 [230]
O:15:052	677 [175]	9519 [0]	10196 [175]	4 [4]	23 [18]	27 [22]	72 [72]	338 [338]	410 [410]	1 [1]	0 [0]	0 [0]	10633 [608]
O:15:053	56 [11]	980 [0]	1036 [11]	4 [1]	26 [1]	30 [2]	11 [11]	33 [33]	44 [44]	0 [0]	0 [0]	0 [0]	1110 [57]
O:15:054	65 [54]	1679 [0]	1744 [54]	124 [70]	1387 [0]	1511 [70]	8 [8]	56 [56]	64 [64]	0 [0]	0 [0]	0 [0]	3319 [188]
O:15:055	218 [100]	4640 [0]	4858 [100]	328 [120]	3470 [0]	3798 [120]	11 [11]	46 [46]	57 [57]	1 [0]	12 [0]	13 [0]	8726 [277]
O:15:070	0 [0]	0 [0]	0 [0]	0 [0]	11 [0]	11 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	11 [0]
O:15:071	3 [3]	32 [0]	35 [3]	1 [1]	1 [0]	2 [1]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	37 [4]
O:15:089	3 [2]	55 [0]	58 [2]	8 [7]	86 [0]	94 [7]	0 [0]	1 [1]	1 [1]	0 [0]	2 [0]	2 [0]	155 [10]
O:15:090	54 [9]	940 [0]	994 [9]	4 [2]	52 [4]	56 [6]	8 [8]	29 [29]	37 [37]	0 [0]	0 [0]	0 [0]	1087 [52]
O:15:091	180 [42]	3154 [0]	3334 [42]	17 [3]	237 [7]	254 [10]	33 [33]	106 [106]	139 [139]	1 [0]	0 [0]	1 [0]	3728 [191]
O:15:092	94 [44]	992 [0]	1086 [44]	0 [0]	1 [0]	1 [0]	16 [16]	68 [68]	84 [84]	0 [0]	0 [0]	0 [0]	1171 [128]
O:15:096	0 [0]	5 [0]	5 [0]	0 [0]	1 [0]	1 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	6 [0]
O:15:099	25 [4]	393 [0]	418 [4]	26 [2]	283 [1]	309 [3]	1 [1]	9 [9]	10 [10]	0 [0]	0 [0]	0 [0]	737 [17]
O:15:100	175 [53]	2652 [1]	2827 [54]	13 [6]	170 [35]	183 [41]	16 [16]	70 [70]	86 [86]	0 [0]	0 [0]	0 [0]	3096 [181]
Totals	1789 [549]	29560 [1]	31349 [550]	737 [270]	8244 [66]	8981 [336]	199 [199]	857 [857]	1056 [1056]	18 [1]	590 [0]	608 [1]	41994 [1943]

[1] Rims include restorable vessels and partially restorable vessels.

[ ] Numbers in brackets refer to number of sherds analyzed.

This chapter is organized into eight sections. Methodological issues germane to sampling the assemblage are discussed first. Next, data from the temper study are presented and analyzed. Attribute-based analyses of plainware and redware samples are then presented. As part of this analysis we discuss the results of a petrological study of the plainware-redware assemblage from the Rye Creek Project. This actualistic study provides a petrological baseline for future research in the Tonto Basin and enables us to make some observations regarding the technology and economics of utilitarian pottery production in the study area. The chapter concludes with an extended treatment of the plainwares and redwares as components of a single technological tradition through time. Because one primary goal of this analysis is to identify temporal trends within the assemblage, many of the data tables in this chapter are structured in terms of three phases for which adequate sample sizes are available: Gila Butte (ca. A.D. 750-850), Sacaton (ca. A.D. 950-1150) and early Classic period or Roosevelt phase (ca. A.D. 1150-1300). Note that an insufficient number of unambiguous Santa Cruz phase (ca. A.D. 850-950) contexts were recovered for inclusion in the analysis. The remaining data tables seek to characterize the entire assemblage and will include data from all datable time periods (i.e., sherds from indeterminate temporal contexts are excluded from consideration as "noise" within the data set).

For the purposes of this volume, redwares are defined as sherds whose cross sections display evidence of a contrast between the color and texture of the vessel fabric and which exhibit a red slip or wash on the sherd's surface. Redware has been consistently associated with later (i.e., Classic period) sites in the Tonto Basin (Bruder and Ciolek-Torrello 1987; Wood 1987; Woodward et al. 1985). Consequently, the frequency of redwares varies across project sites according to time period. The wide range in sherd counts from different sites is, in large part, explained by differences in site type and function, two topics discussed elsewhere (see Chapter 28, Volume 3).

This chapter concentrates on data collected during the in-depth analysis of plainware and redware samples recovered from the best, typologically unmixed contexts identified during the contextual assessment. Research goals and assumptions are first discussed, followed by a treatment of the plainware and redware assemblages as separate entities. Finally, the two wares are evaluated in combination to ascertain temporal and functional aspects of the Rye Creek ceramic assemblage.

RESEARCH GOALS AND ASSUMPTIONS

The sporadic nature of Tonto Basin research to date provides an incomplete understanding of the plainware and redware traditions reflected in the recovered archaeological assemblages. Simon and Redman (1990:65) note that understanding variation within Tonto ceramics requires the identification of discrete manufacturing traditions, of functional traits, and source materials. As the tempo of Tonto Basin research increases, many conclusions drawn from the Rye Creek ceramic analysis may be revised and dismissed. It is our intent simply to characterize the plainware-redware assemblage in terms of technological, functional, and temporal patterns.

Two fundamental research problems were addressed that involved the Rye Creek plainwares and redwares: technological variation through time and cultural identity.

The first portion of our chapter concentrates on selected ceramic attributes in a dynamic context, moving from the Gila Butte phase to the early Classic period. The goal of our detailed focus on particular attributes is to quantitatively document aspects of the Central Arizona Ceramic Tradition as described by Wood (1987:6-9). Some attributes that we describe directly pertain to manufacturing technology, such as surface finish, smudging and slipping. Other attributes focus on resource procurement, especially the range of temper sources represented. Still other morphological variables capture the variety of vessel forms in the RCM plainware/redware assemblage. The detailed attribute descriptions that this chapter contains are not trivial. Unlike decorated ceramic traditions, plainwares--and especially plainwares from Central Arizona--have rarely been the subject of detailed study (Wood 1987:9). The type of research reported here is essential for establishing an empirical baseline regarding content and appearance of Tonto Basin plainwares. This baseline acts as a standard for comparison with previously described assemblages in the Tonto Basin. Such a foundation also provides the basis for using ceramics to explore broader issues such as seasonality and site function, cultural affiliation, political economy and patterns of interaction. We cannot begin to address these broader anthropological issues with ceramics until basic details of the utility ceramic assemblage are understood. Through our attribute-based approach, we present data that serve as a starting point for making meaningful ceramic comparisons of assemblages across various regions in Central Arizona.

Additional issues are presented as preliminary studies that will be pursued in greater detail during the Roosevelt Community Development study undertaken by Desert Archaeology, Inc. (Doelle et al. 1991): the evidence for early redwares in the Tonto Basin, changes in the organization of ceramic production, and ceramic function as a reflection of site function. Ceramic production and distribution are explored using a quantitatively based temper study. Pottery function, as a reflection of site function, is briefly explored. Broad issues are addressed through the ceramic analysis, and multiple hypotheses are offered. These should be further explored in future, larger-scale ceramic studies in the region, such as those being undertaken for the Bureau of Reclamation's Roosevelt Lake Projects (Ciolek-Torrello et al. 1990; Doelle et al. 1991; Rice 1990). Two goals structure this chapter: 1) to provide baseline information on the plainware and redware ceramics recovered at the mitigated sites as representative of the Upper Tonto Basin utility ware tradition; and 2) to identify salient research issues that should be addressed in future plainware-redware analysis in the area.

Temporal Change and Implications for Cultural Identity

Our research goals for the Rye Creek Project include the collection and analysis of plainwares and redwares to provide a foundation for future ceramic studies in the Tonto Basin. Limited research exists on utilitarian ceramics from the Upper Tonto Basin, aside from brief descriptions in site reports (Bruder and Ciolek-Torrello 1987; Haas 1971b; Hammack 1969b; Huckell 1977, 1978). As noted by Clark (Chapter 12, this volume), a decorated ceramic tradition probably does not appear in the Tonto Basin until ca. A.D. 1200, or the Classic period. Consequently, plainware (and later, redware) ceramics hold great potential for inferences concerning changing adaptations through time. The nature of the Rye Creek Project, and of the resultant ceramic samples, dictated that our primary interests were in tracking temporal changes at the attribute and assemblage levels in the plainware-redware ceramics. Clearly, the most dramatic temporal change lies in the introduction of a well-defined redware tradition (Jeter 1978:75), most clearly expressed during the Classic period, or the Roosevelt and Gila phases. Whether the presence of redwares is sufficient as a temporal diagnostic remains open to debate in studies of Tonto Basin ceramics (e.g., Jewett 1986). Elson (Chapter 25, Volume 3) suggests that the ratio of redwares to plainwares, rather than the simple presence of redware ceramics, is a temporally sensitive variable. In-depth attribute analysis of the plainware assemblage also identified changes in individual and collective attributes from the Gila Butte phase to the Classic period that may prove valuable in grossly dating Upper Basin assemblages that lack reliable intrusive ceramics.

Our ability to identify temporally diagnostic attributes in the plainware-redware assemblage has numerous implications that transcend issues of cross-dating. For example, changes at the assemblage level, such as the appearance of new vessel forms, changing vessel ratios, and the development of the slipped, smudged redware tradition, may indicate changing patterns in settlement and subsistence. These cultural changes may also be reflected in the assemblage, through attribute changes that involve vessel wall thickness or surface treatment. The general developmental pattern of the utility ware tradition (discussed in detail in the following sections) is one of increasing technological sophistication and growing uniformity across redwares and plainwares. This is particularly apparent by the Classic period. Patterning in the temper source data also suggests shifting patterns of resource use that may inform on the economic structure of the region. Finally, changes in the plainware-redware assemblage may be important to deciphering changing spheres of interaction from the Preclassic to Classic periods in the Upper Tonto Basin, an issue of great interest to archaeologists working in the Basin and surrounding periphery. The notion of ethnicity in archaeological assemblages has been hotly debated, especially in attempts to understand the prehistory of the Upper Basin and Tonto Basin in general (Hohmann and Kelly 1988; Pilles 1976; Wallace, Stark, and Elson 1991; Whittlesey and Reid 1982; Wood 1985). Morphological variability in the plainware-redware assemblage, in its functional and resource constraints, holds one key to recognizing sources of influence -- and, theoretically, of possible migrants -- that shaped the Tonto Basin archaeological record.

Ceramic Production and Distribution

Preliminary research on the sedimentary geology of the Tonto Basin provides an empiric foundation for developing hypotheses related to changes in ceramic production and distribution in the Upper Tonto Basin. The temper study focuses on utilitarian wares (i.e., plainwares and redwares), because the Tonto Basin lacks an indigenous decorated ceramic tradition prior to the Classic period. Research through the Roosevelt Community Development Study will focus on both temper sources and paste characterization to examine the economic structure of late Preclassic and early Classic pottery production (Doelle et al. 1991).

Site Function

Small sample sizes from individual sites limit the range of site function-level inferences drawn from analysis of the plainware and redware assemblages. Nevertheless, sites are grouped as functional aggregates, and their ceramics examined, to investigate site function. As an ancillary source of information, analysis of these assemblages may shed light on site use in terms of seasonality and particular function.

RESEARCH METHODS AND ANALYTIC COMPONENTS

This section describes components of the plainware and redware analysis in order to address the research goals of our analysis. Only rim sherds (including rims on reconstructible and partially reconstructible vessels) were used in this analysis for a number of reasons. First, rim sherds can be identified to vessel shape with greater precision than can body sherds, which in turn allows for a variety of analyses. Second, Orton's (1982) computer simulation experiments that assess a measure for estimating the number of vessels represented determined that rims yield the best results for modeling the composition of prehistoric ceramic assemblages (see also Rice 1987:222; Wallace, Heidke, Craig, and Elson 1991). Analysis of the ceramic assemblage involved several different, overlapping collections during the analytic process, including the plainware and redware rims and reconstructible and partially reconstructible vessels.

The plainware and redware analysis involved a series of components. These stages included (but were not limited to) the selection of appropriate recovery contexts through an assessment of archaeological context (discussed by Wallace et al. in Chapter 11 and Wallace in Appendix B, this volume), the attribute-based analysis of plainwares and redwares, and an analysis of the reconstructible plainware and redware vessels. Each segment of analysis contributed to formulating the research strategy for the following component and for the analytical procedures that were subsequently used.

The Rye Creek Project plainware and redware ceramic analysis was designed by James Heidke and Miriam Stark in consultation with Mark Elson, Henry Wallace, Douglas Craig and William Doelle. Recording and analysis of the technological and morphological data was conducted by Stark. Recording and analysis of the temper data were conducted by Heidke. Sections on early redwares in the Tonto Basin and on plainware seriation were done in collaboration by the two analysts.

An overall assessment of archaeological recovery contexts was accomplished through a battery of analyses described in Chapter 11. The contextual assessment involved a series of analytical techniques that have as their goal explaining or evaluating the depositional history of a particular archaeological feature. This approach was used as a sampling strategy, to identify the least temporally mixed deposits (glossed hereafter as "unmixed" deposits) that could be used to identify trends through time. The results of these analyses are presented in Appendix B. As described in Chapter 11, analyzed contexts were those that exhibited evidence of untransformed secondary refuse behaviors. Potentially unmixed features included pithouses, trash-filled pits, and trash middens. De facto contexts (in this analysis, floor assemblages) and features containing burial assemblages or pits with restorable vessels were later added to the plainware-redware sample as additional contexts to address specific research questions discussed elsewhere in this chapter.

In this analysis, archaeological contexts can include several behaviorally separable components, and floor (Stratum 19, 20, or 19/20) and fill strata (Stratum 10, 11 or 10/11) in a given structure may be assigned to temporally discrete periods, especially in the cases of trash-filled pithouses (see Elson Chapter 5, Volume 1 for a discussion of strata designations). Class 1 features considered in the contextual assessment were restricted to structures and clearly identifiable trash areas, thereby excluding nonstructural features such as burials, crematoria, and extramural surfaces. The category "structural features" included both pithouses and masonry structures. One advantage of the analytical techniques used here over previous methods is that nonfloor contexts may be quantitatively evaluated for inclusion within the analysis. Exclusive reliance on floor ceramics, a common procedure in many archaeological investigations, may yield a much smaller sample size. For example, if only floor contexts were analyzed at the Gila Butte site of Ushklish, Haas (1971b:51) would have looked at a maximum of 6 percent of the total ceramic assemblage in any given structure.

Contextual class designations were generated on the basis of five lines of evidence: 1) a ceramic assessment (i.e., sherd size/density judgment), 2) a ground stone assessment (i.e., completeness and frequency of ground stone artifacts [see Chapter 15]); 3) evidence of burning within the feature or within particular strata of that feature, 4) evidence of cultural-environmental disturbance within the feature or within particular strata of that feature, and 5) general field observations by the excavators during the data recovery process, including notes on feature superpositioning. The ceramic component of the assessment used sherd size and degree of abrasion in plainware rim sherds to calculate and evaluate a size-density measure. Each of the five types of analysis produced a class ranking for a given deposit. Evaluation of these multiple lines of evidence through gross averaging produced an overall assessment for each feature by stratum. It was this overall assessment upon which the plainware-redware analysis relied. Contexts were designated as belonging to one of three classes which were ranked in descending order of degree of confidence in their temporal and contextual integrity.

Previous research by Desert Archaeology relied heavily on field notes and ceramic indicators of contextual integrity in what have been called "contextual summaries" or "typological assessments" (e.g., Heidke 1989a:63, 1990:71) of particular features. Superpositioning, conjoins among strata and among features, and the association of decorated, temporally discrete ceramics formed the foundation for these earlier evaluations. The objective of earlier research, like the present study, was to understand depositional histories of particular features and to identify temporally unmixed deposits. We wished to assess whether the multipronged analytical program used in the Rye Creek Project (in which ceramic measures form one part of a broader analysis) produced similar assessments to those based solely on ceramic measures. Comparison between the ceramically-based assessment and the overall assessment indicated a general agreement on Class 1 and Class 2 contexts. More disagreement was found between the ceramically-based Class 3 contexts and the overall assessments of these contexts. Class 3 contexts were omitted from the next stage of plainware-redware analysis, in which a series of attributes were examined.

Some of the Classic period deposits contained a predominantly redware assemblage in which plainware sherds represented a smaller frequency. To compensate for this imbalance, the class rankings developed for redware-bearing deposits derived density measures from the combined plainware-redware counts (see Wallace et al., Chapter 11, this volume). The size measure was derived solely from plainware rims for reasons having to do with analytic consistency in the sampling procedure. First, we assumed that plainware and redware rims should be subject to the same formation processes within a single deposit. Second, plainwares and redwares may not be equally susceptible to abrasion processes, because previous research by Simon and Burton (1989) found that redwares were more resistant to breakage than were plainwares. Finally, redware sherds tend to be smaller than plainware sherds on average, because redware vessels generally were smaller than plainware vessels. Were we to use redware rim size data, the redware-bearing deposits would exhibit a different signature from exclusively plainware deposits despite similar or identical depositional histories.

Initially, Class 1 contexts were deemed most reliable for identifying temporal trends where unmixed deposits are critical. At that point, Class 2 contexts were grouped with Class 1 contexts for examining site function at the site and site type level. In subsequent tests of Class 1 and Class 2 nominal variables (Chi square, Fisher's exact) we consistently found no significant differences at the .05 level. Although it is quite possible that the Class 1 and 2 distinctions are important for certain artifact classes, and should be used where appropriate, in the plainware-redware assemblage, the analytic boundary lay in the distinction between Class 1 and 2 contexts and Class 3 contexts. Class 3 contexts were therefore omitted from analysis. Additionally, unique analytic deposits that were not included in the contextual assessment, such as crematorium features (at AZ Site O:15:52) and cremations were also included in the overall analysis due to their potential significance. Because meaningful differences were not observed between the Class 1 and Class 2 plainwares and redwares, the Class categories were collapsed and used as a single sample for the analysis that is presented in the following sections. Table 13.2 presents the deposits within Class 1 and 2 categories that were used in this analysis.

PLAINWARE ANALYSIS

Ware Designations and Research Methods

We first discuss criteria used in making ware classifications and variables employed in our analysis. Tonto Basin plainwares exhibit a wide range of variability regarding surface treatment, temper type, and vessel forms (Simon and Burton 1988:311). Consequently, previous analyses of Tonto Basin ceramics have produced widely divergent classificatory systems for excavated plainware (i.e., unslipped) and redware assemblages. No consensus has been reached regarding distinctions that separate the Verde Red and Verde Brown series from the Tonto Red and Tonto Brown series within the Alameda Plainwares (see Whittlesey and Reid 1982:76 for discussion). Several Tonto Basin researchers have employed this distinction (Bruder and Ciolek-Torrello 1987; Hammack 1969b; Huckell 1978; Jeter 1978; McGuire 1977; Wood 1987). Type groupings in past studies have relied on tempering material (Haas 1971:49; Hammack 1969b:146; Wood 1987:8) and surface treatment (Hammack 1969b:146; Wood 1987:8) to identify discrete cultural groups. Whether these attributes successfully distinguish Verde from Tonto plainwares is a matter of debate. Huckell (1978:24) observes that "based on attributes of temper, paste and finish it is virtually impossible to adequately separate sherds from the Tonto Basin, the Verde Valley and the Payson Region from one another." Other researchers agree with this point (e.g., Hohmann 1985:347; Jeter 1978). Variability within the Tonto plainwares is obvious, especially in the range of temper sources represented (see also Hammack 1969b). Traditional (i.e., macroscopic) temper-based identifications of types within the Tonto plainwares do not appear to agree with microscopic temper-based identifications of types. The Star Valley plainware analysis by Simon and Burton (1989) illustrates this point, as patterning in their composition tables strongly contrasts with the standard type definitions for the greater Tonto Basin area.

The lack of consensus in identifying Tonto (vs. Verde) plainwares and in unpacking the variability within the Tonto series has not prevented researchers from using plainware assemblages for arguments concerning divergent cultural identities. Considerable controversy exists in the literature over the cultural identity of Central Arizona plainwares recovered from the Tonto Basin (see also Elson et al., Chapter 3, Volume 1; Wallace, Stark, and Elson 1991). Moreover, the geographical origin for these wares is a matter of dispute. Colton (1946) and Colton and Hargrave (1937) maintained that the Verde-Tonto series were part of the Alameda Brownwares and associated with the Sinagua Branch. More recent work by Hammack (1969b) and Huckell (1978) also relies on the Sinagua connection. Breternitz (1960) and Schroeder (1975), on the other hand, interpret Verde Brown as Hohokam in origin and contrast it with later intrusive types brought into the valley by the Sinagua. Compounding the problem is the fact that within the Tonto Basin identical types have been variously interpreted as Salado, Hohokam, Sinagua, or Mogollon, depending upon their association with small amounts of diagnostic pottery and upon the background of the particular ceramic analyst (Huckell 1977; Haas 1971b; Hammack 1969b; Jeter 1978; Whittlesey and Reid 1982).

Researchers challenging the traditional Verde-Tonto ware distinctions have used a variety of alternative approaches that involve lumping the plainwares into larger groupings. Variations on this approach include the following: 1) Tonto-Verde plainwares (e.g., Huckell 1978); 2) Alameda plainwares (e.g., Hohmann 1985); 3) Gila-Tonto Series (Wood 1987); 4) brownwares (Bruder and Ciolek-Torrello 1987; Jewett 1985; Whittlesey and Reid 1982); or 5) unnamed permutations of unslipped and slipped (undecorated) wares (Jeter 1978; Simon and Burton 1988). Because the Alameda series has a relatively broad distribution, other researchers have encountered similar classificatory problems in the Verde Valley (e.g., Breternitz 1960; Jewett 1986) and in the Mazatzal mountains that lie immediately south of the Rye Creek Project area (Howard 1990:196).

Table 13.2. Depositional contexts with ceramics included in the plainware-redware analysis.

Site	Feature	Stratum/Level
Class 1 Contexts included in analysis:		
O:15:52	2	20
O:15:52	11	20
O:15:52	14	20
O:15:52	21	20
O:15:52	25	20
O:15:52	34	20
O:15:54	9	20
O:15:55	11	20
O:15:55	18	20
O:15:55	19	20
O:15:91	11	20
O:15:92	14	10
O:15:92	14	20
O:15:92	14	30
O:15:100	1	20
O:15:100	3	10
O:15:100	3	20
O:15:100	3	50
O:15:1	1	Level 1
O:15:1	2	Level 2
O:15:1	2	Level 3
O:15:1	3	Level 1
O:15:1	3	Level 2
O:15:1	3	Level 3
Class 2 Contexts included in analysis:[1]		
O:15:52	6	20
O:15:52	9	10
O:15:52	12	10
O:15:52	13	20
O:15:52	14	10
O:15:52	18	20
O:15:52	21	10
O:15:52	22	20
O:15:52	32	20
O:15:52	36	20
O:15:52	36	10
O:15:52	46	20
O:15:52	48	50
O:15:52	50	50
O:15:52	51	50
O:15:52	59	50
O:15:52	66	20
O:15:52	70	50
O:15:52	71	50
O:15:52	85	50
O:15:52	88	50
O:15:52	117	50
O:15:52	120	50

Table 13.2. Continued.

Site	Feature	Stratum/Level
O:15:53	1	20
O:15:53	5	20
O:15:53	9	20
O:15:53	14	10
O:15:53	14	20
O:15:53	15	20
O:15:53	16	20
O:15:54	2	50
O:15:55	5	10
O:15:55	5	20
O:15:55	5	30
O:15:55	8	50
O:15:55	6	10
O:15:55	6	20
O:15:55	11	10
O:15:55	11	30
O:15:55	17	50
O:15:55	18	30
O:15:55	19	10
O:15:55	19	30
O:15:55	21	50
O:15:71	1	10
O:15:89	1	10
O:15:89	1	20
O:15:90	3	20
O:15:90	4	20
O:15:90	4	30
O:15:91	5	20
O:15:91	5	30
O:15:91	11	10
O:15:99	1	10
O:15:99	3	20
O:15:99	5	10
O:15:100	4	10
O:15:100	4	20
O:15:100	12	10
O:15:100	12	20
O:15:100	25	50

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[1] Mortuary features are included as Class 2 contexts and have Statum 50 designations.

The Rye Creek ceramic analysis relied on a variant of the alternative approaches by separating redwares from plainwares but ignoring the Tonto-Verde distinctions. An important component of our ceramic analysis involves temper sourcing, thereby hindering the use of types within the Central Arizona plainware series defined in Wood (1987). Temporal trends identified previously in surface treatment and slipping provided a rationale for maintaining the distinction between plain (i.e., unslipped, undecorated) and red (i.e., slipped, undecorated) wares (Simon and Burton 1989; Wood 1987). Within the plainwares, protohistoric and historic ceramics were analyzed separately (see Ferg, Chapter 23, this volume). Red and plain corrugated wares also were segregated from the rest of the plainwares and redwares. A small number of rim sherds were assigned to an "Indeterminate red or plain" category, and Salado redwares (rare in the sample) were noted during analysis.

Attribute Analysis of Plainware Ceramics

As early as the late 1930s, Anna Shepard argued that more attention should be given to those attributes that "were as easily identified in sherds as in an entire vessel, including color, texture, surface finish, thickness of wall, hardness, and composition of temper and pigment" (quoted in Wheat 1991:129). More recently, Schiffer (1982:342-343) suggested numerous time-sensitive attributes, including fire-clouding, vessel wall thickness, bowl: jar ratios, and the percentage of slipped and smudged sherds. Our analysis sought to address these named attributes, among others. Several research objectives guided the attribute-based analysis of the recovered plainware ceramics. Our first goal was to provide a descriptive characterization of the plainware collection in terms of the relative proportions of specific attributes and attribute combinations present. The descriptive characterization presented as a result of this goal provided a needed data base for the Upper Tonto Basin, with which future researchers can begin to assess spatial, temporal, functional and behavioral variability in the plainware data. In order to further this goal, the plainware attribute data from the Deer Creek site (AZ O:15:52) were supplemented with similar data from Ushklish, a contemporaneous site situated in the Upper Tonto Basin, approximately 10 kilometers southeast of the Deer Creek site (Haas 1971b).

The first step in recording plainware data involved laying out the plainware rim sherd assemblage within each feature to identify sherd matches, referred to in this analysis as conjoining sherds. Intrafeature matches were identified across strata, levels, or bags within the same feature where sherds conjoined. Conjoining sherds were assigned a single observation number and recorded as belonging to the provenience in which the largest number or the largest sized sherd was found. Subsequent to inspection for sherd matches, each plainware rim sherd was assigned an individual observation number. In those cases all of the sherds were counted as a single observation, and this observation was recorded within the provenience from which the largest sherd originated.

Next, attribute and provenience data were recorded for all plainware rims and reconstructible (including partially reconstructible) vessels recovered from structural features in the 13 mitigated sites. Observations on sherd size and degree of abrasion were recorded on a total of 883 plainware sherds during this first stage of analysis as part of the formation process study outlined in Chapter 11. Laboratory processing and this initial analysis produced baseline information for all sites and all structural contexts regarding relative proportions of plainwares, redwares and decorated wares, sherd size, and degree of abrasion.

The contextual assessment utilized sherd size and abrasion data to select the least temporally mixed (i.e., Class 1-2) contexts. Results of the analysis were used to identify a sample of plainware and redware rims from 12 of the 13 mitigated sites for further study. Sixty (or 62.5 percent) out of 96 total depositional contexts (i.e., discrete strata from pithouses, masonry structures, and subfeatures) from the mitigated sites contained sherds that were examined during the second stage of analysis. The second analysis recorded 27 plainware attributes and 30 redware attributes to examine temporal, spatial, and functional variability in the project area. Plainware and redware rims from Class 1 and Class 2 contexts were analyzed using identical attributes. The resultant data sets are compared and contrasted in the last section of this chapter. Related to contextual assessment concerns was the decision to eliminate virtually all Stratum 2 (alluvial overburden) and Stratum 9 (sheet trash) deposits. Two exceptions to this policy were made. The first exception concerned the search for early redwares: five field-classified "redware" sherds from Stratum 9 contexts were examined from the Deer Creek site (AZ O:15:52). The second exception (no stratum given) lay in two sherds examined from AZ O:15:71, where a total of four sherds was analyzed.

Variables in the Plainware Analysis

Both nominal and continuous attributes (Read 1974:216) were employed in the plainware rim analysis (See Appendix E). Seventeen nominal attributes were recorded for each plainware rim sherd observation. They are:

1. *Sherd size* (SIZE). Each observation was recorded as fitting into one of 5 size classes that coincided with the size classes used in the decorated ceramic analysis by Clark (Chapter 12, this volume). The five categories are as follows: 1) 2.5-5.0 cm^2; 2) 5.0-16.0 cm^2; 3) 16.0-49.0 cm^2; 4) 49.0-100.0 cm^2; and 5) >100.0 cm^2. All sherds less that 2.5 cm^2 in size were omitted from the plainware analysis (and generally not collected in the field), although these sherds were included in the decorated ware analysis.

2. *Rim Exterior Abrasion* (ABRASION). Abrasion patterns on interior and exterior vessel surfaces reflect different types of use, depositional, and postdepositional processes. Interior rim abrasion may represent traces of use such as stirring or sealing with a lid. Exterior abrasion, dispersed across the rim's surface, should be a more accurate indicator of postdepositional formation processes. Accordingly, each observation was recorded as exhibiting some degree of exterior abrasion and categories were established to determine the extent of the abrasion: 1) abrasion absent; 2) >0-25 percent surface abraded; 3) 26-75 percent surface abraded; 4) 76-100 percent surface abraded. Sherds showing evidence of burning (specifically, blackened interior and exterior surfaces and exfoliation), damaged or chipped sherds and worked sherds were excluded from the abrasion assessment, and were classified as indeterminate.

3. *Ceramic Type* (CERTYPE). Each observation was recorded as belonging to one of several plainware categories. Because plainwares and redwares were analyzed separately, the various categories used in this attribute class were: 1) generic plainwares (including locally made sherds previously classified in other reports as either Tonto or Verde); 2) protohistoric plainware; or 3) indeterminate plainware or redware.

4. *Vessel Part* (VESPART). Each observation was recorded as either a rim sherd, a partially reconstructible vessel (25-75 percent complete) or a reconstructible vessel (75-100 percent complete).

5. *Vessel Shape* (SHAPE). Each observation was recorded as displaying either an indeterminate, bowl, jar, scoop, other, or indeterminate flare-rim vessel shape.

6. *Vessel Form* (VESFORM). Bowl vessel shape observations were recorded as either indeterminate bowl, plate/platter, outcurved, hemispherical, incurved, semiflare-rim, outcurved, straight walled and "other." Jar vessel shape observations were recorded as either indeterminate jar, indeterminate flare-rim, tall straight collar, short straight collar, tall flare-rim, short flare-rim, seed jar, tall semiflaring straight collar, and short incurved straight collar. Indeterminate vessel shape observations were recorded as either indeterminate or indeterminate flare-rim. Scoop vessel observations were also recorded. Illustrations of vessel forms are presented later in this chapter.

7. *Rim Length* (RIMLENG). The percent of rim present was recorded for each observation using a standard diameter-measurement template (P. Rice 1987:222). Five percent intervals were utilized from 0 percent up to 50+ percent. Damaged sherds and those sherds lacking intact rims on which estimates could be made were coded as "indeterminate."

8. *Rim Shape* (RIMSHAPE). Each observation was recorded as displaying either an indeterminate rim shape (including those rim sherds with damaged or highly abraded rims), rounded, tapered, sharp beveled, round beveled, square, or miscellaneous (usually bulbous) rim shape. Illustrations of rim shapes are presented later in this chapter.

9. *Rim End Consistency* (RIMCON). Each observation was evaluated for the consistency present at either end of each rim sherd. The rim shapes found at either end of the sherd were compared; where the rim shape type varied, the rim end consistency was considered inconsistent. Where the rim shapes found at both ends

of a given sherd were identical or basically similar, the rim end consistency was considered consistent. Observations were grouped into the indeterminate category in cases of severe edge damage or edge grinding, and in cases where less than 20 percent of the present sherd edge contained an intact rim.

10. *Sherd Rim Evenness* (RIMEVEN). Each observation was assessed for the degree of rim evenness. Observations were classified into three groups: (1) undulating rim edge; (2) basically even rim edge; and (3) indeterminate. Observations were grouped into the indeterminate category in cases of severe edge damage or edge grinding, and in cases where less than 20 percent of the present sherd edge contained an intact rim.

11. *Fire Cloud* (FIRE). The presence or absence of fire clouds was recorded for each observation. Secondarily burned, interior and exterior smudged, and otherwise questionable observations were recorded as "indeterminate."

12. *Interior Surface Treatment* (INTSURF). Each observation was recorded as displaying either a polished, wiped, hand smoothed, anvil impressed, or indeterminate interior surface treatment. A sherd was coded as "polished" if the surface was smooth and highly lustrous and/or displayed facets indicative of stone polishing. A sherd was coded as "wiped" if the surface was smooth, displayed little or no luster, and displayed any type of mark indicative of wiping. A sherd was coded as "hand smoothed" if the surface was smooth but displayed no sheen, wipe marks, or anvil impressions. A sherd was coded as "anvil impressed" if anvil impressions (as semirounded indentations) were present. "Indeterminate" observations consisted of those cases that either did not clearly display one of the four treatments or were heavily eroded.

A caveat is included here regarding the use of the interior surface treatment variable with jar rim sherds. Patterns of interior surface finish on jars may exhibit extreme variability from the vessel rim to the vessel base. Vessel rims likely receive the same surface treatment as do jar exterior surfaces. Below the rim (where it is difficult or impossible to burnish) the surface may display anvil scars or evidence of wiping. Because virtually all jar sherds included in the ceramic analysis terminated at the vessel shoulder or above, the "interior surface finish" attribute as recorded likely does not reflect patterns across the vessel's entire interior surface, as is the case with bowl sherds.

13. *Exterior Surface Treatment* (EXTSURF). See "Interior Surface Treatment" for all attributes except for "anvil impressed." A sherd was coded as "paddle impressed" if paddle impressions were present. "Indeterminate" observations consisted of those cases which either did not clearly display one of the four treatments or were heavily eroded.

14. *Surface Treatment Pattern* (PATTERN). Each observation was recorded as exhibiting one of five patterned surface treatments, or surface treatment pattern indeterminate. The five patterned surface treatments are (1) interior and exterior parallel to rim, (2) interior parallel and exterior perpendicular to rim, (3) interior perpendicular and exterior parallel to rim, (4) interior and exterior perpendicular to rim, and (5) "other" (including pattern-polished observations). Those sherds that were heavily abraded or that did not clearly display one of the four treatments on both the interior and exterior surfaces were coded as "indeterminate."

15. *Smudging* (SMUDGE). Each observation was recorded as either being smudged on the interior for bowls, jars and indeterminate vessel forms. Sherds exhibited evidence of secondary firing or severe abrasion were recorded as "indeterminate." Interior smudging took two forms: self-contained interior smudging, and interior smudging that extended over the rim of the vessel to cover some portion of the exterior surface of the sherd. Occasionally, sherds were encountered that appeared to be smudged on the interior and the exterior surfaces and were recorded as another category.

16. *Worked Sherd* (WORKED). Each observation was recorded as either not worked, mend hole present, one edge ground, two edges ground, spindle whorl blank, sherd disk, rim ground, or "other."

17. *Evidence of Burning* (BURNING). Each observation was recorded as either burned or unburned. Evidence of burning included orange-hued oxidation, an ashy gray exterior from exposure to intense fire, a

blackened surface and core or fire-blackening. Those sherds for which ambiguous evidence of burning was observed were recorded as "indeterminate."

Three variables were recorded for each observation in order to characterize the technological attribute "temper." Determinations regarding these attributes were accomplished by examining a fresh break in the sherd using an incident-light binocular microscope.

18. *Temper Source Generic* (TSG). The temper source "generic" is derived from observation of the rock fragments and monomineralic grains known to define the tectonic origin of the observed grain types.

19. *Temper Source Specific* (TSS). The temper source "specific" is derived from observation of the distinctive suite of associated rock fragments and monomineralic grains known to define the source. These specific sources are referred to as petrofacies, following Lombard (1987 [SXB.20]:343; see also Bates and Jackson 1980).

20. *Temper Type* (TT). The "temper type" variable characterized the technological decision made by the prehistoric potter with regard to the addition of an "artificial" tempering material to the otherwise "natural" temper composition of a given petrofacies. The various "temper types" present in the assemblage is discussed in the section on ceramic temper resource characterization, following discussion of plainware and redware technological attributes.

21. *Carbon Streak* (CARBON). The presence or absence of a carbon streak in the sherd's paste was recorded for each observation. Burned or otherwise questionable observations were recorded as "indeterminate."

22. *Micaceous Surface* (MICASURF). Each observation was recorded as displaying either no micaceous surface sheen, surface mica derived from the clay and floated to the surface by polishing, a highly micaceous surface sheen, or micaceous surface "indeterminate."

Five continuous attributes were recorded for each observation on plainware rim sherds. These are:

23. *Orifice Diameter* (ORIFDIA). Measurements for orifice diameters on both bowl and jar rim sherds were taken where possible. Measurements were taken using a standard diameter-measurement template, marked off in one centimeter units (Rice 1987:223). Samples with a rim length of five percent or greater were measured with the template to the nearest half centimeter. Orifice diameters could not be estimated for asymmetrical vessels such as scoops.

24. *Aperture Diameter* (APETDIA). Measurements for aperture diameters on jar rim sherds were taken where possible. Measurements were taken using a standard diameter-measurement template, marked off in one centimeter units (Rice 1987:223). This attribute was only recorded for jar vessel forms with a rim length of five percent or greater. The measurement was taken at the point of greatest constriction, using the template to the nearest half centimeter. Where rim sherds (or reconstructible and partially reconstructible vessels) proved asymmetrical, diameters were recorded as indeterminate.

25. *Jar Rim Height* (HEIGHT). This attribute was only recorded for constricted jar forms. Each measurement was taken using a contour gauge, and taken to the nearest millimeter. The rim was visually leveled (see Rice 1987:222-223), and the measurement taken from the most constricted point in the aperture to the top of the rim. The same method was applied to collared jars as to flare-rimmed jars. Each observation was measured three times to reduce inconsistency; the recorded observation represents an average of the three measurements. Where the range of the three measurements exceeded 6 millimeters, the observation was recorded as indeterminate. Measurements were recorded to the nearest millimeter.

26. *Upper Body Profile Slope* (ANGLE). This attribute was only recorded for constricted jar forms. Measurements for upper body profile slopes were taken using a vertically mounted adjustable triangle. The upper body slope angle is measured at the inflection point, located immediately below the rim. The inflection

point is defined as the "point on the vessel silhouette marking the change of direction of curvature of two parts of the vessel" (Rice 1987:218). To measure the slope angle, the rim was visually leveled and an adjustable triangle was placed against the interior surface of the jar vessel wall. Each observation was measured three times to reduce inconsistency; the recorded observation represents an average of the three measurements. Where the range of the three measurements exceeded 6 degrees, the observation was recorded as indeterminate. Measurements were taken to the nearest degree.

27. *Vessel Wall Thickness* (BODTHICK). Each observation was measured with a vernier caliper to the nearest half millimeter. Measurement was taken approximately one centimeter below the terminus of the rim form where possible; where impossible, measurements were taken at the lowest portion of the vessel body present on the rim sherd. Each observation was measured three times to reduce inconsistency; the recorded observation represents an average of the three measurements. Where observations exhibited a range of vessel wall thicknesses that exceeded one millimeter, observations were recorded as indeterminate.

Continuous attributes listed here are discussed in a section following the redware analysis in which plainware and redware attributes are examined in relation to one another.

Restorable Plainware Vessels

Mills' (1989:133) discussion of ceramic assemblage formation underscores problems that occur when restorable vessels and sherds are treated separately during analyses. In our analysis, we have treated each restorable vessel as a "sherd" observation to examine patterning within the entire ceramic assemblage. We recognize that some incomparability results from combining observations from small rim sherds (with relatively low information content) with information from restorable or partially restorable vessels (with exceptionally high information content). However, we decided that the problem of incomparability was relatively minor and did not warrant the exclusion of restorable or partially restorable vessels from the assemblage-level analysis. Table 13.35 (presented later in this chapter) lists all of the restorable and partially restorable plainware and redware vessels by site. Both plainwares and redwares are listed in the table, and the entire restorable vessel assemblage is discussed in a later section of this chapter.

RESULTS OF THE PLAINWARE ANALYSIS

The plainware analysis was designed to examine relationships among ceramic technology and ceramic function within a dynamic framework, as presented in the attribute description in the previous section. Discussion of these attributes is structured accordingly. Table 13.3 presents patterning in the basic plainware nominal data. This table, and subsequent tables explore relationships among ceramic technology, ceramic function, and temporal variability at varying levels of detail.

Sherd Size and Methodological Considerations

Information on sherd size is useful for evaluating the range of information produced by our assemblage and for evaluating the contextual integrity of the deposits under study. For the contextual assessment, ceramics represent an ideal artifact category through which to assess the role of size in identifying different types of depositional contexts and their degree of disturbance. Differing ceramic compositions and environmental conditions affect the fragility of ceramics. Simon and Burton (1988) found significant differences in the strength of Tonto Basin ceramics that the authors attributed to temper differences and surface treatment. Other noncultural formation processes that have size effects include water, wind, and worms and other burrowing animals (Schiffer 1983; 1987). These various behaviors all encourage size sorting, as smaller artifacts move downward through archaeological deposits. Moreover, certain soil compositions (e.g., sand, loam) encourage the movement of small artifacts downward and of large artifacts upward.

Table 13.3. Plainware attribute data recorded from rim sherds and restorable vessels from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Variable/Attribute	Bowls	Jars	Total[1]	Bowls	Jars	Total[1]	Bowls	Jars	Total[1]
Sherd Size									
<5cm^2	14 (16.7)	7 (14.3)	27 (17.8)	19 (17.8)	9 (23.1)	32 (20.5)	10 (17.2)	3 (3.4)	20 (11.4)
5-16cm^2	41 (48.8)	24 (48.9)	77 (50.7)	71 (46.7)	21 (53.8)	98 (62.8)	38 (65.5)	42 (47.7)	101 (57.7)
16-49cm^2	17 (20.2)	13 (26.5)	30 (19.7)	14 (13.1)	8 (20.5)	22 (14.1)	9 (15.5)	31 (35.2)	41 (23.4)
49-100cm^2	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.9)	0 (0.0)	1 (0.6)	1 (1.7)	7 (8.0)	8 (4.6)
>100cm^2	12 (14.3)	5 (10.2)	18 (11.8)	2 (1.9)	1 (2.6)	3 (1.9)	0 (0.0)	5 (5.7)	5 (2.9)
	84	49	152	107	39	156	58	88	175
Rim Exterior Abrasion									
Absent	58 (80.6)	40 (90.9)	110 (72.4)	93 (90.3)	33 (94.3)	132 (84.6)	49 (89.1)	84 (96.6)	159 (90.9)
Present	14 (19.4)	4 (9.1)	22 (14.5)	10 (9.7)	2 (5.7)	14 (9.0)	6 (10.9)	3 (3.5)	9 (5.1)
Indeterminate	0 (0.0)	0 (0.0)	20 (13.1)	0 (0.0)	0 (0.0)	10 (6.4)	0 (0.0)	0 (0.0)	7 (4.0)
	72	44	152	103	35	156	55	87	175
Rim Shape[2]									
Squared	29 (47.5)	7 (17.5)	39 (33.3)	64 (66.7)	20 (57.1)	89 (63.6)	29 (58.0)	45 (55.6)	88 (55.7)
Rounded	24 (39.3)	28 (70.0)	63 (53.9)	30 (31.3)	11 (31.4)	45 (32.1)	16 (32.0)	24 (29.6)	48 (30.4)
Tapered	2 (3.3)	4 (10.0)	8 (6.8)	1 (1.0)	0 (0.0)	1 (0.7)	1 (2.0)	1 (1.2)	2 (1.3)
Beveled	1 (1.6)	0 (0.0)	1 (6.8)	0 (0.0)	0 (0.0)	0 (0.0)	2 (4.0)	4 (4.9)	8 (5.1)
Other/Misc.	1 (1.6)	1 (2.5)	2 (1.7)	1 (1.0)	3 (8.6)	4 (2.9)	1 (2.0)	1 (1.2)	3 (1.9)
Indeterminate	4 (6.6)	0 (0.0)	4 (3.4)	0 (0.0)	1 (2.9)	1 (0.7)	1 (2.0)	6 (7.4)	9 (5.7)
	61	40	117[2]	96	35	140	50	81	158
Rim Consistency									
Consistent	61 (72.6)	40 (81.6)	117 (77.0)	96 (89.7)	35 (89.7)	140 (89.7)	50 (86.2)	81 (92.1)	158 (90.3)
Inconsistent	23 (27.4)	9 (18.4)	35 (23.0)	11 (10.3)	4 (10.3)	16 (10.3)	8 (13.8)	7 (7.9)	17 (9.7)
	84	49	152	107	39	156	58	88	175
Rim Evenness									
Basically Even	18 (21.4)	9 (18.4)	30 (19.7)	39 (36.5)	15 (38.5)	57 (36.5)	27 (46.5)	32 (36.4)	74 (42.3)
Undulating	66 (78.6)	40 (81.6)	122 (80.3)	68 (63.5)	24 (61.5)	99 (63.5)	31 (53.5)	56 (63.6)	101 (57.7)
	84	49	152	107	39	156	58	88	175
Fire Clouding									
Present	45 (53.6)	27 (55.1)	82 (53.9)	57 (53.3)	19 (48.7)	81 (51.9)	30 (51.7)	32 (36.4)	75 (42.3)
Absent	30 (35.7)	21 (42.9)	58 (38.2)	34 (31.8)	14 (35.9)	52 (33.3)	26 (44.8)	46 (52.3)	85 (48.6)
Indeterminate	9 (10.7)	1 (2.0)	12 (7.9)	16 (14.9)	6 (15.4)	23 (14.7)	2 (3.5)	10 (11.4)	15 (8.6)
	84	49	152	107	39	156	58	88	175
Carbon Core									
Present	11 (13.1)	6 (12.2)	19 (12.5)	3 (2.8)	0 (0.0)	4 (2.6)	3 (5.2)	1 (1.1)	4 (2.3)
Absent	37 (44.1)	27 (55.1)	74 (48.7)	41 (38.3)	15 (38.5)	58 (37.2)	26 (44.8)	45 (51.1)	86 (49.1)
Indeterminate	36 (42.9)	16 (32.7)	59 (38.8)	63 (58.9)	24 (61.5)	94 (60.3)	29 (50.0)	42 (47.7)	85 (48.6)
	84	49	152	107	39	156	58	50	175
Interior Surface Treatment									
Polished/Burnished	32 (38.1)	8 (16.3)	44 (28.9)	87 (81.3)	16 (41.0)	109 (69.9)	48 (82.8)	75 (85.2)	143 (81.7)
Wiped/Smoothed	48 (57.1)	40 (81.6)	102 (67.1)	16 (14.9)	22 (56.4)	41 (26.3)	5 (8.6)	12 (13.6)	25 (14.3)
Indeterminate	4 (4.8)	1 (2.0)	6 (3.9)	4 (3.7)	1 (2.6)	6 (3.9)	5 (8.6)	1 (1.1)	7 (4.0)
	84	49	152	107	39	156	58	88	175
Exterior Surface Treatment									
Polished/Burnished	29 (34.5)	8 (16.3)	42 (27.6)	75 (70.1)	24 (61.5)	106 (68.0)	48 (82.8)	81 (92.1)	153 (87.4)
Wiped/Smoothed	46 (54.8)	40 (81.6)	99 (65.1)	26 (24.3)	14 (35.9)	42 (26.9)	4 (6.9)	6 (6.8)	14 (8.0)
Indeterminate	9 (10.7)	1 (2.0)	11 (7.2)	6 (5.6)	1 (2.6)	8 (5.1)	6 (10.3)	1 (1.1)	8 (4.6)
	84	49	152	107	39	156	58	88	175

Table 13.3. Continued.

	Gila Butte			Sacaton			Early Classic		
Variable/Attribute	Bowls	Jars	Total[1]	Bowls	Jars	Total[1]	Bowls	Jars	Total[1]
Surface Treatment Pattern									
Interior/Exterior Parallel to rim	67 (79.8)	44 (89.8)	128 (84.2)	95 (88.8)	33 (84.6)	137 (87.8)	53 (91.4)	87 (98.9)	167 (95.4)
Interior/Parallel/Exterior Perpendicular to rim	2 (2.4)	0 (0.0)	2 (1.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Interior Perpendicular/ Exterior Parallel to rim	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)
Interior/Exterior Perpendicular to rim	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.7)	0 (0.0)	1 (0.6)
Other	2 (2.4)	0 (0.0)	2 (1.3)	1 (0.9)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)
Indeterminate	13 (15.5)	5 (10.2)	20 (13.2)	11 (10.3)	6 (15.4)	18 (11.5)	4 (6.9)	1 (1.1)	6 (3.4)
	84	49	152	107	39	156	58	88	175
Smudging									
Smudged	18 (21.4)	4 (8.2)	22 (14.5)	55 (51.4)	17 (43.6)	76 (48.7)	37 (63.8)	68 (77.3)	122 (69.7)
Unsmudged	59 (70.2)	42 (85.7)	120 (78.9)	41 (38.3)	20 (51.3)	66 (42.3)	18 (31.0)	18 (20.5)	46 (26.3)
Indeterminate	7 (8.3)	3 (6.1)	10 (6.6)	11 (10.3)	2 (5.1)	14 (9.0)	3 (5.2)	2 (2.3)	7 (4.0)
	84	49	152	107	39	156	58	88	175

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[1] Excludes sherds with inconsistent rims.

[2] Includes indeterminate and indeterminate flare-rim forms.

Sherd size was an important consideration in the contextual assessment process, as one index of the degree of disturbance or movement of plainwares in particular contexts. Natural and cultural formation processes have been demonstrated to affect the size sorting of artifact assemblages (Schiffer 1987:267). In addition, previous Tonto Basin research established that small sherds (i.e., 5.0 cm^2 or smaller) constituted a substantial percentage of the plainware-redware assemblage. For example, about 33 percent of the plainwares at Ushklish fell into this size class (Haas 1971:44). In addition, about 55 percent of the plainwares/redwares recovered from AZ O:15:67 (the Granite Ridge site, Locus 1) were 5.0 cm^2 or smaller (Huckell 1978:22); 38.9 percent of the redware-plainware sherds from O:15:42 (Casita Escondida) also fell into this size class (Huckell 1978:80).

Cultural formation processes have an important effect on size sorting among ceramic assemblages. One general postdepositional process is trampling by humans and animals (e.g., DeBoer and Lathrap 1979; Gifford 1928; Neilsen 1991), which serves to reduce the average sherd size in a given ceramic assemblage. Other behavioral processes have been documented in the ethnoarchaeological literature. Maintenance disposal activities among the contemporary Tzeltal Maya were described by Deal (1985:259), in which structures, patios, and extramural surfaces such as plazas regularly undergo sweeping and cleaning episodes that affect the patterning of sherds by class categories during the course of a site's occupation. Such size sorting, however, may not occur when structures are abandoned or when activity areas are not habitually cleaned. Other factors affecting Tzeltal pottery disposal include scavenging, collecting, shortcutting, children's play and intentional refuse dumping (Deal 1985:271).

Sherd size can be measured from the archaeological and the systemic contexts (Schiffer 1976). Within the archaeological context, size can be measured using the surface area of a particular sherd. This measure is an objective assessment of artifact size in the archaeological context and is equally applicable for sherds derived from a range of vessel shapes and forms. In the systemic context, sherd size is measured as the proportion of the vessel that is represented. Cultural formation processes discussed previously illustrate means by which portions of a vessel can be distributed across areas that remain occupied and used by a house's or community's inhabitants. Because rims form the analytic unit in this analysis, our "rim length" variable measures the degree of vessel completeness (or the percentage of rim present).

Influence of Size on Determination of Vessel Shape

Overall vessel size has an effect on sherd size. Large pots will produce large fragments after initial vessel breakage, and large sherds likely reduce less quickly through trampling and other activities. Because plainwares exhibited a wider range in size distribution than did redwares (and larger plainware vessels were recorded, on average, than were large redware vessels). Table 13.4 presents sherd size data by ceramic ware through time. Also see Table 13.3 for plainware data and Table 13.12 for redware data by phase. In viewing the redware data in Table 13.4 and elsewhere through this chapter, the possibility of a small number of pre-Sacaton redwares in the assemblage should be noted, although the evidence for such redwares is equivocal. Relative to the overall size distribution for both the Gila Butte and the Sacaton phases, small redware sherds (i.e., 2.5-5.0 cm^2) are disproportionately represented. While this pattern is far less clear during the early Classic period (Roosevelt phase), the redware size weighting during the earlier phases has a profound impact on redware analysis. Nearly half of the "Gila Butte" redwares are smaller than 5.0 cm^2, severely restricting the amount of available information. Time has a less significant effect on sherd size than does ware. Sherds from later contexts are, on the whole, slightly larger than sherds from earlier contexts, although this pattern was not examined through statistical means.

Table 13.4. Size distribution of plainwares and redwares through time. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Size	PW	RW	Total	PW	RW	Total	PW	RW	Total
<2.5cm^2	0 (0.0)	3 (13.6)	3 (1.7)	0 (0.0)	1 (1.8)	2 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)
2.5-5cm^2	27 (17.8)	9 (40.9)	36 (20.6)	32 (20.5)	23 (40.4)	55 (25.4)	20 (11.4)	12 (5.2)	34 (8.2)
5-16cm^2	77 (50.7)	8 (36.4)	85 (48.6)	98 (62.8)	27 (47.4)	127 (58.5)	101 (57.7)	136 (59.4)	242 (58.3)
16-49cm^2	30 (19.7)	2 (9.1)	32 (18.3)	22 (14.1)	5 (8.8)	28 (12.9)	41 (23.4)	65 (28.4)	110 (26.5)
49-100cm^2	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	0 (0.0)	1 (0.5)	8 (4.6)	8 (3.5)	16 (3.9)
>100cm^2	18 (11.8)	0 (0.0)	19 (10.9)	3 (1.9)	1 (1.8)	4 (1.8)	5 (2.9)	8 (3.5)	13 (3.1)
	152	22	175	156	57	217	175	229	415

Note: Totals include indeterminate plainwares and redwares.
PW = plainware
RW = redware

Artifact size has a negative effect in efforts to identify vessel shape and form in the Rye Creek Project ceramic assemblage, which relies primarily on rim sherds (see Duennwald 1986; Howard 1990; for similar problems encountered with ceramics from Shoofly and the Pine Creek Project). This is best seen using the bowl-jar distinction. Bowl rim sherds represent a higher proportion of the vessel than do jars, whose total volume tends to be greater than that of bowls. In addition, shape constraints inherent in jars (restricted aperture vessels) require relatively larger jar sherds than bowl sherds for proper identification. Therefore, the higher the percentage of small sherds in the assemblage, the higher the frequency of bowls. Fragmentary sherds with everted rims often were placed in the "indeterminate flare-rim" category because these small sherds lacked a complete rim and aperture curvature.

Sherd size is important for providing a set of metrically based size classes that can be compared across vessel shapes and across data sets. Table 13.5 presents the distribution of sherd size by shape as measured on a size template. Several trends are evident within the plainwares. First, nearly 100 percent of the sherds in the indeterminate category are 16 cm^2 or smaller in size. Indeterminate flare-rim shapes, as potential small jar sherds, also cluster in that size class. Second, plainware jar rims are underrepresented (relative to the totals) in the smallest size class, as are combined plainware and redware jar sherds. Plainware and redware jar sherds are also overrepresented in the larger size categories (i.e., 16 cm^2 and above), illustrating the bias against the recognition of small jar sherds as previously outlined. Finally, redware jars are poorly represented in the largest category, which consists largely of reconstructible and partially reconstructible vessels. At least two alternative hypotheses may explain this latter pattern. The redware patterning may reflect ware-based differential curation, in which redware jars are more commonly curated (and therefore have longer use lives and lower frequencies) than are plainware jars. The second hypothesis -- that a smaller quantity of redware jars were produced relative to plainware jars -- seems more likely. Data derived from Table 13.5 can be used to calculate an odds ratio that examines proportions of jars and bowls within each ware (i.e., [plainware jars (176)/plainware bowls (249)]/redware jars (61)/redware bowls (161)] = 1.86). Using this ratio, there are nearly 1.9 times as many plainware jars as redware jars in the assemblage, a pattern that is probably statistically significant.

The second index of sherd size, the percentage of rim present, was measured on a diameter measurement template. Small rim sherds are problematic with regard to rim diameter measurements, since vessel mouth asymmetry produces a rim that is either vertically or horizontally uneven, "making it difficult to establish the precise orientation and diameter of the sherd" (P. Rice 1987:223). Gauging the percent of rim present provides a shape and vessel form-specific measurement of completeness. Table 13.6 demonstrates that small jar sherds (i.e., those having five percent or less of a rim present) are underrepresented in both plainwares and redwares. Moreover, unlike bowls, jar sherds have a larger portion of the rim present. Predictably, sherds in the "Indeterminate" category have 5 percent or less of their rims present, and the "Indeterminate flare-rim" category is heavily weighted toward the smaller rim percent class.

Because size influences the analyst's ability to assign vessel shape to particular rim sherds, all plainware rim sherds less than 5.0 cm^2 were omitted from analysis. Redware sherds were treated somewhat differently, because an effort was made to analyze all potentially "early" (i.e., Gila Butte and Sacaton phase) redware sherds. Selected redware sherds in the "2.5-5.0 cm^2" category were included in the analysis to maximize the database for these phases.

Effect of Size on Assemblage Composition

The representation of bowl and jar forms in a given archaeological assemblage does not directly reflect the representation of certain vessel shapes and forms in the systemic assemblage. Plainware and redware jar rim sherds, whose forms exhibit restricted apertures and globular shapes, are underrepresented in the assemblage relative to their frequency. This point was also noted by Duennwald (1986:12) in her preliminary analysis of the Shoofly plainware assemblage. Bowls, with rims that are roughly similar in diameter to their bodies, consequently may be overrepresented in the Rye Creek Project assemblage. For this reason, ratios developed to compare relative frequencies of bowls and jars do not accurately represent the systemic ceramic assemblage. Bowl:jar ratios are a conventional component of ceramic analyses in the study area and for this reason some information is offered later in the chapter on bowl:jar ratios.

Exterior Surface Abrasion

Documenting the frequency and intensity of exterior surface abrasion in the Rye Creek plainware assemblage provides information on how each deposit was formed. Sherd abrasion was included as an index of refuse deposit type for the contextual assessment, rather than as part of a use-wear study that would most directly benefit from analysis of interior abrasion on basal (rather than rim) sherds. The abrasion variable was recorded as part of the initial, contextual assessment to test its potential as a signature of refuse deposit types.

Table 13.5. Cross-tabulation of vessel shape by sherd size for rim sherds and restorable vessels from Gila Butte, Sacaton, and early Classic contexts. Scoop observation not included. Column percentages are given in parentheses.

	Bowl			Jar			Flare-rim (Shape Indeterminate)			Indeterminate Shape			
Sherd Size	PW	RW	Total	PW	RW	Total	PW	RW	Total	PW	RW	Total	Total (Comb.)
<5cm^2	43 (17.3)	12 (7.5)	55 (13.4)	19 (10.8)	2 (3.3)	21 (8.9)	6 (22.2)	1 (14.3)	7 (20.6)	11 (36.7)	33 (42.9)	44 (41.1)	130 (16.1)
5-16cm^2	150 (60.2)	94 (58.4)	244 (59.5)	87 (49.4)	34 (55.7)	121 (51.1)	20 (74.1)	6 (85.7)	26 (76.5)	18 (60.0)	36 (46.8)	54 (50.5)	454 (56.3)
16-49cm^2	40 (16.1)	43 (26.7)	83 (20.2)	52 (29.6)	21 (34.4)	73 (30.8)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.3)	7 (9.1)	8 (7.5)	170 (21.1)
49-100cm^2	20 (0.8)	5 (3.1)	7 (1.7)	7 (4.0)	3 (4.9)	10 (4.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	17 (2.1)
>100cm^2	14 (5.6)	7 (4.4)	21 (5.1)	11 (6.3)	1 (1.6)	12 (5.1)	1 (3.7)	0 (0.0)	1 (2.9)	0 (0.0)	1 (1.3)	1 (0.9)	36 (4.5)
Totals	249	161	410	176	61	237	27	7	34	30	77	107	807

PW = plainware
RW = redware

Table 13.6. Cross-tabulation of vessel shape by percentage of rim present for rim sherds and restorable vessels from Gila Butte, Sacaton, and early Classic contexts. Scoop observation not included. Column percentages are given in parentheses.

	Bowl			Jar			Flare-rim (Shape Indeterminate)			Indeterminate[2] Shape			
Percent of Rim	PW	RW	Total	PW	RW	Total	PW	RW	Total	PW	RW	Total	Total (Comb.)
0-5%[1]	191 (76.7)	116 (72.0)	307 (74.9)	98 (55.7)	38 (62.3)	136 (57.4)	20 (74.1)	6 (85.7)	26 (76.5)	29 (96.7)	77 (100.0)	106 (99.1)	575 (72.9)
5-10%	43 (17.3)	35 (21.7)	78 (19.0)	57 (32.4)	20 (32.8)	77 (32.5)	7 (25.9)	1 (14.3)	8 (23.5)	1 (3.3)	0 (0.0)	1 (0.9)	164 (20.8)
10-15%	0 (0.0)	2 (1.2)	2 (0.5)	13 (7.4)	1 (1.6)	14 (5.9)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	16 (2.0)
>15%	15 (6.0)	8 (5.0)	23 (5.6)	8 (4.5)	2 (3.3)	10 (4.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	33 (4.2)
Totals	249	161	410	176	61	237	27	7	34	30	77	107	788

[1] Includes indeterminate percent.
[2] Includes redware body sherds in sample.

Schiffer (1987) includes abrasion as one of several indicators of formation processes that operated on a particular deposit, in addition to sherd size and density. Ceramic abrasion is defined by Schiffer and Skibo (1989:101) as "a trace that was formed by the removal or deformation of material on a ceramic's surface by mechanical contact, specifically, the sliding, scraping, or, in some cases, striking action of an abrader (i.e., a particle, object, or surface)."

The abrasion data on plainware sherds are presented in Table 13.3. Five categories were used to assess the degree of exterior surface abrasion: 1) surface abrasion absent (Category 0), 2) between 1 and 25 percent surface abraded (Category 1), 3) 26-75 percent surface abraded (Category 2), 4) 76-100 percent surface abraded (Category 3), and Indeterminate, consisting of sherds that were worked, severely damaged (obscuring the surface), or burned (Category -9). Nominal categories were developed for the abrasion analysis. These categories precluded a complete evaluation of the depth or severity of surface abrasion. What was instead being measured was the *areal* extent of the abrasion as it extended over the exterior surface of the rim sherd. The analysis focused on pedestaling, a mechanism that leaves distinct, macroscopically identifiable traces of surface abrasion.

Exterior surface treatment affected the degree to which abrasion was observable. Polished (or slipped and polished) vessels displayed the least abrasion, as would be expected due to the increased abrasion resistance of polished (and slipped and polished) sherds. Many of the sherds under analysis, however, lacked evidence for exterior surface polishing or even for extensive hand-wiping to smooth out the surface. Hand-smoothed vessels will appear to have rougher exterior surfaces than will hand-wiped or polished vessels, and in some cases sherds with hand-smoothed surfaces were classified as indeterminate.

Four basic types of exterior rim sherd surfaces were classified into the indeterminate category: 1) coarsely made, hand-smoothed vessels with undulating surfaces that obscured the wipe marks, 2) vessels with either a sandy or gritty temper and dissolvable clay that, through use, leads to mild pedestaling and the disappearance of all traces of exterior finish (e.g., polishing, hand-wiping). What remains is a gritty surface that may reflect *either* abrasion processes *or* paste types, 3) burned or otherwise damaged sherds that either lack a sufficiently large surface to make a meaningful judgment, or that have spalling or damaged edges. These surfaces may show evidence of heat damage or secondary firing, compositionally related spalling, or chipping and recent breakage that could represent the result of trampling or shovels, or 4) exterior surfaces that simply baffle the analyst to such an extent that no decision can be made as to just *how* abraded the surface might be.

Temporal patterns in plainware rim exterior abrasion are illustrated by shape in Table 13.3. It was expected that older sherds would be more abraded, having been exposed to weathering processes for a longer period of time. This expectation was upheld, as exterior abrasion increases through time. In every phase, bowls tend to have more abraded exteriors than do jars, relative to the total assemblage. Two factors may account for this shape-related pattern. The first is bowl rim curvature, which renders bowl rim exteriors more susceptible to abrasion during use and in refuse deposits after being discarded. The second factor lies in use behaviors that abrade jar orifice/aperture interiors through such activities as storing and sealing with lids. Bowls, subject to different use behaviors, more readily display exterior surface abrasion than do jars. Similar patterning in ongoing research on the Schuk Toak Project ceramic assemblage in the Avra Valley (west of the Tucson Mountains), has been observed in which bowls tend toward more abraded surfaces. Based on our experiences on these two projects, we recommend that for consistency, future abrasion-related interpretations be restricted to bowl sherds.

Vessel Shape and Vessel Form

Both vessel shape and vessle form (i.e., subvariants within each shape catagory) were recorded in our analysis. The analyses described throughout this chapter aggregate data from multiple sites to the phase level. This has been done to mitigate the effects of small sample sizes. In doing so, we assumed that temporally unique attributes would override site functionally specific attributes. A limited analysis of site-specific vessel shape assemblages is contained in the section on pottery function and site function at the end of this chapter. Rim sherds were first assigned to vessel shapes using the traditional typology: bowl, jar, scoop, and a "flare-rim indeterminate" category. The latter designation was used differently than in previous analyses by Desert Archaeology (where "indeterminate flare-rim" may have referred to flare-rim bowls, e.g., Heidke 1989a). Here the category was applied to each rim sherd that lacked sufficiently diagnostic features to assign it to the bowl, jar, or scoop categories. These "flare-rim indeterminate" forms may have been either flare-rimmed jars or semiflare rimmed jars, although the latter category is more likely. To maintain replicability, small flare-rimmed sherds were assigned to this category.

Vessel Shape: Bowl vs. Jar Distinctions

The bowl vs. jar distinction has a long tradition in Southwestern ceramic analysis, despite a host of methodological problems associated with its use. First, the two categories are not mutually exclusive in the current data set, as the (rare) semiflare rimmed, incurved bowl differs from short flare-rimmed jars only in the degree of constriction, a judgment made subjectively by the analyst. Similarly, the "seed jar" category (a hallowed Southwestern archaeological type) resembles an extremely incurved bowl. Second, although some consensus exists as to the range of functions served by "bowls," a bewildering variety of functions may have been served by "jars," from cooking and fermentation to liquid or dry goods storage. Eventually the bowl-jar distinction should be replaced by a classification system that is metrically and functionally based. Such a system would utilize metrically based morphological differences and the results of use alteration and ethnoarchaeological studies to identify behaviorally significant -- and statistically reliable -- categories to replace those currently employed in the analysis discussed here. The development of quantitatively based measures, such as the jar rim angle used in this analysis, should be a primary goal in future studies in the Tonto Basin.

For historical reasons alone, these categories merit use in the Rye Creek Project plainware and redware analysis, with some caveats. Vessel forms were classified according to an evolving typology that used Tucson Basin prototypes as a foundation and added vessel forms to the coding as "atypical" rim sherds were encountered. A plainware vessel form study of the Tonto Basin and environs from the Preclassic and Classic periods provided baseline information that guided inferences from "atypical" rim sherds in establishing new vessel form categories. Figure 13.1 illustrates the range of bowl forms and Figure 13.2 depicts the range of jar forms identified in the plainware/redware analysis. Where rim sherds were too small for proper vessel form identification (e.g., < 5.0 cm^2), they were assigned to the bowl or jar "indeterminate form" category.

Table 13.7 summarizes plainware shape and vessel form data recorded for sherds with determinate forms from the Gila Butte and Sacaton phases and the early Classic period. Vessel shape is first considered. In the Preclassic (i.e., Gila Butte and Sacaton) plainware assemblages for all rims of determinate vessel shape, bowls constituted 64.3 percent.

Although jars appear to be more frequent in the early Classic period, this drop in the proportion of plainware bowls has more to do with the appearance of redware bowls than with true changes in bowl:jar ratios. The percentage of rims coded as "flare-rim, indeterminate" also fluctuates through time. The "flare-rim, indeterminate" shapes, as noted in Table 13.3, tend to fall in the smallest size class, and as noted, lack adequate vessel profile for classification into either the bowl or jar categories. Therefore, changes in the proportions of "flare-rim, indeterminate" forms likely have more to do with sherd size than with genuine shape categories.

The vessel form variable is more informative than is shape, with some caveats regarding jar forms. Unlike bowl rim sherds (from whose curvature and shape entire vessel profiles can often be inferred), jar rim sherds yield limited information regarding the shape of the vessel. A small percentage of large sherds were amenable to measuring upper body profile slopes (21.0 percent of plainwares, 13.1 percent of redwares). Most jar rim sherds, however, only provided morphological information from the shoulder upward. Lacking a large sample of reconstructible plainware jars from the project, the range of variability is not known for jar bodies. Particular details of jar body shape, vessel volume and overall vessel size are lacking in the plainware assemblage. Comparative, reconstructible redware jars from the Star Valley area exhibit low (Classic)

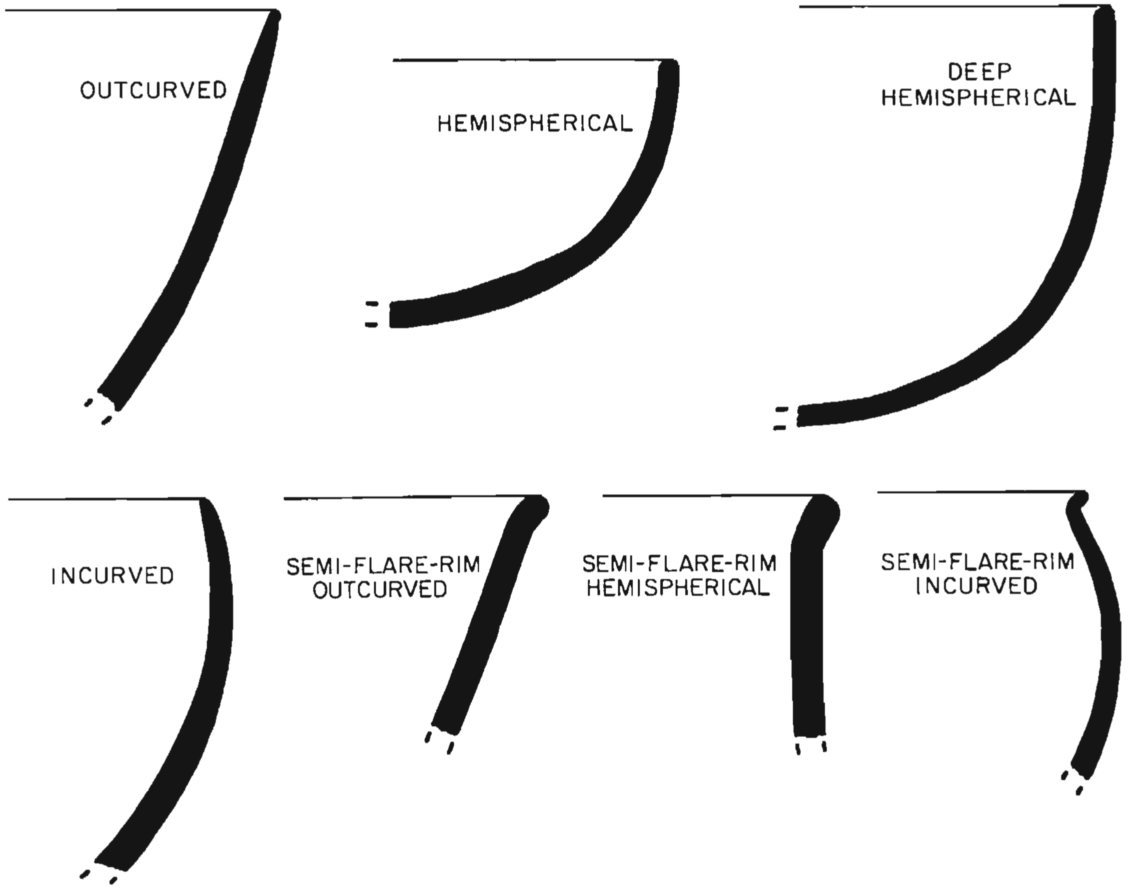

Figure 13.1. Bowl vessel forms recorded in the RCM plainware-redware rim sherds and restorable vessel ceramic assemblage.

shoulders (Simon and Burton 1989; Simon, personal communication 1991), providing some indication of the expected redware jar shapes in the assemblage.

Bowl forms. Several notable trends are evident in bowl vessel forms as illustrated in Table 13.7. First, the percentage of hemispherical bowls drops precipitously by the early Classic period, while three semiflare-rimmed bowl forms gain in popularity. Outcurved bowls become less common, while incurved bows and plate-platters fluctuate through time, both being less frequent during the Sacaton phase and resurging in the early Classic period. The percentage of indeterminate bowl forms also oscillates through time. Sacaton phase bowl rim sherds contain the highest number of indeterminate vessel forms. Given that sherd size affects one's ability to accurately classify vessel form, the Sacaton phase bowl pattern is dimly echoed in the plainware-redware size distribution presented in Table 13.4.

Jar forms. Trends through time within the jars also vary according to form. The percentage of short, flare-rimmed jars remains relatively stable, while seed jars and short, incurved straight collar jars entirely drop out of the assemblage by the early Classic period. Patterns that parallel the phase-by-phase fluctuation of plainware bowl forms are apparent in the short flare-rimmed jars, the neckless jars, and the tall straight-collared jars. Tall flare-rimmed jars gain importance in the early Classic period. The percentage of indeterminate jar vessel forms remains relatively consistent through time.

Vessel Shape and Vessel Size

Previous research on the Ash Creek Project suggested that Classic period sites have a wider range of vessel forms than do Preclassic sites (O'Brien et al. 1985:343). This also seems to be the case with the Rye Creek

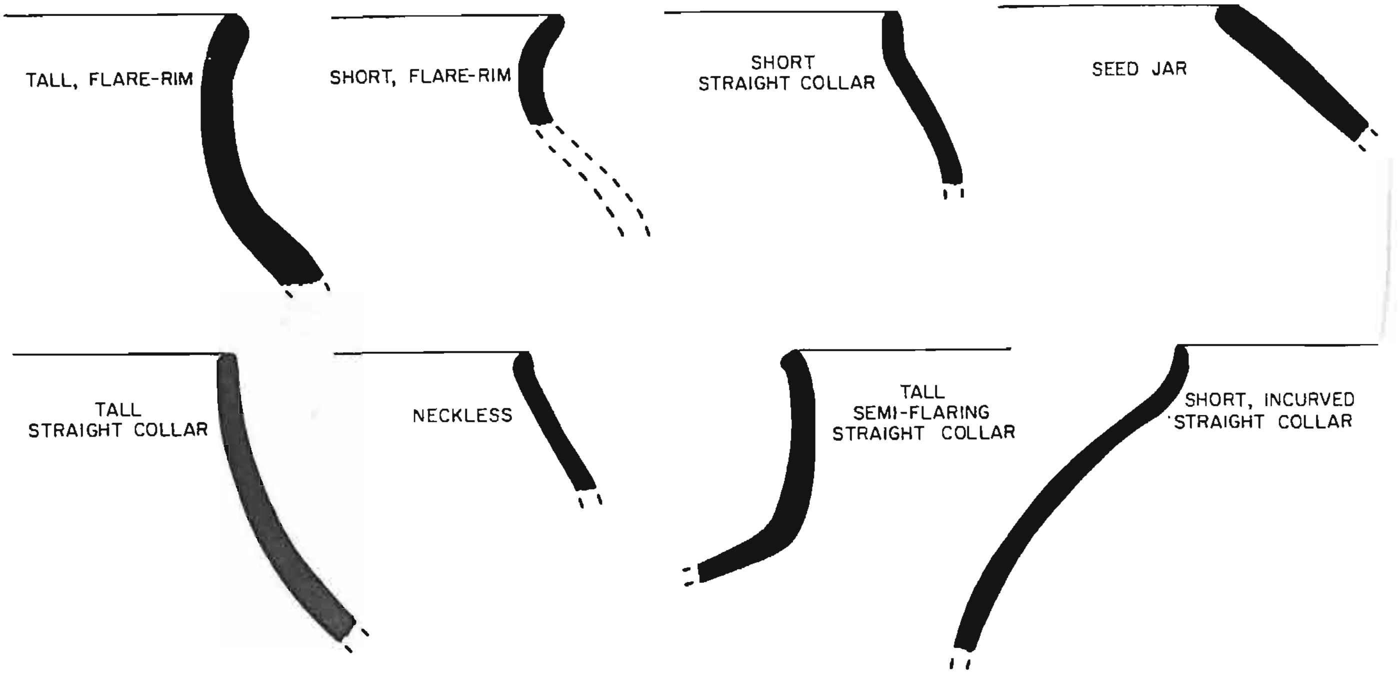

Figure 13.2. Jar vessel forms recorded in the RCM plainware-redware rim sherd and restorable vessel ceramic assemblage.

Project redwares and plainwares, where the diversity of bowl vessel forms gradually increases from the Gila Butte phase to the early Classic period. The fact that jar vessel forms do not show the same pattern may be related to functional constraints and a limited range of variability possible in jar construction.

The substantial changes through time in the plainware vessel forms presented in Table 13.7 may reflect one or more of the following four factors: 1) the introduction of redware vessel forms, 2) discrete "ethnic" groups utilizing the project area at different points in time, 3) changing patterns of resource utilization in the project area through time and resultant changes regarding vessel function, and 4) changing patterns in the organization of ceramic production through time. Each of these factors is discussed here, and the subject is more fully addressed in the section that combines plainware and redware at the conclusion of this chapter.

Redwares. The introduction of redwares into the assemblage substantially reduces the proportion of plainware bowls in the early Classic period assemblage. The plainware bowl sample size in the early Classic period (n=58) is only 54 percent of the sample size recorded for the preceding, Sacaton phase (n=107). This is interesting, since the early Classic period deposits that were examined in the ceramic analysis were from high-density secondary refuse contexts that yielded a high volume of sherds. Small sample size in the latest period, however, related to redware production, must be considered in viewing changing proportions of bowl vessel forms. Whether particular vessel forms lose popularity through phases across both plainwares and redwares are discussed in the concluding section of this chapter.

Cultural identity and its relationship to vessel forms. An alternative interpretation of fluctuations in particular plainware vessel forms by phase lies in the potential use of the area by distinct social groups through time. Looking at Lower Basin ceramics, Simon and Redman (1990:67) comment that different manufacturing methods (including forming and firing) may reflect different ethnic or social groups. Arguments over ethnicity in the Tonto Basin were addressed at the beginning of this chapter. Ethnic distinctions based on macroscopic temper differences (e.g., the Verde/Tonto distinctions) remain unconvincing to us. We do not, however, exclude the possibility that distinct cultural groups, with differing subsistence adaptations and ceramic morphological traditions, may have entered and used the Upper Tonto Basin during the Gila Butte and Sacaton phases and the early Classic period. We return to this point in our concluding section.

Changing patterns of resource utilization and resultant changes in vessel function. Site patterning alone during the Sacaton phase, in relation to the Gila Butte phase and the early Classic period, indicates that the project area was used differently through time. Ciolek-Torrello (1987:38) notes that the Sacaton phase "remains one of the least understood of the post-Archaic occupations" in the Tonto Basin. The presence of small, ephemeral, Sacaton phase sites in the project area with low artifact densities suggests that Sacaton phase land use during this time may have differed from the preceding and succeeding phases. Ciolek-Torrello (1987:38) goes so far as to suggest a "reversion to the seasonal exploitation of wild foods" during this time. It is possible that the sample is incomplete and that the full range of Sacaton phase sites awaits discovery in other portions of the Tonto Basin. Note that the dating of the Rooted site (AZ O:15:92), likely a Preclassic period pithouse village that was destroyed through root-plowing, is unknown but may contain some Sacaton phase components. To date, however, most Sacaton sites mitigated during this.project (and other projects) are small and contain less than three structures. As a result, our plainware data, discussed more fully below, are based on small sample sizes. The data are at least suggestive of differing patterns through time, although this patterning may simply reflect differences in site type rather than overall differences in settlement and subsistence.

Table 13.7. Shape and vessel form data from plainware rim sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Shape	Bowls	Jars	Flare-Rim (Shape Indet.)	Bowls	Jars	Flare-Rim (Shape Indet.)	Bowls	Jars	Flare-Rim (Shape Indet.)
Totals	84 (55.3)	49 (32.2)	11 (7.2)	107 (68.6)	39 (25.0)	3 (1.9)	58 (33.1)	88 (50.3)	13 (7.4)
Bowl Vessel Form									
Hemispherical	38 (45.2)			38 (35.5)			8 (13.8)		
Incurved	12 (14.3)			8 (7.5)			6 (10.3)		
Outcurved	7 (8.3)			8 (7.5)			4 (6.9)		
Plate/platter	2 (2.4)			8 (7.5)			3 (5.2)		
Semiflare-rim, hemispherical	0 (0.0)			0 (0.0)			3 (5.2)		
Semiflare-rim, incurved	0 (0.0)			0 (0.0)			2 (3.5)		
Semiflare-rim, outcurved	0 (0.0)			1 (.93)			8 (13.8)		
Other	1 (1.1)			0 (0.0)			1 (1.7)		
Indeterminate bowl	24 (28.6)			44 (41.1)			23 (39.6)		
Jar Vessel Form									
Short flare-rim		15 (30.6)			3 (7.7)			14 (15.9)	
Short straight collar		14 (28.6)			13 (33.3)			27 (30.7)	
Short incurved straight collar		5 (10.2)			3 (7.7)			0 (0.0)	
Flare-rim indet.		4 (8.2)			0 (0.0)			8 (9.1)	
Seed jar		3 (6.1)			4 (10.3)			0 (0.0)	
Tall flare-rim		1 (2.0)			2 (5.1)			20 (22.7)	
Tall straight collar		1 (2.0)			4 (10.3)			6 (6.8)	
Neckless jar		0 (0.0)			4 (10.3)			1 (1.1)	
Indeterminate jar		6 (12.2)			6 (15.4)			12 (13.6)	

Pottery function has now become an important issue in ceramic studies (e.g., Hally 1986). Identifying vessel function across site types provides one key for estimating site duration (e.g., Schiffer 1975), site population (e.g., Kohler 1978), and subsistence practices (e.g., Braun 1983). Earlier research indicates that pottery function studies can successfully link vessel forms to vessel uses (e.g., Braun 1980; Lindauer 1989). Ceramic studies with Los Muertos materials (Crown 1983; Haury 1945), at La Ciudad (Stark and Heller 1987), and in Star Valley (Lindauer 1989) have addressed some of these issues. This project's analysis of ceramic assemblages, with respect to site function, is discussed in a later section.

Changes in the organization of production. Changing patterns of vessel form may be related to shifts in the organization of ceramic production. Rooted in Pueblo ethnographic analogy, archaeologists traditionally assume that prehistoric potters made and used utility ceramics on a household basis across culture areas for an extended period of time (e.g., Longacre 1970; Hill 1970). The archaeological record of the Tonto Basin exhibits profound changes with the advent of the Classic period (Doyel and Haury 1976; Hohmann and Kelly 1988; Rice et al. 1985; Wood 1986). If organizational restructuring is indeed reflected in Classic period site assemblages, then it is possible that ceramic production and distribution strategies shifted in response to changing organizational strategies. The notion of ceramic specialization in the Tonto Basin has been suggested by Hohmann and Kelley (1988) and is currently under evaluation by Arizona State University's Platform Mound Study (Simon and Redman 1990; but see Elson 1991b). The ethnographic record suggests that organizational changes in plainware production could entail community-based specialization in ceramic production and even in the production of particular vessel forms. These possibilities are explored in more detail in the concluding section of this chapter.

Technological Aspects of the Assemblage

A central focus of our study was to systematically document technological change in the utilitarian ceramic assemblage. This focus is important for seriating ceramic assemblages that lack diagnostic decorated ceramics and for evaluating technologically based arguments about cultural affiliation in the Tonto Basin. Previous plainware analysis identified a number of technological trends through time in the Tonto Basin. Technological expertise appears to increase from the Preclassic to the Classic period, and ceramic technology diversifies (O'Brien et al. 1985). At the ware level, the redware tradition is introduced in the Classic period, but researchers have also noted growing sophistication in individual attributes inherent in the "redware" technology, including smudging, surface treatment and firing technique. The plainware/redware analysis explored these changes at the attribute level, making attempts to distinguish morphological (e.g., rim shape) from technological (e.g., surface treatment, firing practices) characteristics. The following sections address technological aspects of the plainware assemblage in relation to temporal change.

Temper analysis was conducted simultaneously on plainwares and redwares. Accordingly, a detailed discussion of the results is presented immediately after the results of the redware analysis are discussed. In that analysis, basic patterns in the temper data with respect to production locale are given and relationships between temper data and other attributes are explored.

Variability in Vessel Rim Construction

Three variables were recorded that evaluate variability in plainware rim construction: rim shape, rim consistency and rim evenness. We hoped that an analysis of these variables would shed light on technological patterning by vessel form and on the level of technological expertise within and across wares through time. Also, future studies may use aspects of rim construction to help identify localized potting groups within a particular source area.

Within the plainwares, one of three rim shapes was observed on the majority of rim sherds: squared, rounded or tapered shapes (Figure 13.3). In Table 13.3, rim shape appears closely related to vessel form. Bowls are consistently and most strongly associated with squared rim shapes in all three phases, and the majority of nonsquared bowl rims are rounded. That the bowl rim shape pattern is consistent across time suggests manufacturing-related constraints on bowl rim shapes. This is not the case, however, in the plainware jars, where most of the early (Gila Butte) jar rims are rounded but jar rims in subsequent phases tend to be squared. Although rim form designations used in the ceramic analysis differs slightly from other studies, it is perhaps instructive to note that researchers on the Ash Creek Project observed that "straight-walled, slightly rounded to flat" rim forms predominated their plainware assemblage for both Hohokam (i.e., Preclassic) and Salado (i.e., Classic) period sites (O'Brien et al. 1985:343). It would seem that the Rye Creek assemblage rim shapes are similar in form to those of the Ash Creek ceramics.

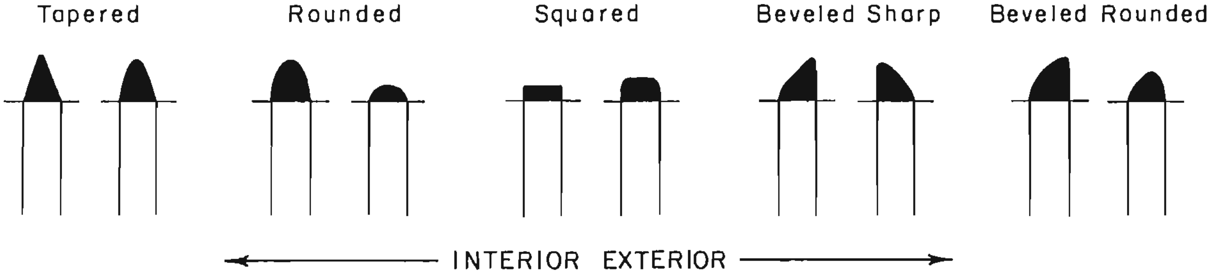

Figure 13.3. Rim shapes recorded in the RCM plainware-redware rim sherd and restorable vessel assemblage.

Two variables, rim consistency and rim evenness, were devised as potential measures of technological expertise. Both of these variables suffer from subjectivity, because they were devised for this project to evaluate their potential. Rim consistency proved a weaker index than did rim evenness, because most bowl and jar rims were consistent throughout the three phases. It is perhaps useful to note, at a general level, that the percentage of consistent rims across vessel forms gradually increases through time. Overall, plainware rims became more even through time. By the early Classic period, plainware bowl rims tend to be more even than jar rims. The rim evenness variable appeared to be a stronger indicator of technological expertise than was the rim consistency variable. Future research might incorporate metrically derived measures of rim evenness which, albeit more labor-intensive, might also be more easily replicated by multiple analysts.

The two most common rim shapes (squared and rounded) were cross-tabulated with rim evenness to ascertain whether a certain rim shape produced uniform results. No general association was found between rim evenness and rim shape in the range of phases represented (i.e., Gila Butte, Sacaton and early Classic period). The two variables are related among Gila Butte plainware bowls (x^2=3.953, 1 df, p=.047). The association did not hold for plainware bowls produced during the two subsequent phases.

Variability in Firing and Surface Treatment

Plainware technological variability also can be assessed by examining aspects of firing and surface treatment. Six variables were considered: fire clouding, carbon cores, interior and exterior surface treatment, surface treatment pattern, and smudging. Each of these variables reflects some aspect of the production technology, including manufacturing and firing stages.

Fire clouding, which causes color variation across vessel surfaces, results from differential access to oxygen during the firing process (Rye 1981:120). The frequency of fire clouding was used as one index of technological finesse, because ethnoarchaeological research suggests that fire clouds result from firing accidents (e.g., Reina and Hill 1978:40 for Chinautla potters in Guatemala). We assumed that growing technological sophistication would be reflected in a decreased frequency of fire clouding through time. Given some knowledge of the range of pastes present in the assemblage, carbon cores provide information on the firing atmosphere and, indirectly, on the skill associated with firing. Surface treatment informs on the degree of labor investment in each vessel (using the "Production step measure" concept of Feinman et al. 1981). We hoped that data on surface treatment pattern would reveal the degree of manufacturing uniformity at different points in time. Smudging, as another potential measure of labor investment, occurs during or immediately after the firing process and can also be tracked through time. Each of these six variables are treated in turn.

Fire clouding. Table 13.8 presents data on fire clouding for the plainwares. Fire clouding as an attribute is problematic, because different firing techniques (e.g., open firing vs. pit firing, inverted vessel stacking vs. upright vessel stacking, the extent of the use of waster sherds) and the use of different types of fuel can affect the degree and location of fire clouding. Crown's (1983) research with Classic period redware vessels from Los Muertos, in identifying "deliberate" fire clouding (Crown 1984:125), points out a potential additional problem: distinguishing intentional fire clouding from accidental fire clouding. The concept of intentional fire clouding is foreign to ethnographic accounts of potters worldwide, who view fire clouds as firing mistakes and prefer unmarred vessel surfaces. The possibility that intentional fire clouding was practiced during the Tonto Basin's Classic occupation has not been eliminated, nor have such patterns yet been identified. In this analysis, we assume that the Phoenix and Tonto Basins were occupied by discrete Classic period populations who practiced separate (but in some respects parallel) ceramic technological traditions. For this reason, we feel justified in hypothesizing that fire clouding has an inverse relationship with manufacturing expertise in the Tonto Basin. Consequently, with an increasingly sophisticated technology one might see a reduction in the frequency of fire clouding. Patterning in the fire cloud variable in Table 13.3 does indicate that fire clouding decreases by 10 percent in the overall assemblage between the Gila Butte phase and the early Classic period, although little significant distinctions can be seen by vessel form.

Across vessel shapes for the Gila Butte phase, fire clouds more often appeared on the interior and exterior surfaces (dual surface) than on a single surface, although fire clouds were much more likely to appear on the exterior of vessels than on the interior surface. Not surprisingly, this pattern was more pronounced among jars than among bowls, which had a slightly higher tendency for exterior (than for dual surface) fire clouding. The pattern changes in Sacaton phase plainwares, where vessels are almost three times more likely to have exterior fire clouding than dual surface patterning. This pattern may be a relic of the small sample size and the much higher number of bowls than jars in the Sacaton phase assemblage. Where sample sizes are more even in the early Classic period, the bias toward exterior fire clouding persists.

Carbon core. Core color reflects the presence or absence of a difference in firing conditions at the vessel's surface and at its wall's core (Rye 1981:119). Prehistoric pottery often contains organic materials that oxidize when reaching sufficiently high (i.e., above 600 degrees C) temperatures during the pottery firing process (Rice 1987:88). Numerous factors determine the length of time required to burn out organic materials in clay, such as firing temperature and time, amount of carbon in the material and so forth (Rice 1987). Incomplete oxidation of the clay leads to a visible band or "carbon core" that is observable in the middle of a sherd's cross section. Explaining why some sherds have carbon cores and some do not is most difficult, although Rye (1981:115) contends that carbon cores are indicators of the atmosphere and temperature of firing. Following

Rye, we hypothesized that observations of carbon cores in the plainwares would decrease through time as the overall technological expertise increased.

Serious problems were encountered during analysis of carbon core data. It proved difficult to distinguish a true carbon core from smudging that penetrated the sherd's surface from either the interior or exterior surface. The relationship between smudging and carbon cores was noted previously in contemporary Puebloan ceramics, in which "smudging penetrates the entire thickness of the wall, considerable carbon being deposited within the wall interior" (Rogers 1980:2). The extremely high percentage of plainware sherds classified "indeterminate carbon core" precluded a detailed analysis of this variable. The pattern, although from a small sample, tentatively suggests that carbon cores decrease through time. Definitive conclusions await future research on the relationship between smudging and carbon cores.

Table 13.8. Fire clouding data from plainware rim sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Location of Fire Clouding	Bowls	Jars	Total	Bowls	Jars	Total	Bowls	Jars	Total
Interior surface	3 (3.6)	6 (12.2)	9 (6.8)	10 (9.4)	5 (12.8)	15 (10.3)	5 (8.6)	6 (6.8)	11 (7.5)
Exterior surface	22 (26.2)	7 (14.3)	29 (21.8)	34 (31.8)	10 (25.6)	44 (30.1)	20 (34.5)	13 (14.8)	33 (22.6)
Interior and Exterior surface	20 (23.8)	14 (28.6)	34 (25.6)	13 (12.2)	4 (10.3)	17 (11.6)	5 (8.6)	13 (14.8)	18 (12.3)
Absent	30 (35.7)	21 (42.9)	51 (38.3)	34 (31.8)	14 (35.9)	48 (32.9)	26 (44.8)	46 (52.3)	72 (49.3)
Indeterminate	9 (10.7)	1 (2.0)	10 (7.5)	16 (14.9)	6 (15.4)	22 (15.1)	2 (3.5)	10 (11.4)	12 (8.2)
Totals	84	49	133	107	39	146	58	88	146

Surface treatment. The surface treatment variable primarily distinguished burnished surfaces from those that were smoothed, wiped, or scarred from paddle-and-anvil forming. Patterning in plainware surface treatment is presented in Table 13.3. Recent experimental research suggests that burnishing significantly increases a vessel wall's strength (Wallace 1989:37), although other research contradicts this view (Fournier 1989). Burnishing may also reduce vessel wall permeability or enhance heating effectiveness.

Previous research in the Tonto Basin indicates that temporal patterning exists in plainware surface treatments, most specifically at the level of slipping. In the plainwares, surface treatment appears to be a more robust index of ceramic technology than is fire clouding. Dichotomous categories (i.e., burnished/polished vs. unburnished/unpolished) can be readily identified and replicated. Moreover, surface treatment should not be affected by idiosyncrasies in firing behavior. Looking generally at the assemblage, the "redware" tradition in the Classic period ushers in a more labor-intensive ceramic technology. It is not clear what this increase in the number of "production step measures" (Feinman et al. 1981) represents, but it is clear that this technology transcends archaeological distinctions between slipped (i.e., red) and unslipped (i.e., plain) wares in the Classic period.

The intensity or labor investment in hand-wiping varied tremendously from rim sherd to rim sherd. Coarsely made vessels with perfunctory wiping often displayed ambiguous exterior surface patterns. Manufacture-related grooving from careless wiping or scraping produced parallel (and often multiple) grooves parallel to the rim. This type of grooving differs from intentional decorative grooving or postdepositional plow scarring, in that manufacture-related grooving leaves light (rather than deep) impressions. On some of the roughest exterior surfaces, this production-related grooving was still visible, leaving light impressions on the ceramic surface. In ambiguous cases, the presence of light grooving was used as an indicator of intact (although not perfectly smooth) surfaces where visible.

The strongest patterning for interior surface treatment intensification through time is visible in the bowls, where the percentage of burnished-polished rim sherds more than doubles from the Gila Butte to the Sacaton phase. Plainware jars exhibit a similar pattern that appears more dramatic in the rate of change, despite the expectation that jar interiors would exhibit less surface finishing than would bowl interiors. Less than half as many Gila Butte phase jars had interior burnishing, yet by the early Classic period equal proportions of plainware bowls and jars had burnished interior surfaces.

Table 13.9 presents an in-depth analysis of interior surface treatment for the plainware sample. There appears to be an inverse relationship between the proportion of wiped and polished/burnished vessels (across vessel forms) for each of the three phases. Hand-smoothed vessels also exhibit a decrease in representation from the Gila Butte phase to the early Classic period, with a gap in the Sacaton phase that may be a result of sample size problems. The percentage of anvil-impressed interior surfaces also decreases through time, while the proportion of sherds with indeterminate interior surface treatments remains somewhat stable, although slightly decreasing through time.

Table 13.9. Interior surface treatment data from plainware rim sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Type of Surface Treatment	Bowls	Jars	Total	Bowls	Jars	Total	Bowls	Jar	Total
Polished/Burnished	32 (38.1)	8 (16.3)	44 (28.9)	87 (81.3)	16 (41.0)	109 (69.9)	481 (82.8)	75 (85.2)	143 (97.9)
Wiped	44 (52.4)	33 (67.4)	90 (59.2)	14 (13.1)	19 (48.7)	36 (23.1)	4 (6.9)	10 (11.4)	22 (15.1)
Hand-Smoothed	3 (3.6)	4 (8.2)	7 (4.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.7)	1 (1.1)	3 (2.1)
Anvil-Impressed	1 (1.2)	3 (6.1)	5 (3.3)	2 (1.9)	3 (7.7)	5 (3.2)	0 (0.0)	1 (1.1)	1 (0.7)
Indeterminate	4 (4.8)	1 (2.0)	6 (4.0)	4 (3.7)	1 (2.0)	6 (3.9)	5 (8.6)	1 (1.1)	6 (3.4)
Totals	84	49	133	107	39	146	58	88	146

Note: Totals include all shapes (bowl, jar, flare-rim indeterminate, scoop, indeterminate shape).

Exterior surface treatment on plainware sherds is presented in Table 13.3 and in greater detail in Table 13.10. In the Gila Butte phase, percentages of exterior and interior surface treatments, by shape, are nearly identical. The proportion of exterior burnished-polished jars nearly quadruples from the Gila Butte to the Sacaton phase, diverging from the trends noted for interior surface treatment. Also mirroring the interior surface treatment trends, the percentage of plainware bowls displaying burnished exterior surfaces doubles from the Gila Butte to the Sacaton phase, and this trend continues into the early Classic period.

The overall assemblage at each point in time mirrors the relationships noted in Table 13.10 between polished/burnished surfaces and wiped surfaces. Hand-smoothing is somewhat less common as an exterior surface treatment, overall, than as an interior surface treatment. A smaller proportion of vessels show evidence of paddle impressions than of anvil impressions (noted in Table 13.10). This pattern may suggest a value placed on smooth exterior surfaces, which are more highly visible than are interior surfaces on at least some vessel forms. A slightly higher percentage of sherds were included in the "indeterminate exterior surface treatment" than were included in the same category for interior surface treatment.

Similar patterning was observed among the interior and exterior surface treatment variables in the plainwares. Where vessel interiors (below the rim) could be observed, burnishing was generally done on both the interior and exterior surfaces. Finishing attributes recorded on jars were restricted to the rim area, which may vary greatly from the body of the vessel, where anvil marks or wiping may characterize its interior. Consequently, the surface finish data obtained for plainware jars were uninformative. For plainware bowls, burnished interior and exterior treatments were associated in each phase. A significant relationship exists between burnished bowl interior and exterior surfaces in the Gila Butte (χ^2=12.351, 1 df, $p<.001$) and Sacaton (χ^2 =10.178, 1 df, p=.001) phases. Small sample size for early Classic period bowls precluded their analysis here. The strong association found between interior and exterior surface treatments for plainware jars in the Gila Butte (χ^2 = 9.374, df 1, p=.002) and Sacaton phases (χ^2 = 3.888, 1 df, p=.049) and the early Classic period (χ^2 = 6.980, 1 df, p=.008) may be less important. These relationships may simply indicate that interior jar rims were finished as part of the exterior burnishing process. That a similar relationship is found among redware bowls (χ^2 = 41.895, 1 df, $p<.001$) and redware jars (χ^2 = 16.148, 1 df, $p<.001$) in the early Classic suggests similarity in technology across plainwares and redwares.

Table 13.10. Exterior surface treatment data from plainware rim sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Type of Surface Treatment	Bowls	Jars	Total	Bowls	Jars	Total	Bowls	Jars	Total
Polished/Burnished	29 (34.5)	8 (16.3)	37 (27.8)	75 (70.1)	24 (61.5)	99 (67.8)	48 (82.8)	81 (92.1)	129 (88.4)
Wiped	43 (51.2)	38 (77.6)	81 (60.9)	26 (24.3)	14 (35.9)	40 (27.4)	4 (6.9)	6 (6.8)	10 (6.8)
Hand-Smoothed	3 (3.6)	1 (2.0)	4 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.7)	0 (0.0)	1 (0.7)
Paddle-Impressed	0 (0.0)	1 (2.0)	1 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Indeterminate	9 (10.7)	1 (2.0)	10 (7.5)	6 (5.6)	1 (2.6)	7 (4.8)	5 (8.6)	1 (1.1)	6 (4.1)
Totals	84	49	133	107	39	146	58	88	146

Surface treatment pattern. Surface treatment pattern is a variable employed in previous analyses to detect standardization of manufacture as well as temporally diagnostic pattern polishing (e.g., Crown 1983). Burnished surfaces often display striation patterns from the treatment process, whether or not these patterns are intended as decoration. True pattern polishing was not observed in the plainwares. The results of the surface treatment analysis of the plainware sherds, presented in Table 13.3, are of marginal interest. Excluding the indeterminate cases (which decrease by nearly 75 percent from the Gila Butte to the early Classic period), most sherds display signs of polishing/burnishing in patterns that parallel the rim on the interior and exterior surfaces. An exceedingly small proportion of the plainwares show evidence of burnishing parallel to the rim on the interior surface and perpendicular to the rim on the exterior surface.

Smudging. Smudging results from intentional reduction at the end of the firing process through smothering the fire with organic materials (e.g., dung, sawdust) to blacken one or both vessel surfaces (Rice 1987:109). The smudging process may be used for aesthetic or functional motivations (or both). Ethnographically, dual surface smudging produces black wares that are highly valued in both the Southwest (San Ildefonso) and in Mexico (van de Velde and van de Velde 1939). From a functional standpoint, smudging reduces permeability in vessel surfaces by sealing vessel pores:

> Liquids could be retained better, and bacteria would find it considerably more difficult to enter the surface that propagate within the wall of the vessel. . . . Culinary vessels that were repeatedly heated would not require a polished and/or smudged interior; however, fungal attack on seeds is a recognized problem, and heavily smudged interiors could have been useful in vessels designed for seed storage (Rogers 1980:4).

Rye (1981:26) notes that a variety of organic materials have been utilized as sealants worldwide, including liquids, resins, gums and pitches. Ethnographically, surfaces are often smudged or otherwise sealed to facilitate liquid storage, to enhance cooling effectiveness, or to create a watertight storage environment that renders its contents resistant to decomposition. Among the Kalinga of northern Luzon, for example, the interior surfaces of newly fired cooking vessels are coated with resin to reduce permeability during cooking (Longacre 1981).

Previous research in the Tonto Basin by Wood (1987:7) demonstrates that smudging grows increasingly common in the Alameda Plainwares through time. The plainware analysis confirms this earlier observation, as illustrated in Table 13.3. More bowls are consistently smudged through time than are jars, as the proportion of smudged bowls triples from the Gila Butte phase to the early Classic period. Jars undergo an even more striking change, with a ninefold increase in the percentage of smudged vessels from the early to late phases.

Patterns of smudging vary somewhat, as illustrated in Table 13.11. Although the majority of smudging occurs on the interior surfaces of vessels throughout the sequence, the proportion of vessels that are smudged on both surfaces fluctuates through time. A noteworthy trend among interior smudged vessels (both bowls and jars) lies in the increase of rims that exhibit interior smudging extending to just below the rim on the exterior surface. A similar pattern was noted by Wheat (1954) at Crooked Ridge Village (contemporary with the Gila Butte phase Deer Creek site). Wheat (1954:99) attributes this patterning to firing in an inverted position over a fuel producing abundant carbon. Additionally, five times as many sherds were noted in the early Classic period with this smudging pattern as had been observed during the Gila Butte phase. Reasons why smudging increases through time in the Tonto Basin and elsewhere remain to be explored, and this technological attribute appears to crosscut wares; this is discussed in the concluding section of this chapter.

Table 13.11. Smudging data from plainware rim sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Location of Smudging	Bowls	Jars	Total	Bowls	Jars	Total	Bowls	Jars	Total
Interior Smudging only	14 (16.7)	4 (8.2)	18 (13.5)	42 (39.3)	11 (28.2)	53 (36.3)	28 (48.3)	59 (67.0)	87 (59.6)
Interior Smudging extends to exterior	3 (3.6)	0 (0.0)	3 (2.3)	5 (4.7)	4 (10.3)	9 (6.2)	8 (13.8)	9 (10.2)	17 (11.6)
Smudging on exterior and interior	1 (1.2)	0 (0.0)	1 (0.8)	8 (7.5)	2 (5.1)	10 (6.8)	1 (1.7)	0 (0.0)	1 (0.7)
Smudging Absent	59 (70.2)	42 (85.7)	101 (75.9)	41 (38.3)	20 (51.3)	61 (41.8)	18 (31.0)	18 (20.5)	36 (24.7)
Indeterminate	7 (8.3)	3 (6.1)	10 (7.5)	11 (10.3)	2 (5.1)	13 (8.9)	3 (5.2)	2 (2.3)	5 (3.4)
Totals	84	49	133	107	39	146	58	88	146

Based on exploratory analysis with the technological variables, we hypothesized that some, if not all, of the variables were related to one another. In other words, as the labor invested in surface treatment (i.e., burnishing) increased over time, so too did the care in constructing even rims or smudging vessel interiors. Several bivariate analyses were performed to explore the interrelatedness of these variables by vessel form and through time. The relationship between consistent rims and burnished interiors was approached first. Across the entire plainware assemblage, the two variables were associated for the three phases combined ($x^2 = 6.493$, 1 *df*, p=.011). Substantial changes were noted from the Gila Butte phase to the early Classic period. This relationship was clearly expressed among the plainware bowls for the three phases combined ($x^2 = 5.921$, 1 *df*, p=.015), whereas no association was found within the plainware jars. Among plainware bowls, no association was found between these variables in the Gila Butte phase ($x^2 = 0.011$, 1 *df*, p=.918) but in the early Classic period burnished interiors and consistent rims are positively associated ($x^2 = 4.523$, 1 *df*, p=.033). Consistent rims and burnished exterior surfaces were only found to be associated in the plainware bowls for the early Classic period ($x^2 = 6.280$, 1 *df*, p=.012).

Experimental research by Rogers (1980) suggests that smudging is most effective when accompanied by polishing or burnishing. Moreover, smudging and burnishing independently increase through time in the sample. Accordingly, the relationship between smudging and surface treatment was examined by shape and location of burnish. Despite problems outlined previously with understanding jars' interior surface finish, both bowls and jars were examined. Although a significant relationship exists between the presence of smudging (almost exclusively on the vessel's interior) and interior burnishing for the entire plainware bowl assemblage ($x^2 = 25.739$, 1 *df*, $p<.001$), phase-by-phase analysis reveals that the association is only significant for the Gila Butte phase ($x^2 = 10.536$, 1 *df*, p=.001). It may be important that the Gila Butte plainware sample contains the highest percentage of "locally" produced ceramics (this pattern is discussed in a following section on ceramic resource characterization). No relationship exists between the two attributes for Sacaton phase and early Classic period plainware bowls. A similar pattern occurs in the plainware jars. Across phases, all smudging and burnished interiors are associated ($x^2 = 34.695$, 1 *df*, $p<.001$). Why this is the case is not entirely clear, although small sample size for early Classic plainware bowls may affect the patterning. Regarding exterior surface treatment, smudging and burnishing are also associated for the bowls across phases ($x^2 = 33.842$, 1 *df*, $p<.001$) as well as for the plainware jars ($x^2 = 24.427$, 1 *df*, $p<.001$).

The relationship between smudging and fire clouding was also evaluated, since smudging increases and fire clouding decreases through time. Cross-tabulation of fire clouding and smudging across all plainwares (regardless of time) indicated a significant association ($x^2 = 14.821$, 1 *df*, $p<.001$). When examined by phase, only early Classic plainwares exhibited a strong relationship between smudging and fireclouding ($x^2 = 26.792$, 1 *df*, $p<.001$; Yule's Q=-.7619). This patterning also was evident at the shape level of analysis, where the two variables were associated in both bowls ($x^2 = 4.488$, 1 *df*, p=.034) and jars ($x^2 = 9.649$, 1 *df*, p=.002) during the early Classic period.

That these changes in firing technology and surface treatment are technological (rather than functional or site-specific) in nature is suggested by the monotonic increase from one phase to the next of both interior and exterior surface treatments. Some attributes, as well as particular vessel forms, fluctuate during the Sacaton phase, ostensibly because Sacaton phase sites within the project area are small and likely more functionally specific. Yet the proportion of rims with burnished-polished interior and exterior surfaces increases through time, regardless of site type. Another notable observation is that plainware technology changes in the same direction as the later redware technology, which is at least suggestive of a single technological tradition with both slipped and unslipped variants. This point is discussed in more detail in conjunction with multidimensional scaling techniques described in the seriation section of this chapter.

REDWARES

Attribute Analysis of Redware Ceramics

The ceramic analysis identified as redwares all sherds that exhibited evidence of a slip on one or both of the sherd's surfaces. Simon and Burton (1989:312) described this form of slip as "an iron oxide, or hematite, rich slip that was added as an extra layer to the vessel surface." Recent research by Elson and Gunderson (Chapter 22, this volume) indicates that argillite, a locally available material, may also have been used as a slip in ceramic production.

Virtually all of the redwares analyzed from the Rye Creek assemblage were not corrugated. Salado Red corrugated sherds were an infinitesimal component of the redware assemblage. A total of four Salado Red corrugated sherds were identified during the analysis, and these sherds came from sites AZ O:15:1 (N=2), AZ O:15:55(N=1), and AZ O:15:100 (N=1). We believe that the low proportion of Salado Red corrugated sherds in the analyzed sample grossly reflects the representation of Salado Red corrugated sherds in the entire excavated ceramic assemblage.

Many ceramic analyses in the Phoenix and Tonto Basins have discussed difficulties in distinguishing between redwares and plainwares in their assemblages (e.g., Abbott 1983:34-39, 1988; Doyel 1974; Heacock and Callahan 1988). One problem associated with assigning sherds to one or the other category lies in the arena of floated "self-slipped" sherds; intensive burnishing can produce a distinct, slip-like appearance on the sherd's surface that is the same color as the vessel fabric. In addition, some red-slipped sherds are thoroughly oxidized through the firing process and their surfaces are identical in hue to their interior fabric (Abbott 1988:22). The "redware" category as used in this analysis refers exclusively to sherds that display clear evidence of a red slip or wash, seen as a visible color break between the core and the surface, that is visible under a low-powered microscope. Those sherds that appeared self-slipped were assigned to the plainware category. Sherds that appeared slipped but lacked a red hue were classified as "indeterminate plainware/redware" and constitute a minority of the assemblage (18 sherds, or 2 percent of the analyzed sample). Because our analysis distinguishes redwares from plainwares, these "indeterminate" sherds were excluded from in-depth analysis.

Redware analysis began by recording 30 attributes and provenience information for all redware rims and reconstructible (including partially reconstructible) vessels recovered from Class 1-2 contexts that were identified during the contextual assessment discussed in a previous section of this chapter (also refer to Table 13.2 for list of deposits). Selected redware rim sherds from Class 3 deposits, as well as body sherds from Class 1, 2 and 3 deposits from Preclassic sites, were added to the analysis to examine the evidence for early redwares in the Tonto Basin. A series of questions was addressed using the redwares that examined temporal, functional and technological aspects of the ceramic assemblage.

Variables in Redware Analysis

Most variables recorded during the plainware analysis were also included in the redware analysis. Some modifications were made for surface treatment variables to accommodate higher degrees of polishing found on the redwares than were previously observed on the plainwares. Several slip-related variables were added to the redware analysis as well, to evaluate technological and stylistic variability in the slipped wares.

Identical to the plainware analysis, the analysis began by assigning individual observation numbers to each separate (i.e., nonconjoining) rim sherd. In those cases in which a number of sherds from different strata, levels, or bags within the same feature conjoined, a single number was given, based on the provenience from which the largest sherd originated.

Both nominal and continuous attributes (Read 1974:216) were employed in the redware rim analysis. Twenty-five nominal attributes and five continuous attributes were recorded for each redware rim sherd observation. Only those attributes that were modified for the redware analysis are discussed below. Refer to the previous section on the plainware analysis for descriptions of attributes that were recorded for both wares. The attributes recorded for redware sherds are:

1. *Sherd size* (SIZE). See plainware rim attribute.

2. *Rim Exterior Abrasion* (ABRASION). See plainware rim attribute.

3. *Ceramic Type* (CERTYPE). Each observation was recorded as belonging to one of several redware categories. Since plainwares and redwares were analyzed separately, the various categories used in this attribute class were: 1) generic redware, or 2) Salado redware.

4. *Vessel Part* (VESPART). See plainware rim attribute.

5. *Vessel Shape* (SHAPE). See plainware rim attribute.

6. *Vessel Form* (VESFORM). See plainware rim attribute.

7. *Rim Length* (RIMLENG). See plainware rim attribute.

8. *Rim Shape* (RIMSHAPE). See plainware rim attribute.

9. *Rim End Consistency* (RIMCON). See plainware rim attribute.

10. *Sherd Rim Evenness* (RIMEVEN). See plainware rim attribute.

11. *Fire Cloud* (FIRE). See plainware rim attribute.

12. *Interior Surface Treatment* (INTSURF). Slight modifications were made on the interior surface treatment attribute recorded for plainwares during the redware analysis. These changes were made to accommodate slipped and polished surfaces that characterize the majority of the redware sherds analyzed. Each observation's interior surface was recorded as having one of the six following characteristics: 1) high polish; 2) medium polish; 3) light polish; 4) wiped (i.e., no polish); 5) hand-smoothed; or 6) anvil-impressed. Damaged or highly eroded interiors (including basal body sherds for parts of the analysis) were recorded as "indeterminate." Following Heidke (1990:66), high polish observations displayed smooth, highly lustrous surfaces that lacked polishing facets. Medium polish observations exhibited lustrous surfaces but also had visible polishing facets. Light polish observations displayed a matte to lustrous surface and polishing facets. Wiped observations exhibited smooth, matte surfaces and shallow surface scoring. Observations recorded as "anvil-impressed" resembled "wiped" observations but additionally showed impressions from the anvil used to shape the vessel during paddle and anvil finishing. Regarding jar interior surfaces, refer to the plainware attributes for an important methodological note.

13. *Exterior Surface Treatment* (EXTSURF). See "Interior Surface Treatment" above.

14. *Surface Treatment Pattern* (PATTERN). See plainware rim attribute.

15. *Smudging* (SMUDGE). See plainware rim attribute.

16. *Worked Sherd* (WORKED). See plainware rim attribute.

17. *Evidence of Burning* (BURNING). See plainware rim attribute.

18. *Slip Location* (SLIP). Each observation was recorded as being slipped in one of six ways: 1) on the interior only; 2) on the interior and rim; 3) on the interior and rim with an exterior band; 4) as a full slip (covering the interior, rim and exterior surfaces of the sherd); 5) on the exterior and rim; or 6) on the exterior only.

19. *Slip Depth* (DEPTH). Each observation was recorded as displaying either a thick or thin slip, or slip depth "indeterminate." A slip was recorded as thick if a visible layer of pigment was noted in cross section. A slip was recorded as thin if a distinct color difference was discernible between the paste and surface; "thin" slips were generally observable only through the use of a binocular microscope. In some cases, temper grains were visible through "thin" slips. Depth "indeterminate" included all observations that exhibited highly eroded surfaces or extremely fugitive slips.

20. *Fugitive Slip* (FUGIT). The slip on each observation was evaluated regarding the fugitive nature of the slip, and was placed into one of four categories: 1) extremely fugitive; 2) mildly fugitive; 3) not fugitive; and 4) indeterminate. An extremely fugitive slip readily wipes off with a wetted finger (see Wallace 1986b:72), leaving a deep slip-covered stain on a paper towel. A mildly fugitive slip leaves a faint blotch on a paper

towel. Observations recorded as "not fugitive" left no discoloration on the paper towel. Those sherds having damaged, abraded or eroded surfaces were classified as indeterminate for this variable.

Three variables were recorded for each observation in order to characterize the technological attribute "temper." Determinations regarding these attributes were accomplished by examining a fresh break in the sherd using an incident-light binocular microscope.

21. *Temper Source Generic* (TSG). See plainware rim attribute.

22. *Temper Source Specific* (TSS). See plainware rim attribute.

23. *Temper Type* (TT). See plainware rim attribute.

24. *Carbon Streak* (CARBON). See plainware rim attribute.

25. *Micaceous Surface* (MICASURF). See plainware rim attribute.

Five continuous attributes were recorded for each observation on redware rim sherds. They are:

26. *Orifice Diameter* [cm.] (ORIFDIA). See plainware rim attribute.

27. *Aperture Diameter* [cm.] (APETDIA). See plainware rim attribute.

28. *Jar Rim Height* (HEIGHT). See plainware rim attribute.

29. *Upper body profile slope* (ANGLE). See plainware rim attribute.

30. *Vessel Wall Thickness* (BODTHICK). See plainware rim attribute.

Continuous attributes are discussed in a following section that examines combined metric data from the plainware and redware rims in relation to one another.

RESULTS OF THE REDWARE ANALYSIS

Univariate results of the redware analysis are discussed by attributes that were presented in the previous section. Unlike the plainwares, where temporal change can be explored from three phases, substantial numbers of redware first appear during the Sacaton phase and are strongest in the early Classic period. Data were collected from sherds that appeared in "Gila Butte" phase contexts at the Deer Creek site (AZ O:15:52). However, poor contextual integrity characterizes the deposits from which "Gila Butte" phase redwares were recovered. The dating of these potentially early redwares is discussed at the end of this section. Change through time is better addressed through use of the plainware data than through the redwares, although some changes may be observed.

Where patterning in particular redware attributes mirrors that of the plainwares, the redware discussion is abbreviated to avoid redundancy with the results of the plainware analysis. Selected bivariate relationships are also examined in the following section. An analysis of combined plainware/redware data follows the results of the redware analysis and places both wares into a broader technological tradition. Table 13.12 presents redware nominal attribute data that (in large part) parallel the plainware information presented in Table 13.3. Each attribute is be discussed below.

Additionally, and unlike the plainwares, several redware sherds smaller than 5.0 cm^2 were included in the analysis as potentially early redwares. As illustrated in Table 13.4, redwares on the average tended to be slightly smaller than the plainwares. Within the redwares, sherd size increases slightly over time, and this pattern reflects, in part, the presence of more restorable vessels in the early Classic period than in preceding phases. More restorable redware bowls than jars were recovered during the Rye Creek Project.

Exterior Surface Abrasion

Rim exterior abrasion was more common among redware sherds than among plainware sherds, a pattern that ran counter to our initial assumptions about the ability of redware surface treatment to resist abrasion. During the early Classic period, for example, abraded redware rims are five times as common as abraded plainware rims. For both the Sacaton phase and early Classic period, redware rims have a greater tendency toward abrasion than do plainware rims. Why this is the case is not entirely clear. No association was found between the thickness of the slip and abraded surfaces. Since the majority of early Classic redwares were classified as bowls, perhaps redware bowls were used differently than plainware bowls and jars. Redware bowls were recorded in higher frequency than were redware jars. It is possible that the abrasion patterns recorded in the redwares result from different vessel uses and represent use alteration traces, rather than artifact movement traces.

Vessel Shape and Vessel Form

Table 13.13 presents information on redware vessel shapes and forms from the Sacaton phase and early Classic period, although the exceptionally small size of the Sacaton phase sample precludes discussion of the patterning in any detail. During the early Classic period, redware bowls are more than twice as common as redware jars.

Almost one-third of the early Classic redware bowls were indeterminate in form, but eight bowl forms also were represented in the assemblage. Hemispherical and outcurved bowls each comprise approximately one-fourth of redware bowl sherds that were assignable to specific forms (25.6 percent and 24.0 percent, respectively). Semiflare-rimmed outcurved bowls, also found among the early Classic plainwares, make up almost one-fifth (19.2 percent) of the redware assemblage.

About 15 percent of the early Classic period redware jars could not be identified to jar form. Short straight-collared jars had the highest representation (38 percent) of the identifiable redware jars, while short, flare-rimmed and tall, flare-rimmed jars each contributed 16 percent to the assemblage. Indeterminate flare-rim jars comprised another 10 percent, making flare-rim jars the most common early Classic redware form (42 percent of the determinate forms).

Technological Aspects of the Assemblage

Variability in Vessel Rim Construction

The same three variables recorded to evaluate variability in plainware rim construction were used in the redware analysis: rim shape, rim consistency, and rim evenness. We hoped that analysis of the same variables in the redwares would illuminate aspects of technology within vessel forms and at the ware level through time. Variables related to redware rim construction are presented in Table 13.12. In the Sacaton phase and early Classic period, rounded and squared rim shapes crosscut vessel shape categories to some extent. Bowls tend

Table 13.12. Redware attribute data recorded from rim (and selected body) sherds from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Variable/Attribute	Bowls	Jars	Total[1]	Bowls	Jars	Total[1]	Bowls	Jars	Total[1]

Table 13.12. Continued.

Sherd Size									
<5cm^{2}	0 (0.0)	0 (0.0)	3 (13.6)	0 (0.0)	0 (0.0)	1 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)
5-16cm^{2}	2 (100.0)	1 (100.0)	17 (77.3)	7 (100.0)	0 (0.0)	50 (87.7)	97 (63.8)	35 (59.3)	148 (64.6)
16-49cm^{2}	0 (0.0)	0 (0.0)	2 (9.1)	0 (0.0)	1 (100.0)	5 (8.8)	43 (28.3)	20 (33.9)	65 (28.4)
49-100cm^{2}	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (3.3)	3 (5.1)	8 (3.5)
>100cm^{2}	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.8)	7 (4.6)	1 (1.7)	8 (3.5)
	2	1	22[2]	7	1	57	152	59	229[1]
Rim Exterior Abrasion									
Absent	1 (50.0)	1 (100.0)	8 (36.4)	2 (28.6)	1 (100.0)	19 (33.3)	91 (59.9)	38 (64.4)	136 (59.4)
Present	1 (50.0)	0 (0.0)	14 (63.6)	5 (71.4)	0 (0.0)	36 (63.2)	61 (40.1)	21 (35.6)	93 (40.6)
Indeterminate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.5)	0 (0.0)	0 (0.0)	0 (0.0)
	2	1	22	7	1	57[1]	152	59	229[2]
Rim Shape									
Squared	1 (50.0)	1 (100.0)	2 (50.0)	4 (57.1)	1 (100.0)	6 (66.7)	57 (41.9)	16 (30.2)	81 (39.7)
Rounded	1 (50.0)	0 (0.0)	2 (50.0)	3 (42.9)	0 (0.0)	3 (33.3)	66 (48.5)	34 (64.2)	106 (52.0)
Tapered	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (3.7)	0 (0.0)	5 (2.5)
Beveled	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (2.9)	0 (0.0)	4 (2.0)
Other/Misc.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (2.9)	3 (5.7)	8 (3.9)
Indeterminate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	2	1	4[2]	7	1	9[2]	136	53	204[2]
Rim Consistency									
Consistent	2 (100.0)	1 (100.0)	4 (18.2)	7 (100.0)	1 (100.0)	9 (15.8)	136 (89.5)	53 (89.8)	204 (89.1)
Inconsistent	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.5)	12 (7.9)	4 (6.8)	17 (7.4)
Indeterminate	0 (0.0)	0 (0.0)	18 (81.8)[1]	0 (0.0)	0 (0.0)	46 (80.7)[1]	4 (2.6)	2 (3.4)	8 (3.5)[1]
	2	1	22[2]	7	1	57[2]	152	59	229[2]
Rim Evenness									
Basically Even	0 (0.0)	0 (0.0)	0 (0.0)	2 (42.9)	0 (0.0)	3 (5.3)	74 (48.7)	31 (52.5)	110 (48.0)
Undulating	2 (100.0)	1 (100.0)	4 (18.2)	5 (71.4)	1 (100.0)	8 (14.0)	75 (49.3)	26 (44.1)	112 (48.9)
Indeterminate	0 (0.0)	0 (0.0)	18 (81.8)	0 (0.0)	0 (0.0)	46 (80.7)	3 (1.9)	2 (3.4)	7 (3.1)
	2	1	22[2]	7	1	57[2]	152	59	229[2]
Fire Clouding									
Present	1 (50.0)	1 (100.0)	5 (22.7)	3 (42.9)	1 (100.0)	20 (35.1)	52 (34.2)	17 (28.8)	74 (32.3)
Absent	1 (50.0)	0 (0.0)	17 (77.3)	4 (57.1)	0 (0.0)	35 (61.4)	92 (60.5)	41 (69.5)	146 (63.8)
Indeterminate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.5)	8 (5.3)	1 (1.7)	9 (3.9)
	2	1	22[2]	7	1	57[2]	152	59	229[2]
Interior Surface Treatment									
Polished/Burnished	0 (0.0)	1 (100.0)	1 (4.6)	0 (0.0)	1 (100.0)	5 (8.8)	133 (87.5)	49 (83.1)	191 (83.4)
Wiped/Smoothed	2 (100.0)	0 (0.0)	19 (86.4)	7 (100.0)	0 (0.0)	45 (79.0)	10 (6.6)	7 (11.9)	21 (9.2)
Indeterminate	0 (0.0)	0 (0.0)	2 (9.1)	0 (0.0)	0 (0.0)	7 (12.3)	9 (5.9)	3 (5.1)	17 (7.4)
	2	1	22[2]	7	1	57[2]	152	59	229[2]
Exterior Surface Treatment									
Polished/Burnished	0 (0.0)	1 (100.0)	1 (4.6)	0 (0.0)	1 (100.0)	1 (1.8)	27 (17.8)	7 (11.9)	35 (15.3)
Wiped/Smoothed	1 (50.0)	0 (0.0)	18 (81.8)	7 (100.0)	0 (0.0)	48 (84.2)	111 (73.0)	48 (81.4)	172 (75.1)
Indeterminate	1 (50.0)	0 (0.0)	3 (13.6)	0 (0.0)	0 (0.0)	8 (14.0)	14 (9.2)	4 (6.8)	22 (9.6)
	2	1	22[2]	7	1	57[2]	152	59	229[2]
Smudging									
Smudged	0 (0.0)	1 (100.0)	18 (81.8)	6 (85.7)	1 (100.0)	52 (91.2)	136 (89.5)	52 (88.1)	201 (87.8)
Unsmudged	2 (100.0)	0 (0.0)	3 (13.6)	1 (14.3)	0 (0.0)	5 (8.8)	14 (9.2)	7 (11.9)	25 (10.9)
Indeterminate	0 (0.0)	0 (0.0)	1 (4.6)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.3)	0 (0.0)	3 (1.3)
	2	1	22[2]	7	1	57[2]	152	59	229[2]
Slip Location									
Interior only	0 (0.0)	0 (0.0)	0 (0.0)	1 (14.3)	0 (0.0)	3 (5.3)	1 (0.7)	0 (0.0)	1 (0.4)
Exterior only	1 (.50)	1 (100.0)	20 (90.9)	5 (71.4)	1 (100.0)	53 (93.0)	144 (94.7)	54 (91.5)	213 (93.0)
Interior and Exterior	1 (.50)	0 (0.0)	1 (4.6)	1 (14.3)	0 (0.0)	1 (1.8)	7 (4.6)	5 (8.5)	13 (5.7)
Indeterminate	0 (0.0)	0 (0.0)	1 (4.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.9)
	2	1	22[2]	7	1	57[2]	152	59	229[2]
Slip Depth									
Thick	0 (0.0)	1 (100.0)	8 (36.4)	2 (28.6)	0 (0.0)	20 (35.1)	60 (39.5)	24 (40.7)	92 (40.2)
Thin	2 (100.0)	0 (0.0)	13 (59.1)	5 (71.4)	1 (100.0)	32 (56.1)	87 (57.2)	32 (54.2)	127 (55.5)
Indeterminate	0 (0.0)	0 (0.0)	1 (4.6)	0 (0.0)	0 (0.0)	5 (8.8)	5 (3.3)	3 (5.1)	10 (4.4)
	2	1	22[2]	7	1	57[2]	152	59	229[2]

Table 13.12. Continued.

Fugitive Slip									
Fugitive	0 (0.0)	1 (100.0)	5 (22.7)	2 (28.6)	0 (0.0)	17 (29.8)	37 (24.3)	21 (35.6)	65 (28.4)
Not fugitive	2 (100.0)	0 (0.0)	10 (45.5)	5 (71.4)	0 (0.0)	18 (31.6)	76 (50.0)	28 (47.5)	113 (49.3)
Indeterminate	0 (0.0)	0 (0.0)	7 (31.8)	0 (0.0)	1 (100.0)	22 (38.6)	39 (25.7)	10 (16.9)	51 (22.3)
	2	1	22[2]	7	1	57[2]	152	59	229[1]

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[1] Includes indeterminate and indeterminate flare-rim forms.
[2] Includes redware body sherds.

to have squared or rounded rim shapes, and the predominant bowl rim shape fluctuates from one phase to the next. Early Classic redware jar rims tend to be rounded, in contrast to contemporary plainware jar rims, which are generally squared. Tapered and beveled rim shapes are only found among redware bowls.

Following the plainware technological analysis, variables of rim consistency and rim evenness were applied to the redware rims to measure technological expertise. As previously discussed, both of these variables rely on subjective (i.e., analyst-specific) judgments. Rim consistency was a slightly stronger variable in the redwares than it was among the plainwares, because the percentage of consistent rims increased by 11 percent from the Sacaton phase to the early Classic period. The frequency of even rims substantially increased from the Sacaton phase to the early Classic, during which time redware rims were slightly more even than plainware rims. No association was found between rim shape and rim evenness in the redwares at large. Among the plainwares, these two variables were related in Gila Butte phase bowls.

Variability in Firing and Surface Treatment

Paralleling the plainware analysis, redware technological variability was assessed by examining aspects of firing and surface treatment. Six variables considered in the plainware analysis also were used for the redwares: fire clouding and carbon cores, interior and exterior surface treatment, surface treatment pattern, and smudging (see the plainware analysis section for the rationale behind particular variables). Because redwares appear later in the phase sequence of the Tonto Basin, the objectives in examining redware technological variability differed somewhat from those outlined for the plainwares. Our first objective was simply to characterize the range of variability in the early Classic redwares, providing a foundation for future research that compares early and late Classic redwares. A second objective was to acquire baseline data on redware rims that could be compared with data from contemporary plainwares, as one test of our hypothesis for technological continuity across Tonto Basin plainwares and redwares. Distinctive redware attributes -- slipping, polishing and smudging -- all reflect increased labor investment over the plainwares that had previously dominated the assemblage. What the early Classic redwares look like, and how they compare with contemporary plainwares, are discussed in a following section. Each of the six technological variables are treated in turn.

Fire clouding. Fire clouding is a problematic attribute that not only reflects different firing techniques but also reflects different contact points of the vessel with firing materials. Yet patterns seen among the plainwares prompted an examination of fire clouding among early Classic redware rims. Overall, fire clouds were observed on almost one-third of the redwares, a slightly smaller frequency than that observed among the plainwares.

Table 13.14 presents a detailed analysis of the location of fire clouding in redware rim sherds in the assemblage. In general, fire clouding was more commonly observed on the exteriors of vessels, although the presence of interior smudging on the majority of redwares clearly affects the observed patterning. This pattern is most clearly expressed in the Sacaton phase but continues into the early Classic period. Fire clouding in the redwares was more pronounced among bowls than jars. As is the case with the plainwares, the pattern may in part reflect higher frequencies of bowls than jars in the early Classic period assemblage.

Carbon core. We hypothesized that observations of carbon cores in the early Classic period redwares (Table 13.14) would mirror patterning in the plainwares described in a previous section. Like the plainware analysis, the redware analysis encountered problems in distinguishing a carbon core from smudging that penetrated the sherd's surface from either the interior or exterior surface. The extremely high percentage of redware sherds classified "indeterminate carbon core" precluded a detailed analysis of this variable. The carbon core frequencies in redwares resemble the plainware patterning shown in Table 13.3. In the early Classic period, carbon cores were observed on remarkably few (2.6 percent) sherds for which determinations could be made.

Surface treatment. In the redware analysis, surface treatment primarily distinguished burnished or polished surfaces from those that were smoothed, wiped, or scarred from paddle-and-anvil forming. Redwares, unlike the plainwares, may exhibit a high degree of treatment in the form of a polish or luster across the vessel's surface. Redware rims displayed a slightly higher degree of surface treatment (both interior and exterior surfaces) than did the plainwares.

Over three-fourths of the analyzed redwares exhibited a polished or burnished interior (Table 13.14). Two-thirds (69.6 percent) of the redware sherds with burnished-polished surfaces were bowls in shape. Most redware jars also had burnished-polished interior surfaces as well. Table 13.15 presents the range of interior surface treatments observed in the redware sample. Combining rims and bodies for the Sacaton phase, less than half of the sample displays burnished or polished interior surfaces. By the early Classic period, however, the percentage of sherds with a burnished-polished interior surface nearly doubles, and twice as many jars have wiped interior surfaces as do redware bowls.

Patterns of exterior surface treatment among early Classic redwares strongly contrast with contemporary plainwares, in which interior and exterior surfaces become more burnished through time (Table 13.16). A minority of redware rims display exterior burnishing-polishing (15.3 percent overall). Slightly more bowls than jars have highly finished exterior surfaces, but the pattern as a whole looks much different than that of the plainwares. Among both early Classic period bowls and jars, for example, wiped surfaces constitute the most frequent category. As the exteriors of these vessels are also slipped, it is possible that the wiping and slipping process occurred together, but no association was found. Only 11.8 percent (Table 13.16) of early Classic bowl exteriors exhibited paddle impressions, suggesting that for redwares, a slipped exterior may be as important (or more so) than a polished-burnished exterior surface.

From a technological viewpoint, it seems reasonable to assume that surface finish represents a single technical step, whether it affects one or both surfaces. Patterning in the early Classic period redwares supports this assumption. Interior and exterior surface treatments (i.e., burnishing-polishing on one or both surfaces) are associated at the .001 level ($x^2=90.293$, 4 *df*) across vessel shapes. This association is also evident within that period's bowls ($x^2=74.108$, 4 *df*, $p<.001$) and within early Classic redware jars ($x^2=20.132$, 4 *df*, $p<.001$). The use of other surface finishing techniques (e.g., slipping, smudging) may have affected potters' decisions regarding whether to burnish one or both surfaces.

Relationship between rim consistency and surface treatment. Because significant associations were noted during the plainware analysis between technological attributes, several attributes were cross-tabulated for redware rim sherds in relation to surface treatment. The early Classic period provides the largest, and therefore most reliable, sample of redwares. No significant association was found between rim consistency and interior surface treatment. Rim consistency and exterior surface treatment are also not related in the aggregated (i.e., Sacaton phase and early Classic period) redware assemblage.

No association was found at the $p=.05$ level between rim evenness and interior or exterior surface treatment across the redwares for bowls and jars. Sacaton redwares contained insufficient sample sizes (at the shape level) for a meaningful comparison of rim evenness and interior surface treatment.

Table 13.13. Shape and vessel form data from redware rim sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte				Sacaton				Early Classic			
Shape[1]	Bowls	Jars	Flare-Rim (Shape Ind.)	Scoop	Bowls	Jars	Flare-Rim (Shape Ind.)	Scoop	Bowls	Jars	Flare-Rim (Shape Ind.)	Scoop
	2 (.66)	1 (.33)	0 (0.0)	0 (0.0)	7 (.78)	1 (.11)	1 (.11)	0 (0.0)	152 (69.7)	59 (27.1)	6 (2.8)	1 (.4)
<u>Bowl Vessel Form</u>												
Hemispherical	0 (0.0)				3 (42.9)				27 (17.8)			
Incurved	0 (0.0)				0 (0.0)				10 (6.6)			
Outcurved	1 (0.5)				0 (0.0)				25 (16.5)			
Plate/Platter	0 (0.0)				0 (0.0)				2 (1.3)			
Semi flare-rim, hemispherical	0 (0.0)				0 (0.0)				6 (4.0)			
Semi flare-rim incurved	0 (0.0)				0 (0.0)				13 (8.6)			
Semi flare-rim outcurved	0 (0.0)				0 (0.0)				20 (13.2)			
Other	0 (0.0)				1 (14.3)				1 (0.7)			
Indeterminate	1 (0.5)				3 (42.9)				48 (31.6)			
<u>Jar Vessel Form</u>												
Short flare-rim		0 (0.0)				0 (0.0)				8 (13.6)		
Short straight collar		1 (100.0)				0 (0.0)				19 (32.2)		
Short incurved straight collar		0 (0.0)				0 (0.0)				0 (0.0)		
Flare-rim indet.		0 (0.0)				0 (0.0)				5 (8.5)		
Seed jar		0 (0.0)				1 (100.0)				4 (6.8)		
Tall flare-rim		0 (0.0)				0 (0.0)				8 (13.6)		
Tall straight collar		0 (0.0)				0 (0.0)				3 (5.1)		
Neckless jar		0 (0.0)				0 (0.0)				0 (0.0)		
Other jar		0 (0.0)				0 (0.0)				3 (5.1)		
Indeterminate jar		0 (0.0)				0 (0.0)				9 (15.3)		
Body sherd (Shape ind.)		19				48				10		

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[1] Excludes indeterminates (majority are body sherds).

Table 13.14. Fire-clouding data from redware rim and body sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Location of Fire clouding	Bowls	Jars	Total	Bowls	Jars	Total	Bowls	Jars	Total
Interior surface	1 (50.0)	0 (0.0)	2 (9.1)	0 (0.0)	1 (100.0)	1 (1.8)	6 (60.5)	6 (10.2)	14 (6.1)
Exterior surface	0 (0.0)	1 (100.0)	3 (13.6)	3 (42.9)	0 (0.0)	18 (31.6)	34 (22.4)	6 (10.2)	43 (18.8)
Interior & Exterior surface	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.8)	12 (7.9)	5 (8.5)	17 (7.4)
Absent	1 (50.0)	0 (0.0)	17 (77.3)	4 (57.1)	0 (0.0)	35 (61.4)	92 (60.5)	41 (69.5)	146 (63.8)
Indeterminate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.5)	8 (5.3)	1 (1.7)	9 (3.9)
Totals	2	1	22	7	1	57	152	59	229

Note: Totals include body sherds of indeterminate shape.

Table 13.15. Interior surface treatment data from redware rim and body sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Type of Surface Treatment	Bowls	Jars	Total	Bowls	Jars	Total	Bowls	Jars	Total
Polished/Burnished	2 (100.0)	1 (0.0)	11 (50.0)	4 (57.1)	0 (0.0)	25 (43.9)	133 (87.5)	49 (83.1)	191 (83.4)
Wiped	0 (0.0)	0 (0.0)	9 (40.9)	3 (42.9)	0 (0.0)	25 (43.9)	8 (5.3)	6 (10.2)	16 (7.0)
Hand-Smoothed	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	1 (1.7)	4 (1.8)
Anvil-Impressed	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (5.2)	1 (0.7)	0 (0.0)	1 (0.4)
Indeterminate	0 (0.0)	0 (0.0)	2 (9.1)	0 (0.0)	0 (0.0)	4 (7.0)	9 (5.9)	3 (5.1)	17 (7.4)
Totals	2	1	22	7	1	57	152	59	229

Note: Totals include body sherds of indeterminate shape.

Surface treatment pattern. About two-thirds of the early Classic redwares exhibited surface treatment parallel to rim on both the interior and exterior surfaces (Table 13.12). In comparing the Sacaton phase sample with the early Classic sample, the percentage of "interior and exterior parallel" sherds more than doubled. This pattern may, in part, reflect differences in sample size. In addition, however, we may be observing an increasingly uniform technological tradition, across the plainwares and redwares, in the early Classic period. Little evidence was found in the redwares of formalized "pattern polishing," as seen in the Salt-Gila redwares during the Classic period (Crown 1983). Although both bowls and jars exhibit a small amount of variability in the type of surface treatment, no significant patterns emerge from the early Classic redwares regarding surface treatment.

Smudging. Smudging proved to be a more robust variable than was surface treatment pattern, as most of the redwares (almost equivalent percentages of bowls and jars) were smudged for both the Sacaton phase and early Classic period. Turning to Table 13.17 for a detailed analysis of smudging, most vessels exhibit interior smudging. About 86 percent of Sacaton phase bowls were interior smudged, and 89 percent of early Classic bowls were interior smudged. A similar percentage of early Classic redware jars were smudged on the interior. The category "interior smudging extends to exterior" was developed as a potential temporal indicator, although the cultural processes contributing to this particular patterning remain to be explored. In the redwares, the frequency of sherds in this category nearly doubles from the Sacaton phase to the early Classic period. Although no such pattern is noted among the plainwares, the combined frequency of this category changes from 6.9 percent (14 of 203) in the Sacaton phase to 14.7 percent (55 of 375) in the early Classic period. Future research in this area could utilize experimental techniques and collections analysis from areas outside the Tonto Basin to help unravel the factors that are responsible for this distinctive smudge pattern.

Table 13.16. Exterior surface treatment data from redware rim and body sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Type of Surface Treatment	Bowls	Jars	Total	Bowls	Jars	Total	Bowls	Jars	Total
Polished/Burnished	0 (0.0)	1 (100.0)	1 (4.6)	0 (0.0)	1 (100.0)	1 (1.8)	27 (17.8)	7 (11.9)	35 (15.3)
Wiped	0 (0.0)	0 (0.0)	5 (22.7)	2 (28.6)	0 (0.0)	12 (21.1)	65 (42.8)	21 (35.6)	94 (41.1)
Hand-smoothed	1 (50.0)	0 (0.0)	11 (50.0)	3 (42.9)	0 (0.0)	26 (45.6)	28 (18.4)	13 (22.0)	43 (18.8)
Paddle-Impressed	0 (0.0)	0 (0.0)	2 (9.1)	2 (28.6)	0 (0.0)	10 (17.5)	18 (11.8)	14 (23.7)	35 (15.3)
Indeterminate	1 (50.0)	0 (0.0)	3 (13.6)	0 (0.0)	0 (0.0)	8 (14.0)	14 (9.2)	4 (6.8)	22 (9.6)
Totals	2	1	22	7	1	57	152	59	229

Note: Totals include body sherds of indeterminate shape.

Relationship between fire clouding and smudging. No association at the p=.05 level was found between fire clouding and smudging in the redwares.

Relationship between surface treatment and smudging. Results of the plainware analysis identified relationships between types of surface treatment and smudging. Smudging and burnished interiors in the plainwares are associated across all three phases. In the redwares, however, no association was found between smudging and surface treatment.

Aspects of slip. Three variables related to slip were investigated in the redware analysis: slip location, thickness, and degree of fugitiveness. We hoped that exploring these attributes would provide preliminary information on Upper Tonto Basin redwares. The latter two variables were explored as a noninstrumental means of identifying variation in slip composition. Elson and Gundersen (Chapter 22, this volume) describe the results of argillite characterization studies, which suggest that argillite may have been used as a slip for some of the redware ceramics in the assemblage. Many factors may account for differences in slip depth and fugitiveness. Particular temper-paste combinations, different pigment sources or personal or community idiosyncrasies are all potential contributors to the slipping patterns observed in the redwares.

For both the Sacaton phase and early Classic period, most vessels (bowl and jars) were slipped only on their exterior surfaces (Table 13.18), although in the early Classic period a small proportion of vessels were slipped on both surfaces. On about one-third of the sherds with slipped exteriors, the slip covered the rim, while most

Table 13.17. Smudging data from redware rim and body sherd sample form Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Location of Smudging	Bowls	Jars	Total	Bowls	Jars	Total	Bowls	Jars	Total
Interior Smudging only	0 (0.0)	1 (100.0)	17 (77.3)	3 (42.9)	1 (100.0)	47 (82.4)	106 (69.7)	45 (76.3)	163 (71.2)
Interior Smudging extends to exterior	0 (0.0)	0 (0.0)	1 (4.5)	3 (42.9)	0 (0.0)	5 (8.8)	30 (19.7)	7 (11.9)	38 (16.6)
Smudging on exterior and interior	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Smudging absent	2 (100.0)	0 (0.0)	3 (13.6)	1 (14.3)	0 (0.0)	5 (8.8)	14 (9.2)	7 (11.9)	25 (10.9)
Indeterminate	0 (0.0)	0 (0.0)	1 (4.6)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.3)	0 (0.0)	3 (1.3)
Totals	2	1	22	7	1	57	152	59	229

Note: Totals include body sherds of indeterminate shape.

slipped exterior sherds did not display evidence of this pattern. Interior-slipped sherds were uncommon. Slip depth varied a great deal, but more than half of the Sacaton phase and early Classic period redwares exhibited thin slips. In Table 13.19, gradations in the degree of fugitiveness are provided (following the criteria listed in a previous section). The frequency of "extremely fugitive" slipped sherds decreases from the Sacaton phase to the early Classic period as the number of "not fugitive" slips increases. This patterning may reflect changing sources of redware production, in which different centers utilize different slipping techniques or different pigment sources.

The relationships between the three slip-related variables were next examined. We first hypothesized that the most fugitive slips might also be the thinnest, having lost most of the pigment from their surfaces, but no association was found between these two variables. It was then hypothesized that slip thickness or depth might be related to the location of the slip; perhaps exterior-slipped vessels had thinner slips. No association was found between slip depth and slip location. Finally, we examined the relationship between slip location and degree of fugitiveness. We felt that exterior-slipped vessels might have more "fugitive" slips as a result of use. Again, no association between the slip location and degree of fugitiveness was found at the $p=.05$ level. Compositional studies of slip materials -- in concert with temper sourcing and paste characterization -- are needed in future research to refine our understanding of Upper Tonto Basin redwares.

EVIDENCE FOR EARLY REDWARES IN THE UPPER TONTO BASIN

Earlier reconstructions of Preclassic settlement in the Tonto Basin that emphasize colonization models provide an additional incentive for evaluating the presence of early redwares in the Upper Tonto Basin. Located squarely in the midst of the "Northeastern Hohokam Periphery" (Wood and McAllister 1980), previous models view the RCM project area (specifically the Hardt Creek-Deer Creek-Rye Creek locality) as sparsely populated during the Pioneer and Colonial periods by Archaic-like populations (Wood and McAllister 1980:184). The presence of early redwares, if identified, provides one line of evidence for an indigenous Preclassic population in the Upper Basin, thereby challenging models of Hohokam-driven colonization of the area (e.g., Wood and McAllister 1980).

Recently established evidence for early redwares in the Tucson Basin (Bernard-Shaw 1989, 1990; Swartz 1991) and Phoenix Basin (Cable and Doyel 1985, 1987) prompted the search for early redwares in the Tonto Basin. In the Tucson Basin, Heidke's (1990) recent analysis suggests that a redware tradition was present prior to the

Table 13.18. Slip location data from redware rim and body sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

	Gila Butte			Sacaton			Early Classic		
Location of Slip	Bowls	Jars	Total	Bowls	Jars	Total	Bowls	Jars	Total
Interior surface only	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)	1 (0.4)
Interior surface and rim	0 (0.0)	0 (0.0)	0 (0.0)	1 (14.3)	0 (0.0)	3 (5.3)	0 (0.0)	0 (0.0)	0 (0.0)
Full slip	1 (50.0)	0 (0.0)	1 (4.6)	1 (14.3)	0 (0.0)	1 (1.8)	7 (4.6)	0 (0.0)	13 (5.7)
Exterior surface and rim	0 (0.0)	0 (0.0)	0 (0.0)	1 (14.3)	0 (0.0)	1 (1.8)	45 (29.6)	5 (8.5)	74 (32.3)
Exterior surface only	1 (50.0)	1 (100.0)	20 (90.9)	4 (57.1)	1 (100.0)	52 (91.2)	99 (65.1)	22 (37.3)	139 (60.7)
Other	0 (0.0)	0 (0.0)	1 (4.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	32 (54.2)	1 (0.4)
Indeterminate	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)	1 (0.4)
Total	2	1	22	7	1	57	152	59	229

Note: Totals include body sherds of indeterminate shape.

Table 13.19. Quality of slip on redware rim and body sherd sample from Gila Butte, Sacaton, and early Classic contexts. Column percentages are given in parentheses.

Degree of Fugitiveness	Gila Butte	Sacaton	Early Classic
Extremely fugitive	7 (31.8)	20 (35.1)	48 (21.0)
Mildly fugitive	5 (22.7)	17 (29.8)	65 (28.4)
Not fugitive	10 (45.4)	18 (31.6)	113 (49.3)
Indeterminate	0 (0.0)	2 (3.5)	3 (1.3)
Totals	22	57	229

Note: Totals include body sherds of indeterminate shape.

production of Rincon Red in the Sedentary period. Tortolita Red ceramics were recovered from the Lonetree site and more recently the Romero Ruin site. The Lonetree site produced radiocarbon dates with a two sigma weighted average intercept and maximum data range of A.D. 581 (644) 675 (1990:85). Disagreement exists within the Tonto Basin over dating of the earliest, locally produced redware. Haas (1971:47) reports that Ushklish redwares that grossly fit the definition of Mogollon redwares date to the late A.D. 600s or early 700s.

Previous research by Wood (1987) suggests the presence of a "post-Formative, pre-Classic" (Wood 1987:27) red-firing ware referred to as Tonto Red. As described by Wood (1987), Tonto Red varies widely in surface finish (from smoothing to a lustrous polish) and in color (from brick red to a dull gray, where fire clouds are present). The unifying features of Tonto Red appear to be its production within the Tonto Basin and its lack of patterned striations when such striations are present. All redwares in the RCM analysis, which by definition must exhibit evidence of a red slip or a wash, fall outside consideration as candidates for the Tonto Red category. However, we also classified a small number of sherds (N=18, or 2% of all sherds examined) as "indeterminate redware or plainware." A total of 18 sherds from six different sites fell into this category (AZ O:15:1, AZ O:15:54, AZ O:15:55, AZ O:15:71, AZ O:15:89, and AZ O:15:100). These sherds, reddish in color but lacking a visible slip, were evaluated as possible candidates for the Tonto Red category.

For various reasons that we will outline, we believe that none of these "indeterminate redware or plainware" sherds could be considered Tonto Red. One of the six sites listed above was assigned to a Preclassic phase (Sacaton): AZ O:15:100. Four "indeterminate red or plain" sherds from this site fall into the right time frame for Tonto Red. The sherds consist of a single body sherd (indeterminate vessel form), a smudged and burnished hemispherical bowl, a smudged and burnished incurved bowl, and a burnished tall, straight collar jar. All three sherds also exhibited fire clouds.

We feel secure in concluding that the RCM assemblage analyzed in this chapter does not exhibit evidence for a red-firing Preclassic Tonto Red ware. The cultural diversity that is the prehistoric Tonto Basin's hallmark cautions us against making generalizations regarding the presence of Preclassic red-firing pottery throughout the entire Basin. Indeed, its absence in the Upper Tonto Basin makes Tonto Red an even more intriguing topic, requiring detailed study in the future. Documentation of its spatial distribution and technological variety and re-firing experiments in future projects will help archaeologists refine our understanding of the earliest Tonto Basin redwares.

The evidence from the Rye Creek Project for early redwares in the Tonto Basin is equivocal. The presence of conflicting evidence from the technological and temper analyses suggests that the issue of early redwares warrants some consideration. Redwares were recovered from all the Preclassic sites on the project and their contexts assessed. A sample of rim sherds and body sherds was used to examine the evidence for Gila Butte phase redwares in the assemblage. Various dating techniques discussed elsewhere (Chapter 12) identified three mitigated sites as containing Gila Butte phase ceramics: AZ O:15:52, AZ O:15:90, and AZ O:15:100. Of these sites, only the Deer Creek site (AZ O:15:52) was classified as containing a Gila Butte phase occupation. The rest of the sites were occupied primarily during the Sacaton phase.

Twenty-two redware sherds were recovered from the Deer Creek site (refer to Table 13.20). Most of these were body sherds recovered from sheet-trash contexts, catalogued as Stratum 9. No redware rim or body sherds were recovered from Class 1 contexts. The low contextual integrity of the redware-bearing deposits precludes a typological phase assignment for the redwares. Four redware sherds were collected from the surface, a single bowl rim sherd was recovered from a pit feature, and all but one of the remaining redware sherds were recovered from upper pithouse fill deposits, some of which were contextually or temporally mixed. The occurrence of redwares in mixed contexts makes an early temporal placement suspect. Interestingly, a similar pattern was found at Ushklish: 66 percent (327) of the redwares recovered from Ushklish were from "grid" (surface collection) contexts, and most of the remaining redwares were from house fills (Haas 1971). On contextual grounds, the evidence for early redwares is weak, and Haas (1971:47) comments that the Ushklish redwares might be indistinguishable from Gila Red sherds, a poorly defined type dating to sometime during the late Preclassic and early Classic periods.

For these reasons, the Deer Creek redwares fell outside of the sampling procedure used in the redware attribute analysis. Limited attribute data were recorded given the presence of Snaketown Red-on-brown ceramics, the Gila Butte phase assignment of many of the features at Deer Creek, and the absence of a Classic period component at the site. Findings from typological and temper analyses provides slightly contradictory results. From a technological viewpoint, the redwares at the Deer Creek site exhibit little differences from Classic period redwares found elsewhere in the project area. From a temper perspective, however, a large percentage of the redwares suggest local production. Each of these viewpoints is briefly explored.

The Technological Perspective

Visual inspection of the Deer Creek redwares revealed great variability in technological attributes such as surface finish, smudging and slipping; they lack technological attributes that readily distinguish them from Sacaton phase redwares. Nineteen of the 22 sherds are body sherds, and about 56 percent of the sherds were smaller than 5 cm^2, limiting the number of observations that could be meaningfully recorded. No evidence

Table 13.20. Deer Creek redware provenience, vessel part, and temper source data.

Feature	Stratum	Vessel Part	Tectonic Setting of Sand Temper	Quantity
0	9	Body	Granitic	1
0	9	Body	Metamorphic	4
5	9	Body	Granitic	1
5	51	Body	Metamorphic	1
6	9	Rim	Metamorphic	1
13	9	Body	Metamorphic	1
14	9/10	Body	Metamorphic	1
18	9	Rim	Granitic	1
18	9	Body	Metamorphic	1
18	9	Body	Indeterminate, low temper percent, small temper grains	1
19	19	Body	Metamorphic	1
21	9	Body	Metamorphic	1
36	2/10	Body	Metamorphic	1
36	9/10	Rim	Indeterminate	1
36	10	Body	Metamorphic	2
36	19	Body	Metamorphic	1
37	2/9	Body	Metamorphic	1
117	50	Rim	Metamorphic	1

of burning was recorded for the assemblage, and most (73.9 percent) lacked fire clouding. One of four redware rim sherds exhibits Classic redware characteristics, in its smudged, highly polished interior and its slipped, highly polished exterior. Three-fourths (78.2 percent) of the redware sherds exhibited interior smudging, and exteriors were slipped on 91.3 percent of the sherds. Half of the sherds had thin slips on their exterior, and almost half (43.5 percent) of these slips were mildly or very fugitive in nature. Almost one-third (29.4 percent) of the sherds had wiped interior surfaces and lightly polished exterior surfaces. Another 23.5 percent of the redwares had lightly polished interior and exterior surfaces, suggesting that these sherds, from contextually mixed deposits, may date to the Classic period.

The Temper Source Perspective

The temper source data discussed in detail in the following section, lead us to believe that the redwares probably are associated with the early occupation of the Deer Creek site. For the entire project area the highest percentage of "local" metamorphic sand-tempered plainwares was recovered at Deer Creek (43.2 percent, n=139). The percentage of plainware rims containing "local" metamorphic sand temper then declined in the Sacaton phase data set (13.2 percent, n=137) and the early Classic Period data set (20.8 percent, n=164). The early Classic period redwares contain the lowest percentage of "local" metamorphic sand tempered vessels (9.5 percent, n=209). The redwares recovered from Deer Creek contain the highest percentage of "local" metamorphic sand-tempered vessels (85.0 percent, n=20 [2 indeterminate observations deleted]). Therefore, the site from which the highest percentage of "local" plainwares were recovered also contained a small number of redware ceramics that displayed an even higher percentage of "local" metamorphic sand temper.

In conclusion, this project did not produce irrefutable evidence for the presence of pre-Sacaton phase redwares. Our evidence for the production of a redware type in the Upper Tonto Basin dating to the Gila Butte phase or earlier is circumstantial. The small size of the redware sample recovered from the Deer Creek site and the fact that the redwares were only recovered from deposits exhibiting low contextual integrity indicates that the assignment of a type name to those sherds would be premature. Our purpose is to alert other researchers working in the Tonto Basin of the possibility of an indigenous early redware tradition. The "Gila Butte" phase redwares are problematic in the entire set of tables that are used in this chapter.

CERAMIC TEMPER RESOURCE CHARACTERIZATION: THE PETROFACIES CONCEPT

With the increasing variety of chemical characterization techniques for sourcing pottery, mineralogically based techniques have become less widely used. Temper-based sourcing methods provide an inexpensive means of characterizing large samples and are particularly useful in geologically diverse regions such as the Tonto Basin. This section first describes the concepts and methods involved in our form of temper characterization. We then present results of our petrological study of the RCM plainware-redware assemblage and discusse issues related to ceramic production and distribution.

The need for recording quantitative data on temper composition has been recognized in numerous recent ceramic studies that have utilized petrographic analysis (Dickinson and Shutler 1979; Rye 1981; Garrett 1986; Schubert 1986; Beynon et al. 1986; Lombard 1987c; Ferring and Perttula 1987; Jones 1988; Stoltman 1989, 1991; F. Plog and Upham 1989; Donahue et al. 1990; Barnett 1990). The application of point-counting techniques during petrographic analysis represents a major advance in methodological rigor over the qualitative characterization scheme employed by Shepard (1942:Appendix II). She would doubtless have applauded their acceptance, given that she viewed "exact and detailed petrographic analysis" as one of the three principles underlying a successful technological investigation of ceramics (Shepard 1942:226). Unfortunately, two of Shepard's greatest insights into the methods necessary for the successful application of petrography in ceramic characterization have not been developed as thoroughly by the discipline.

The first of these insights entails the recognition that geological mapping has seldom been conducted in sufficient detail to characterize the compositional variability in a geographic locale at the level of precision frequently required by archaeological studies. Therefore a need exists for the archaeologist to conduct a reconnaissance sample of potential ceramic raw materials (Shepard 1946:268). A reconnaissance sample consisting of the collection and petrographic analysis of sands draining all of the various formations present in a study area would be required in order to characterize the potential ceramic materials available for the production of a sand-tempered ware (Shepard 1936: 411, 563, 578). Limited collections of potential sand-temper resources have been included as a part of the investigations of prehistoric ceramic production and distribution in Papua New Guinea (Rye 1981), Jordan (Beynon et al. 1986), and the Lesser Antilles (Donahue et al. 1990). A much more complete characterization of the potential sand-temper resources available to prehistoric potters results from work in the Tucson Basin in that area by R. Wallace (1957) and by Lombard (1986, 1987a, 1987b, 1987c, 1987d, 1989b, 1990; Lombard and Craig 1989).

The second of Shepard's insights regards the necessity of characterizing the temper in larger lots of sherds than is practical to analyze petrographically so that accurate estimates of the proportions of the various tempers are identified in the study. Shepard addressed this issue in numerous reports (1936:407, 1938:205, 1939a:251-252, 1939b:252, 1942:141-141, 230, 241, 1964:519, 1965a:82). In fact, two of the three principles she identified as necessary for successful technological investigations of ceramics -- adequate sampling and the correlation of archaeological and technological data -- are subsumed under this issue (Shepard 1942:226). Sample adequacy is perhaps best addressed in relation to a given project's specific research design. Establishing methods that ensure a high correlation between archaeological and technological data is an issue that applies to any study involving those classes of data. Shepard (1965:161) described the "ideal" technological study as one in which the petrographic and binocular microscopic studies of the ceramic assemblage are used to complement each other. The transmitted-light polarizing (petrographic) microscopic analysis objectively defines the composition of the nonplastic grains present in the sherd's paste (Shepard 1942:227). This definition establishes key grain types (Dickinson and Shutler 1979:1674) that the ceramic analyst can then use for classifying temper using the reflected-light binocular microscope. Key grains may be either "inconspicuous but distinctive" (Shepard 1942:142) or easily identified (Shepard 1965b:163). Importantly, petrographic analysis alone establishes the reliability of classifications made by the ceramicist. Identification with the binocular microscope alone is not sufficient (Shepard 1942:229). On the other hand, once a correlation between analysts has been established, the binocular microscopic classification of sand temper can proceed. This classification allows for the rapid and relatively inexpensive compilation of temper characterization information for the entire data set. Consequently, statistically meaningful sample sizes can be established affordably (Shepard 1942:140, 227; Dickinson and Shutler 1979:1674; Bishop et al. 1982:283).

The purpose of this section, then, is to introduce a method of ceramic temper characterization that begins with the collection and petrographic characterization of potential temper resources within a study area. This analysis utilizes a quantitative petrographic point-counting technique that is applicable to both the reconnaissance sand sample and the ceramic sample. The technique produces a high correlation between the quantitative petrographic characterization of ceramic samples and the qualitative binocular microscopic characterization of ceramic samples.

Our study builds on the methods developed by Lombard for the Tucson Basin and while applying them to the Tonto Basin. The first step in that method entails the development of a *predictive model* of sand compositional zones, based on the region's mapped bedrock geology, geomorphology, and sedimentary history; the model is used to guide sand sampling. The predictive model for the Tonto Basin compiled by Lombard (1989a) indicated that seven sand compositional zones were present. The predictive model was then tested through the collection and analysis of sand samples. Two stages are represented in that analysis. First, the sand samples are point-counted using the petrographic microscope. The point-counted data reflect the actual composition of the samples, rather than their inferred composition. Second, the recorded point-count data were entered into a number of statistical analyses. The results of those statistical analyses represent an *actualistic model* of sand composition in the basin. The actualistic model indicates that twelve sand compositional zones are present in the Tonto Basin. Development of the Tonto Basin actualistic model, below, is prefaced by a general discussion of the petrographic method and theory behind the model. The results of the actualistic model are then used to examine temporal trends in ceramic production and distribution in the Upper Tonto Basin using data from the Rye Creek Project.

DEVELOPING AN ACTUALISTIC MODEL FOR SAND TEMPER CHARACTERIZATION

Advances in Petrographic Method and Theory

The petrographic point-counting technique employed in this study uses Dickinson's (1970) system of classification for characterizing the composition of rock-fragment-rich, or subquartzose, sandstones in order to determine their geological sources. The subquartzose sandstones are those in which less than 75 percent of the detrital grains are quartzose. They include the graywackes and the arkoses (Dickinson 1970:696). The definition of graywacke cited in Dickinson immediately suggests, to the archaeologist, why the point-counting technique developed for their characterization should also be applicable to ceramics. That is, "Graywacke was defined by Jameson in 1808 as a kind of sandstone composed of *grains of sand of various sizes bound together in a clay paste*" (Dickinson 1970:696 citing Bailey 1930 [emphasis added]). The comparison of pottery to sedimentary rocks has been drawn by various archaeologists (Bishop 1980:49; Williams 1983:302). Therefore, the application of petrographic techniques developed for the characterization of sedimentary rocks, especially the rock-fragment-rich types, to ceramic thin-sections represents a logical extension of that analogy.

The major advantage of Dickinson's characterization scheme over other methods is that grain types are identified in a consistent, reproducible fashion. Identification error is minimized by using stains that aid in the identification of feldspars (Chayes 1952). Standard optical mineralogical techniques are used to identify monocrystalline mineral grains (Phillips 1971; Kerr 1977). The taxonomic system pioneered by Dickinson (1970), with improvements to the nomenclature and procedure made by others (Graham et al. 1976; Ingersoll and Suczek 1979; Ingersoll 1983), is used for identifying the polycrystalline lithic or rock fragment types. In that system lithic fragments and rocks are classified using the joint criteria of overall chemical composition and internal texture and fabric (Dickinson 1985:334).

Using traditional point-counting techniques (Basu 1976; Mack and Suttner 1977), the breakdown of rocks into mineral grains can present a problem when the results of a point-count of a very fine-grained sand (or temper) are compared with similar data from a very coarse-grained sand (or temper). The composition of a fine sand and a coarse sand from the same source rocks might appear to be significantly different because more rock fragments will have been broken down into individual crystals in a fine sand than in a coarse sand. Fortunately the dependence of sediment composition on grain size can be reduced to a minimum using the Gazzi-Dickinson point-counting technique (Gazzi 1966; Dickinson 1970). The primary way that this point-counting technique differs from earlier methods is that monomineralic crystals of sand size (> 0.0625 mm) that occur within larger rock fragments are classified in the category of the crystal, rather than in the category of the larger rock fragment. The premise underlying this method is that a mineral grain larger than 0.0625 mm can potentially be broken away from its parent rock fragment and become an individual sand grain. There are a number of advantages gained by using this technique rather than earlier methods. First, it provides more consistent results for all grain types recorded. Second, it reduces the effects of grain size and alteration on composition. Therefore, variation in the frequency of grain types between samples is based almost solely on composition. Third, counting of poorly sorted or coarse-grained sand is faster because the petrographer does not have to determine in what kind of grain a sand-sized crystal occurs. Furthermore, like all quantitative point-counting techniques the reliability of results can be judged using the chart published by Van Der Plas and Tobi (1965).

A more extensive discussion of the application of the Dickinson method of rock fragment identification and the Gazzi-Dickinson point-counting technique to the analysis of ceramic thin-sections can be found in Miksa (Appendix A, this volume) and Lombard (1987a, 1987c). Application of these two techniques to the study of active fluvial sands are discussed in De Celles and Hertel (1989) and Ingersoll (1990). A thorough review of the Gazzi-Dickinson point-counting technique, that includes an evaluation of compositional point-count data recorded using that method and traditional techniques, may be found in Ingersoll and others (1984).

The Petrofacies Concept

One of the major analytical concepts that developed in the field of sedimentary petrology subsequent to Dickinson's (1970) seminal paper on the compositional analysis of graywacke and arkose is that of the petrofacies (Mansfield 1971; Dickinson and Rich 1972; Ingersoll 1978, 1983; Ingersoll et al. 1977; Dickinson et al. 1983; Gamundi et al. 1990). The petrofacies concept, as developed by these sedimentary petrologists, is used to reveal provenience characteristics in their data. The compositional variability present in samples is used to empirically define horizontal or vertical divisions within deposits. Petrofacies units are defined by detailed characterization of sample composition. Individual samples usually are discussed in terms of either the relative percentage of specific point-counted grain types, variously referred to in the sedimentary petrological literature as numerical grain parameters or framework grains, or in recalculated parameters. Recalculated parameters usually are presented as the sum or ratio of multiple framework grain types. In Dickinson's (1970:695) nomenclature the sum of individual grain types is referred to as a primary parameter, while ratios between grain types are referred to as secondary parameters. The concept of the petrofacies, then, has been used to structure our interpretation of the reconnaissance sand sample data. We believe that the petrofacies concept provides the proper analytical model for the analysis of sand samples collected from active fluvial deposits, given a number of assumptions regarding the ubiquitous nature of this resource's availability for prehistoric pottery manufacture. The geological assumptions, reported below, reveal the logical structure of the argument that allows us to accomplish our ultimate objective: relating ceramic sand temper composition to source rock composition.

In order to relate ceramic sand temper composition to source rock composition, we must first relate fluvial sand composition to source rock composition. Drainage basins form the natural units used for the regionalization of our sand data. The drainage basin may be defined as the area that contributes water and, therefore, sediment to a particular stream channel. Each basin is separated from its neighbor by a divide that corresponds to a ridge line depicted on a topographic map (Zhang et al. 1990:189, 190). We note, however, that large drainage basins containing one source rock are rare, and mixing of sand from a variety of source rock types is the norm (Mack 1981:1247). Furthermore, it is expected that even when sampling is conducted at the first-order scale -- individual mountains and individual drainages -- source rock variability will produce a diversity of sand compositions (Ingersoll 1990:734).

The factors that control sand composition are complex, dynamic, and interlinked. A simple equation that summarizes those factors that control sediment composition can be written as:

$$S=f\{L,C,R,Tr,d,t\},$$

where a sand samples composition (S) is a function (f) of source rock lithology (L), climate (C), relief (R), transport history (Tr), and depositional history (d) over time (t). Each of the factors on the right side of the equation represents a complex of variables with the exception of the "time" term.

Source rock lithology is a reflection of plate tectonic regime and exposure age (Basu 1985:3) and is of critical importance in determining the *allowable* range of sand compositions (Johnsson and Stallard 1989:768, emphasis in original). It may therefore be thought of as the primary factor determining final sand composition.

Climate is a reflection of an area's rainfall and temperature and is itself dependent on latitude, elevation, orographic effects, and land-water distributions (Basu 1985:3). Accordingly, climate has an effect on the rate of mechanical and chemical weathering and controls vegetation and biochemical alteration (Basu 1985:3-4). The effect of climate on source rocks in determining sand composition can be ruled out if climatic conditions are constant throughout the study area (De Celles and Hertel 1989:1553), a situation that would often be encountered when studying intraregional ceramic temper resources. Otherwise, it has been shown (Suttner et al. 1981) that sands derived from the same type of source rocks in humid-temperate climates and arid and semiarid climates have distinct compositions. The sands collected from humid-temperate climates exhibit increased compositional maturity relative to those collected from arid and semiarid climates because the rate of chemical weathering is enhanced. At the onset of weathering the source rock is essentially a single rock fragment. As weathering proceeds the rock fragment is disaggregated, releasing smaller rock fragments and monocrystalline grains. The greater the degree of weathering, the greater the number of monocrystalline grains released from the source rock fragments and from the subsequent gravel-sized and sand-sized rock fragments (Mack and Jerzykiewiez 1989:36). In humid tropical climates chemical weathering may substantially overprint the original source rock composition (Johnsson and Stallard 1989:768).

Relief is a measure of the potential energy in the system. It is an expression of how high a particle is with respect to the base level of a system, and has been expressed variously as elevation and slope angle. Elevation is the absolute height of the particle above the system's base level. The higher a particle is, the more potential it has to be transported. Slope angle refers to the angle of the surface on which a particle rests. As this angle increases (i.e., as the surface steepens), the particle is more likely to move, or will move further if it is already in motion. Basu (1985:12-13) notes that for sedimentary systems, when the slope on which sedimentation is occurring exceeds the angle of repose for that sediment, transport factors are enhanced. Likewise, when sedimentation is occurring on a slope which is less than the angle of repose, the effects of climatic factors are increased. The factors of relief and location within a drainage basin have been combined into the concept of "landscape position." In other words, the potential energy of a particle, and the processes most likely to affect it, is affected not only by its absolute height and the angle of the slope on which it rests, but also by its location within the drainage basin and the size of the drainage basin. As the catchment area above a particle (or sediment) increases, so does the potential for modification to that particle.

Transport history is a reflection of the kinetic energy, or energy of movement, in the system. As suggested above, the effect of relief on the transformation of source rocks into sand is related to the modification of sediment composition that results from mechanical breakage during fluvial transport (Mack and Jerzykiewicz 1989:38). Mechanical breakage is most pronounced in high-gradient mountain streams because of the influence of the gravel-sized fraction (Suttner et al. 1981), while transport in sandy bedload, low-gradient streams has little effect on composition (Russell 1937; Hayes 1962). Transport distance also has an effect in determining the final composition of a sand. The expectation is that there will be less correlation between final sand composition and source rock composition the longer the distance that the sand has been transported from the source rock, and that the sands will exhibit a systematic increase in compositional and textural maturity downstream (Franzinelli and Potter 1983:37; De Celles and Hertel 1989:1561). However, relatively short transport distances (<10 km) are expected to produce negligible effects on final sand composition, even in high-gradient streams (Basu 1976:704).

Depositional history is an expression of selective processes that actively sort sand particles according to their size, shape, and density (Lucci 1985:23). The effect of those processes is most pronounced in those minerals that have a greater specific gravity, the so-called heavy minerals. Changes in hydraulic conditions during the deposition of a sand unit will cause fluctuations in heavy mineral proportions among samples (Morton 1985:259). Accordingly, changes in heavy mineral proportions do not necessarily indicate a change in sediment source, but they may produce related sands of strongly contrasting appearance, a situation Dickinson and Shutler (1979:1667) refer to as placer concentrations.

A simple equation that summarizes the factors responsible for the actual recorded composition of a given sand sample may be written as:

$$S=f\{L,C,R,Tr,d,t,e\},$$

where the sample's recorded composition (S) is a function (f) of the source rock lithology (L), the climate (C), the relief (R), the transport history (Tr), and the depositional history (d) over time (t), and the expected compositional error introduced during point-counting (e). Van Der Plas and Tobi (1965) provide one way to estimate error through their two standard deviation chart for judging the reliability of point-count results. In our Tonto Basin sand samples source rock lithology, relief, transport history, depositional history, and time probably represent the factors most responsible for the point-counted compositions. Climate is probably not an important factor given that the entire basin is arid.

IMPLEMENTING AN ACTUALISTIC STUDY OF SAND-TEMPERED CERAMICS

Study Background

The prehistoric ceramic series produced in the Tonto Basin represents an ideal data set with which to demonstrate the utility of the petrofacies method of technological characterization for a number of geological and archaeological reasons.

Geology and Geomorphology

The Tonto Basin is situated within the mountainous "Transition Zone" of central Arizona (Chronic 1983). The Transition Zone, which separates the Colorado Plateau to the north from the Basin and Range province of the southern deserts, is the smallest physiographic province in Arizona, confined to a 50 mile (80 km) wide band along the base of the Mogollon Rim and Colorado Plateau. The Tonto Basin can be characterized as a "typical down-faulted, sediment-filled, basin-and-range trough lying between uplifted mountains" (Royse et al. 1971:8). A variety of different source rocks are exposed in the study area's mountains and foothills. Those plutonic, hypabyssal, volcanic, metamorphic, and sedimentary source rocks supply a wide range of regionally distinct sand compositions (Figure 13.4).

A predictive model for sediment compositional zones within the basin's alluvium was developed prior to the fieldwork to guide sand sampling (Figure 13.5 adapted from Lombard 1989a). This model used the mapped bedrock geology and the characteristic drainage basin pattern to infer the spatial extent and compositional characteristics of alluvium shed from bedrock sources. The predictive model served two purposes in the development of an actualistic model of sand composition. First, the sand samples were used to empirically test the predictive model. Second, the sand samples were used to evaluate the degree of compositional variability present in sands derived from geologically similar source rocks.

The geometry of the modern drainage systems facilitated the mapping and prediction of sediment composition in the study area. Streams draining into the trunk streams of the Tonto Basin, Tonto Creek and Rye Creek, have cut down through the late Tertiary sediments filling the valley floor leaving deeply incised stream courses. The Tertiary sediments are left as terraces along the valley, preserving a record of the earlier depositional and soil formation history. Modern sedimentary processes occur within these incised stream courses, allowing the streams to retain their source rock signature as they flow through the eroded basinal deposits. Some complication is introduced into the process due to the incorporation of Tertiary soil and sediment into the sand samples. The effects of this are negligible, however, because the source rocks are the same for both sediments, the drainage patterns have changed little since the Tertiary, and the soil deposits are easily recognizable as such.

Sand sampling focused on those streams that drain the largest area of land in order to maximize the documentation of the region with a limited number of samples. However, smaller drainages were also included in the sample because the stream was located within 1 km of a major prehistoric site. The sand samples that were collected represent the most abundant sand sources that exhibit the size, sorting, and abrasion characteristics similar to those observed in ceramic temper. These wash sands are almost always very fine to very coarse in size. They are subangular to subrounded in shape, indicating a relatively short transport distance from their source rocks.

The Ceramic Series

To successfully apply the petrofacies concept to the analysis of archaeological ceramics, the petrographer must be able to regularly point-count an adequate number of sand grains in the ceramic thin-sections to provide data for statistical analysis. In order to maximize the number of sectioned sand grains the thin-sections were cut parallel to the surface of the vessel wall rather than perpendicular to it. Ceramic thin-sections were mounted on standard 27-mm by 46-mm petrographic slides. The mounted portion of the ceramic usually covered an area of at least 20 mm by 35 mm, thereby providing an adequate surface for point-counting 400 temper grains.

Another prerequisite for petrofacies assignment is that the ceramic analyst must be able to observe enough temper grains using the binocular microscope in order to classify accurately the temper composition. The Tonto Basin ceramic series meets that prerequisite. The analyzed ceramics include plainwares recovered from deposits that were assigned Gila Butte, Sacaton, and early Classic period dates, using typological and absolute methods, and redwares that were recovered from Sacaton and early Classic period deposits. A qualitative assessment of the grain size distribution indicates that these ceramics are tempered with very poorly sorted, subangular to subrounded sand that ranges from very fine (0.0625 mm) to very coarse (1.0 - 2.0 mm) with only a few granule-sized grains (2.0 - 4.0 mm) observed. In general, the modal grain size is coarse sand (0.5 - 1.0 mm). Simon and Burton (1989) report a similar grain size distribution in the plainwares recovered from the Star Valley sites, which are located approximately 20 km northeast of the project area. A qualitative assessment of the ratio of temper to clay matrix suggests that temper sand usually ranges from 40 to 60 percent of the paste by volume. Given these compositional parameters and the fact that we can calculate the minimum area of the sherd's edge (in mm^2) examined under the binocular microscope (calculated by multiplying the length of the perimeter present in the smallest size class by the minimum average vessel wall thickness recorded), we estimate that even on the smallest sherds examined more than 200 temper grains will be observed. Two-hundred grains, therefore, appears to represent a sufficiently large minimum number for the accurate qualitative characterization of a vessel's temper source and temper type, given the high accuracy obtained in the classification of those attributes (see "Statistical Analyses of Ceramic Samples" below). It should be emphasized that the temper source and temper type characterizations are determined by examining first and foremost the area of the sherd's edge under the binocular microscope, not the sherd's surfaces. Sherd surfaces also are examined under the binocular microscope, but our experience suggests that they are a generally unreliable indicator of composition, a position supported by anecdotal observations in the literature (Doelle 1985:141-145; Mattson 1989:24).

Application of the petrofacies concept to the analysis of archaeological ceramics has led us to recognize three temper attributes that are easily observed and characterized using the binocular microscope: generic temper source, specific temper source, and temper type. These attributes are also easily recorded for later statistical examination using qualitative variables, and can be easily correlated with petrographic determinations of temper composition using various sampling techniques to select ceramics for thin-section analysis (Heidke 1990:80-81).

Two of these attributes relate to the inferred production source of the sample. The first attribute, "generic source," is used to characterize the tectonic origin of the observed temper grains. A given sherd is attributed to a generic source based on the binocular microscopic observation of the rock fragments and monomineralic grains known to define a particular tectonic setting (e.g., quartz- and feldspar-rich sand temper indicates a granitic source). The second attribute, "specific source," is used to characterize the petrofacies of origin for the observed temper grains. A given sherd is attributed to a "specific source" based on the binocular microscopic observation of the distinctive suite of rock fragments and monomineralic grains (the key grains) known to define a particular petrofacies.

The difference between the "generic" and the "specific" attributes is in the greater level of spatial resolution implied by the petrofacies. In practice, the information recorded by the "generic" attribute is redundant with the information recorded by the "specific" attribute when the sand temper observed in a given sherd allows for its assignment to a petrofacies. It is sometimes the case, however, that the sand temper does not exhibit any or all of the key grains necessary for a specific assignment, but the temper grains that are observed are sufficient to categorize the generic tectonic origin for the sand. Important compositional and limited provenience information could be lost in those cases if only an attribute recording the petrofacies of origin was utilized during analysis, because the petrofacies assignment of all such cases must, by definition, be recorded as "indeterminate." Furthermore, in the early stages of a study involving a previously undocumented region, such as the Tonto Basin, knowledge of the "key grains" defining the petrofacies is unknown to the petrologist and the ceramicist. For that reason, the ceramicist (in consultation with the petrographer) recorded a number of "key grain" types that were hypothesized to be sensitive to spatial variability in the resource, although not necessarily in a fashion correlative with a single petrofacies. In this way the "specific source" variable was given some flexibility with regard to the degree of specificity implied that was related to our partial knowledge of the resource database at the beginning of the study.

The third temper attribute recognized is the "type" of temper present. This attribute is used to characterize technological decisions made by the prehistoric potter with regard to the addition of an "artificial" tempering material to the otherwise "natural" temper composition of a given petrofacies (or "generic source"). Three criteria are used to evaluate whether a tempering material is artificial or natural: grain size, grain shape, and expected observation of the rock or mineral type within the sands of a given petrofacies (or generic source). Artificial tempers have been found to occur in a more restricted size range and to display more subequant, angular grain shapes when compared with natural tempers (Lombard 1985:303; Rye 1981:37, 52). As well, based on the prior compositional analysis of the sand samples, it should be known whether or not all of the petrofacies contain all of the grain types recorded; the expectation is that they will not. Therefore, when a rock or mineral that is not known to occur naturally within the sands of a given petrofacies (or generic source) are observed and they occur in a limited size range and exhibit an angular shape, there is strong evidence for considering that temper component artificial rather than natural.

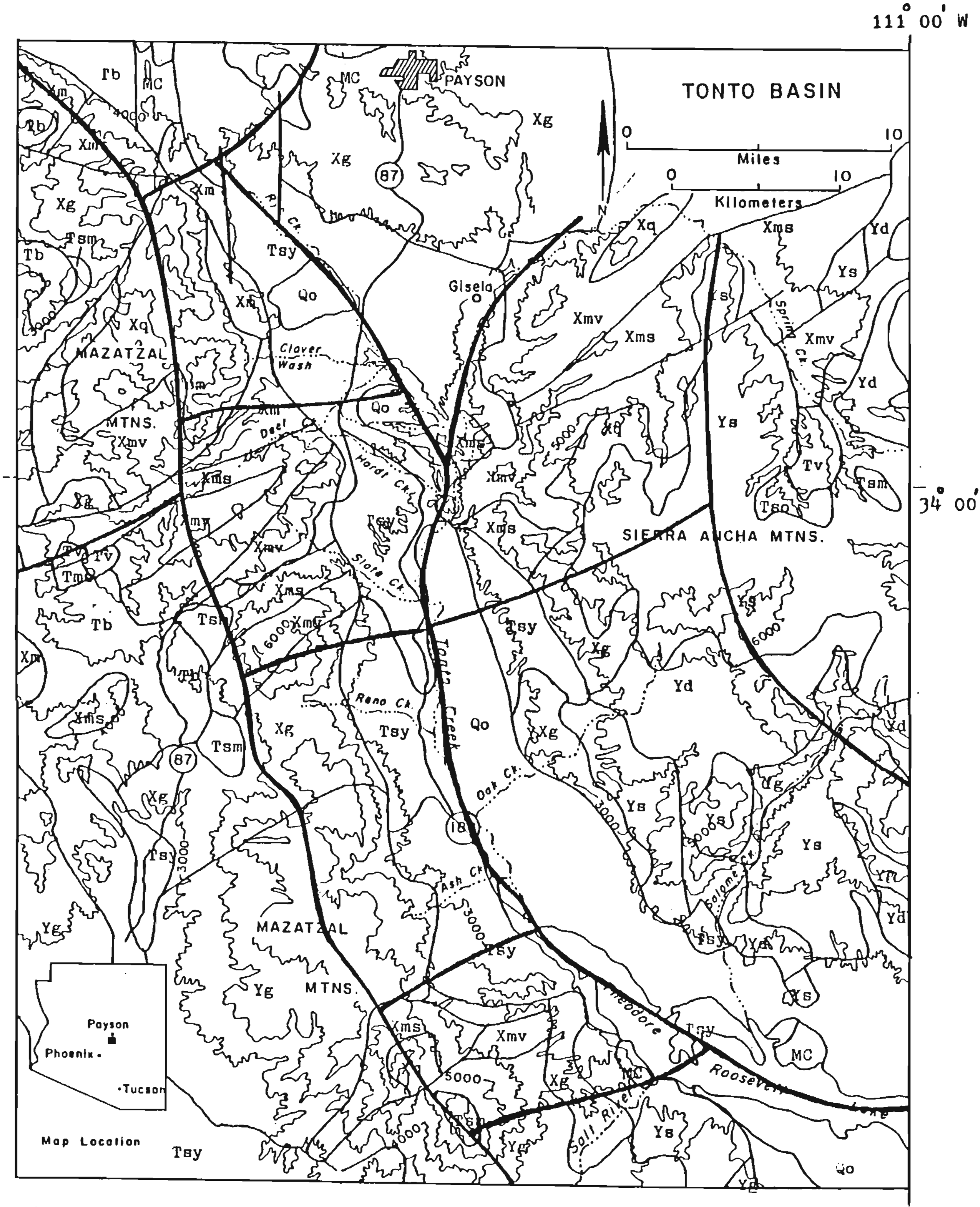

Figure 13.4. Geology of the Tonto Basin area (from S. Reynolds, 1988, Geologic Map of Arizona).

EXPLANATION OF MAP UNITS

Qo = Older surficial deposits (Holocene to middle Pleistocene) -- alluvium with less abundant talus and eolian deposits.

Tsy = Sedimentary rocks (Pliocene to middle Miocene) -- units deposited during and after late Tertiary normal faulting, commonly capped by patches of Quaternary surficial deposits.

Tb = Basaltic rocks (late to middle Miocene; 8 to 16 Ma) -- units, such as Hickey Formations, erupted after most mid-Tertiary volcanism and tectonism.

Tsm = Sedimentary rocks (middle Miocene to Oligocene; 15 to 38 Ma) -- deposited during mid-Tertiary orogenic activity in the Basin and Range Province and the southwestern transition zone.

Tv = Volcanic rocks (middle Miocene to Oligocene; 15 to 38 Ma) -- Silicic to mafic flows and pyroclastic rocks; includes some subvolcanic intrusions.

Tso = Sedimentary rocks (Oligocene to Eocene or locally Paleocene) -- units deposited on the Colorado Plateau and Transition zone prior to or during the initial phases of mid-Tertiary volcanism.

MC = Sedimentary rocks (Middle Proterozoic) -- limestone, sandstone, and shale of the Grand Canyon Supergroup, Apache Group, Troy Quarzite, and local basalt flows and diabase.

Yd = Diabase (middle Proterozoic; 1100 Ma).

Yg = Granitoid rocks (Middle Proterozoic; 1400 -- coarse-grained porphyritic biotite bearing granite.

YXg = Granitoid rocks (Early Proterozoic; 1650 to 1750 Ma) -- Fine-to coarse-grained leucocrateic granite, diorite, gabbro minor granodiorite and quartz monzonite, commonly foliated.

Xq = Quartzite (Early Proterozoic; 1700 Ma) -- Mazatzal Groups and similar rocks.

Xm = Metamorphic rocks (Early Proterozoic; 1650 to 1800 Ma) -- undifferentiated metasedimentary, metavolcanic, and gneissic rocks.

Xms = Metasedimentary rocks (Early Proterozoic; 1650 to 1800 Ma) -- Lithic arenite, graywacke, quartz arenite, conglomerate, shale, and mafic and felsic volcanic rocks.

Xmv = Metavolcanic rocks (Early Proterozoic; 1650 to 1800 Ma) -- intrusive and extrusive rhyolite, granophyre, minor interbedded conglomerate, shale, graywacke, and mafic volcanic rocks.

Key to Figure 13.4.

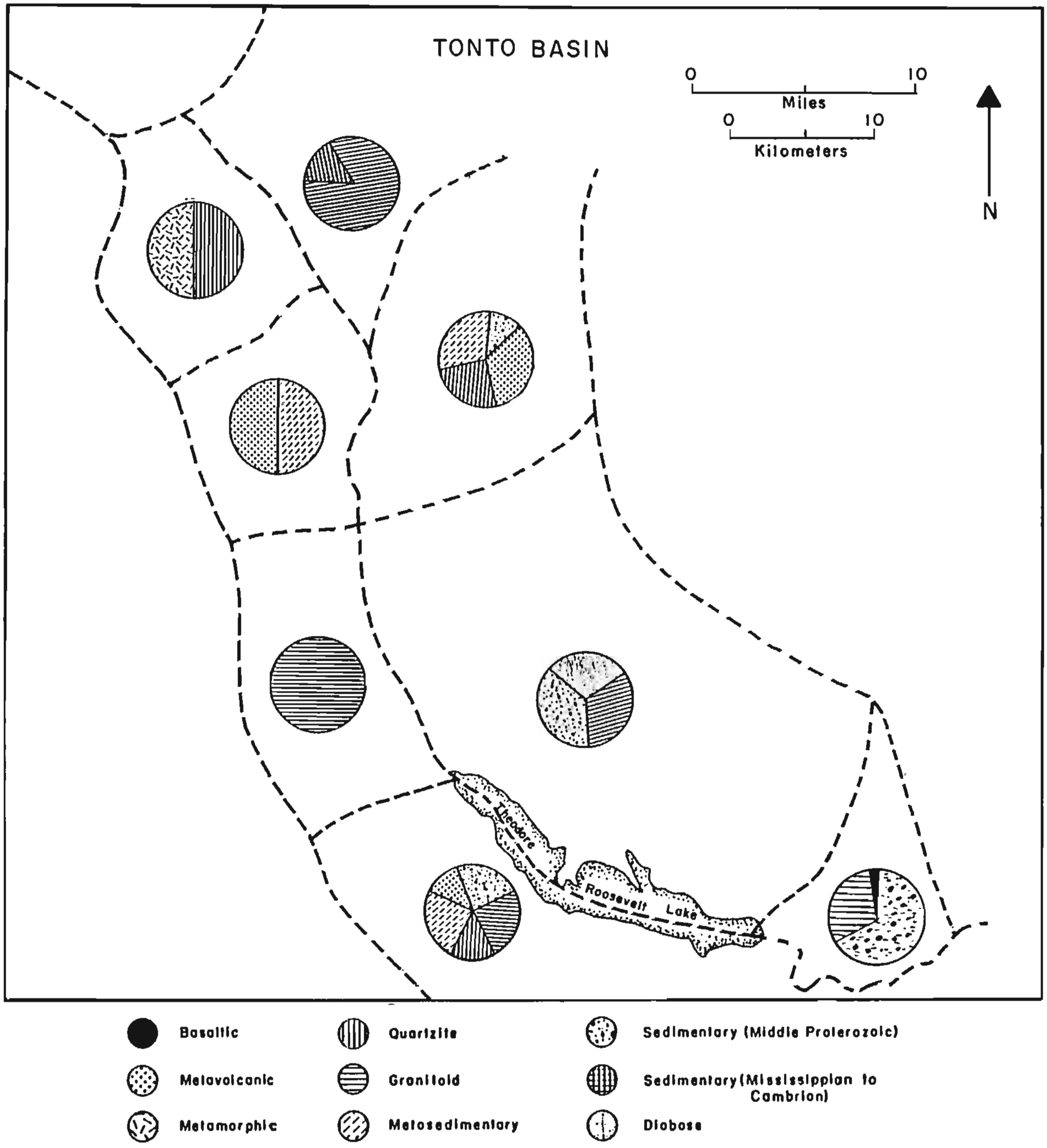

Figure 13.5. Geological map of the Tonto Basin area showing predicted petrofacies.

Testing the Predictive Model

Statistical Analyses of Sand Samples

Three statistical analyses were conducted with the point-count data recorded from the wash sand samples. The first analysis utilized correspondence analysis as a method of data reduction and exploration. In that analysis the sand samples were classified into "generic" groups in which samples derived from similar tectonic settings were predicted to cluster together. That analysis was conducted as a first check on the level of resolution provided by the predictive model. It facilitated the identification of some samples that did not display their expected generic compositions, and led us to reassign some samples to new petrofacies that had not been predicted based on the mapped bedrock geology. The second analysis used principal components analysis and discriminant analysis to further investigate the generic compositions. The principal components analysis was used to reduce the dimensionality of the original data set in order to make its underlying structure easier to understand. The discriminant analysis was used to demonstrate that the compositions of the generic groups are statistically distinguishable, and to determine a set of functions that best discriminates between the tectonic groups. The third statistical analysis again utilized discriminant analysis. This time it was used to show that the compositions of the specific petrofacies are statistically distinguishable, and to determine the sets of functions that best discriminate between the petrofacies.

The correspondence analysis, principal components analysis, and discriminant analysis utilized in this study make full use of the quantitative point-count data recorded. Other researchers who have advocated the collection of quantitative petrographic data for ceramic characterization have limited their method of data interpretation to a visual, comparative approach utilizing ternary, or triangular, diagrams (e.g., Dickinson and Shutler 1979; Ferring and Perttula 1987; Lombard 1987c; Stoltman 1989, 1991). Powerful critiques of that method concentrate on the problem of closure and the closed array (Skala 1979; Aitchinson 1982, 1984a, 1984b, 1986, 1989). Skala (1979:4) notes that triangular diagrams are frequently used in the study of petrological problems to graphically represent the quantitative relations between variables of ternary systems in which the variables occur as triplets with constant sums, but by dividing the data by their row sums the data go from an open to a closed array. The problem of closure was recognized while searching for appropriate methods with which to analyze the present data set. The actual point-counted frequencies recorded are utilized in the data matrix of the correspondence analysis, therefore no closure occurs. In the principal components analysis and discriminant analysis only a subcomposition of the point-counted parameters were studied. In order to remove the problem of closure from those data sets the logratio transform, developed by Aitchison (1986) for the analysis of compositional data was applied to the data prior to the analyses. Following Aitchison (1984b:623) the symmetric, or centered, logratio transform was chosen because we intended to utilize the data in a principal components analysis. We believe, therefore, that the methods utilized in the following analyses represent an informed use of the types of multivariate techniques necessary for pattern recognition in quantitative point-count data, and that these techniques could be applied to advantage by other researchers studying sand composition in samples drawn from either a stream sediment deposit or a ceramic paste.

First Statistical Analysis: Classification of Generic Source. Over the last decade correspondence analysis has become one of the favored multivariate techniques for the analysis of spatial data in archaeology (Hill 1974; Bolviken et al. 1982; Johnson 1984; Holm-Olsen 1985; Bertelsen 1985; Ringrose 1988; Bremer 1989; Weller and Romney 1990; see also Djindjian 1989 for an extensive review of the French archaeological literature utilizing correspondence analysis) as well as geology (Teil and Cheminee 1975; David et al. 1977; Oleson and Carr 1990; Pereira et al. 1990; Zhou et al. 1991). Correspondence analysis represents the multivariate technique of choice for the analysis of the sand sample point-count data for three reasons. First, the technique could be applied directly to the original data. Therefore, there was no problem of going from the open to the closed array. In correspondence analysis a simple transformation is applied to the contingency table of the sand sample observations (rows) and the point-count parameters (columns) to yield a square symmetric matrix for which eigenvalues and eigenvectors are calculated. Second, the technique requires only that all values in the data matrix must be positive (zeros are acceptable) and that all row and column totals must be greater than zero (Hill 1979:10; Weller and Romney 1990:72). This is an important assumption with regard to a database containing samples derived from an extremely heterogeneous set of source rocks. In the Tonto Basin we expected that many of the grain type parameters recorded would not be encountered in sand samples collected from all portions of the study area. This sort of fundamental between-sample compositional variability, encountered in a quantitative petrographic analysis, represents one of the greatest differences separating its analytical requirements from those of instrumental characterization studies, where the expectation exists that all elements recorded will be present in each sample with only their relative concentrations exhibiting variation between samples. Finally, correspondence analysis was chosen because it is a technique that displays the rows and columns of the data matrix as points in the same low-dimensional geometrical space. This means that one can examine relations not only among row or column variables but also between row and column variables (Weller and Romney 1990:55; Oleson and Carr 1990:675). Therefore, correspondence analysis not only provides a summary and simplification of the data matrix, but it also provides a global view of the information contained in the matrix, thereby stimulating possible explanations (Greenacre 1984:3).

The present study utilized the detrended correspondence program of Hill (1979) for the first statistical analysis of the wash sand data. One hundred and six sand samples were collected in the field (See Appendix A for sample locations). Approximately two-thirds of those (n=71) were point-counted. Sixty-eight of those samples were collected from washes, one sample was collected from the Salt River, one sample was collected from the surface of Rye Creek Ruin, and one sample was collected from the Tertiary sediment deposit composing Fisher Mesa. Three of these 71 samples were not included in the correspondence analysis. A phyllite-rich sand sample draining a minor tributary of Slate Creek (sample TB-77) was not included because it had only been collected and point-counted in order to document the presence of the phyllite source. The sample collected from the Salt River (sample TB-1) was not included because the size, sorting, and abrasion characteristics of the sand observed in the ceramic paste suggested that mature trunk stream sands had not been utilized as temper. The sample from Fisher Mesa (sample TB-83) was not included because it represented a soil sediment sample, not a stream sample, and its size and sorting characteristics were not similar to those observed in the ceramic paste.

Table 13.21 defines the point-count parameter symbols used in the detrended correspondence analysis graphs (see Miksa, Appendix A for complete definitions of the point-count parameters). Figure 13.6 is a plot of the sand samples and point-count parameters for the first two factors (note, the first factor is plotted on the vertical axis and the second factor on the horizontal axis). Figure 13.7 is a plot of similar data for the first and third factors. The first factor accounts for 49.6 percent of the variation, the second factor accounts for 25.4 percent, and the third factor accounts for 17.1 percent -- a total of 92.1 percent of the variation in the first three factors -- leading us to conclude that the technique was highly successful in reducing the dimensionality of the data.

Each factor is readily interpretable in geologic terms of tectonic origin when ranked parameter optimal scores of each factor are examined (Table 13.22). In our study, tectonic origin refers to the usual classification of rocks as being of igneous, metamorphic, or sedimentary origin, and differentiates between three of the principal categories of igneous rocks (volcanic, plutonic, and hypabyssal). The first factor is interpreted as a contrast between rocks on the one hand and minerals on the other, because the lithic parameters generally received the highest positive factor scores while the minerals received the lowest factor scores (including negative factor scores). The first factor may also represent degree of plagioclase feldspar alteration as the three plagioclase parameters were ranked sequentially from highest to lowest PLAGGN, PLAGAL, and PLAG. The second factor is interpreted as a contrast between two sedimentary rock types, with the argillaceous rock parameter (LMA) receiving a high positive score and the siltstone parameter (LSS) receiving the lowest negative factor score. The third factor is interpreted as a contrast between the sedimentary rocks and the volcanic rocks, based on the high positive ranking of the sedimentary rock parameters (LSCA, LSCH, LSS, and LSA) and the low negative rankings of the volcanic rock parameters (LVM, LVV, LVH, and LVF). The third factor also is interpreted as a measure of anorthosite content, a pattern that is expressed by the positive ranking of the plagioclase parameters (PLAG, PLAGAL, and PLAGGN) and the negative ranking of the alkali feldspar parameters (KSPAR and MICR). Note also that the third factor, like the first factor, may represent the degree of plagioclase feldspar alteration based on the factor rankings of the three plagioclase parameters.

Table 13.21 Point-count parameters.

Symbol	Definition
QTZ	Quartz
KSPAR	Alkali feldspars
MICR	Microcline feldspar
PLAG	Plagioclase feldspars <10% altered
PLAGAL	Plagioclase feldspars 10-90% altered
PLAGGN	Plagioclase feldspars >90% altered
PYR	Undifferentiated members of the pyroxene and amphibole groups (including hornblende)
OO	Undifferentiated opaque minerals
EPI	Undifferentiated members of the epidote family
MUSC	Muscovite mica
BIOT	Biotite mica
CHLR	Chlorite
CACO	Calcium carbonate
GAR	Undifferentiated garnet group minerals [counted but not observed]
LVF	Felsic to intermediate volcanic
LVM	Microlithic volcanic
LVV	Vitreous volcanic
LVH	Hypabyssal (microphaneritic) volcanic
LSS	Siltstone
LSA	Argillaceous rock
LSCH	Chert
LSCA	Fine-grained carbonate
LMM	Quartzite
LMF	Foliated quartzite
LMA	Metamorphic aggregate
LMT	Metamorphic rock with planar texture
LMTP	Fine-grained planar metamorphic
SHERT	Sherd temper (ceramics only)

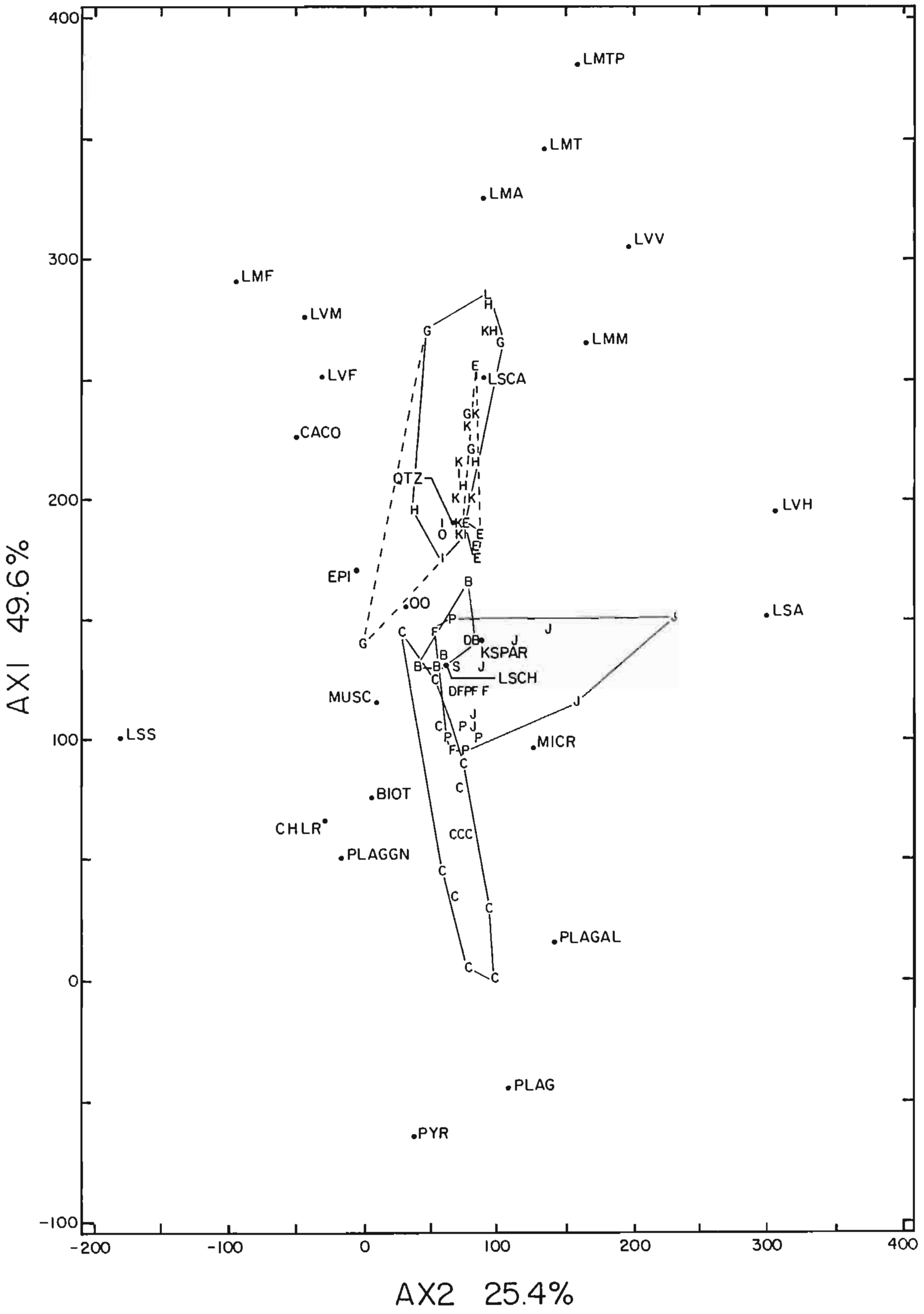

Figure 13.6. Correspondence analysis plot of sand samples and point-count parameters for first two factors.

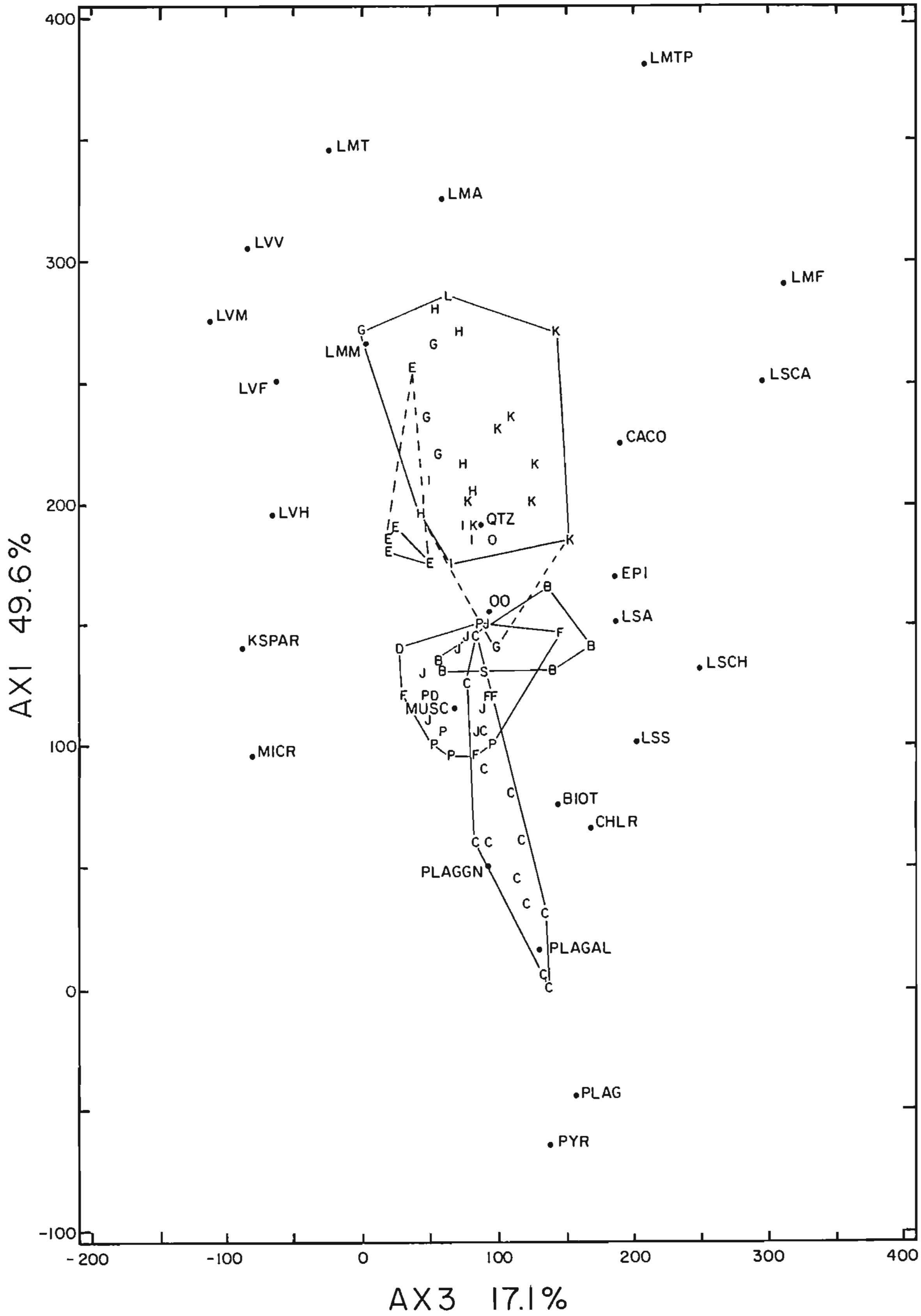

Figure 13.7. Correspondence analysis plot of sand samples and point-count parameters for first and third factors.

Table 13.22. Ranked parameter scores.

FACTOR 1 Ranked		FACTOR 2 Ranked		FACTOR 3 Ranked		FACTOR 4 Ranked	
LMTP	379	LVH	307	LMF	312	LSCH	391
LMT	344	LSA	301	LSCA	296	LSS	322
LMA	322	LVV	196	LSCH	250	LSA	235
LVV	302	LMM	165	LMTP	210	LVV	220
LMF	288	LMTP	160	LSS	203	PLAG	213
LVM	274	PLAGAL	142	CACO	190	OO	198
LMM	264	LMT	135	LSA	189	LMM	192
LSCA	250	MICR	125	EPI	187	LVM	186
LVF	246	PLAG	107	CHLR	169	LVH	177
CACO	223	LMA	92	PLAG	157	LVF	174
LVH	191	LSCA	91	BIOT	145	LMT	167
QTZ	187	KSPAR	82	PYR	137	MUSC	148
EPI	170	QTZ	69	PLAGAL	132	LMA	144
OO	152	LSCH	57	OO	94	BIOT	133
LSA	146	PYR	38	PLAGGN	93	PYR	100
KSPAR	138	OO	32	QTZ	84	QTZ	81
LSCH	128	MUSC	9	MUSC	68	PLAGAL	59
MUSC	111	BIOT	6	LMA	59	LMTP	49
LSS	98	EPI	-7	LMM	4	KSPAR	20
MICR	92	PLAGGN	-16	LMT	-25	MICR	18
BIOT	74	CHLR	-29	LVF	-61	PLAGGN	-64
CHLR	61	LVF	-30	LVH	-67	LSCA	-66
PLAGGN	49	LVM	-45	MICR	-82	CACO	-84
PLAGAL	12	CACO	-50	LVV	-84	LMF	-192
PLAG	-46	LMF	-93	KSPAR	-87	CHLR	-197
PYR	-65	LSS	-180	LVM	-111	EPI	-254
Eigenvalue	0.371		0.190		0.128		0.059
Percent of variation explained	49.6		25.40		17.11		7.89
Cumulative percentage	49.6		75.00		92.11		100.00

Note: See Table 13.21 for definitions of abbreviations.

The predicted diabasic, granitic, and metamorphic compositions of the sand samples shown in Figure 13.5 are found to accord well with the factor interpretations. Table 13.23 reports the predicted tectonic setting of the sand samples, with an additional coding label indicative of their petrofacies assignments included. Convex hulls, the smallest convex region that contains all of the points, were drawn around the samples from each group of petrofacies that were predicted to have been derived from a similar tectonic setting. The sand samples predicted to exhibit a predominantly metamorphic composition (Petrofacies G, H, I, K, and sample L) are located in the upper portion of the plot and are well separated from the sand samples predicted to exhibit either a granitic composition (Petrofacies F, J, and P) or a diabasic composition (Petrofacies C) which are located in the lower portion of the plot (Figures 13.6 and 13.7). Therefore, the sand samples reflect the opposition between rocks and minerals observed in the rankings of the point-count parameters on the first factor. The granitic and diabasic sand samples also are generally well separated in the plot of the first two factors.

The correspondence analysis plot of the sand samples also indicated the presence of four petrofacies that had not been predicted using the mapped bedrock geology (Figure 13.8). Petrofacies B represents a sand of granitic-sedimentary composition. These samples had been predicted to exhibit the diabasic composition of Petrofacies C. Petrofacies D represents a sand of granitic composition; these samples had been predicted to exhibit either the diabasic composition of Petrofacies C (sample TB-30) or the metamorphic composition of Petrofacies G (sample TB-63). Petrofacies E represents a sand of mixed granitic-lithic composition. These samples had been predicted to exhibit the granitic composition of Petrofacies F. Petrofacies O represents a sand of volcanic composition; that sample had been predicted to exhibit the granitic composition of Petrofacies J.

The correspondence analysis plot also indicated that the sample collected from the surface of Rye Creek Ruin (sample TB-68, coding label L) exhibited a lithic-rich composition as was predicted. It also indicated that the sand sample collected from Rye Creek near Rye Creek Ruin (sample TB-41, coding label S) exhibited a granitic composition. This was an unexpected result given that the streams draining into Rye Creek from the west exhibit a metamorphic composition, while those draining into Rye Creek from the east exhibit a mixed granitic-lithic composition. The significance of this result is discussed later in this chapter.

Finally, the plot indicated that two samples exhibited unusual compositions relative to other samples collected from sources draining similar tectonic settings. These unusual samples were indicated as dashed lines when drawing the convex hulls around the tectonic distributions. In both cases it was determined that the sample had been collected from a floodplain setting, rather than a stream channel proper.

The reader will have observed that the first dimension of the factor plots is extremely linear. That linearity is apparently a result of the detrending process incorporated into the correspondence analysis program utilized in this study. In the documentation for that program Hill (1979:1) argues that a detrended correspondence analysis will avoid the "arch" or "horseshoe" problem that results from the quadratic dependency of the second axis on the first axis, and also that it will avoid the compression of axis ends. Greenacre (1984:232), however, argues that detrending itself may introduce other problems during analysis. Therefore, it is expected that a reanalysis of the wash sand data (presented in Appendix A) utilizing a correspondence analysis program other than Hill's, such as the one in BMDP (Dixon et al. 1988) or Anthropac (Borgatti 1990), may produce somewhat different results from those reported here.

Second Statistical Analysis: Discrimination of Generic Source. The correspondence analysis generally supported the predictive model's assignment of sand compositional zones at the tectonic level of analysis, although four additional zones were identified. In order to assign sherds to these tectonic groups it was first necessary to: (1) determine a set of functions that best discriminate between the groups; and (2) use those functions to assign in a probabilistic manner sherds inferred to have originated from one of the groups. Only a subcomposition of the point-count parameters were utilized in this analysis. Furthermore, a number of recalculated point-count parameters were used so that the original value of all discriminating variables would be greater than zero (Table 13.24). The parameters included in this analysis were total plagioclase feldspars (P), the alkali feldspars (K), quartz (QTZ), total volcanic lithic fragments (LV), total sedimentary lithic

Table 13.23. Tectonic setting and petrofacies assignments of sand samples.

DIABASIC

C. 4,5,10,11,12,14,16,19,22,24,25,26,28 (Diabasic ANCHAS)

GRANITIC

D. 30,63 (Granitic ANCHAS) [Not predicted]
F. 32,35,64,84,87 (Granitic PAYSON)
J. 60,61,92,93,95,97,99 (Granitic MAZATZALS)
P. 101,102,103,104,106,107 (Granitic MAZATZALS)

METAMORPHIC

G. 34,37,43,50,54 (Metamorphic ANCHAS)
H. 49,51,55,69,72 (Metamorphic MAZATZALS)
I. 52,56,57,59 (Metamorphic MAZATZALS)
K. 66,67,70,71,79,85,88,90 (Metamorphic RYE BASIN)

GRANITIC-SEDIMENTARY

B. 2,6,7,8,9 (Granitic-Sedimentary ANCHAS) [Not predicted]

MIXED: GRANITIC-LITHIC

E. 31,39,40,42,45 (Wedge) [Not predicted]

VOLCANIC

O. 100 [Not predicted]

MISCELLANEOUS

A. 1 (Salt River trunk stream) [Not included in correspondence analysis]
L. 68 (Rye Creek Ruin surface)
M. 77 (Phyllite source) [Not included in correspondence analysis]
N. 83 (Fisher Mesa) [Not included in correspondence analysis]
S. 41 (Rye Creek)

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fragments (LS), total metamorphic lithic fragments (LM); and members of the pyroxene and amphibole groups (PYR). Those seven parameters represent, on average, 90 percent of all point-count observations recorded from the sand samples. Other point-count parameters were not included for one of two reasons: either the parameter was absent in one or more of the sample groups or the parameter occurred at a frequency of less than one percent in all sample groups. As noted above, the point-count data were transformed into logratios prior to conducting the analyses. All of the sand samples included in the correspondence analysis also were included in this second statistical analysis, with two exceptions. The single sample representing a sedimentary tectonic setting (sample TB-100, Petrofacies O) was not included because it would have violated the assumption of discriminant analysis that each group contain at least two cases (Klecka 1980:11). In addition, the sample collected from the surface of Rye Creek Ruin (sample TB-68) was not included.

Prior to entering the logratio transformed point-count data in a discriminant analysis, a principal components analysis was conducted in order to verify that the underlying structure of the data remained similar to that observed in the correspondence analysis. Table 13.25 reports the results of that analysis. The first component accounts for 41 percent of the variation in the data. It is readily interpretable in geologic terms, and like the first factor of the correspondence analysis it reflects a similar pattern in the data. The first principal

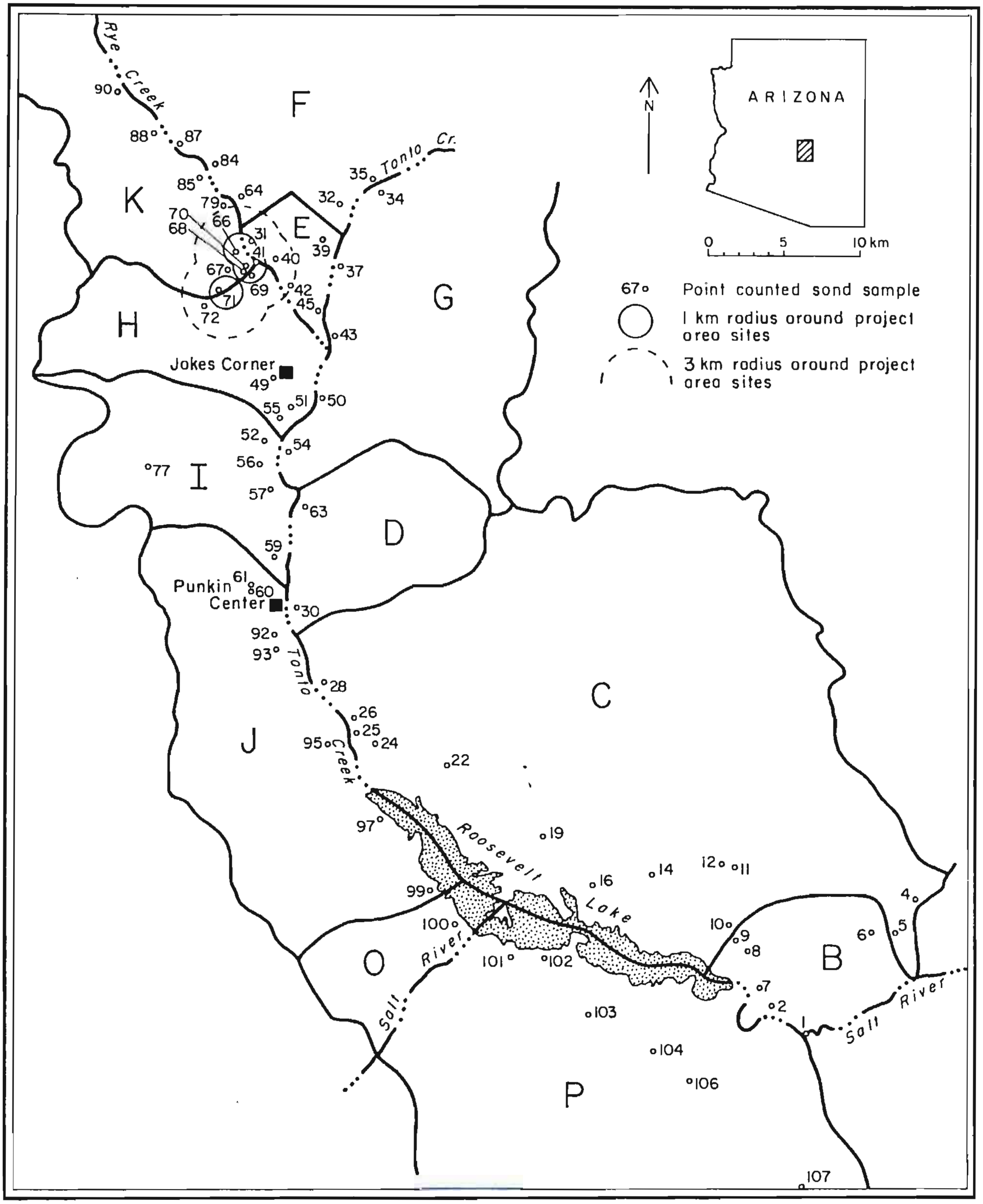

Figure 13.8. Actualistic petrofacies identified through correspondence analysis of sand samples.

Table 13.24. Recalculated point-count parameters.

A. Partially altered plagioclase feldspars
(PPAL = PLAG + PLAGAL)

B. Total plagioclase feldspars
(P = PLAG + PLAGAL + PLAGGN)

C. Alkali feldspars
(K = KSPAR + MICR)

D. Total volcanic lithic fragments
(LV = LVF + LVM + LVV + LVH)

E. Total sedimentary lithic fragments
(LS = LSS + LSA + LSCH + LSCA)

F. Total metamorphic lithic fragments
(LM = LMM + LMF + LMA + LMT + LMTP)

component represents a contrast between volcanic (LV) and metamorphic (LM) rocks on the one hand, and the plagioclase feldspars (P) and pyroxene/amphibole (PYR) minerals on the other.

The transformed sand sample point-count data were then entered in a discriminant analysis. The classification matrix resulting from that analysis is reported in Table 13.26. Examination of this table shows that the discriminant analysis of the sand data resulted in an accuracy of 87.7 percent correct predictions. As would be expected from the correspondence analysis, the discriminant analysis indicated that there is a degree of compositional overlap between some of the samples at the tectonic level of analysis. No compositional overlap was observed between the lithic-rich sand samples that represent Petrofacies E, G, H, I, and K, and the mineral-rich sand samples that represent Petrofacies B, C, D, F, J, and P. The discriminant analysis also predicted that the wash sand sample collected from Rye Creek near Rye Creek Ruin (sample TB-41) exhibited a granitic composition. The unusual nature of that assignment has been commented on above, and will be addressed further in the discussion of "specific" sources below.

Third Statistical Analysis: Discrimination of Specific Source. The discriminant analysis, like the correspondence analysis, showed that two macro-compositional groups are present in the Tonto Basin sands: a lithic-rich group of sands and a mineral-rich group of sands. Accordingly, two additional discriminant analyses were conducted.

The first of those analyses was conducted to determine the set of functions that best discriminates between the petrofacies predicted to be present in the lithic-rich sands. That analysis used the same seven logratio transformed point-count parameters that were utilized in the discriminant analysis reported above. The two sand samples identified in the correspondence analysis as exhibiting unusual compositions and were determined to have been collected from floodplain settings were not included in the analysis. The classification matrix resulting from the discriminant analysis is reported in Table 13.27. Examination of this table shows that the discriminant analysis of the lithic-rich sand data resulted in 88 percent of the samples being correctly predicted as to petrofacies membership. Furthermore, all of the misclassifications occurred between the various metamorphic petrofacies. No misclassifications occurred among the mixed granitic-lithic Petrofacies E and the metamorphic Petrofacies G, H, I, and K.

The last analysis of the sand samples was conducted to determine the set of functions that best discriminate between the petrofacies predicted to be present in the mineral-rich sands. Inspection of the point-count data indicated that the percentage of extremely altered plagioclase feldspars (i.e., >90% altered) showed considerable variation by petrofacies within these samples. Accordingly, two plagioclase feldspar parameters were utilized in the discriminant analysis. The first is the recalculated parameter that sums the PLAG and

Table 13.25. Sand sample principal component loadings and percent variance explained.

	Principal Components					
Parameter	1	2	3	4	5	6
P	-0.915	0.004	0.127	-0.024	0.295	-0.247
K	-0.035	-0.913	-0.141	0.132	-0.338	-0.119
QTZ	0.351	-0.818	-0.131	-0.215	0.339	0.172
LV	0.712	0.120	0.383	0.563	0.122	0.020
LS	0.167	0.494	-0.845	0.108	0.038	0.006
LM	0.736	0.363	0.271	-0.486	-0.108	-0.070
PYR	-0.913	0.193	0.191	0.003	-0.137	0.274
Eigenvalue	2.872	1.929	1.025	0.629	0.363	0.182
Percent variance explained by component	41.029	27.558	14.638	8.983	5.188	2.604
Cumulative percent	41.029	68.587	83.225	92.208	97.396	100.000

Table 13.26. Classification matrix of tectonic setting for known and "unknown" Tonto Basin wash sand samples. Accuracy of prediction is 87.7 percent (n = 65).

	Predicted Group				
Assigned Group	Granitic-Sedimentary	Diabasic	Granitic	Mixed: Granitic-Lithic	Metamorphic
Granitic-Sedimentary	3	0	2	0	0
Diabasic	0	10	3	0	0
Granitic	2	0	18	0	0
Mixed: Granitic-Lithic	0	0	0	4	1
Metamorphic	0	0	0	0	22
"Unknown" sample from Rye Creek (#TB41)	0	0	1	0	0

PLAGAL point-count parameters (PPAL). The second is the highly altered plagioclase point-count parameter (PLAGGN). Therefore eight logratio transformed parameters were included in the discriminant analysis of the mineral-rich sands: PPAL; PLAGGN; K; QTZ; LV; LS; LM; and PYR. The classification matrix resulting from that analysis is reported in Table 13.28.

Examination of Table 13.28 shows that the discriminant analysis of the mineral-rich sands resulted in approximately 82 percent of the samples being correctly assigned as to petrofacies membership. Misclassifications occurred between the granitic-sedimentary Petrofacies B and the granitic Petrofacies P, between the diabasic Petrofacies C and both the granitic-sedimentary Petrofacies B and the granitic Petrofacies P, and amongst the granitic Petrofacies D, F, J, and P. The statistical misclassification of samples recovered from diabasic Petrofacies C may be attributable to unusually low proportions of the heavy mineral pyroxene (PYR parameter) being present in some samples.

The discriminant analysis predicted a Petrofacies F composition for the sand sample collected from Rye Creek near Rye Creek Ruin (sample TB-41). Petrofacies F is the closest granitic source, and sediment from Petrofacies F enters Rye Creek upstream from where TB-41 was collected. Miksa (Appendix A, this volume) notes an unusual type of feldspar intergrowth texture in the samples collected from Petrofacies E. That type of intergrowth texture was not observed in any of the other analyzed sand samples collected from the Tonto Basin with the exception of sample TB-41 from Rye Creek. Therefore, while the discriminant analysis predicts a Petrofacies F composition for sample TB-41 there is qualitative evidence that contradicts that prediction. We note, however, that the sand in sample TB-41 is doubtless related to the granitic composition of Petrofacies F as Rye Creek should contain a mixture of sediments from Petrofacies E, F, H, and K. It is also important to note that the type of feldspar intergrowth texture that was observed in the sands from Petrofacies E and sample TB-41 was not observed in any of the thin-sectioned ceramics.

Table 13.27. Classification matrix of petrofacies for known Tonto Basin metamorphic and mixed: granitic-lithic sand samples. Accuracy of prediction is 88.0 percent (n = 25).

	Predicted Petrofacies Group				
Assigned Petrofacies Group	E	G	H	I	K
E	4	0	0	0	0
G	0	3	0	1	0
H	0	1	4	0	0
I	0	0	0	4	0
K	0	0	0	1	7

Statistical Analyses of Ceramic Samples

We now turn from the sand samples to a focus on plainware-redware sherds within the RCM assemblage. The temper composition of all plainware and redware rim sherds and restorable vessels recovered from well-dated, behaviorally unmixed deposits (as determined through the contextual assessments) was classified with the aid of the reflected-light binocular microscope at 10-X magnification. Approximately 95 percent of all temper observations fell into one of twelve compositional groups (Table 13.29). "Representative" (Shepard 1936:460) or "typical" (Bishop et al. 1982:279) examples of each group were selected for petrographic analysis. Approximately 5 percent of each group was thin-sectioned and point-counted. Two redwares recovered during the testing phase also were included in the petrographic analysis because characteristics of their slip and paste (Heidke 1989b:130) suggested that they may represent a distinct redware type.

Figure 13.9 is the correspondence analysis plot of the first two factors of the sherd point-count data. Analysis of the sherd data resulted in a plot that closely resembles that produced by the sand data. In the sherd plot the first factor again reflects a contrast between rocks and minerals. Convex hulls were drawn around each group of sherds that were predicted to exhibit temper sand derived from a similar tectonic setting based on the binocular microscopic classification. The upper convex hull is drawn around those sherds previously classified as containing a lithic-rich metamorphic sand temper (groups D, E, and H). The lower left convex hull is drawn around those sherds previously classified as containing a mineral-rich granitic sand temper (groups A, B, C, and I), while the lower right convex hull is drawn around those sherds previously classified as containing a mineral-rich sand with high percentages of pyroxene and/or hornblende (groups F and K).

The functions derived from the first discriminant analysis of the sand data were then used to classify the tectonic origin of the point-counted sherds' sand temper (Table 13.30). That classification represents an independent check on the binocular microscopic assignment of each sherd's temper group, and indicates that the binocular microscopic assessment of tectonic setting was correct approximately 95 percent of the time. The sherds that were classified as containing a metamorphic sand temper were then also classified as to petrofacies using the functions derived from the discriminant analysis of the metamorphic and mixed granitic-lithic sand samples (Table 13.31). The discriminant classification of the metamorphic sand-tempered sherds indicates that most of them exhibit either a Petrofacies H or K composition, while only a few exhibit a Petrofacies I composition, and that Petrofacies E and G are not represented. Importantly, all of the sites in the project area lie within Petrofacies H and K, and all of sherd group D were assigned to Petrofacies K. The sherds that were classified in the first discriminant analysis as containing a mineral-rich sand temper were then classified as to petrofacies using the functions derived from the discriminant analysis of the granitic and diabasic sand samples (Table 13.32). That analysis indicates that most of those sherds exhibit either a Petrofacies F or J composition, and all of sherd group B were assigned to Petrofacies J. Petrofacies C and D are also well represented. Only two sherds were attributed to Petrofacies P. No sherds were classified as Petrofacies B in composition.

Table 13.28. Classification matrix of petrofacies for known and "unknown" Tonto Basin granitic, granitic-sedimentary, and diabasic sand samples. Accuracy of prediction is 81.6 percent (n = 38).

	Predicted Petrofacies Group					
Assigned Petrofacies Group	B	C	D	F	J	P
B	4	0	0	0	0	1
C	1	10	0	0	0	2
D	0	0	2	0	0	0
F	0	0	1	3	0	1
J	0	0	0	1	6	0
P	0	0	0	0	0	6
"Unknown" sample from Rye Creek (#TB41)	0	0	0	1	0	0

The discriminant analysis of the thin-sectioned sherds, therefore, produced three findings, namely: (1) most of the metamorphic sand-tempered sherds exhibit either a Petrofacies H or K composition; (2) most of the mineral-rich granitic sand-tempered sherds exhibit either a Petrofacies F or J composition; and (3) no sherds exhibiting a Petrofacies B, G, or E composition were identified. We have already noted that the project area lies within Petrofacies H and K. Therefore, metamorphic sand-tempered sherds exhibiting those petrofacies' compositions are compatible with local geology and may be considered products of "local" manufacture. The other two sources that were strongly represented in the point-counted sherds are Petrofacies J and F. The distance from the project area to Petrofacies J suggests that those ceramics doubtless represent "nonlocal" production sources. The proximity of Petrofacies F to the project area and the reasonably large percentage of the point-counted sherds that were attributed to that source is more problematic.

Table 13.29. Binocular microscopic classification of sand-temper groups.

Tectonic Origin	Key Grain	N (% Total analyzed sherds)	N (% Thin-sectioned sherds)	Percentage of each unique temper group thin-sectioned	Unique Group Label*
Plutonic	Absent/Indeterminate	200 (23.7)	9 (18.0)	4.5	A
Plutonic	White opaque	54 (6.4)	4 (8.0)	7.4	B
Plutonic	Pink opaque	182 (21.5)	8 (16.0)	4.4	C
Plutonic	Minor Pyribole	49 (5.8)	5 (10.0)	10.2	I
Plutonic or Hypabyssal	High Pyribole	87 (10.3)	6 (12.0)	6.9	F
Metamorphic	Absent/Indeterminate	40 (4.7)	2 (4.0)	5.0	D
Metamorphic	Metasedimentary	113 (13.4)	8 (16.0)	7.1	E
Indeterminate Plutonic-Metamorphic I	Absent/Indeterminate	35 (4.1)	2 (4.0)	5.7	H
Indeterminate Plutonic-Metamorphic II	Absent/Indeterminate	24 (2.8)	2 (4.0)	8.3	J
Indeterminate Hypabyssal or Metamorphic	Pyribole?	9 (1.0)	1 (2.0)	11.1	K
Indeterminate, low temper percent, small temper grains	Absent/Indeterminate	36 (4.3)	2 (4.0)	5.6	G
High LMT	Schist	5 (0.6)	1 (2.0)	20.0	M
"Type 1" Redware (from testing)	Not Applicable	N/A	2 (N/A)	N/A	N

*Note: The "Unique Group Label" is not related to the alphabetical label assigned to each petrofacies.

The major assumption underlying the successful application of the petrofacies concept to the analysis of archaeological ceramics is that prehistoric potters utilized sand temper resources located near the site of ceramic production. Arnold's survey of the ethnographic literature supports the soundness of this assumption (1985:51-52, 232, Table 2.2). A boxplot summarizing his data on the distance traveled by potters to a temper resource shows that half of all traditional potters working in terrestrial environments (i.e., nonmaritime settings, 26 examples included) utilize a temper resource located within 1 km of their settlement and that three-quarters utilize a resource located within 3 km (Figure 13.10). Furthermore, the data summarized in this boxplot used the longest distance reported when a range of distances was given. If the boxplot had summarized Arnold's data using the shortest distances, then the upper hinge of the distance distribution would be at 2 km rather than 3 km. Accordingly, we consider 3 km to be a reasonable estimate of the likely maximum distance a traditional potter would be willing to travel to collect sand temper. Circles of 1 km and 3 km radius were therefore drawn around the southernmost, easternmost, and northernmost of the sites in the project area in order to estimate the likely "local" temper resource procurement zone (see Figure 13.8). Based on that estimate, we could consider petrofacies F sand-tempered sherds indicative of possible local production only for those ceramics recovered from sites located at the north end of the project area. Those ceramics are referred to as "possibly local" in the following discussion of ceramic production and distribution.

Table 13.30. Classification of "unknown" sand-tempered sherd samples based on discriminant functions derived from wash sand samples. Accuracy of binocular microscopic classification is 94.7 percent (n=38; indetermiante groups F, G, H, J, K, M, and N not included.

	Predicted Tectonic Setting				
Binocular Microscopic Classification of Sand Temper	Granitic-Sedimentary	Diabasic	Granitic	Mixed: Granitic-Lithic	Metamorphic
Plutonic Group A	0	1	8	0	0
Plutonic Group B	0	0	4	0	0
Plutonic Group C	0	0	8	0	0
Plutonic Group I	0	1	4	0	0
Plutonic or Hypabyssal Group F	0	6	0	0	0
Metamorphic Group D	0	0	0	0	2
Metamorphic Group E	0	0	0	0	8
Indeterminate Plutonic-Metamorphic Group H	0	0	0	0	2
Indeterminate Plutonic-Metamorphic Group J	0	0	1	0	1
Indeterminate Hypabyssal-Metamorphic Group K	0	1	0	0	0
Indeterminate (Low temper percent, small temper grains) Group G	0	0	2	0	0
High Schist Group M	0	0	0	0	1
"Type 1" Redware (from testing) Group N	0	0	0	0	2

CERAMIC PRODUCTION AND DISTRIBUTION EVIDENCE IN THE UPPER TONTO BASIN

Petrofacies assignments of the point-counted sherds were used as a guide to model the actual frequencies of specific sources represented in the entire analyzed sample. In future studies of Tonto Basin ceramics the key developed by Miksa (Appendix A, this volume) for the qualitative recognition of the individual petrofacies should be used during the binocular microscopic classification of temper sands (see Doelle et al. 1991). As that key was not available when the data were recorded for this study, approximate petrofacies frequencies were interpolated by combining the distribution of petrofacies assignments for the point-counted sherds with their frequencies in the unique temper source groups of each ware and for each point in time (Table 13.32). The data reported in Table 13.33 were then simplified by graphing the frequencies in a series of pie charts.

Figure 13.11 shows the trends in "local," "nonlocal," and "possibly local" ceramics by time and ware. The highest percentage of "locally" produced ceramics occurs in the plainwares recovered from the earliest dated contexts, those of the Gila Butte phase. The percentage of "locally" produced plainware ceramics declines thereafter. Very few of the Early Classic redwares were locally produced. Most of those redwares were

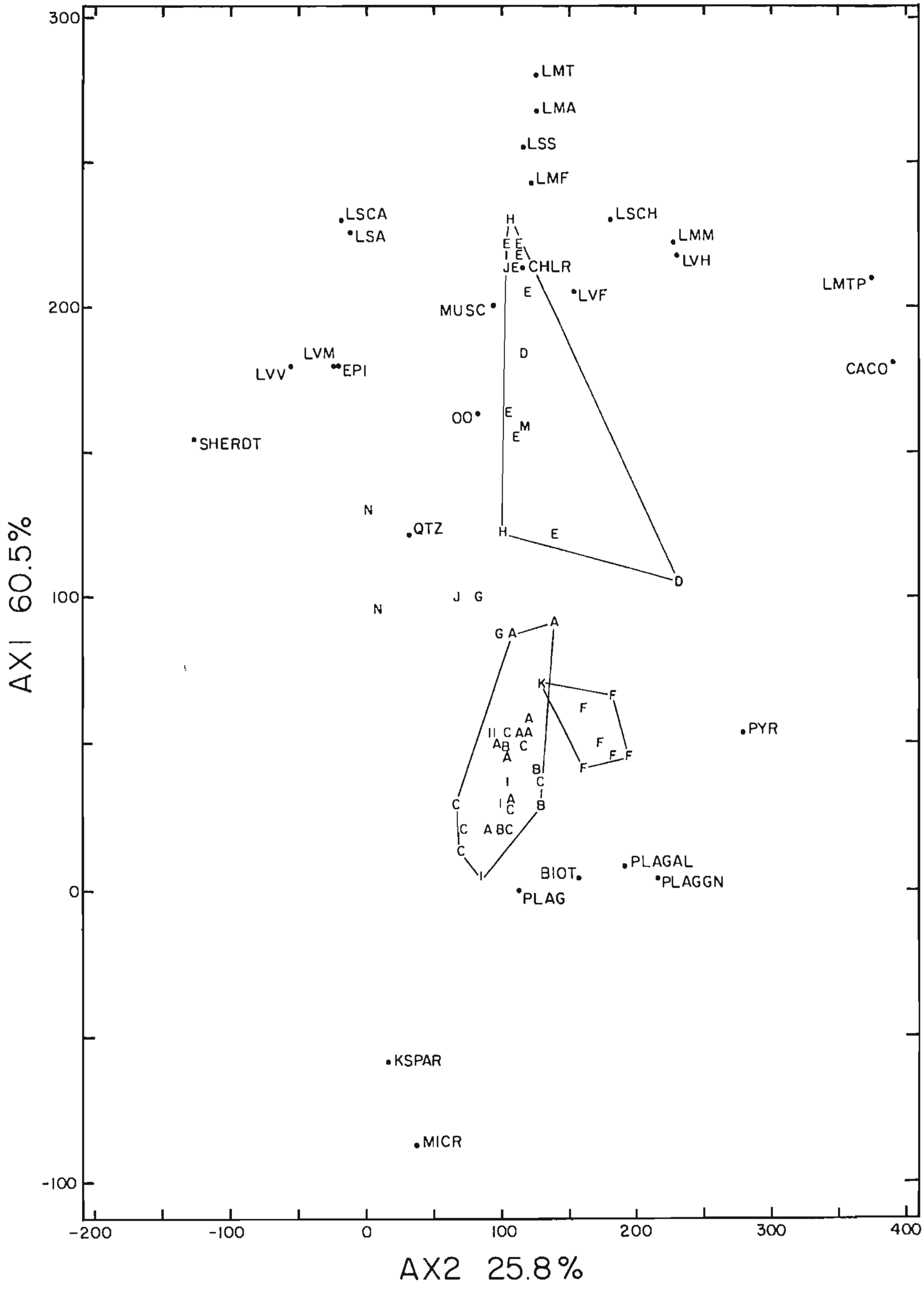

Figure 13.9. Scatterplot of the percentage of faceted polishing stones present in the ground stone assemblage by the overall percentage of plainwares and redwares containing metamorphic sand temper.

Table 13.31. Classification of "unknown" metamorphic sand-tempered sherd samples based on discriminant functions derived from metamorphic and mixed: granitic-lithic wash sand samples.

Binocular Microscopic Classification of Sand Temper	Predicted Petrofacies E	G	H	I	K
Metamorphic Group D	0	0	0	0	2
Metamorphic Group E	0	0	5	1	2
Indeterminate Plutonic-Metamorphic Group H	0	0	1	1	0
Indeterminate Plutonic-Metamorphic Group J	0	0	1	0	0
"Type 1" Redware (from testing) Group N	0	0	0	0	2

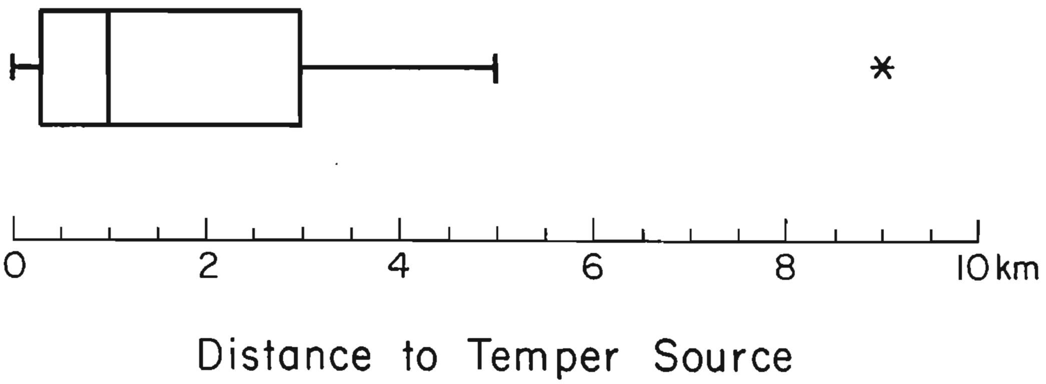

Figure 13.10. Summary of data on distance traveled by potters to temper resources (data derived from Arnold 1985:51-52, 232, Table 2.2).

produced somewhere in Petrofacies J. Another way to examine the data is to assign the petrofacies to larger zones vis-à-vis the region's trunk streams (Figure 13.12). Virtually all of the Gila Butte phase plainwares were produced at sites located west of Tonto Creek. During Sacaton and Early Classic times a large percentage of the plainwares were produced at sites located east of Tonto Creek, but very few were produced at sites located south of the Salt River. Few of the Early Classic redwares were produced east of Tonto Creek and fewer still south of the Salt River. As noted above, most of those redware ceramics were produced in Petrofacies J, which is located to the west of Tonto Creek south of the project area. Virtually all of the analyzed ceramics were tempered solely with sand (Table 13.34).

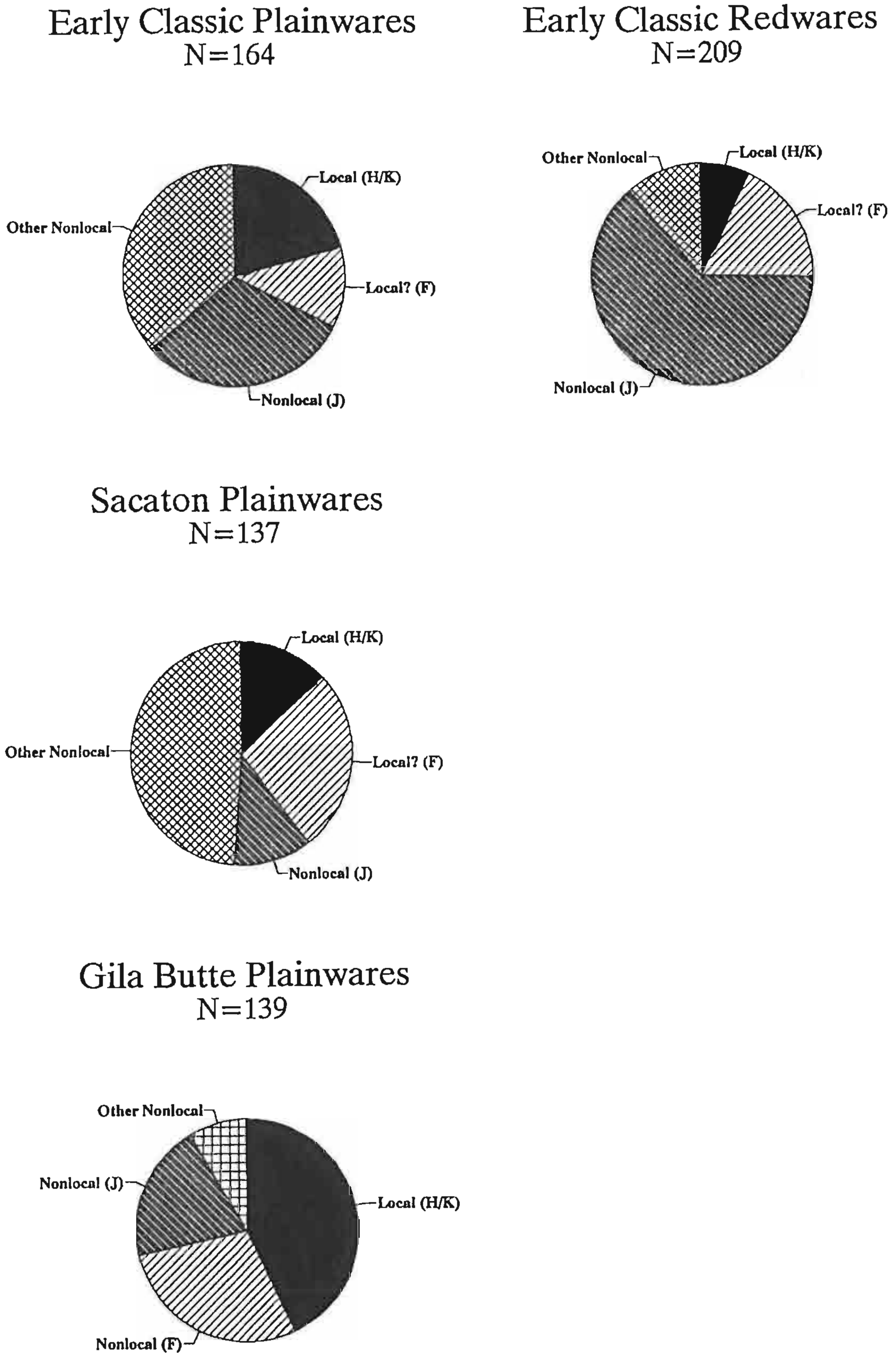

Figure 13.11. Trends in "local", "nonlocal", and "possibly local" ceramics by time and ware.

Table 13.32. Classification of "unknown" granitic and diabasic sand-tempered sherd samples based on discriminant functions derived from granitic, granitic-sedimentary, and diabasic wash sand samples.

	Predicted Petrofacies					
Binocular Microscopic Classification of Sand Temper	B	C	D	F	J	P
Plutonic Group A	0	0	2	2	4	1
Plutonic Group B	0	0	0	0	4	0
Plutonic Group C	0	0	3	0	5	0
Plutonic Group I	0	2	0	2	0	1
Plutonic or Hypabyssal Group F	0	3	0	3	0	0
Indeterminate Plutonic-Metamorphic Group J	0	0	0	1	0	0
Indeterminate Hypabyssal-Metamorphic Group K	0	0	0	1	0	0
Indeterminate (low temper percent, small temper grains) Group G	0	0	0	1	0	0

The temper source data collected during this study provides an indirect view of ceramic production and specialization. That is, the sand temper observed in most of the analyzed ceramics indicates "nonlocal" production sources. The highest percentage of "locally" manufactured plainwares occurs at the Deer Creek site (AZ O:15:52) dating to the earliest phase. That site also had the highest percentage of faceted polishing stones in the ground stone assemblage (Figure 13.13, faceted polishing stone data abstracted from Craig and Eppley, Table 15.3, this volume). The overall evidence for ceramic production from this Gila Butte phase site, therefore, suggests localized ceramic production possibly at the household level. The "nonlocal" ceramics recovered from that site also indicate that exchange relationships were occurring to the north and south of the site on the west side of Tonto Creek (Petrofacies F and J), and to a limited extent east of Tonto Creek (Petrofacies C).

When the later Sacaton and early Classic ceramic collections are examined at the site level rather than at the phase level of analysis, a positive correlation is also observed between the percentage of sherds exhibiting local metamorphic sand temper and the percentage of faceted polishing stones in the ground stone assemblage. That is, the higher the percentage of local ceramics in a site's collection, the higher the percentage of polishing stones (the collection from Rye Creek Ruin, which is limited to artifacts recovered from test units in three trash mounds, represents the only exception to that trend). However, the percentage of local ceramics and polishing stones is always lower at these Sacaton and Roosevelt phase sites when compared with the Gila Butte phase site. The spatial extent of exchange relations also increased in Sacaton and early Classic times relative to Gila Butte, as indicated by the percentage of plainwares produced east of Tonto Creek and south of the Salt River. The nature of the production system for these ceramics remains unknown, but the temper findings suggest a qualitatively different organization than that observed for the earlier Gila Butte phase settlement.

Early Classic Plainwares
N=164

Early Classic Redwares
N=209

Sacaton Plainwares
N=137

Gila Butte Plainwares
N=139

Figure 13.12. Assignment of petrofacies to larger zones vis-à-vis the region's trunk streams.

Table 13.33. Interpolated petrofacies frequencies in the analyzed sand-tempered ceramics.

	Metamorphic			Granitic				Diabasic
Phase/Ware	H	I	K	D	F	J	P	C
Gila Butte/ Plainware (N=139)	40.3%	0	2.9%	0	28.4%	20.1%	0	8.3%
Sacaton/Plainware (N=137)	0	0	13.2%	22.2%	26.5%	11.6%	4.7%	21.8%
Early Classic/ Plainware (N=164)	16.5%	0	4.3%	28.0%	11.9%	31.0%	6.2%	2.1%
Early Classic/ Redware (N=209)	2.3%	2.3%	4.9%	0	18.3%	63.4%	1.1%	7.6%

Table 13.34. Temper types present in the analyzed ceramics. Row percentages are given in parentheses.

	TEMPER TYPE					
Phase/Ware	Sand	Sand and Mica	Schist	Sand and Schist	Phyllite	Indeterminate
Gila Butte/ Plainware	146 (96.0)	3 (2.0)	2 (1.3)	1 (0.7)	0	0
Sacaton/Plainware	150 (96.2)	2 (1.3)	3 (1.9)	0	0	1 (0.6)
Early Classic/Plainware	174 (99.4)	0	0	0	0	1 (0.6)
Early Classic/Redware	225 (98.3)	3 (1.3)	0	0	1 (0.4)	0

Production of red-slipped ceramics began in earnest in the early Classic period. Most of the redwares recovered from the project area were produced somewhere in Petrofacies J. Although the nature of the production system that manufactured those ceramics and the distribution system that brought them to the Upper Tonto Basin remains unknown, the magnitude of their frequency suggests that "intensive producers" (P. Rice 1991:266) were involved. Two platform mound communities are located in Petrofacies J -- Horse Pasture and Park Creek -- and the large scale production of redwares from this petrofacies in our collections may indicate that redware production was under the direction or control of one or both of those communities. Alternatively, it may indicate that some residents of the Lower Tonto Basin may have become specialists in pottery production as the size of the Classic period occupation increased and access to arable land decreased. Arnold (1985:168-201) has argued for the importance of population pressure and declining land base in the development of ceramic specialization.

DISCUSSION

A number of important issues that need to be considered whenever one wishes to relate source rock composition to sand (and sand temper) composition have been presented in the previous sections. The fact that heterogeneity of source rocks is to be expected within a drainage and that climate, relief, transport history, and depositional history all affect final sand composition, indicates that mapped bedrock geology alone does not represent an actualistic model for the accurate characterization of potential sand temper resource

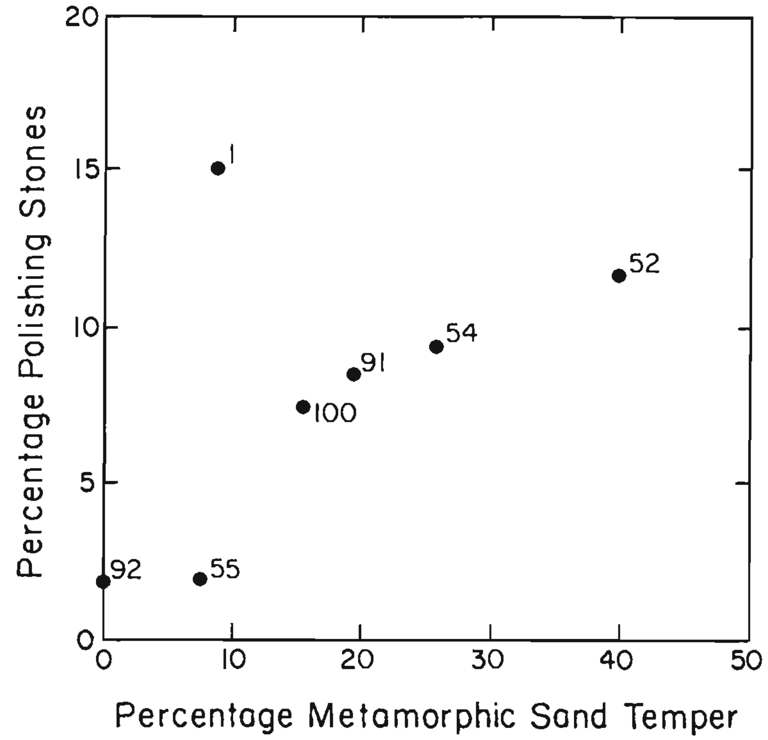

Figure 13.13. Scatterplot of the percentage of faceted polishing stones present in the ground stone assemblage by the overall percentage of plainwares and redwares containing metamorphic sand temper.

compositions within a region. In order to develop an actualistic model, we advocate the use of the point-counting methods previously discussed to determine statistical representations of the modal compositions of samples, and the petrofacies concept to reveal provenience characteristics in the point-count data. Applied to the regionalization of potential sand temper resources, the petrofacies concept accords well with arguments by Bishop and others (1982; Arnold et al. 1991) that compositional analysis is essentially spatial in nature and that the development of a zonal approach is necessary because ceramic raw materials can exhibit considerable homogeneity over an extensive area. Review of a study area's bedrock geology, geomorphology, and sedimentary history can suggest whether sufficient compositional variability would be expected to occur in the area in order to allow for its subdivision into petrofacies. Only the compositional data recorded from the sand samples allows that expectation to be tested (Figure 13.14). The sand samples also provide the empiric data used to define the spatial extent of each petrofacies, and to assess the degree of compositional variability present within each petrofacies. Once an actualistic model has been developed, the petrofacies' compositional data can be applied to the characterization of sand temper. This result leads us to suggest that, when applied to an analysis of archaeological ceramics, the concept of the petrofacies, or sand compositional zone, may be thought of as a spatial analogue to the temporal phase. That is, a given petrofacies represents a parameter that bounds a unit of ceramic production space, just as a given phase represents a parameter that bounds a unit of ceramic production time. We recognize that the boundaries of the petrofacies, like those of the phase, are heuristic in nature. Although we strive to make the boundaries as natural as possible (i.e., in accord with objective or independent criteria), the models are artificial constructs imposed on the archaeological data in order to clarify patterning within it (cf., Hargrave 1932:Foreward).

The twelve petrofacies defined by the Tonto Basin actualistic model clearly point to a major problem inherent in type definitions, such as the Central Arizona Plainware series, that are partially based on sand temper composition. If the actual amount of geological variation in a region is not well documented, then the validity of type definitions based on geological data must remain questionable. The alternative is to create overdrawn type distinctions that confuse cultural variation with geological variation, a problem noted by Jeter (1978:74) and Bruder and Ciolek-Torrello (1987:91).

In our sand samples most of the ones identified as mineral-rich in composition conform to the description of Tonto Plain/Tonto variety published in Wood (1987:14-15). Their composition is predominantly made up of arkosic sand (i.e., a quartz sand containing 25 percent or more feldspar grains), biotite mica flakes, and black crystal fragments. A distinction cannot be made between the black crystal fragments that represent pyroxene crystals and those that represent hornblende crystals in sand sample or as temper; that distinction can only be made using the petrographic microscope. All of the analyzed sand samples from Petrofacies D, F, and P would produce a Tonto Plain/Tonto variety temper composition. Sand samples TB-6, TB-8, and TB-9 from Petrofacies B, and sample TB-92 from Petrofacies J could not produce pottery classified as Tonto Plain/Tonto variety in composition because they contain less than 25 percent feldspar grains. Sand sample TB-24 from Petrofacies C could not produce pottery classified as Tonto Plain/Tonto variety in composition because it lacks biotite mica. Given those exceptions 86.8 percent of the mineral-rich sand samples (n=38) could produce pottery classified as Tonto Plain/Tonto variety in composition. Based on our discriminant analysis of the sand data we could, therefore, view Petrofacies B, C, D, F, J, and P as resource zones for compositionally distinct, unnamed subvarieties of the type Tonto Plain/Tonto variety.

In contrast to the mineral-rich sand samples most of the sand samples identified as lithic-rich in composition do not conform to the description of Tonto Plain/Tonto variety published in Wood (1987), nor do they exhibit compositions similar to any of the types described in the Central Arizona Plainware series discussed in Wood. Among the lithic-rich sand samples only samples TB-39 and TB-42 from Petrofacies E, sample TB-34 from Petrofacies G, and sample TB-52 from Petrofacies I would produce a Tonto Plain/Tonto variety temper composition. Two of the remaining 24 lithic-rich sand samples -- TB-31 and TB-40 from Petrofacies E -- would produce a Tonto Plain/Verde variety temper composition (Wood 1987:13-14). Their composition is predominantly made up of arkosic sand with biotite mica flakes, but they lack black crystal fragments. With the exception of the four sand samples listed below, the remaining lithic-rich sand samples could not produce pottery classified as Tonto Plain/Tonto variety because they contain less than 25 percent feldspar grains. The four exceptions are: sand sample TB-54 from Petrofacies G and TB-70 from Petrofacies K that lack biotite mica as well as adequate amounts of feldspar; sample TB-71 from Petrofacies K that lacks black crystal fragments as well as adequate amounts of feldspar; and sample TB-59 from Petrofacies I that contains enough feldspar but lacks biotite mica. Overall 78.6 percent of the lithic-rich sand samples (n=28) do not exhibit compositions conforming to any recognized type; generally those sands are dominated by metamorphic rock fragments. In his discussion of Tonto Plain, Wood (1987:18) has noted that there are a number of minor, unnamed local varieties present on the Tonto National Forest, especially in the northern portion of the forest. Based on our discriminant analysis of the sand data we could, therefore, view Petrofacies E, G, H, I, K, and O as resource zones for compositionally distinct, unnamed minor varieties of Tonto Plain.

Application of the petrofacies concept to the analysis of archaeological ceramics also leads us to recognize that while the selection and processing of temper resources are directly reflected in the compositional data, inferences regarding ceramic production and exchange must necessarily relate the compositional data to other conditions (Bishop et al. 1982:275). The qualitative and quantitative analyses of the temper can distinguish among the known potential sources of this ceramic raw material by establishing probable relationships of pottery production to geographically localized raw materials (Bishop et al 1982:275-276). Those relationships must, however, be evaluated through the use of other independent lines of evidence. In the present study, the only independent line of evidence available was the percentage of faceted polishing stones in the ground stone assemblage. We would also recommend that the study area's settlement system be evaluated, especially the distance between settlements and the degree of seasonality exhibited by settlements, followed by an evaluation of the lithic, faunal, macrobotanical, and pollen data for insights into the effective catchment area utilized by a settlement. The degree to which the effective catchment of settlements regularly overlaps affects inferences regarding the use of temper resources. The presence or absence of pottery-forming tools, pottery-finishing tools, ceramic raw materials, and any evidence of ceramic firing also provides another critical body of evidence

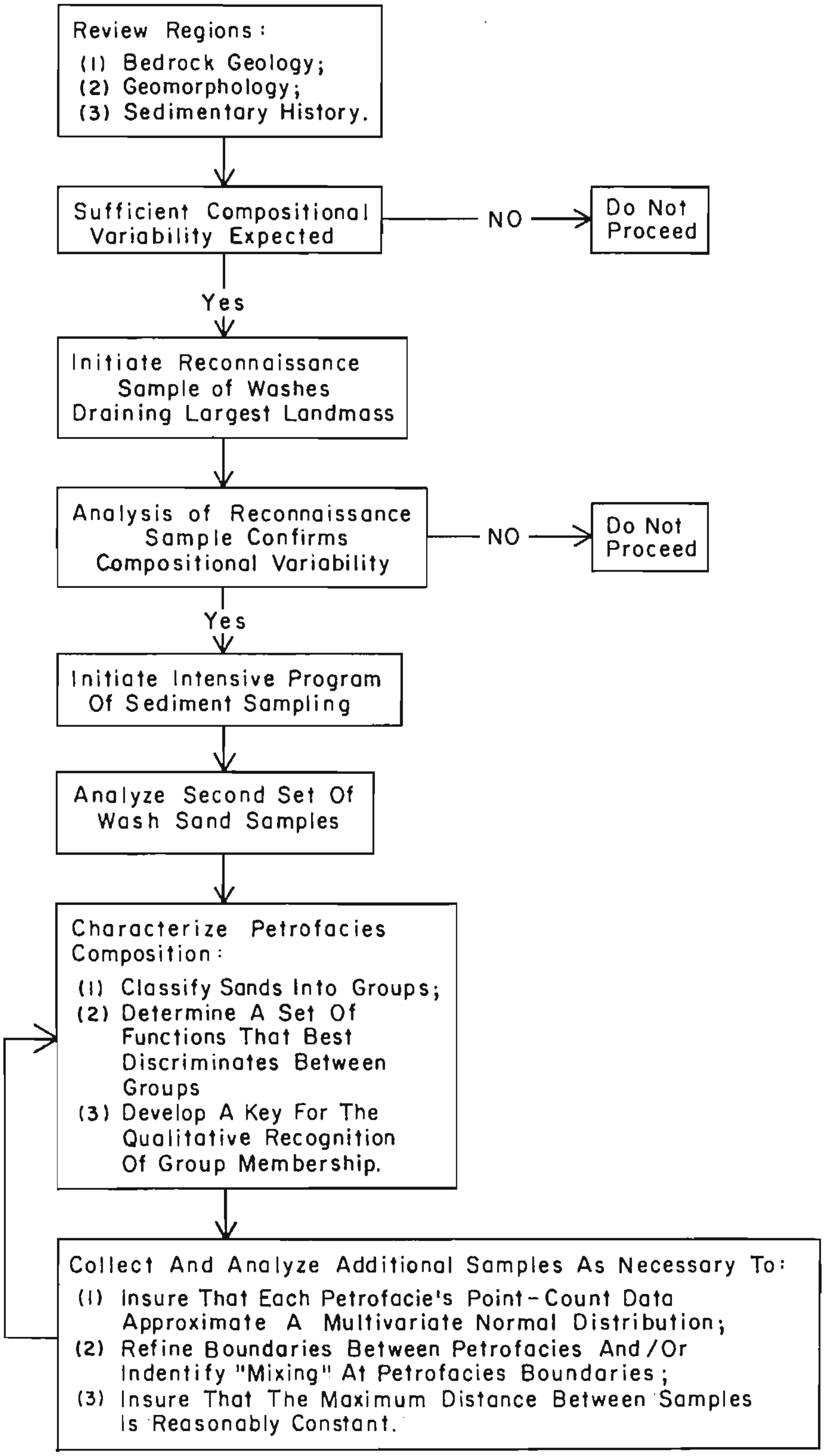

Figure 13.14. Flow chart showing the steps involved in the development of an actualistic petrofacies model.

with which to evaluate the compositional data. We emphasize the importance of considering both lines of evidence in evaluating the possibility of localized ceramic production. Previous arguments for localized ceramic production in the Tonto Basin have, in the absence of temper or paste data, equated artifactual evidence (e.g., sherd piles, possible puddling pits) with localized production (e.g., Rice 1985: 134, 154). Our approach stresses reliance on multiple lines of archaeological and archaeometric evidence in examining ceramic production sources.

Finally, applying the petrofacies concept to the analysis of archaeological ceramics has a major advantage over instrumental characterization techniques in terms of sample size. Nearly all sand-tempered vessels can be characterized by the ceramicist as an integral part of an attribute-based analysis that also includes the recording of provenience, morphological, technological, and decorative-design variables for each vessel. Once that information has been collected and the accuracy of the ceramicist's classification has been assessed with the petrographic data, other detailed ceramic studies may proceed. Although the principal goal of most characterization studies consists of evaluating evidence for ceramic production and exchange, the potential result of spatial control over the entire ceramic data set far exceeds production and distribution studies. The ability to partition the ceramic data set by production source allows two aspects of artifact variability to be examined. Variability related to ceramic production source can be examined by comparing specific morphological, technological, or decorative-design attribute frequencies in the ceramics recovered from one site (or context) but produced in two or more sources. Variability related to ceramic exchange or distribution can be examined by comparing these attribute frequencies in ceramics produced in one source but recovered from two or more sites (or contexts). The two aspects of artifact variability may be examined synchronically, or dynamic variability may be examined using diachronic data. The synchronic and/or diachronic data sets may consist of one or multiple wares. The petrofacies concept, therefore, furthers the development of problem-oriented archaeological research that extends beyond most petrographic or instrumental characterization studies. We now turn to metric morphological attributes of the assemblage that include both redwares and plainwares.

COMBINED DATA FROM PLAINWARES AND REDWARES

Metric Data

In this section we summarize the results of our analysis of metric data from the redwares and plainwares. Metric data listed in Table 13.35 and graphically presented Figures 13.15-13.23 employ two standard graphical formats: the histogram and the box-and-whisker plot. For each quantitative attribute displayed (e.g., bowl orifice diameter, vessel wall thickness, rim height), we use one or more graphs to report a data set from a particular point in the sequence. For example, we often compare the distributions of data sets from the three phases examined throughout the chapter (i.e., Gila Butte, Sacaton and early Classic) to identify temporal trends in the metrical data.

Box-and-whisker plots provide visual summaries of frequency distributions for particular ceramic attributes. This form of plot provides needed detail in cases where one or both of the tails of a distribution contain extremely large or small values (Hartwig and Dearing 1979:23). The median value of each data batch is indicated by the central vertical line within the "box." The median splits the ordered batch of measurements in half; the hinges split the remaining halves in half again. These hinges bound the interquartile range or midspread of the distribution. The ends of the "whiskers" denote the adjacent (usually outermost) values. Outside values are indicated by an asterisk; far outside values (or outliers) are indicated by a circle (see also Velleman and Hoaglin 1981:66-69). The vertical dashed lines mark the upper and lower hinges of the entire data batch of each variable. Their presence allows for the rapid identification of individual data batches having unusually high or low median values.

Table 13.35. Metric morphological data from Gila Butte, Sacaton, and early Classic contexts by ware.

Phase	Bowl Orifice Diameter (cm)			Bowl Vessel Wall Thickness			Jar Aperture Diameter (m)			Jar Vessel Wall Thickness (mm)			Jar Rim Height (mm)			Jar Upper Body Profile Slope (degrees)		
	PW	RW	Total	PW	RW	Total	PW	RW	Total	PW	RW	Total	PW	RW	Total	PW	RW	Total
GILA BUTTE																		
Number	29	0	29	80	2	82	18	1	19	48	1	49	27	1	29	14	0	15
Minimum	14.00	-	14.00	3.30	4.50	3.30	7.50	16.00	7.50	4.00	6.80	4.00	3.30	16.00	1.70	8.50	N/A	8.50
Maximum	41.00	-	41.00	7.10	5.70	7.10	22.00	16.00	22.00	8.40	6.80	8.40	21.80	16.00	21.80	61.00	N/A	61.00
Median	21.00	-	21.00	4.95	5.10	4.95	15.00	16.00	15.00	5.60	N/A	5.60	13.80	16.00	13.80	44.50	N/A	47.00
Mean	23.95	-	23.95	5.08	5.10	5.08	15.17	16.00	15.21	5.69	6.80	5.72	13.16	16.00	12.86	42.25	N/A	42.87
SD	8.36	-	8.36	0.86	0.85	0.86	3.52	N/A	3.42	0.87	N/A	0.87	5.12	N/A	5.41	14.20	N/A	13.89
SACATON																		
Number	16	1	18	99	7	108	8	0	8	31	1	32	18	0	19	9	0	9
Minimum	13.50	26.00	13.50	3.80	3.90	3.80	10.00	N/A	10.00	3.90	6.20	3.90	4.50	N/A	4.50	39.50	N/A	39.50
Maximum	35.00	26.00	35.00	7.10	6.40	7.10	27.00	N/A	27.00	7.60	6.20	7.60	23.70	N/A	23.70	73.00	N/A	73.00
Median	22.75	N/A	24.00	5.00	4.90	5.00	18.25	N/A	18.25	5.90	N/A	6.00	15.00	N/A	16.00	51.00	N/A	51.00
Mean	23.25	26.00	23.67	5.11	5.14	5.12	18.31	N/A	18.31	5.80	6.20	5.81	14.26	N/A	14.35	52.50	N/A	52.50
SD	7.08	N/A	6.77	0.75	0.79	0.74	4.71	N/A	4.71	1.07	N/A	1.06	6.18	N/A	6.02	10.75	N/A	10.75
EARLY CLASSIC																		
Number	13	44	58	53	142	201	31	19	52	80	53	138	43	30	76	14	8	23
Minimum	10.00	8.00	8.00	4.00	3.90	3.90	11.50	6.50	6.50	4.20	4.40	4.20	5.80	7.40	5.80	13.40	56.20	13.40
Maximum	53.00	42.00	53.00	8.30	8.30	8.30	30.00	29.00	30.00	11.70	9.70	11.70	60.00	35.80	60.00	73.00	78.00	78.00
Median	22.00	25.00	24.25	5.70	5.60	5.70	22.00	17.50	20.00	7.50	6.00	6.80	18.00	15.00	15.45	49.75	69.00	59.00
Mean	22.54	24.56	24.15	5.78	5.75	5.75	21.84	18.58	20.49	7.51	6.00	6.89	21.02	16.70	19.20	47.92	68.96	56.01
SD	10.51	7.22	7.96	0.97	0.85	0.88	4.59	5.27	5.08	1.27	1.08	1.40	12.28	6.98	10.41	16.03	6.83	16.54

Note: Totals include indeterminate vessel forms, miscellaneous vessel forms (i.e., scoop, indeterminate flare-rim), and indeterminate red or plain.
SD = standard deviation.

Analysis of nominal attributes discussed in the foregoing sections suggests the existence of a broad technological tradition that encompasses both plainwares and redwares. If one accepts this premise, metric variability in the plainwares and redwares is best examined in relation to each other. Table 13.35 presents metric data recorded from the plainware-redware assemblage by ware. Five variables are examined by vessel shape: vessel orifice-aperture diameter, vessel wall thickness, jar rim height, and jar upper body profile slope. Nominal variables vary in their analytical power, a point alluded to in a previous discussion of the rim consistency and rim evenness variables. Metric morphological data are at least as powerful as the strongest nominal variables, since ideally different researchers could collect very similar metric data from the same sherd. Replicability is enhanced through the use of well-defined parameters in collecting these data, such as minimum sherd size or rim percentage. These rigorous procedures, however, limited our analysis to only a small percentage of the total plainware-redware assemblage. Patterning in each variable is first presented, followed by a discussion of temporally sensitive trends.

Orifice Diameter (Bowls)

Orifice diameter provides a fairly reliable index of bowl size and, in normally distributed assemblages, can be used to assess the degree of standardization present in a particular ceramic assemblage. As mentioned in the variable descriptions, our analysis specified that five percent or more of the rim be present to increase the accuracy of measurements. Rigorous methods -- contextual analysis and the 5 percent or more restriction -- produced a small but dependable set of orifice diameter data. The patterns discussed herein should be viewed as results of a pilot study. Subsequent research, using larger sample sizes, may explore these points in greater detail.

Consequently, orifice diameters were recorded on approximately one-fourth (105) of the total bowl rim sherds. Bowl orifice diameter data presented in Figure 13.15 indicate that orifice diameter ranged from 8.0 cm to 53.0 cm during the three phases examined across plainwares and redwares. The series of histograms presented in Figure 13.16 indicates that plainware bowl orifice diameter slightly decreases through time as the degree of variability increases. Early Classic period redware bowls are slightly larger than contemporary plainware bowls.

These histograms suggest that through time, bowls become more size-differentiated. Size classes are indistinct during the Gila Butte phase, where the two "size classes" are separated by only two centimeters. Sacaton phase patterning may indicate three size classes, although the small sample size precludes a proper examination of the data in this analysis. By the early Classic period, however, two patterns are evident: 1) discrete size groupings among plainware bowls; and 2) size uniformity among redware bowls. The latter pattern may reflect specialized production sources that produce somewhat standard-sized bowls. Future research in the area would benefit from characterization studies that identify production sources.

Aperture Diameter (Jars)

Aperture diameter for plainware and redware jars is included in Table 13.35. For the three phases under consideration, aperture diameter ranges from 6.5 cm to 30.0 cm in the combined assemblage. Among plainwares, aperture diameter increases through time, as does the degree of variability. Early Classic jar apertures vary by ware; plainware jar aperture diameters tend to be slightly larger than contemporary redwares. In Figure 13.17, aperture diameter data from the three phases are presented. Although small sample size limits the conclusions that can be drawn, it is interesting to note that plainware jars (unlike plainware bowls) remain strong components of the early Classic ceramic assemblage and that they are relatively uniform in their apertures.

Jar aperture is a poor indicator of vessel size, because the relationship between aperture and vessel body shape varies widely and is poorly understood. Large globular jars and elongated, relatively narrow jars may exhibit similar aperture measurements. Ideally, vessel size is assessed using proportions involving the variables of vessel height, diameter and aperture (Crown 1983:187; Longacre et al. 1988). These ratio measurements, however, require extensive vessel profiles that are only available in restorable and partly restorable vessels.

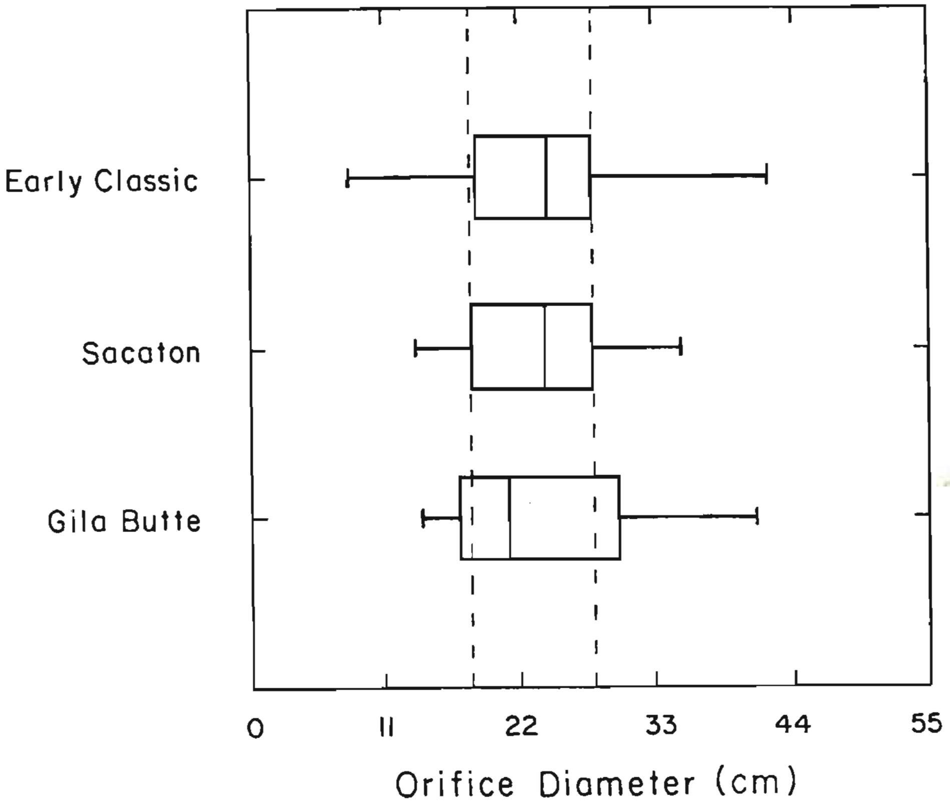

Figure 13.15. Bowl orifice diameter by phase: plainwares and redwares combined.

Data on jar apertures in the plainware-redware assemblage should thus be viewed as gross indicators, at best, of vessel size. Additional morphological data, only available on whole vessels, would be necessary to examine the degree of standardization present in the RCM plainware-redware jars during different time periods. Insufficient data were available from the RCM reconstructible jars to pursue any further analysis.

Vessel Wall Thickness

Vessel wall thickness, a commonly recorded attribute in ceramic analyses, reflects a series of technological and functional considerations. Temper particle size (Rye 1981:27), paste composition (Rice 1987:227,228), and construction techniques affect the range of thickness of a vessel's wall (Rye 1981:60). The sheer size of a vessel and its intended functions also influence wall thickness. Large vessels require thicker walls and may require a higher percentage of tempering materials than do smaller vessels (Rice 1987:227). Because wall thickness may vary greatly in different locations of the same vessel, measurements of rim wall thickness present a partial picture of any given pot. Vessel wall thickness has been suggested to have potential in some areas to be used as a seriation tool (Braun 1988). Thickness also has been used as a functional indicator. Braun (1983), for example, interprets changes in eastern Woodland vessel wall thickness as responses to changing food preparation techniques. Changes in wall thickness also may be related to changing resource use (i.e., changes in clay or temper sources) and to less tangible aesthetic factors that are largely unrelated to functional concerns. Vessel wall thickness was measured for plainware and redware sherds in the Rye Creek Project ceramic analysis and thickness data are presented by vessel shape in Table 13.35.

Unlike other metric variables discussed in this section, vessel wall thickness measurements were obtained for most of the sampled rim sherds. Across the assemblage, vessel wall thickness ranges from 3.3 mm to 11.7 mm. Plainware jars tend to have thicker walls than do bowls through all three phases, and this pattern intensifies

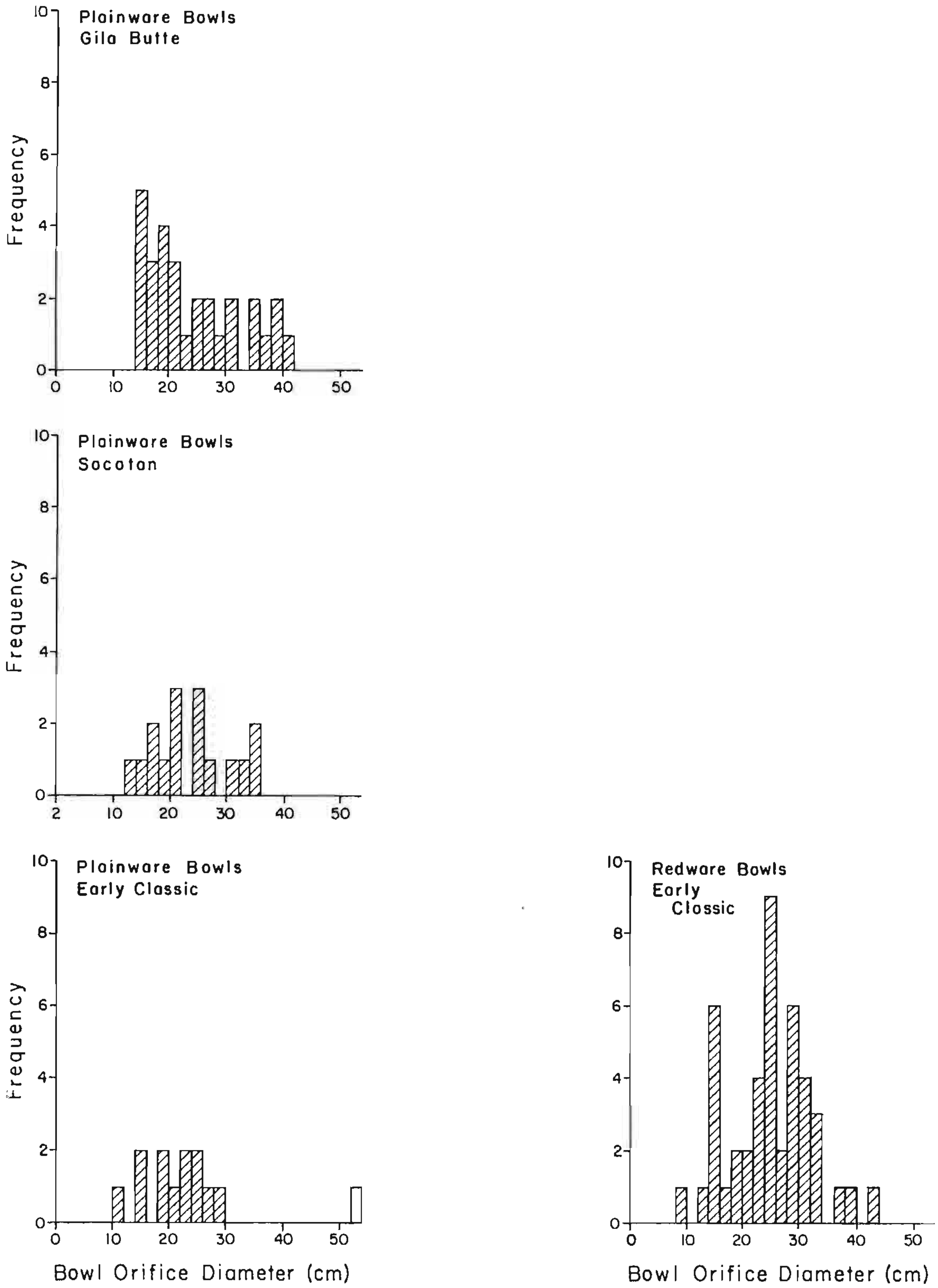

Figure 13.16. Bowl orifice diameter by phase and ware.

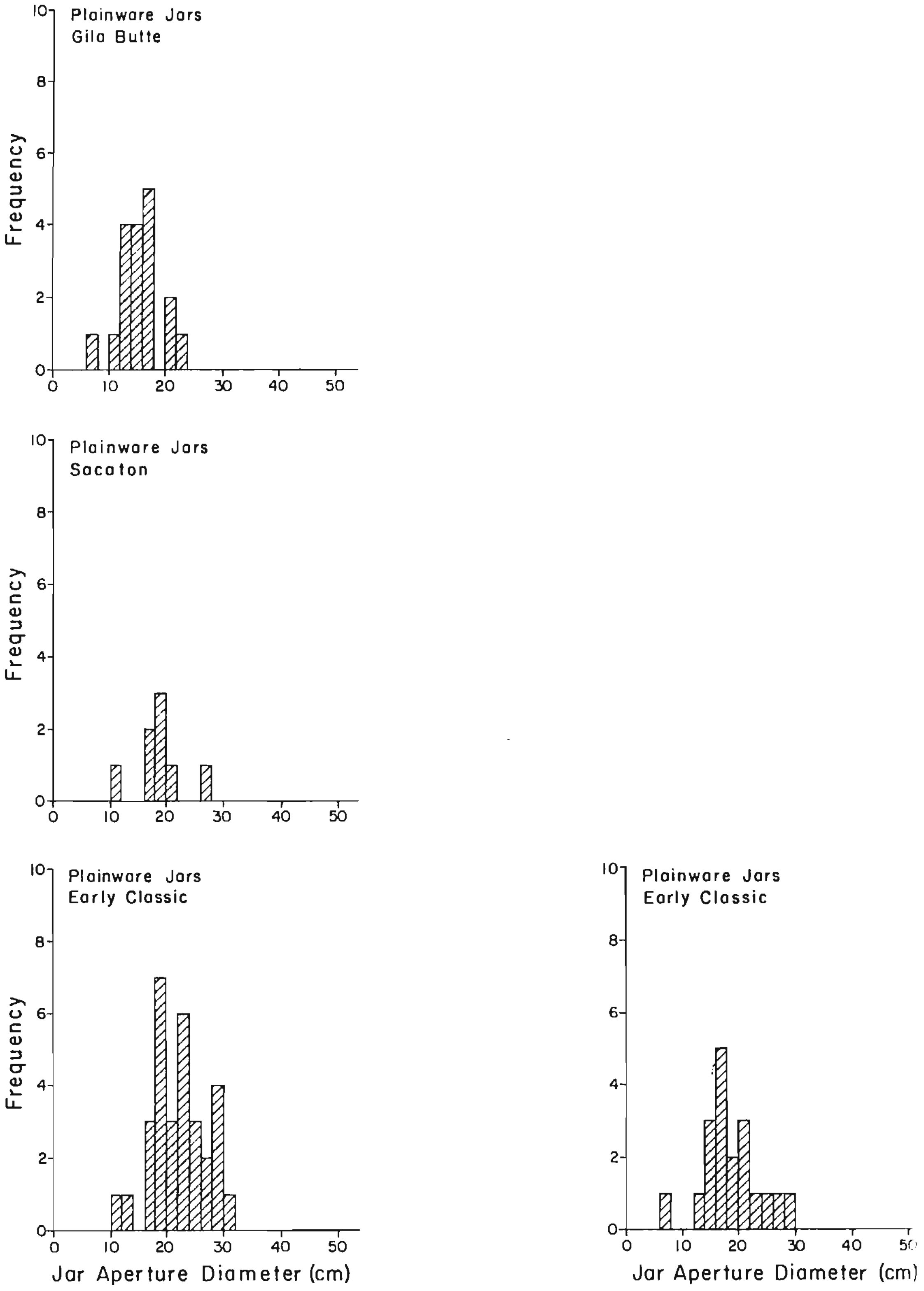

Figure 13.17. Jar aperture diameter by phase and ware.

through time, as illustrated in Figure 13.18. A similar pattern occurs among early Classic period redwares. Size and storage requirements associated with jars may explain shape-based differences, but this study did not explore factors behind this pattern in detail. Some increase in vessel wall thickness is evident at the assemblage level from the Gila Butte phase through the early Classic period. Heidke's analysis of temper source use in the project area presented elsewhere in this chapter suggests patterns of changing resource areas through time. Raw material factors, as well as a potentially increased need for storage (and, hence, for larger jars), may contribute to increased vessel wall thickness. The influence of differing percentages of bowls and jars through time requires an examination of this trend by shape and phase.

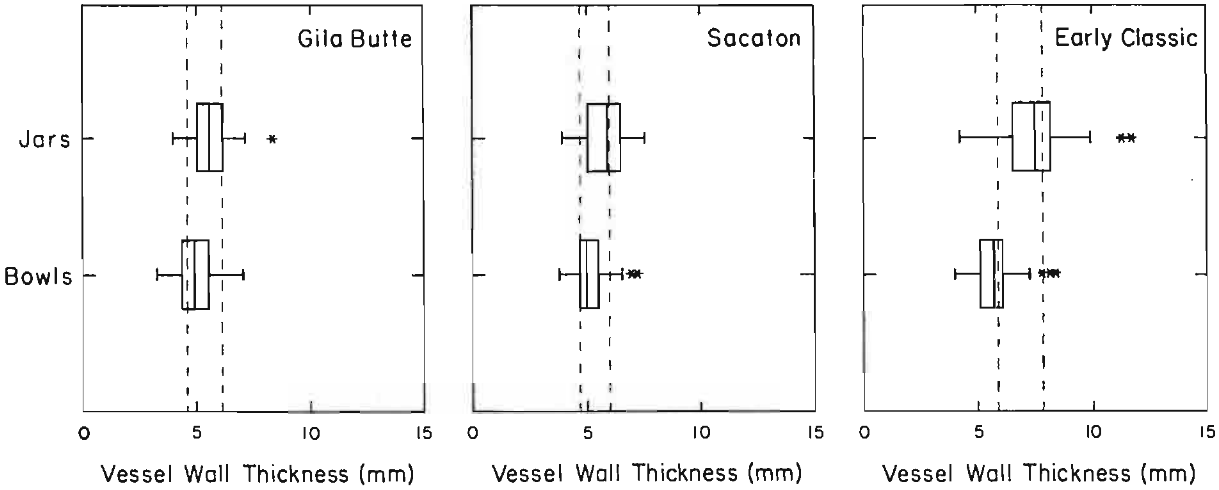

Figure 13.18. Vessel wall thickness in plainware jar rim sherds and restorable vessels through time.

Bowls. Among plainware and redware bowls of all phases, thickness ranged from 3.3 mm to 8.3 mm. Plainware and redware wall thickness data are similar through time. Variation in plainware bowl wall thickness drops slightly between the Gila Butte and Sacaton phases. The upsurge in plainware variation during the early Classic period in part reflects the dominance of redwares in the bowl assemblage. The Sacaton redware sample (prohibitively small for statistical comparison) closely resembles plainware wall thickness data from the same phase. Plainware bowl walls increase in thickness from the Gila Butte phase to the Classic period, as illustrated in Figure 13.19. During the early Classic period, the range and mean for vessel wall thickness are nearly identical for plainware and redware bowls (Figure 13.20). This pattern provides one line of evidence that plainwares and redwares may have been manufactured using the same production techniques during the early Classic period. On a more speculative note, perhaps the ceramics were primarily manufactured by a limited number of potters. One might propose a model of mobile potters (as is the case, for example, with Ethiopian Falasha potters) who manufactured ceramics throughout the Tonto Basin. Redwares may represent a more labor-intensive ceramic within a single technological tradition.

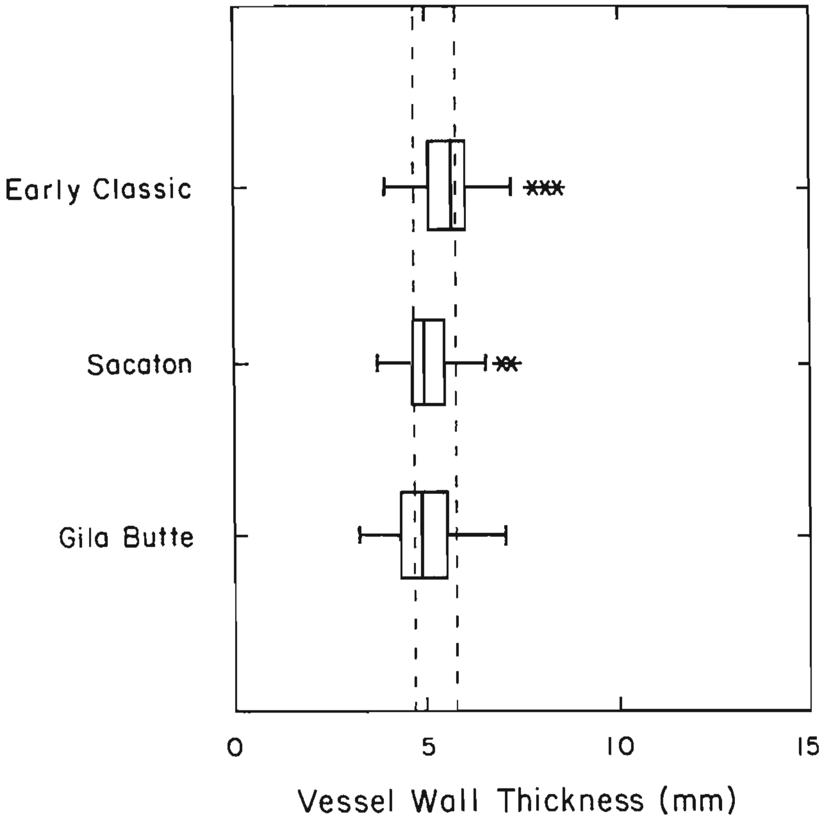

Figure 13.19. Vessel wall thickness in plainware bowl rim sherds and restorable vessels through time.

Jars. Vessel wall thickness in plainware and redware jars (all phases) ranged from 3.9 mm to 11.7 mm. Plainware jars exhibit increased wall thickness from the Gila Butte phase to the early Classic period, as seen in Figure 13.21. The trend in jars is stronger than in bowls. In the early Classic period, plainware jars have thicker vessel walls than do their redware counterparts. Functionally discrete uses of the redware and plainware jars may help explain differences in wall thickness. Early Classic mean jar apertures vary according to ware, as plainware jars tend to be larger than do redware jars. Larger jars require thicker vessel walls (Rice 1987:227). Large plainware jars would be advantageous for dry storage, whereas smaller, more portable redware jars might function as water containers. These possibilities are discussed later in this chapter.

Jar Rim Height

Jar rim height has been recorded in various analyses by Desert Archaeology (e.g., Heidke 1989a, 1990) as a temporally sensitive variable. This seems to be the case in the Rye Creek Project assemblage as well. Figure 13.22 illustrates a slight increase in height from Gila Butte phase to the early Classic period. Plainware jars have slightly higher rims than do redware jars, suggesting a different range of vessel forms and functions. Closer inspection of height patterning in the plainwares (and early Classic period redwares) is presented in Figure 13.23. Plainware jar rim height is tightly clustered for the Gila Butte and Sacaton phases. The early Classic period witnesses an expansion in variability of jar rim height in both plainwares and redwares, although the pattern is far stronger in the former. Referring back to the data on vessel forms presented in Tables 13.7 (plainware vessel forms through time) and 13.13 (redware vessel forms through time), some of this increased variability is related to the increased frequency of jars with "tall" rims (i.e., tall straight collar, tall flare-rim) through time. In the combined plainware/redware assemblage, "tall" rims comprise 4 percent of the Gila Butte jar assemblage, 15.4 percent of the Sacaton assemblage, and 25.2 percent of the early Classic assemblage. Nearly 30 percent (26/88) of the early Classic plainware jars have "tall" rims, whereas only 18.7 percent (11/59) of the redware jars have "tall" rims. Combined vessel wall thickness, aperture and rim height data suggest different uses for plainware and redware jars during the early Classic period, when redware jars first appear in significant quantities within the assemblage. Clearly, more research using these combined attributes to illuminate aspects of vessel function is needed.

Upper Body Profile Slope

Upper body profile slope (or "angle") was recorded on all jar rims that were sufficiently complete to contain an upper body profile. A disappointingly small number of jar rims proved adequate to the task, and the results are presented in Table 13.35. A slight trend toward increasingly steep angles through time is suggested by the figures. Small sample size in both plainwares and redwares precludes serious consideration of the variable in this analysis.

Plainware and Redware Restorable Vessels

Basic information on restorable and partially restorable plainware and redware vessels (RVs) recovered during the project are presented in Table 13.36. We provide these data for future analyses that rely on whole vessels for measurement. Ceramics from 5 of the 12 analyzed sites contained restorable or partially restorable vessels (sites AZ O:15:52, AZ O:15:55, AZ O:15:91, AZ O:15:92 and AZ O:15:100), for a total of 41 identifiable vessels. Additional indeterminate vessels also are noted. All field-recorded restorable or partially restorable vessels in Class 1-Class 2 contexts or in burial-crematorium features were inspected during the plainware/redware analysis. Two major reasons excluded a large proportion of the field-recorded restorable or partially restorable vessels from the analysis that follows: 1) less than 25 percent of the vessel was present, or 2) rim sherds were absent (although substantial numbers of body sherds were present), precluding classification of the vessel by shape and/or form. Several of the excluded, field-recorded restorable or partially restorable vessels were notable as probable reused sherds. Similar cases of sherd reuse has been noted previously in the Hohokam (Sullivan et al. 1991) and Mogollon (Wheat 1954) areas. Field-recorded restorable or partially restorable vessels that were reclassified as "sherd piles" were noted in features at three sites dated to the Sacaton phase (Feature 14 at AZ O:15:91; Features 3 and 6 at AZ O:15:100) and early Classic period, (O:15:55, Feature 17). Two of these features (Feature 17 at AZ O:15:55 and Feature 14 at AZ O:15:91) are small pits that may have been used for refuse disposal or storage. The remaining two features at AZ O:15:100 are pithouses.

Similar reuse functions have been proposed for sherd piles noted at other contemporary sites in central Arizona in the past. At Crooked Ridge Village (ca. 165 km southeast of the Deer Creek site), for example, Wheat (1954:100) comments,

> "That large sherds often served as utensils is evidenced by their occurrence on floors where there is no reason to believe they are the result of breakage subsequent to the collapse of the house."

Vessel shape. Sixty percent (25 of 41) of the restorable vessel assemblage consisted of bowls, while jar forms and one indeterminate vessel form comprised the remainder of the assemblage. About 60 percent of the restorable vessels were recovered from funerary contexts, including crematorium features at the Deer Creek site (AZ O:15:52) cremations and inhumations. Redware restorable vessels, all from AZ O:15:55, comprise about 21 percent (9/42) of the assemblage, or 64.3 percent of the early Classic restorable vessels. Each phase has an exceedingly small sample size of restorable vessels: Gila Butte=19, Sacaton=8; early Classic=14. Moreover, more than half of the restorable vessels are derived from burial contexts. We include the following discussion, recognizing its limited and preliminary nature, for comparison with past and future Tonto Basin projects.

Table 13.36. Restorable and partly restorable plainware and redware vessels recorded from the Rye Creek Project sites.

Site #	Feat. (Type)	Stratum	Obs. #	Ware	% Complete	Comments
O:15:52	14 (Pithouse)	20	12	PW	35-40	Short, straight-collared jar
O:15:52	21 (Pithouse)	20	777	PW	25-30	Hemispherical bowl
O:15:52	21 (Pithouse)	20	14	PW	10?	Straight-collared jar
O:15:52	21 (Pithouse)	20	15	PW	>90	Short flare-rimmed jar
O:15:52	21 (Pithouse)	20	16	PW	25	2 indeterminate shape fragments, including reworked jar base
O:15:52	21 (Pithouse)	20	17	PW	>90	Short incurving straight-collared jar
O:15:52	31 (Crematorium)	50	2	PW	50-60	Deep outcurving bowl
O:15:52	37 (Crematorium)	--	--	PW[1]	75+	Shallow hemispherical bowl
O:15:52	46 (Crematorium)	50	7	PW	90	Hemispherical bowl
O:15:52	51 (Sec. Cremation)	50	8	PW	50	Hemispherical bowl
O:15:52	70 (Crematorium)	50	1	PW	75+	Hemispherical bowl
O:15:52	70 (Crematorium)	50	3	PW	35-45	Hemispherical bowl
O:15:52	70 (Crematorium)	50	4	PW	25	Incurved bowl
O:15:52	70 (Crematorium)	50	5	PW	25	Indeterminate flare-rim jar (possible puki). Only base sherds remain conjoinable.
O:15:52	70 (Crematorium)	50	6	PW	25	Short flare-rimmed jar
O:15:52	71 (Crematorium)	50	1305	PW	80?	Small, hemispherical bowl; possible second bowl (indeterminate form)
O:15:52	88 (Crematorium)	50X	10	PW	25	Hemispherical bowl
O:15:52	88 (Crematorium)	50X	11	PW	40-45	Incurved bowl
O:15:52	120 (Sec. Cremation?)	50	9	PW	25	Short, straight-collared jar, part of a crematorium
O:15:55	5 (Pithouse)	19	782	PW	50	Short flare-rim jar
O:15:55	5 (Pithouse)	30	1208	RW	50	Miniature shallow hemispherical bowl
O:15:55	8 (Inhum/Cremation)	50	1209	RW	99	Small, deep hemispherical bowl
O:15:55	8 (Inhum/Cremation)	50	1210	RW	55-60	Incurved, semiflare-rimmed bowl
O:15:55	17 (Inhumation)	50	1211	RW	100	Miniature, short straight-collared jar
O:55:55	17 (Inhumation)	50	1216	RW	75	Deep outcurved bowl

Table 13.36. Continued.

Site #	Feat. (Type)	Stratum	Obs. #	Ware	% Complete	Comments
O:15:55	17 (Inhumation)	50	1217	RW	65-70	Shallow, incurved bowl
O:15:55	18 (Mas. Pitroom)	20	778	PW	80	Tall, straight-collared jar
O:15:55	18 (Mas. Pitroom)	20	779	PW	80-90	Indeterminate jar
O:15:55	18 (Mas. Pitroom)	20	780	PW	80	Tall, straight-collared jar
O:15:55	18 (Mas. Pitroom)	20	781	PW	<25?	Short flare-rimmed jar
O:15:55	21 (Inhumation)	50	1213	RW	60-65	Deep, semiflare-rim incurved bowl
O:15:55	21 (Inhumation)	50	1214	RW	25	Hemispherical, semiflare-rimmed bowl, Gila shoulder
O:15:55	21 (Inhumation)	50	1215	RW	95	Deep, semiflare-rimmed incurved bowl with a Classic (indented) base
O:15:91	0 (Surface Find)	9	---	PW	30	Tall, straight-collared jar
O:15:91	11 (Pithouse)	20	783	PW	30	Hemispherical bowl
O:15:91	18 (Pit)	50	---	PW	30	Tall, straight-collared jar
O:15:92	13 (Inhumation)	50	---	PW	85-90	Slightly incurved bowl
O:15:92	16 (Inhumation)	50	---	PW	80+	Slightly incurved bowl
O:15:100	25 (Inhumation)	50	1302	PW	85-90	Small hemispherical bowl
O:15:100	25 (Inhumation)	50	1303	PW	75	Small, slightly incurved bowl
O:15:100	25 (Inhumation)	50	1304	PW	35	Extremely short, straight-collared jar; Gila shoulder

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[1] Field-classified as plainware, but likely a local red-on-brown; most of paint has disappeared.

PW = plainware

RW = redware

Note: Selected sherds less than 25 percent complete were classified as RVs if backhoe trenches had cut through areas where the vessel parts were later excavated. RV analysis included refitting and an inspection of temper and surface attributes of sherds within RV bags to assess whether all of the sherds actually belonged to the same vessel. Field-classified RV's were voided from analysis where sherd clusters, once conjoined, comprised less than 25 percent of the total vessel (excluding vessels sheared in backhoe trenching) or where rim sherds were absent from the sherd cluster (precluding classification).

Gila Butte Phase Restorable Vessels

One unique Gila Butte phase feature type is the "crematorium" feature, described by Swartz in the site report for the Deer Creek site in Volume 1 (Chapter 7). Similar crematorium features were found at the sites of Buh bi laa and East Fork in the White Mountains of central Arizona (Halbirt and Dosh 1991). These sites are

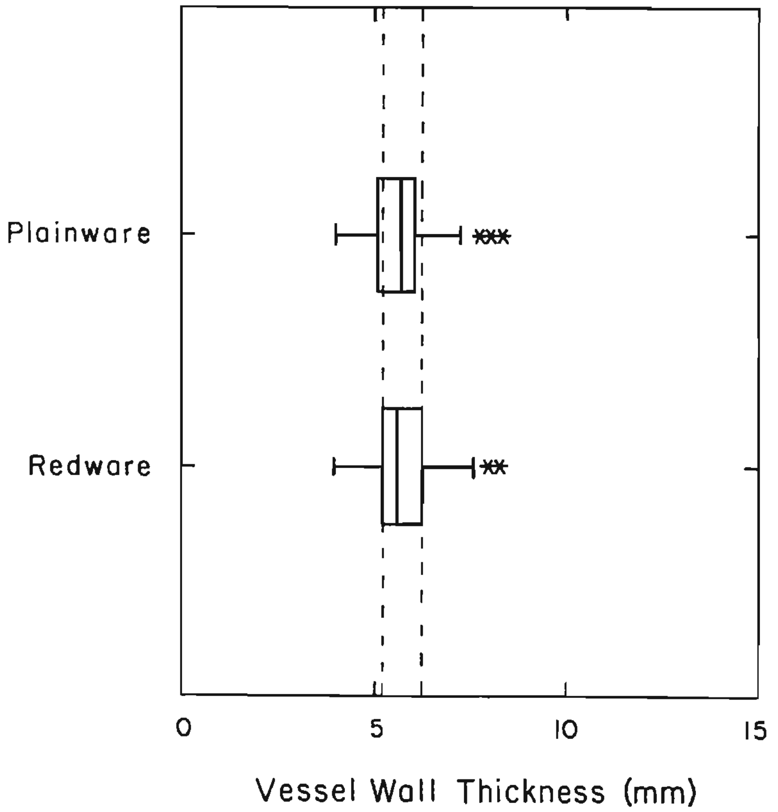

Figure 13.20. Vessel wall thickness in early Classic period bowl rim sherds: plainware vs. redware rims and restorable vessels.

roughly contemporaneous with the Deer Creek site, and are located approximately 135 km to the east. Most of the restorable vessels at Buh bi laa were found in pithouse, rather than crematorium, contexts. The Alma Plain vessel forms illustrated for the Buh bi laa excavations considerably overlap with forms recovered from the Deer Creek site (no vessel profiles were available from the East Fork site). In addition, the single burial feature with grave goods reported from Buh bi laa contained a predominance of bowls, similar to crematorium features at the Deer Creek site.

The presence of these crematorium features suggests the possibility of non-Hohokam influences on the site (Elson 1991a; see Chapter 29, this volume). At least 13 crematorium features were excavated at the Deer Creek site. Five of these yielded parts of 11 vessels, some of which exhibited evidence for exposure to intense heat that produced surface exfoliation and fire-warping. Only two of the restorable vessels, both from a single crematorium (Feature 70), were identified as jars. One of these consisted of two detached sections: rim sherds and basal sherds. The basal sherds formed a shallow concave, disk-shaped form with possibly ground edges. These may be indications of vessel reuse as a supporting mold for pottery-making, known as a *puki*. In her study of Pueblo pottery-making, Bunzel (1929:7) notes that *pukis* may be made from bowls, baskets, or ground sherds. Pueblo potters utilize *pukis* as a "turntable" during vessel-forming, to give the vessel's bottom its initial curvature, and to support the vessel during the shaping process (Christensen 1991:1). Similar artifacts have been reported from Plateau sites in the Mesa Verde region (e.g., Farwell 1981) and throughout the Anasazi area (Christensen 1991). Alternately, the jar base may have served as a bowl or a pot lid, the latter function explaining the presence of wear along the base's edge. Hemispherical bowls predominate the crematorium assemblages, while five out of six restorable vessels from pithouses on the site are jar forms. The overall bowl:jar ratio for the Gila Butte phase restorable vessels is 1.7:1.

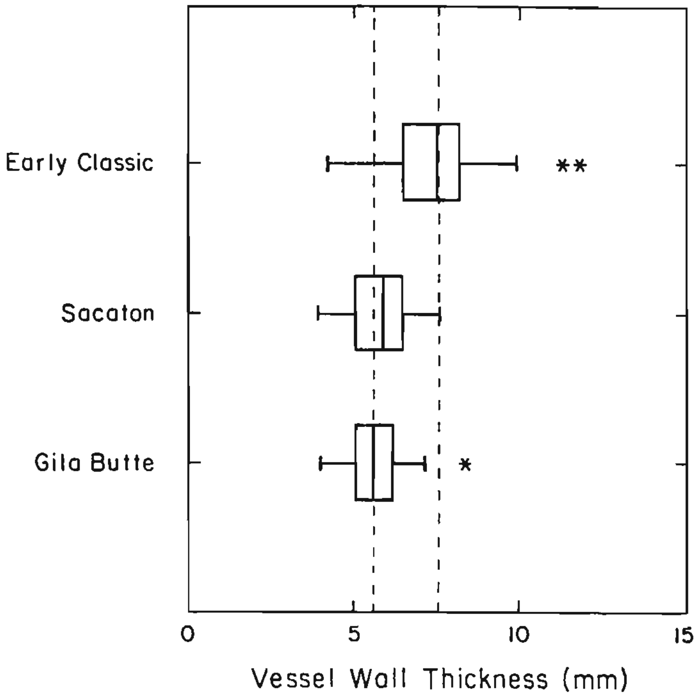

Figure 13.21. Vessel wall thickness in plainware jar rim sherds and restorable vessels through time.

Sacaton Phase Restorable Vessels

The majority of restorable vessels from Sacaton phase contexts (recovered from AZ O:15:91, AZ O:15:92 and AZ O:15:100) also derive from burial contexts. Seventy-one percent (5) of the vessels were recovered from three inhumation features, all of which were children or infants. Incurved or slightly incurved bowls were the most common Sacaton phase vessel form, in contrast to hemispherical bowls in the preceding Gila Butte phase. The bowl:jar ratio remains the same in the Sacaton phase as it was for the Gila Butte phase, at 1.7:1.

Early Classic Period Restorable Vessels

Early Classic period restorable vessels included plainware and redware forms. Two out of three miniature vessels from the Boone Moore site (AZ O:15:55) were found in burial contexts, supporting a trend noted by O'Brien et al (1985:340) for Salado period burial ceramic assemblages (also see NA 16,486, Mazatzal House, in Ciolek-Torrello 1987:49). The restorable vessel assemblage from the Boone Moore site also suggests that jars are the most common vessel form recovered from pithouses, while bowls are more commonly found in burials, a point made by previous Tonto Basin researchers (Hohmann and Kelley 1988:225; O'Brien et al. 1985:340). The bowl:jar ratio (combining plainwares and redwares) is 1.4:1. Among redwares, the ratio is 7.0:1, while all of the restorable plainware vessels are jars.

Another interesting trend lies in the concentration (89 percent) of redwares in burial contexts (although one redware vessel was recovered from a pithouse). Unlike the restorable plainware vessels, many of the redware forms are distinctively early Classic, including semiflared-rims, pronounced shoulders and indented bases. A similar observation in assemblages excavated south of the project area prompted Bruder and Ciolek-Torrello (1987:103) to suggest that "most . . . redwares found in burial contexts are either a distinct variant manufactured especially as mortuary furniture or imports from other areas." Temper sourcing, described in a previous section, illuminates aspects of local versus nonlocal ceramic production in the early Classic period.

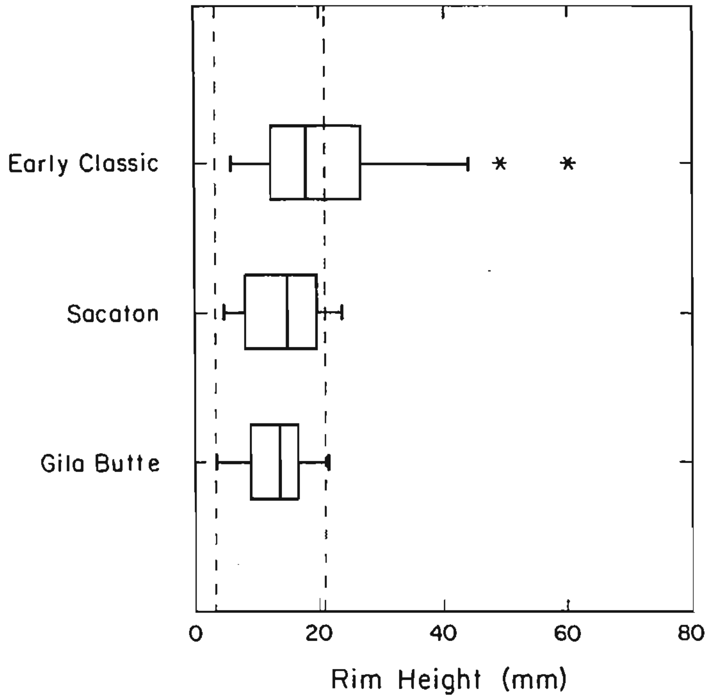

Figure 13.22. Rim height in plainware jar rim sherds and restorable vessels through time.

However, most of the diagnostic early Classic bowl forms are present in restorable vessels excavated as components of mortuary assemblages.

PLAINWARE SERIATION

Plainware seriation has the potential to enhance our dating techniques for excavated deposits and during the course of surveys. The current plainware seriation study attempts to statistically verify the anecdotal observations made by previous researchers in the Tonto Basin.

This attribute-based analysis identified several temporally sensitive attributes in the plainwares and redwares. These trends had also been noted by previous researchers working in southern and central Arizona. With respect to southwestern Arizona, potential relative dating techniques outlined by Schiffer (1982:342-343) include continuous plainware attributes such as percentage of redwares and smudged sherds. Similar trends have been noted in areas adjoining the project area from Schroeder's (1952) earlier recognition of this trend to more recent projects; (in the Tonto Basin (Wood 1987:7), in the Verde Valley (Lerner 1986:91), in the Mazatzals (Howard 1990:196), and into the Mogollon, (Wheat 1955:79). We reasoned that these temporally sensitive attributes might help place in time excavated deposits that lacked diagnostic ceramics. Evaluating the strength of this temporal patterning required several steps. The analyzed plainware ceramics were assigned Gila Butte phase, Sacaton phase, and early Classic (Roosevelt phase) period dates based on their association with specific decorated types. Four plainware technological attributes -- presence of smudging, burnished interior surfaces, burnished exterior surfaces, and rim evenness -- exhibited significant monotonic temporal trends in the assigned phase level groupings. We therefore reasoned that a multidimensional model may offer a more appropriate perspective for identifying regional patterning in time-related changes in plainware production technology and that the phase level trends should be reflected at the site and feature level of analysis.

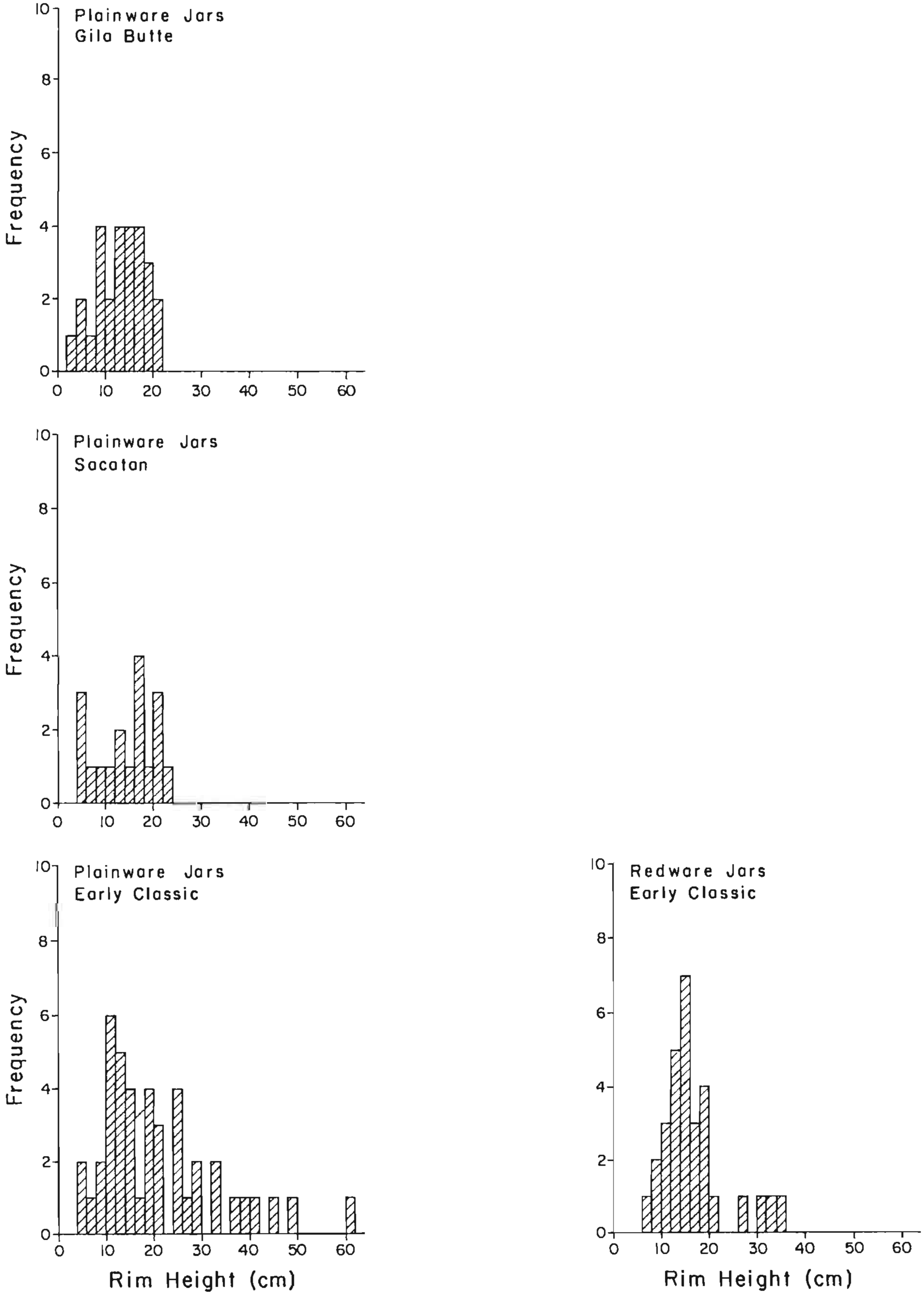

Figure 13.23. Rim height in plainware and redware jar rim sherds and restorable vessels through time.

Other researchers working in central Arizona also have identified time-related changes in plainware technology. At the broadest (i.e., assemblage) level, the percentage of redwares increased through time, a pattern noted by most previous Tonto Basin research (e.g., Bruder and Ciolek-Torrello 1987; Hohmann 1985; Wood 1987:26). Previous researchers have also identified Preclassic/Classic period distinctions in surface treatment of vessels for the Hohokam (Doyel 1974) and in the Tonto (Whittlesey and Reid 1982:75) Basin. Lerner (1984) first proposed a seriation of sites located in the Lower Verde Valley through a multivariate analysis of three plainware attributes: the percentage of slipped sherds, the percentage of polished sherds, and the percentage of Wingfield Plain sherds. Woodward and others (1985) proposed a seriation of sites located in the Lower Tonto Basin through a multivariate analysis of three plainware attributes similar to those used by Lerner: the presence or absence of a slip or wash, the type of surface treatment, and the major temper constituent. Our proposed seriation differs from those of Lerner (1984) and Woodward and others (1985) in two significant respects. First, it pertains only to the unslipped plainwares. As noted above, the frequency of slipped plainwares, or redwares, is strongly related to time. Redwares are rare in Preclassic deposits but are abundant in Classic period deposits (see Elson, Chapter 25, this volume). Second, temper composition, whether considered as an attribute of a named plainware type or as a major constituent of the ceramic fabric, is not included in the seriation. Significant changes in the composition of the analyzed temper over time have been noted in a previous section. Those changes are viewed as shifts in the nature of exchange and interaction between the project area sites and the rest of the Tonto Basin, rather than changes in pottery technology per se. In fact, we argue that the temporal changes in plainware technology identified in this study exist largely independent of production area, and *may* reflect widespread changes in a shared technological tradition that extended from at least the Upper Tonto Basin to the Tucson Basin (also see Wood 1987:9, 26).

In recent years, multidimensional scaling has become one of the favored techniques for analyzing chronological trends in archaeological data (Cowgill 1972; Drennan 1976; Kendall 1971; Kruskal 1971; LeBlanc 1975; Marquardt 1978; Wallace 1986a). It was considered an appropriate method for a seriation based on the plainware technological frequency data. Table 13.37 presents the percentage values of the four technological attributes in each site's analyzed plainwares. A matrix of normalized Euclidean distances was computed from these data. That matrix was then entered into the multidimensional scaling routine. Three trial runs were conducted with one-dimensional, two-dimensional, and three-dimensional solutions specified. Examination of the stress values produced by each trial run indicated that the one-dimensional solution was optimal. Figure 13.24 is a plot of that ordering. The seriation produced by multidimensional scaling is similar to the ordering based on typological criteria, leading us to conclude that the ordering does represent time. We note, however, that one of the Sacaton phase sites (AZ O:15:91) plots "earlier" than the other two Sacaton phase sites. The frequency of buffware types recovered from the contexts of these sites was examined in order to explain that placement. Table 13.38 reports the frequency of Santa Cruz Red-on-buff and Sacaton Red-on-buff ceramics recovered from the Sacaton phase deposits used in the seriation (abstracted from Clark, Chapter 12, Tables 12.8-12.10, this volume). Calculation of an odds ratio using that data shows that Sacaton Red-on-buff occurs 3.75 times more frequently than Santa Cruz Red-on-buff at AZ O:15:92 and AZ O:15:100 when compared with AZ O:15:91. The odds ratio, therefore, suggests that AZ O:15:91 may have been occupied somewhat earlier in the Sacaton phase than AZ O:15:92 and AZ O:15:100. If that is true, then it also suggests that the proposed plainware seriation provides a relatively sensitive indicator of the time of ceramic production.

A second multidimensional scaling analysis of the plainware technological attributes was conducted using feature level data (Table 13.39) given the success of the site level plainware seriation. Analysis of those data followed the methods described previously for the site level data. Examination of the stress values produced by each trial run indicated that a two-dimensional solution was optimal. Figure 13.25 is a plot of that ordering. The feature level seriation resembles the phase level ordering, based on typological criteria, and the site level ordering produced by multidimensional scaling. We can therefore conclude that time is represented by the first dimension. We note, however, that the typologically late Classic deposit at Rye Creek Ruin (AZ O:15:1, Feature 1) plots "earlier" than the three early Classic deposits, a situation that would be expected given the lower frequency of smudged and burnished plainwares recovered from that feature. There is no way to assess whether the plainware ceramics recovered from that deposit are representative of late Classic plainwares in general since only one late Classic deposit was available for analysis. It is therefore impossible to ascertain whether the frequency of smudged and burnished plainwares actually declined in the late Classic period or if the observed decrease is related to some unknown aspect of Feature 1. The placement of Feature 20 at the Deer Creek site (AZ O:15:52) is also notable in Figure 13.24. The excavated features at the Deer Creek site generally were assigned either a Gila Butte phase or a Sacaton phase date based on a typological analysis of their decorated ceramics and archaeomagnetic dates. Feature 20, however, lacked both of those dating criteria. The plainware seriation indicates that a Sacaton phase assignment for the fill of that feature is appropriate given its placement between Feature 11 at the Redstone site (AZ O:15:91) and Feature 12 at the Clover Wash site (AZ O:15:100).

Table 13.37. Percentages of four technological attributes used in the seriation of plainware rim sherds and restorable vessels recovered from seven sites.

	PHASE/SITE						
	Gila Butte	Sacaton			Early Classic		
Attribute	Site 52 (n=152)	Site 91 (n=42)	Site 92 (n=44)	Site 100 (n=50)	Site 54 (n=52)	Site 55 (n=92)	Site 1 (n=27)
Smudged %	14.5	47.6	47.7	54.0	65.4	72.8	66.7
Interior Burnished %	29.0	64.3	79.5	60.0	86.5	82.6	77.8
Exterior Burnished %	27.6	42.7	75.0	76.0	88.5	87.0	88.9
Rim Even %	19.7	21.4	40.9	44.0	38.5	38.0	52.3

Table 13.38. Counts of buffware types from Sacaton phase sites used in the plainware seriation.

	BUFFWARE TYPE	
ASM Site Number	Santa Cruz	Sacaton
AZ O:15:91	1	1
AZ O:15:92 and O:15:100	4	15

Odds ratio = (15/4)/(1/1) = 3.75
Data from Clark Tables 12.8-12.10.

Our proposed seriation did not use two of the attributes -- slipping and temper composition -- included in models by Lerner (1984) and Woodward and others (1985). We focused our attention, instead, solely on changes that occurred in the technology of unslipped plainware production over time. Therefore we can treat the production of redware ceramics separately from other changes that occurred in plainware production, and then compare the two trends. In addition, we can examine production source-related variability over time by comparing the frequency of the seriation attributes in the metamorphic sand-tempered sherds, most of which were produced "locally," with their frequency in sherds tempered with "nonlocal" sands.

Figure 13.26 is a scatter-plot of the percentage of redwares present in each feature's rim sherd-restorable vessel collection against the feature's ordination on the first dimension of the multidimensional scaling model. Examination of Figure 13.26 confirms the well-documented pattern of minor redware production during

Preclassic times followed by large-scale redware production in the Classic period. We have already noted that the only feature assigned a late Classic date (AZ O:15:1, Feature 1) exhibited lower percentages of smudged and burnished plainwares relative to those features assigned an early Classic date. We note now that it also contains a lower percentage of redwares. This result leads us to cautiously suggest that major changes in the nature of ceramic manufacture may have begun by the late Classic period. Less effort was placed on the finishing stages of ceramic production, indicated by the lower percentage of burnished plainwares and fewer redwares, as well as less attention to the firing stage of ceramic production, indicated by the lower percentage of smudged vessels.

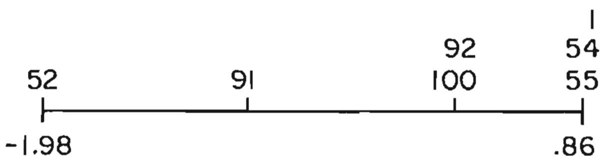

Figure 13.24. One-dimensional plot of plainware technological attributes for seven sites. Stress= .00037.

Table 13.39. Percentages of four technological attributes used in the seriation of plainware rim sherds and restorable vessels recovered from seven sites and ten features.

	PHASE/SITE: FEATURE									
	Gila Butte		Sacaton			Early Classic			Late Classic	Unknown
Attribute	52:14 (n=31)	52:21 (n=51)	91:11 (n=38)	92:14 (n=44)	100:12 (n=24)	1:2 (n=19)	54:2 (n=50)	55:6 (n=52)	1:1 (n=23)	52:20 (n=21)
Smudged %	3.2	13.7	47.4	47.7	33.3	73.7	66.0	73.1	65.2	42.9
Interior Burnished %	16.1	27.4	63.2	79.5	62.5	94.7	86.0	88.5	60.9	71.4
Exterior Burnished %	12.9	25.5	39.5	75.0	75.0	94.7	88.0	84.6	73.9	57.1
Rim Even %	12.9	15.7	21.1	40.9	41.7	47.4	40.0	38.5	60.9	9.5

In order to examine production source-related variability in the plainware technological attributes over time, we grouped the data at the phase level of analysis. Constraints imposed by small sample sizes at either the feature or site level dictated this procedure. It was also necessary to partition the data set into classes that would roughly correspond to local and nonlocal production. The key developed by Miksa (Appendix A, this volume) should permit the binocular microscopic classification of most sand tempers to specific petrofacies in future studies of Tonto Basin pottery. In this study, however, we have had to rely on a less precise classification based on the discriminant analysis of the sand-temper point-count data. The discriminant analysis of the metamorphic sand-tempered sherds indicated that 83.3 percent (n=12) of the point-counted sample exhibited either a petrofacies H or K composition. All of the project area sites lie within those two petrofacies. Therefore, we can assume that most of the metamorphic sand-tempered sherds represent "locally" produced vessels. The discriminant analysis of the mineral-rich sand-tempered sherds indicated that approximately one-fourth ([8/33]) X 100 = 24.2%) exhibit a petrofacies K composition. The ethnographic data summarized by Arnold (1985), and reanalyzed above, indicates that most traditional potters utilize temper resources located within 2 to 3 km of their settlement. Therefore, we can assume that some of the "other sand"-tempered vessels may have been produced "locally," but that most represent "nonlocal" production. A distinctly "nonlocal" data set, recorded from the Redtail and Los Morteros sites located in the northern Tucson Basin (Bernard-Shaw 1989, Wallace 1991), was included for comparison with the frequencies of the plainware technological attributes recorded from the Upper Tonto Basin sites.

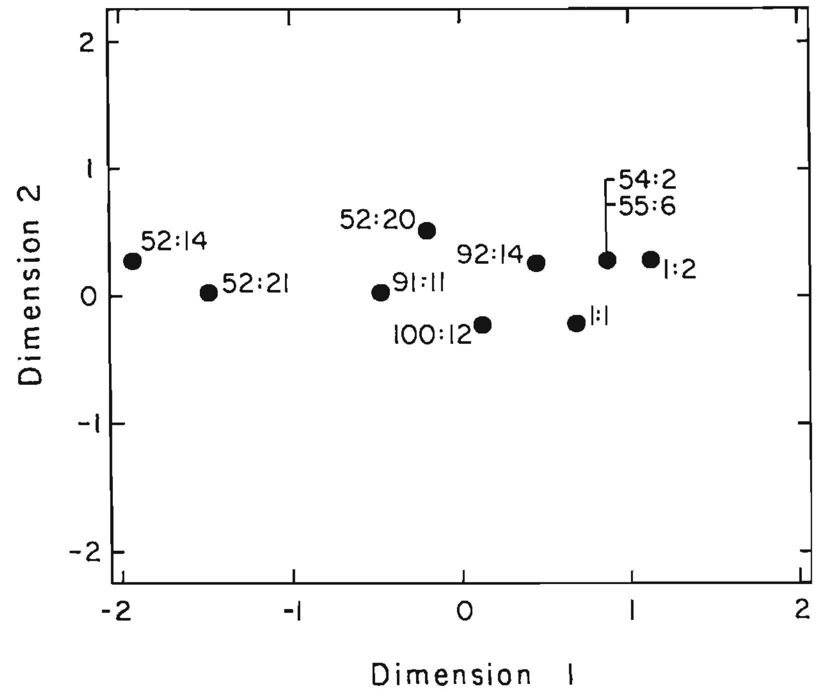

Figure 13.25. Two-dimensional plot of plainware technological attributes for 10 features. Stress=.03183.

Figure 13.27 compares the frequency of smudged vessels in the three temper groups over time. Three trends are immediately apparent. First, all three groups exhibit the same monotonic trend of higher relative percentages of smudged vessels over time. Second, the absolute frequency of smudged vessels varies between the three temper groups at each point in time. Third, the percentage of smudged vessels is highest at each point in time in the "other sand"-tempered, or "nonlocal", vessels recovered from the Upper Tonto Basin.

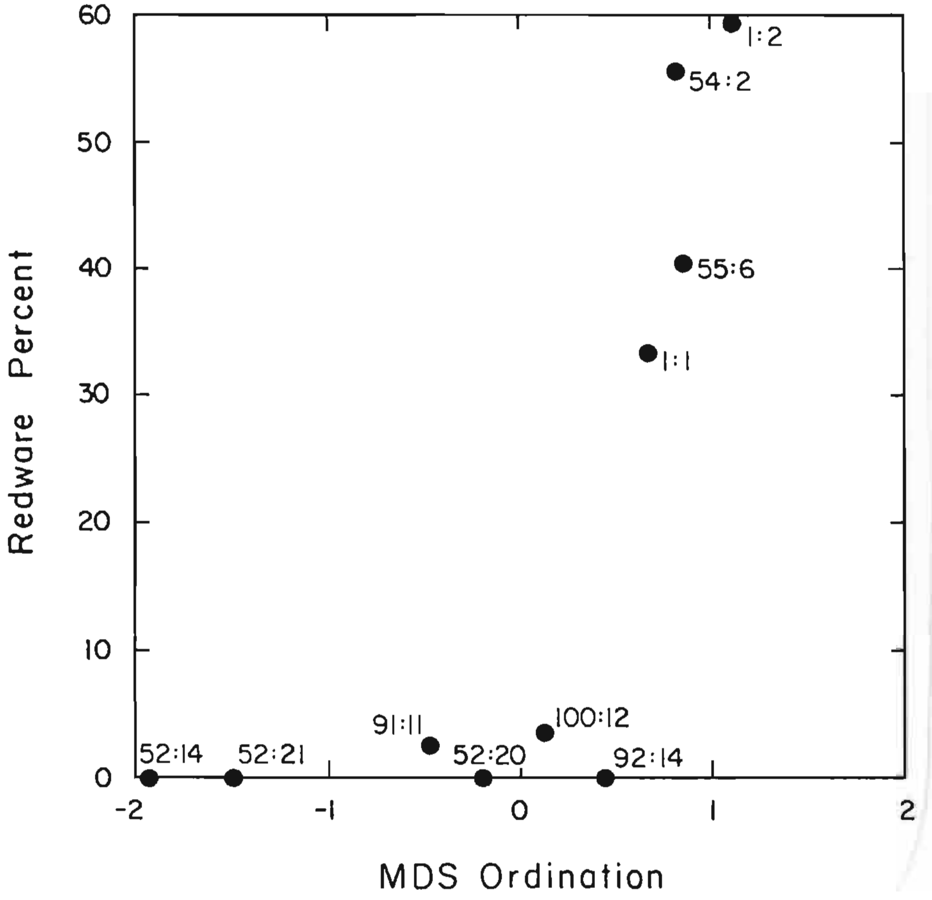

Figure 13.26. Scatterplot of redware percent by MDS ordination for features included in the plainware seriation.

Additional research in the lower Tonto Basin may clarify the specific source areas that are grouped as "nonlocal" in our study.

Figures 13.28 and 13.29 compare the frequency of burnished interior and exterior surfaces in the three temper groups over time. Figure 13.30 compares the frequency of rim evenness in the two Tonto Basin temper groups over time (similar data were not available for the Tucson Basin ceramics). The three trends observed in the smudging variable are also generally applicable to the vessel burnishing and rim evenness variables. The "other

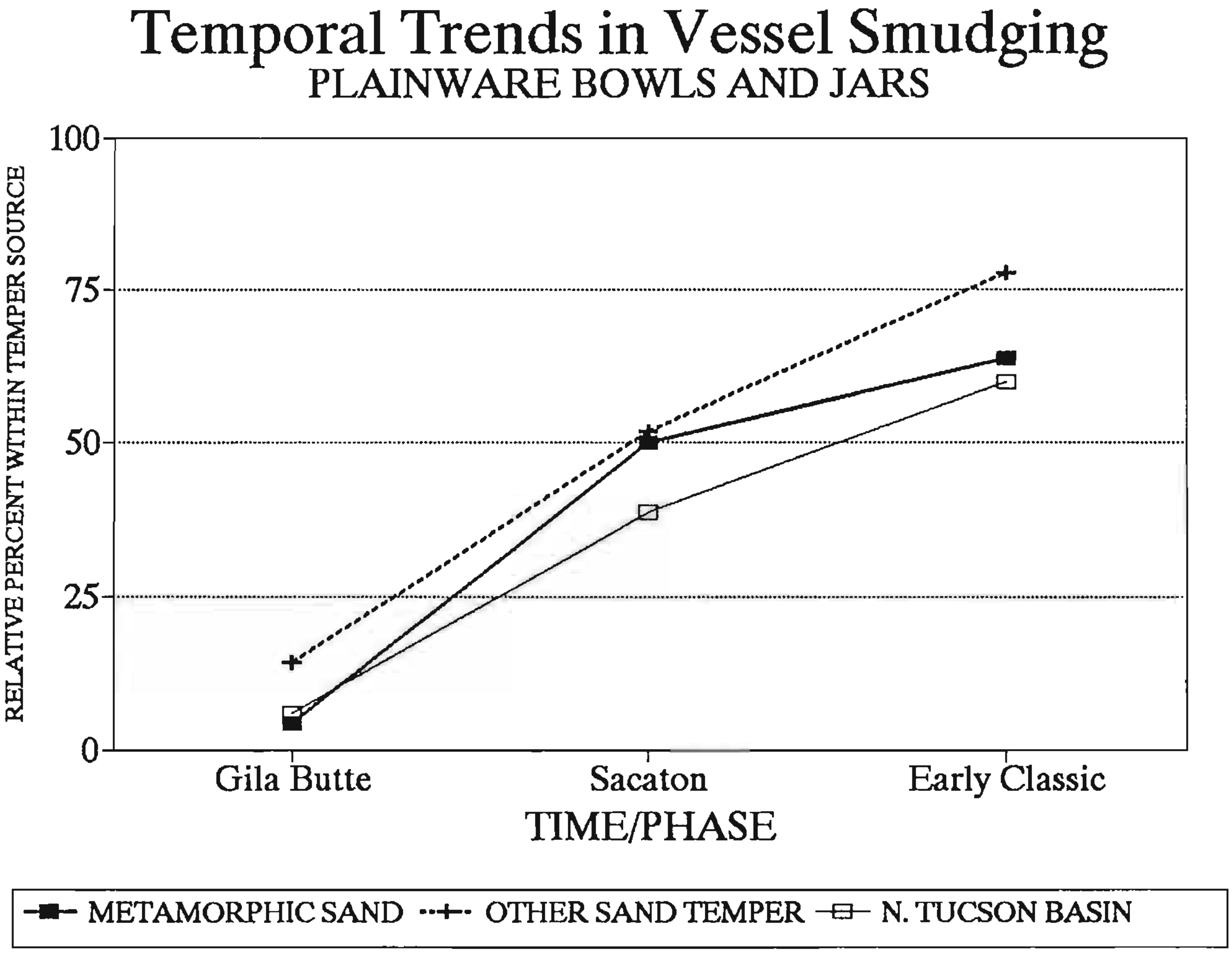

Figure 13.27. Temporal trends in vessel smudging: plainware bowl and jar rim sherds and restorable vessels.

sand"-tempered vessels recovered from the Upper Tonto Basin sites and the ceramics from the northern Tucson Basin sites exhibit a monotonic trend of higher relative percentages of interior and exterior burnished vessels over time. In the metamorphic sand-tempered vessels the highest relative percentage of interior and exterior burnishing occurred in the sherds recovered from the Sacaton phase deposits, with a slight decrease in burnishing exhibited in the early Classic sample. The "other sand"-tempered vessels recovered from the Upper Tonto Basin sites also display a monotonic trend of higher relative percentages of rim evenness over time. The metamorphic sand-tempered vessels show a slight decrease in the percentage of vessels with even rims from the Gila Butte phase to the Sacaton phase, with a subsequent increase from Sacaton to early Classic times.

The fact that similar, systematic changes in plainware technology occurred in ceramics manufactured over a large area suggests to us that all of the vessels *may* reflect a widespread technological tradition that transcends a plainware/redware distinction and the Hohokam/Salado cultural boundary (see Wood 1987:9 for a similar idea regarding the Central Arizona Ceramic Tradition). Other researchers have reached a similar conclusion:

> Diverse ceramic assemblages at Tonto Basin sites suggest a shared body of stylistic, technological and formal information used across the range of pottery wares. This situation holds throughout the central Arizona mountain zone, and thus it becomes important to distinguish between exchange of ceramic information and actual co-residence of cultural groups possessing different ceramic information (Whittlesey and Reid 1982:73).

O'Brien and others (1985:343) also argue for cultural continuity between Hohokam and Salado sites, using selected ceramic attributes. The data also suggest that there may have been more localized expressions of that tradition that were expressed as specific trajectories. For example, the metamorphic sand-tempered sherds, most of which are believed to represent "local" production, generally exhibit a lower frequency of each of the four technological attributes at each point in time relative to the "other sand"-tempered vessels, most of which are believed to represent "nonlocal" production (and include vessels produced in at least five different petrofacies). Accordingly, the extant data suggest that within the widespread technological tradition individual potters or groups of potters working in different portions of the Tonto Basin produced ceramics with similar, although not identical, frequencies of smudging, burnishing, and rim evenness over time. This strongly suggests that future studies should use the key developed by Miksa (Appendix A) for classifying temper to the petrofacies level, because the production source zone of the vessels needs to be taken into account during a seriation.

The plainware seriation described in this section represents a dating tool that should be applicable to survey and excavation data from the Upper Tonto Basin, especially in those cases where decorated ceramics are scarce or altogether absent. Survey collections represent a weaker type of data set to enter in a seriation because a collection from the surface of a site represents an "average" condition that will "mask" any temporal variability in the data (see Heidke 1989b:135-136 for an example from the Upper Tonto Basin). The seriation model should gain in usefulness when applied to the ceramics recovered from excavated contexts that otherwise lack criteria for dating. This would be especially true if the behavioral dimension of the deposit has also been ascertained. We believe that applying the seriation model to plainware rim sherds recovered from behaviorally mixed deposits (i.e., those containing transformed secondary refuse; see Chapter 11) could produce results as misleading as those from a site surface collection, because the transformed secondary trash also represents the "average" conditions present at the site when it filled. For those features where the fill may be inferred to be contextually sound, such as an untransformed secondary refuse deposit, there is reason to believe that specific causal factors led to the deposit's formation. The seriation model allows us to propose a date for the feature's fill in cases such as those that otherwise lack criteria for dating. Feature 20 at the Deer Creek site represents an example of this use for the seriation model.

CULTURAL IDENTITY AND SOURCES OF INFLUENCE IN THE TONTO BASIN

> How does one distinguish the Visigoths from the Catalans, the Aztec from the Chibcha? And how different were the Mogollon from the Hohokam and Anasazi? (Haury 1985:405)

Determining the cultural affiliation of the Tonto Basin's Preclassic inhabitants has become a hallowed pastime in Salado research (e.g., DiPeso 1974; Doyel 1976, 1988; Gladwin and Gladwin 1935; Gumerman and Haury 1979; Haury 1945; Nelson and LeBlanc 1986; Schroeder 1953; Wasley and Doyel 1980; Weaver 1976; Whittlesey and Reid 1982; Wood and McAllister 1980). Salado origins research has concentrated on the nature, timing and sources of influence as well as on the organizational structures that supported populations

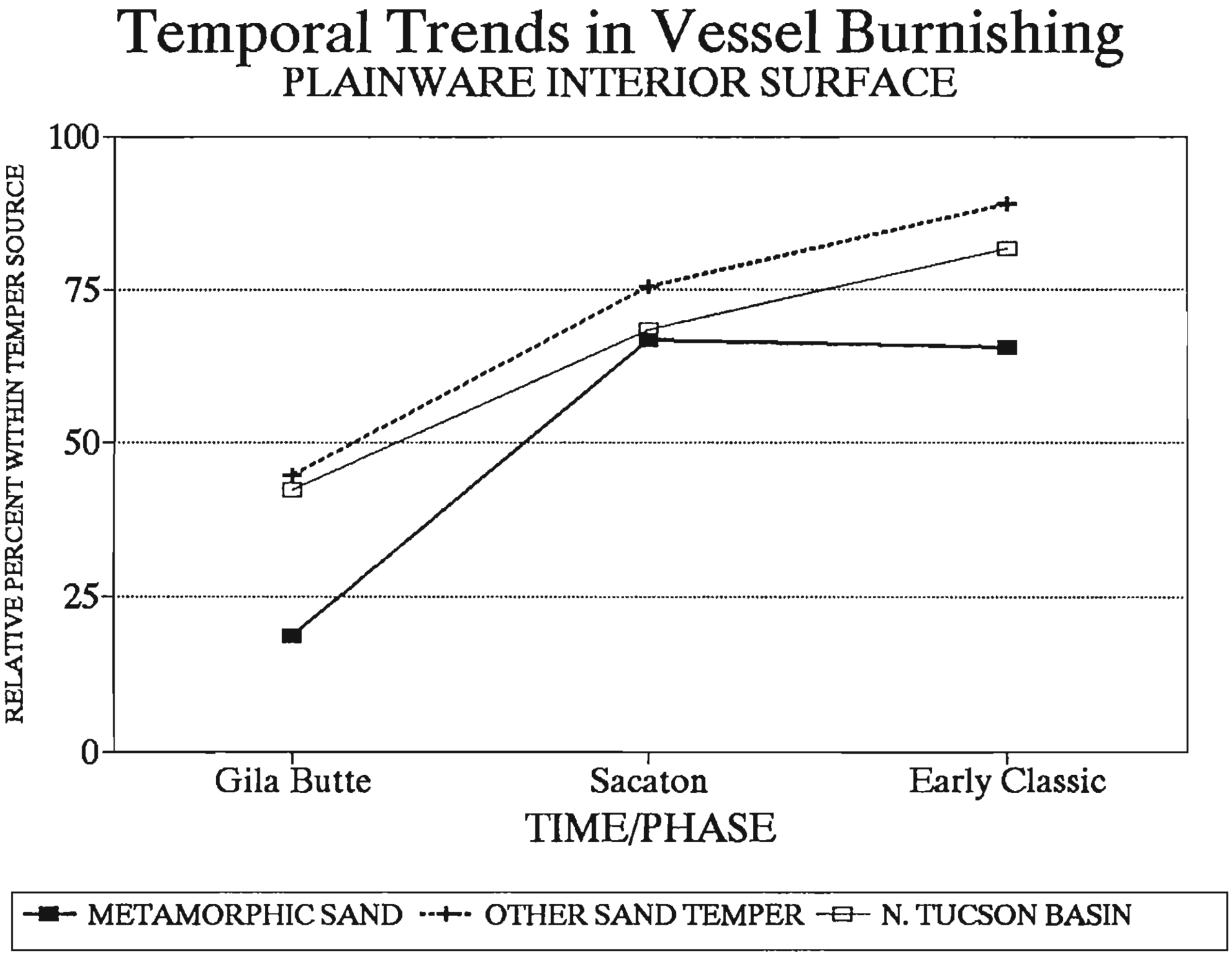

Figure 13.28. Temporal trends in burnishing: plainware rim sherd and restorable vessel interior surfaces.

that developed in, or colonized, the Salado heartland. At least two opposing viewpoints have battled during the fifty years of research on Salado origins. On one side of the debate are those who believe in the colonization of the area by Phoenix Basin Hohokam populations (e.g., Wood and McAllister 1980). On the other are those who believe that an indigenous Tonto Basin population was in place from the Preclassic period onward, and that this population was responsive to numerous and variable cultural influences through the centuries and across sub-regions of the Tonto Basin. That the Tonto Basin was a sort of cultural crossroad is clear from the variety of intrusive ceramic types recovered from most excavations in the region. In addition, the interesting architectural mixture of Pueblo and Hohokam traditions throughout the Salado region has

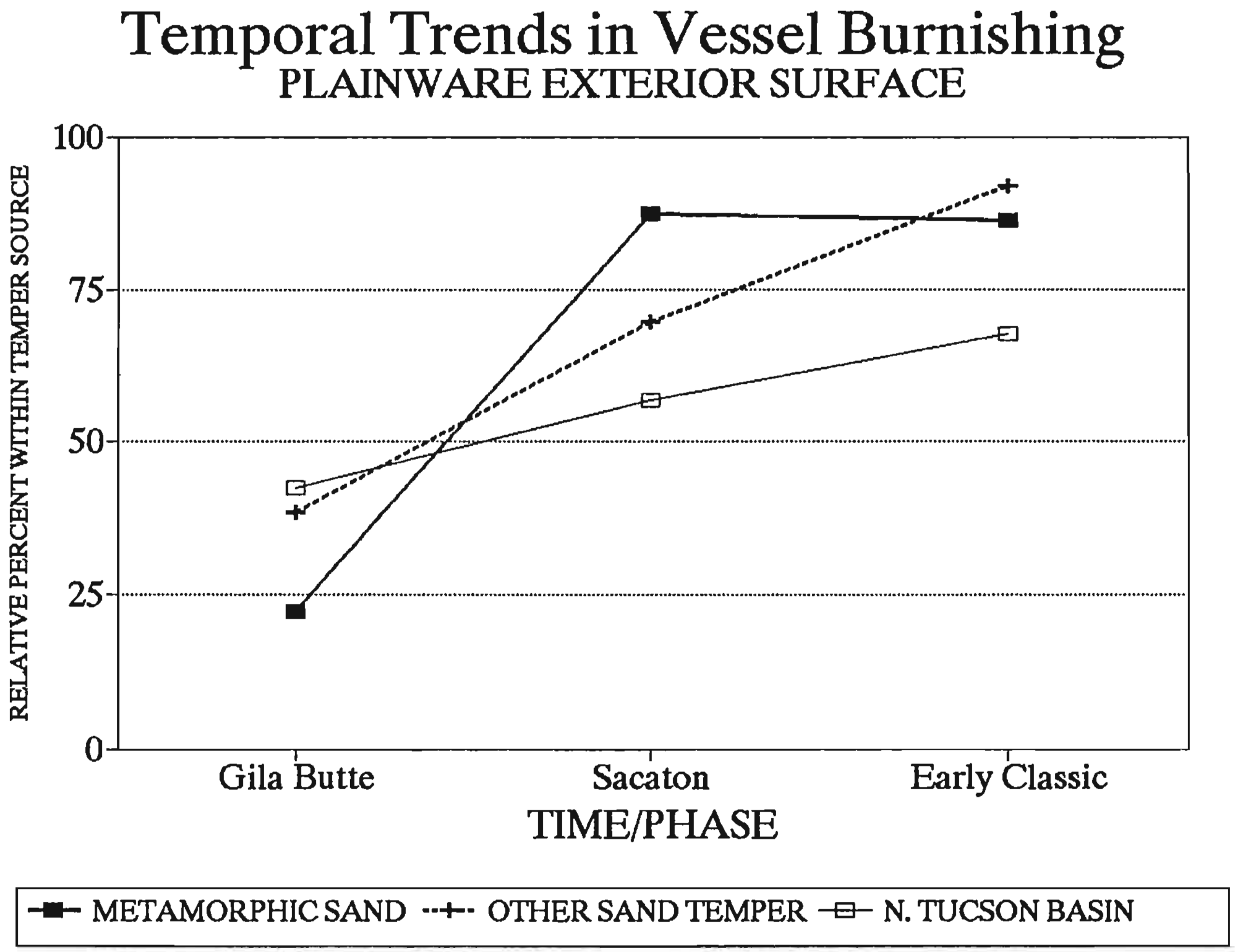

Figure 13.29. Temporal trends in burnishing: plainware rim sherd and restorable vessel exterior surfaces.

prompted some researchers to propose the term "Southern Pueblo" as an alternative to the traditional culture area designations (Nelson and LeBlanc 1986).

The number of adherents to a Gladwinian model of Hohokam colonization today has diminished somewhat with the ever-growing body of excavation and survey data from the Tonto Basin. More might agree with Doyel (1988:291), who views the Salado culture as an amalgam of different populations that have no clear temporal antecedents. Our ceramic analysis has identified the presence of indigenous populations in the Upper Tonto Basin by no later than the mid-eighth century A.D. Clear evidence for this early occupation lies in the

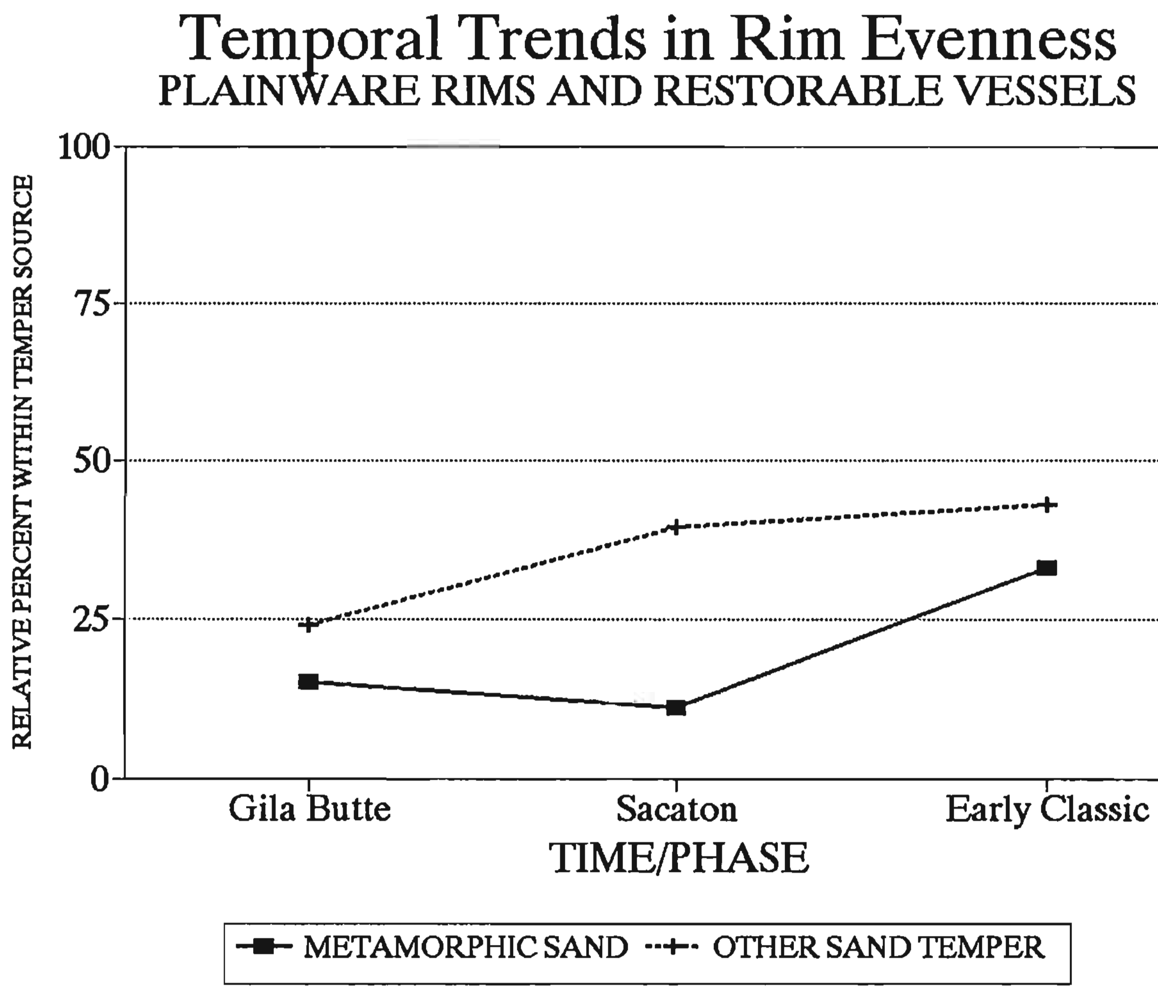

Figure 13.30. Temporal trends in rim evenness: plainware rims and restorable vessels.

presence of locally produced utilitarian pottery. That the Salado development in the Tonto Basin was not entirely local is also likely. The following sections explore possible sources of cultural influence in the earliest well-documented phase (i.e., the Gila Butte phase).

Research throughout the Salado area has emphasized the enormous diversity of cultural remains that are included under the "Salado" culture designation by the Classic period (e.g., Nelson and LeBlanc 1986:7). Salado sites in the Mimbres Valley bear some resemblance to Mogollon traditions in west-central New Mexico (Nelson and LeBlanc 1986) and Salado sites in the Tonto-Roosevelt region look much like the Arizona mountain Mogollon (Whittlesey and Reid 1982). Doyel (1988:290) also points out that sites and their assemblages in the Bylas-to-Safford region look similar to the Point of Pines material. Cultural heterogeneity most certainly characterizes the prehistoric cultural resources of what is now the Tonto National Forest in both the Preclassic and Classic periods. Striking differences are evident between the Lower and Upper Tonto Basin during its early Preclassic period occupation. Affinities with the Hohokam "core" area are strong in the Lower Basin during the Preclassic (e.g., Haury 1932) and Classic periods, as evidence by previous research by Wood and McAllister (1980) and ongoing research through the Arizona State University Platform Mound Study and the Roosevelt Community Development Study by Desert Archaeology. The character of Upper Basin cultural affiliation is more complex, in some ways, than its Lower Basin counterpart since buffwares and whitewares occur together in early assemblages, and Hohokam traits intermingle with Mogollon traits.

In this section of our chapter, we examine cultural identity and sources of influence in the Tonto Basin from an Upper Basin perspective. Our most important contribution to Tonto Basin prehistory is the documentation of locally produced utility ceramics by approximately the eighth century A.D. In doing so we effectively dismiss notions of administered colonization that have been proposed since the Gladwin and Gladwin study in 1935 and is best articulated by Wood and McAllister (1980). We rely on three ceramic indicators in our study: the use of micaceous temper in pottery production in contrast to locally produced nonmicaceous plainware, the absence of locally produced flare-rim bowls (a hallmark of the Colonial Hohokam), and the local production of other vessel forms whose parallels are found in areas to the east and north of the project area. Our discussion of cultural affiliation here does not claim to be definitive, because similar work remains to be done with different artifactual and architectural classes of data. We add these observations on cultural affiliation to stimulate further research in this area and to demonstrate the utility of utilitarian ceramic assemblages for examining the origins of the Salado.

Tonto plainware pottery traditionally has been attributed to various cultural groups by the examination of attributes such as temper, finishing technique, and style of manufacture. Whether these attributes have any true meaning in terms of ethnicity has been questioned for some time now (e.g., Pilles 1976; Jeter 1978). Potential differences in plainware traditions are explored in this study through a combination of a comparative vessel form study and quantitative petrographic analysis. Explanations for the basin's original inhabitants include Hohokam colonization (Wood and McAllister 1980; Wood 1985) as well as in situ development that was later influenced by the Hohokam through trade and interaction (e.g., Fuller et al. 1976; Neitzel 1985). Another theme in Tonto Basin research lies in uncovering the origins of the later Salado settlements. One current theory envisions the Salado as a Classic period Hohokam manifestation (Wood and McAllister 1982; Wood 1985, 1986), while a related model envisions the Tonto Basin as the home of the Hohokam elite (Rice 1985). An alternative viewpoint views the Salado population as Puebloan emigrants from the northern Sinagua (Pilles 1976) or northeastern Mogollon areas (Whittlesey and Reid 1982).

Substantial variability exists in the plainware and redware traditions of the Tonto Basin. In this section, we discuss the importance of "cultural identity" arguments for explaining the temporally distinct patterning observed in the Rye Creek Project plainwares and redwares. Our arguments rest on two key assumptions: 1) cultural influence or "identity" is a dynamic process that shifts throughout the Preclassic and Classic periods in the Tonto Basin, and 2) evidence of identity is best reflected through morphological aspects of the utilitarian ceramic assemblage. The former assumption is supported by Clark's analysis (Chapter 12, this volume) temporal shifts in sources of decorated wares and through recognition of a Classic period "Salado" horizon (Wilcox and Sternberg 1983). The latter assumption derives from the large corpus of ethnoarchaeological literature that now exists. Our study focuses on ethnicity as a shared technological system, reflected in the products of potters at the most inclusive level (i.e., within a broad community), rather than on ethnicity as a series of stylistic boundary markers across various media.

Theoretical Rationale and Previous Research

Research on stylistic variation is now well entrenched in the archaeological literature. In a larger theoretical framework, style has been modeled variously as indicative of stylistic interaction (e.g., Plog 1980), of ethnic identity (e.g., Wobst 1977), and as power negotiation (e.g., Hodder 1982). Ceramics are one of the most common artifact classes for stylistic analyses due to their resilience and ubiquity in the archaeological record. Southwestern studies have focused on decorated ceramics to develop measures that track interaction intensity between groups (see Canouts 1991 for a review of measures) within a dynamic perspective (e.g., Hegmon 1986, 1989; Hantman and Plog 1986). Problems inherent in assumptions that underlie stylistic studies have been effectively critiqued by Hodder (1982) and Plog (1990) and will not be discussed further. This brief background to the subject first examines findings from the ethnoarchaeological literature. Through the ethnographic perspective, style and ethnicity can be studied within an ongoing cultural context. We next turn to the prehistoric Southwest, concentrating on the Tonto Basin and its surrounding regions. Our focus of analysis is unusual among Southwestern studies, since our study uses formal differences in utilitarian -- rather than in decorated -- ceramics to address questions regarding cultural affiliation in the Upper Tonto Basin Preclassic period. Our presentation of ethnoarchaeological and archaeological perspectives on the issue provides empiric support for our strategy.

The Ethnoarchaeological Perspective

> The archaeologist cannot hope to identify all the tribes or ethnic groups that existed in the past, but he can identify *ethnicity* if by this is meant the *mechanism* by which interest groups use culture to symbolize their within-group organization (Hodder 1979:452, emphasis in original).

Ethnoarchaeological literature on ceramic production and distribution has burgeoned in the last two decades (for review of ceramic ethnoarchaeology, see Kramer 1985). Ethnoarchaeological studies of ethnicity tend to focus on nonceramic material culture items, such as spears (Davis 1985), architectural decoration (Wiessner 1989), or studies such as Hodder's (1982) that focus on a range of material culture items including, but not limited to, ceramics. At least two recent studies investigated ceramic variability with respect to ethnicity, one from a stylistic viewpoint (DeBoer 1990 for the Shipibo-Conibo) and another from a stylistic-morphological viewpoint (Longacre 1991, for the Kalinga). In each case, ceramics reflect discrete cultural groupings. In the Peruvian Amazon, Shipibo-Conibo communities express their ethnicity across a variety of media (Deboer 1991), using a suite of related motifs. In the Kalinga case, potters in two neighboring river valleys produce functionally equivalent vessels whose profiles and types of incised decorations differ. Lubo potters from the Tanudan River Valley manufacture vessels with pronounced high shoulders, while Dalupa and Dangtalan potters from the Pasil River Valley make pots with globular bodies (Longacre 1991). Both river valleys are part of the Kalinga subprovince and ethnic group, but there are linguistic and ceramic differences between populations in the two river valleys. The potters themselves recognize these differences and periodically imitate each other's styles.

The contention that cultural identity is best reflected through utilitarian -- rather than decorated -- ceramics is supported by cross-cultural ethnoarchaeological data. Among small-scale agriculturalists, utilitarian pottery is made frequently and used at the household level or at the level of household industry (e.g., DeBoer and Lathrap 1979; Lauer 1974; Longacre 1981; Okpoko 1987; Stark 1991). Whether produced for local consumption or for exchange beyond the producers' community, sharp stylistic and morphological differences often exist among ethnic groups (e.g., Hodder 1979). Pottery production epitomizes this material culture patterning, as localized potting traditions are often distinguishable from different communities. In addition to stylistic variation, morphological differences in the types of shoulders, bases, and rims may reflect ethnic boundaries. Manufacturing techniques for utilitarian pottery (i.e., cooking vessels and water jars) are particularly stable through time, because functional needs constrain the range of acceptable variance in design (e.g., DeBoer 1984; Linton 1944). Particular ceramic forms and ceramic styles are transferred from one generation to the next (Graves 1985; Stanislawski 1977), and these ceramic traditions may be continued even after female potters marry (or are otherwise relocated) away from their villages of birth (Lathrap 1983). Plainware "traditions" are here viewed as reflections of localized potting communities that share technological traditions and access to particular constellations of resources.

These technological traditions, observable in style or in morphology, are somewhat fluid in character. Intermarriage and warfare are two forces that encourage potters away from their home communities to abandon their traditional styles and to adopt those of their new village (e.g., DeBoer 1986). The existence of material culture patterning along ethnic lines varies from one culture to the next, and even through time within a particular culture (e.g., Hodder 1979). How and why ethnicity appears and disappears in the material record is an important topic that lies outside the purview of this study (but see Sackett 1990 for recent discussion). In this study, we explore the hypothesis that distributions of vessel forms (particular to different culture areas) may reflect sources of influence on the Preclassic Upper Tonto Basin.

The Tonto Basin in Geographic Context

Utility ceramics -- in this analysis, divided into plainwares and redwares -- have a long tradition in these debates over cultural identity in the Tonto Basin. This lack of consensus regarding sources of influence has been discussed briefly at this chapter's beginning, as well as elsewhere (see Chapter 3, Volume 1 and Chapters 25 and 28 in Volume 3). Several factors contribute to the discordance in notions regarding Tonto Basin cultural identity vis-à-vis plainwares and redwares. First, different studies have employed varying levels of detail in the level of resolution in temper identification (e.g., macroscopic versus microscopic techniques) and in the nature of petrographic techniques employed (i.e., qualitative vs. quantitative petrography). Disagreement also results from differing conceptions of the relationship between ceramic technology and ethnicity. Traditional, technologically based distinctions between culture areas are based on paddle-and-anvil vs. coil-and-scrape technologies that allegedly characterized the Hohokam and Mogollon cultures (e.g., Wheat 1955:198). This argument has been challenged effectively by work in the area by Whittlesey and Reid (1982:73), who argue that variability in occurrence of these techniques is the rule rather than the exception:

> The data indicate that thinning technique cannot be seen solely as a criterion of ethnic identification; formal and functional criteria must also be considered. The data also show that no blanket classification of Tonto Basin ceramics as typical Classic period Hohokam can be accepted if based solely on paddle-and-anvil thinning.

These techniques may reflect differences in vessel shape rather than differences in cultural identity. Whittlesey and Reid (1982) suggest that bowls were scrape-thinned and jars were paddle-and-anvil-thinned. Yet another alternative explanation lies in the combination of both techniques during the manufacture of a single vessel, as has been observed ethnoarchaeologically in the Philippines (Longacre 1981), in Africa (Hodder 1979), and elsewhere (e.g., Nicklin 1971). If most vessels involved dual techniques, then paddle or anvil scars reveal more about the degree of labor invested in finishing techniques (i.e., burnishing or polishing) than about construction techniques. Rice and Lindauer (1990:81) critique Whittlesey and Reid (1982) and suggest instead that perhaps a large proportion of the assemblage is being imported into the Tonto Basin. Clearly, too little is understood about technological and cultural entailments of particular manufacturing technologies in the Tonto Basin. Research now in progress will employ x-radiography to distinguishing coil-and-scrape from paddle-and-anvil techniques with Roosevelt Platform Mound Study materials (Rice and Lindauer 1990:80-82) and may shed light on these issues.

Finally, researcher bias that results from extended research in a particular area outside the Tonto Basin also looms large in arguments concerning cultural identity. Since Haury's (1932) excavations at Roosevelt 9:6, Hohokam specialists working in the Tonto Basin have argued strongly for Hohokam-like aspects of site assemblages. On the other hand, Mogollon or Sinaguan specialists who have wandered southward into the Tonto Basin have made equally strong claims for Mogollon-like features and artifacts on identical or adjacent sites (see also Chapter 3, Volume 1).

Archaeologically speaking, the Tonto Basin is believed to lack an indigenous decorated-ware tradition in the earlier (i.e., pre-A.D. 1200) time periods, so that a decorated vessel form study would skew the emphasis toward the Salado or Classic period. Data from utility ceramics complement data from decorated ceramics in other important respects. Intrusive sherds inform on gross patterns of exchange and interaction that may occur sporadically throughout the occupation of particular sites. It is generally accepted that a high volume of utility or "index" wares were produced and discarded at a given prehistoric site or within a localized region. Colton's concept of an "index ware" (described in 1958 and elsewhere) equated ubiquity of a particular ware with local production and made explicit a common assumption that the most common pottery types were locally produced. Early petrographic studies that questioned this assumption were largely dismissed because most archaeologists assumed a model of household-based localized ceramic production and village autonomy throughout the prehistoric period (S. Plog 1980). Recently, analysis of Chaco Canyon ceramics has demonstrated that at the Chaco system's peak (ca. A.D. 1100-1200), approximately 50 percent of all ceramics were imported rather than locally produced (Toll 1991:94, Figure 5.2). Such studies challenge the "index ware" concept, and only characterization studies can confirm the validity of the "index ware" approach. However, this vessel form study employs a broad geographic scale for analysis that obviates this problem. One can safely assume that ware series such as the Alma, Alameda and Lino wares were made within a particular culture area and exhibited numerous variants within a shared environment. The same cannot be said of decorated wares that are found in areas like the Tonto Basin. The distinction between decorated ceramics as tradewares, and as ethnic markers, is hazy and fraught with interpretive problems. Utility ceramics -- rather than intrusive decorated ceramics -- should directly monitor ethnicity of the producers through time. This is especially true in systems of nonspecialized ceramic production that likely characterized the Preclassic period Tonto Basin settlement system.

The study of cultural identity presented in this report should be viewed as preliminary in nature, to be pursued in greater detail during the upcoming Roosevelt Community Development Study (Doelle et al. 1991). Here we restrict our focus to the Gila Butte phase in the Upper Tonto Basin represented in the Rye Creek Project at the Deer Creek site (AZ O:15:52). Given the presence of both Snaketown and Gila Butte Red-on-buff ceramics, this is now the earliest ceramic period site known from the Tonto Basin, and arguably an ideal place to examine the nature of the initial Upper Tonto Basin settlement. The high frequency of Hohokam buffwares with demonstrably local plainwares at Deer Creek might support the model for colonization of the Tonto Basin during the Gila Butte phase (Gladwin and Gladwin 1935; Haury 1932; Rice 1985; Wood 1985; Wood and McAllister 1980, 1982, 1984). To others, this association reflects trade rather than colonization (e.g., Neitzel 1985; Whittlesey and Reid 1982:75). Extant cultural identity arguments for Gila Butte phase sites in the Tonto Basin (e.g., Roosevelt 9:6, Ushklish, and now Deer Creek) have focused on intrusive, rather than utility wares. In our preliminary analysis presented here, we rely on temper data that suggest that a substantial percentage of plainwares were produced locally during the Gila Butte phase. We therefore suggest the presence of an indigenous Tonto Basin population by at least the Gila Butte phase. Accordingly, ceramic expressions of cultural identity are explored in relation to ware assemblages, basic technology and vessel form.

The Gila Butte phase vessel form study presented here examines temporal and geographical variation in vessel form at a gross level of analysis. Subsequent research through the Roosevelt Community Development Study will utilize a more detailed, quantified approach to the issue. Although the Tonto Basin literature is particularly scant on the subject of plainware vessel form, efforts to categorize ceramic shapes and track them through time have been attempted in areas neighboring the Tonto Basin for some time (see Wheat 1955; Haury 1976; and Morris 1939 for Mogollon, Hohokam, and Anasazi, respectively). To date, studies of temporal change in decorated wares have overshadowed plainware research. This plainware vessel form study explores directions of cultural identity of Tonto Basin communities through their plainware forms.

Plainware Traditions Surrounding the Tonto Basin

Figure 13.31 presents a schematized illustration of the four Gila Butte phase plainware traditions that surround the Tonto Basin. Plainware traditions in the illustrated section of the Southwest traditionally have been characterized into regional variants, based on grossly defined geographical boundaries and macroscopic differences in temper composition. In the Hohokam area, Gladwin (1933) provided a type description for Gila Plain, and Gila Plain constitutes the most common utility ceramic. Alameda Plainwares are described by Colton (e.g., 1958) and concentrated in the Flagstaff and Verde Valley areas but radiate outward in space. The Alameda series are a more northerly functional equivalent of the Hohokam Gila Plain tradition. In the Mogollon area east of the Tonto Basin is found the Alma Plain series, described by Haury (1936b). Because

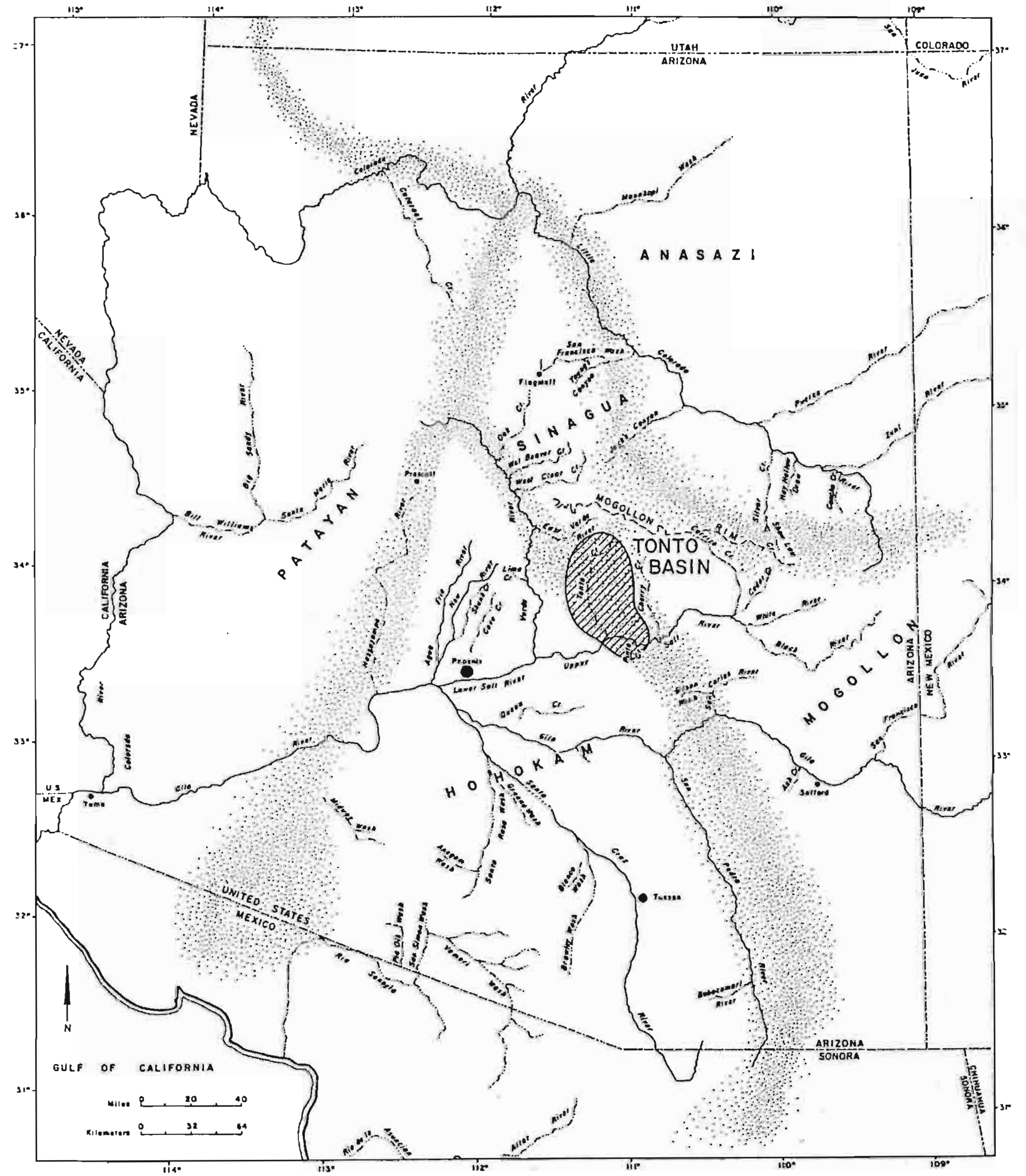

Figure 13.31. Gila Butte phase cultural traditions surrounding the Tonto Basin.

corrugated utility wares become important later in the cultural sequence, this study relies on Alma plainware as the index ware for the Mogollon area. North into the Anasazi area are the Lino Graywares, first described by Kidder and Guernsey in 1921. Within the wares are types and series, described in various publications for each culture area. This study has relied on numerous site reports and on synthetic studies of ware traditions for each culture area. Wheat's (1955) synthesis of Mogollon culture prior to A.D. 1000 provides a baseline for Alma Plain wares, and LeBlanc's (1982) study is a useful supplement. A publication by Gladwin and Gladwin (1933) provides the foundation for Gila Plain for the Hohokam area. The Anasazi Lino Grayware tradition has been exhaustively presented in Morris' (1939) study of the La Plata district and Elizabeth Morris' (1980) study of the Prayer Rock District. Northern Arizona Alameda brownwares are presented in Colton and Hargrave's 1937 and Colton's 1958 publications. Vessel illustrations or photographs and observations from reports of contemporary sites in these four areas also are used in this study.

"Gila Butte" phase sites (i.e., those dating ca. A.D. 700-900) included for each of the four areas are presented in Table 13.40. The reader might note that the time range used in this study is necessarily gross and violates some recent dating models proposed for different cultural sequences in the Southwest. For example, the Gila Butte phase traditionally terminates prior to A.D. 900, as does the Basketmaker III phase. This type of comparative study relies on an array of site reports produced as early as the late 1920s. Consequently, chronological control and methods of dating vary widely from one site report to the next. To compensate for this problem, roughly contemporaneous sites were chosen. Where tree-ring data were available, they provided a chronometric baseline for comparison.

The Tonto Basin is surrounded by contemporaneous utility ceramic traditions, all of which have left their mark on the project area in some respect. To the south lies the Hohokam area, traditionally thought to be most influential during all time periods in the Tonto Basin and characterized by Gila Plain in the early period. The Mogollon area, located northeast of the Tonto Basin, has a long plainware tradition usually called Alma Plain. The Sinagua area to the northwest also contains a temporally bounded set of Alameda Brownwares (Haury 1936b), including sites that fall in the Basketmaker III time period. Further afield lies the Anasazi Lino Gray tradition, thought to characterize Basketmaker III villages across a wide geographical expanse that ranges from southwestern Colorado and western New Mexico to the Little Colorado region of northeastern Arizona. That these wares are basically contemporaneous is suggested by early site reports, intersecting phases in many chronologies, and the association of multiple plainwares at selected sites, such as the Bear Ruin (Haury 1985).

At the compositional level, these traditions are technologically distinct from one another. Such patterning is to be expected, based on the differential distribution of particular clay and temper sources, and this point has been noted in earlier Tonto Basin ceramic studies by Jeter (1978) and, more recently, by Bruder and Ciolek-Torrello (1987). On another level, however, distinctions are less clear when stylistic traditions (here defined through vessel morphology) are compared. Although compositional differences clearly demarcate plainware traditions in any given area, references in the literature suggest that clinal variation, rather than distinct ethnic groups, accounts for much of the observed interregional variability. Within larger areas -- such as the Mogollon or the Hohokam -- are found regional traditions. Alameda Brownwares in the Verde Valley during the Gila Butte phase have been compared with Phoenix Basin Hohokam plainwares and found to be similar in form and technique (Lerner 1986:118). Breternitz (1960a:27), in noting similarities between the Alameda and Gila utility wares, suggests that "what we are currently designating as separate "wares" are actually "series" within a single, basic, paddle-and-anvil brownware found in central and western Arizona."

These plainware traditions, as described in the early literature, are neither monolithic nor static. Subregional variations in vessel form have been identified in detail for the Alma Plainwares (Wheat 1954; Bullard 1962), suggesting the existence of localized traditions -- characterized by distinct vessel forms -- rather than ware horizons that emerge for decorated ceramics during the same time period. Temporal change also has been documented in the sequential types (Martin et al. 1949:198; Wheat 1955) and shapes (Martin 1943; Martin 1940) of Alma Plainwares. Temporally sensitive changes have also been described for Alameda Brownwares (Colton 1958) and Lino Graywares (Morris 1939).

Table 13.40. Sites dated to the "Gila Butte" phase used in the vessel form study, by culture area and region.

Culture Area	Region	Site Name	Reference	Date (A.D.)	Phase	Index Ware
?	Upper Tonto Basin	Deer Creek	This volume	750-950	Gila Butte	Tonto Plain
?	Upper Tonto Basin	Ush Klish	Haas 1971	750-900	Gila Butte	Tonto Plain
?	Lower Tonto Basin	Roosevelt 9:6	Haury 1932	750-950	Gila Butte	Local Plain[2]
Mogollon	White River	Buh bi laa	Halbirt and Dosh 1990	750-900	Gila Butte	Alma Plain
Mogollon	Forestdale	Bear Ruin	Haury 1940	550-700 600-700[2]	Forestdale	Alma Plain
Mogollon	Point of Pines	Crooked Ridge	Wheat 1954	700-900 650-750[3]	San Francisco	Alma Plain
Mogollon	Pine Lawn	SU Site	Martin 1943, Martin 1940 and Rinaldo 1940	550-650	Georgetown	Alma Plain
Hohokam	Tucson Basin	Hodges Site	Kelly 1978	750-950	Gila Butte	Local Plain
Hohokam	Tucson Basin	Redtail Site	Bernard-Shaw 1989	650-750[2] 700-900	Cañada del Oro component	Local Plain
Sinagua	Verde Valley	Calkin's Ranch	Breternitz 1960; Stebbins et al. 1981	775-1425	Hackberry/ Cloverleaf component	Tonto Plain (Verde Brown)
Anasazi	Upper Little Colorado	Flattop	Wendorf 1953	600-800	BMIII/PI	Adamana Brown
Anasazi	Upper Little Colorado	Twin Buttes	Wendorf 1953	700-800	PI (White Mound)	Lino Gray/Alma Plain
Anasazi	Upper Little Colorado	White Mound	Gladwin 1945	750-800	PI (White Mound)	Lino Gray
Anasazi	Upper Little Colorado	White Water	Roberts 1939, 1940	800-900	PI	Lino Gray
Anasazi	Chaco	Shabik'eshchee	Roberts 1929	750-950	BMIII/PI	Lino Gray[4]
Anasazi	Prayer Rock	Prayer Rock Caves	Morris 1980	750-950	BMIII/PI	Lino Gray

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[1] Data not yet analyzed from Arizona State Museum collections.

[2] Haury (1932) did not assign a ware name to these "culinary wares," these would now be considered either Gila or Tonto Plain.

[3] Bannister et. al 1966.

[4] Roberts (1929) did not assign a ware name to these "culinary wares," these would now be considered "Lino Gray," a ware established in 1932 by Hargrave (Ellwood 1980:78).

Early ceramic "traditions" demarcated by the discrete wares reflect localized potting technologies. Ethnoarchaeologically, such patterning often reflects separate pottery-making communities (Arnold 1985). In an early discourse on the Awatovi ceramics, W. Smith (1962) recognized the existence of such traditions, pointing out that intragroup differences were overshadowed by the importance of a broader technological and stylistic tradition in which Awatovi potters worked. He commented that the term "school" aptly described the loose confederations of producers whose vessels, in design or in shape, reflected broad stylistic and technological traditions of particular areas. Smith's observation is borne out by ethnoarchaeological data from Shipibo-Conibo potters in the Peruvian Amazon:

> The Shipibo-Conibo style encompasses an astonishing amount of variability. No two artists ever produce identical designs. The style is complex enough to ensure endless novelty. Style is played with, experimented with, admired, secretly ridiculed, but never copied slavishly. There is always plenty of room for individual artistic expression (DeBoer 1990:103).

That similar variability within cultural ceramic traditions existed in Southwestern prehistory is suggested by the growing number of traditions (particularly decorated traditions) and by the plethora of models now available to explain later prehistoric alliance networks (e.g., Plog 1983; Upham 1982). Well-defined ceramic traditions with widespread distributions have been documented throughout the Mogollon and Anasazi area. The meaning of the social boundaries believed to be reflected in ceramic distributions is a matter of open debate and will not be addressed in this analysis in any detail (see Conkey and Hastorf 1990 for recent views). Rather, we focus here on the starting point: on the early plainware traditions that characterized areas surrounding the Tonto Basin. Earlier research distinguished morphological and technological aspects of the plainware traditions from one another in space, and some researchers suggest changes in each tradition through time. Hohokam plainware ceramics included at least one unique vessel form, the flare-rim bowl, that distinguished it from its northern neighbors. Wheat (1955:199) also notes technological differences between the Hohokam and Mogollon utility wares:

> . . . while the Mogollon made polished wares from the earliest known phases, they were also producing cruder, unpolished type which were technologically more simple. There is no known counterpart in the Hohokam culture, whose earliest pottery was all polished. Whether this indicates a time difference cannot be answered at present.

To Haury, architectural and ceramic differences north of the Hohokam areas in this time period were so pronounced that he proposed the "Mogollon" culture area term (Haury 1936a:45), whose index plainware was called Alma Plain. Smudging was unique to the Mogollon ceramic technology during the Gila Butte (or Basketmaker III) phase (Haury 1985:219). Mogollon ceramics also included stylistic techniques unknown in the Anasazi (Lino Grey) area, such as incising, grass-scoring, punching, and applique (Haury 1936a:44). Morphologically, Mogollon ceramics exhibited a smaller range in form than did their Anasazi counterparts (1936a:44), and Mogollon jar forms had larger orifices than Anasazi equivalents (Haury 1936a:45).

At the SU site, Rinaldo (1940:80) noted Alma Plain vessel forms that were unique to the earlier time period, including neckless globular jars, wide-mouthed jars with flaring rims and "narrow-mouth jars with oral part drawn out from the body." In a subsequent season, Martin (1943:238) added to the early Alma Plain list necked globular jars (or barrel-shaped) with necks and barrel-shaped jars, which Martin described as unique to the Mogollon. The Anasazi ceramic tradition was distinguished by a number of characteristics, most notably the use of handles and lugs (Haury 1985:204), which were discovered archaeologically rare or absent in contemporary Mogollon and Hohokam plainware assemblages. In Figure 13.33, the range of vessel forms used in this study is presented. Vessel form illustrations included in this study are derived from miscellaneous site reports, and appeared either as illustrations or as photographs. Lack of information on vessel scale, as well as a paucity of information on the frequency of particular vessel forms on a given site, constrains the types of conclusions that can be drawn in this comparative study. Still, gross clinal distinctions can be drawn as one moves from one culture area to the next, and these differences are illustrated in Table 13.41. Our use of the concept of "clinal variation" does not imply that we view ethnicity as cultural osmosis, nor that we believe that cultural traits observable in the archaeological record blend into one another to form undifferentiated wholes. That material culture boundaries exist is obvious from the development of culture area terms like Hohokam and Mogollon. We also recognize that in the ethnographic record, isomorphism commonly exists between ethnicity and material culture. However, bridging the gulf between general anthropological theory and the particularities of the Upper Tonto Basin is not possible within the scope of the RCM project. Concepts such as "Mogollon" and "Hohokam" carry a heavy inferential load and quickly move from descriptive devices to quasi-explanatory models (Dean 1988:197; Speth 1988; Wilcox 1980, 1988). The first goal of this sort of research is to sort out spatial variability in material culture at different points in time, as we attempt to do for the Gila Butte phase in the Tonto Basin.

Future research on this subject should involve an in-depth inventory of vessel forms in assemblages from sites for which collections are available. This pilot study simply indicates the utility of further research on the subject.

Figure 13.32 is a revised version of Bullard's map that includes sites reported subsequent to his study. Photographs and illustrations contained in reports from sites located in the illustrated regions were examined for plainware vessel forms in their respective local plainware traditions. The same vessel forms described in the Rye Creek Project plainware-redware analysis (described in a previous section of this chapter) were used in the vessel form study. Supplemental forms were added to the analysis as encountered. As a preliminary attempt to characterize distributions of vessel forms, this study suffers from several problems. Foremost among these is the qualitative nature of the study, because it relied on the reports to provide representative, rather than exceptional, plainware vessel forms. The lack of data on vessel form frequencies in all but a few reports precluded meaningful quantification.

Despite the "unique" attributes of plainware assemblages in their respective traditions, previous researchers working throughout the study area and its environs have noted that these ceramic boundaries were permeable for the Gila Butte-Basketmaker time period between A.D. 700 and A.D. 900. Neighboring plainware traditions show as many similarities as they do differences. At the Bear Ruin, for example, Forestdale Plain (part of the Alma Plainwares) was viewed as a mixture of Anasazi and Mogollon traits. Haury (1985:383) considered Forestdale Plain to be a "hybrid of Lino Gray and Alma Plain." At least one specific Forestdale Plain vessel form at the Bear Ruin mirrors a Lino Gray vessel recovered from the same site (Forestdale Plain: p. 208, figure 26g; Lino Gray: p. 213, Plate 11j). In summarizing Mogollon culture prior to A.D. 1000, Wheat (1955:199) comments that "Mogollon and Hohokam pottery had much in common in the earliest defined phases. Both had plain brown, and slipped and polished red wares. . . . Certain similarities of form in the simple bowl and jars with outcurved rims also are apparent." During this early period, culture area boundaries, later so well defined by decorated ceramics, were permeable. Haury and Sayles (1947:55) observe that the Anasazi boundaries are blurry for this time as well. The clearest boundaries appear on a much smaller scale, among clusters of sites that Bullard (1962) has identified that can be viewed as microregions.

Deer Creek and Questions of Cultural Affiliation

How do plainwares from the Gila Butte phase site of Deer Creek (AZ O:15:52) inform on questions of cultural affiliation? The plainware ceramic assemblage, like the decorated assemblage and the crematorium features, reflects a blend of several neighboring culture areas. From the decorated ceramics, we see evidence for contact with the Hohokam area and points north (i.e., the Tusayan whitewares), with the latter influence increasing into the Sacaton phase. From the architecture, we note similarities among Mogollon sites in the White River district and the Upper Tonto Basin. The evidence for Hohokam influence is present but equivocal. Clark (Chapter 12, this volume) notes that Hohokam buffwares dominate the decorated assemblage during the Gila Butte phase. No flare-rimmed plainware bowls were identified in the Deer Creek assemblage. This lack of flare-rimmed bowls is especially important at the Deer Creek site, because it is at this early site where we have the highest frequencies of locally produced ceramics. Flare-rimmed bowls are a hallmark of Colonial period Hohokam ceramics in both the plain and decorated wares in the Phoenix and Tucson basins.

Another hallmark of Hohokam plainwares for this period lies in the use of muscovite mica, schist, phyllite, or gneiss temper in plainware vessels. Temper composition has often been used as the basis for ascertaining cultural affiliation (e.g., Doyel 1978). These micaceous tempers impart a sheen to vessel surfaces, and are quite common in contemporary assemblages in the Tucson and Phoenix basins. Table 13.42 presents temper data from four Gila Butte phase Hohokam sites to be compared with the Deer Creek data. Only a small proportion of plainwares from the Deer Creek site (3.9%) are micaceous and therefore Hohokam in character, while the percentage of micaceous-tempered plainwares at the four known sites ranged from 42 percent to 69 percent. The absence of micaceous rock tempers in the Deer Creek village plainwares cannot be explained by the absence of suitable resources in the Upper Tonto Basin. Micaceous rock tempers are derived from metamorphic source rocks. The Mazatzal Mountains in the project area are predominantly metamorphic in composition, a fact that is indicated by the mapped bedrock geology (cf., the units indicated as XM and XMS

Table 13.41. Selected vessel forms by region and site.

Site By Culture Area													
TONTO BASIN													
Deer Creek	x	x		x	x		x			x			
Ushklish[1]													
Roosevelt 9:6	x	x		x	x	x							
MOGOLLON: WHITE RIVER													
Buh bi laa	x	x		x		x	x			x		x	
MOGOLLON: FORESTDALE													
Bear Ruin	x	x	x		x	x				x	x		
MOGOLLON: PT. OF PINES													
Crooked Ridge	x		x	x	x	x	x			x	x		
MOGOLLON: PINE LAWN													
SU Site	x	x				x	x	x[2]		x			
MOGOLLON: MIMBRES[3]	x					x	x	x	x	x			
MOGOLLON: SAN SIMON	x					x	x		x	x			
HOHOKAM: TUCSON BASIN													
Hodges Site	x	x	x	x	x					x			
Redtail Site	x		x		x					x			
SINAGUA													
Calkin's Ranch (NA 2385)	x			x			x	x					
Rio de Flag	x	x					x	x		x			
ANASAZI: LITTLE COLORADO													
Flattop	x		x	x		x	x			x		x	
Twin Butte	x	x		x	x	x				x	x	x	x
White Mound		x				x	x					x	
White Water		x		x			x	x		x		x	x
ANASAZI: MISC.													
Shabik' eschee	x			x	x	x				x	x	x	x
Prayer Rock	x	x		x	x	x	x	x		x	x	x	x

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[1] Data not yet analyzed from the Arizona State Museum collections.
[2] Present in San Francisco Red, Saliz variety (Martin 1943:241, Fig. 90; Martin and Rinaldo 1947:367).
[3] Wheat 1955:81, based on following sites: Mogollon Village, Harris Village, Cameron Creek Village.

in Figure 13.4) and the analyzed sand-sample compositions. For example, sand sample TB-77 was collected from a minor tributary of Slate Creek located high in the Mazatzal Mountains. Sixty-three percent of that sample's sand grains represented the types of micaceous source rocks used as artificial temper. A second sample was also analyzed from the Slate Creek drainage (TB-57); that sample was collected downstream from

Figure 13.32. Regions containing "Gila Butte" phase sites in areas surrounding the project area (after Bullard 1962).

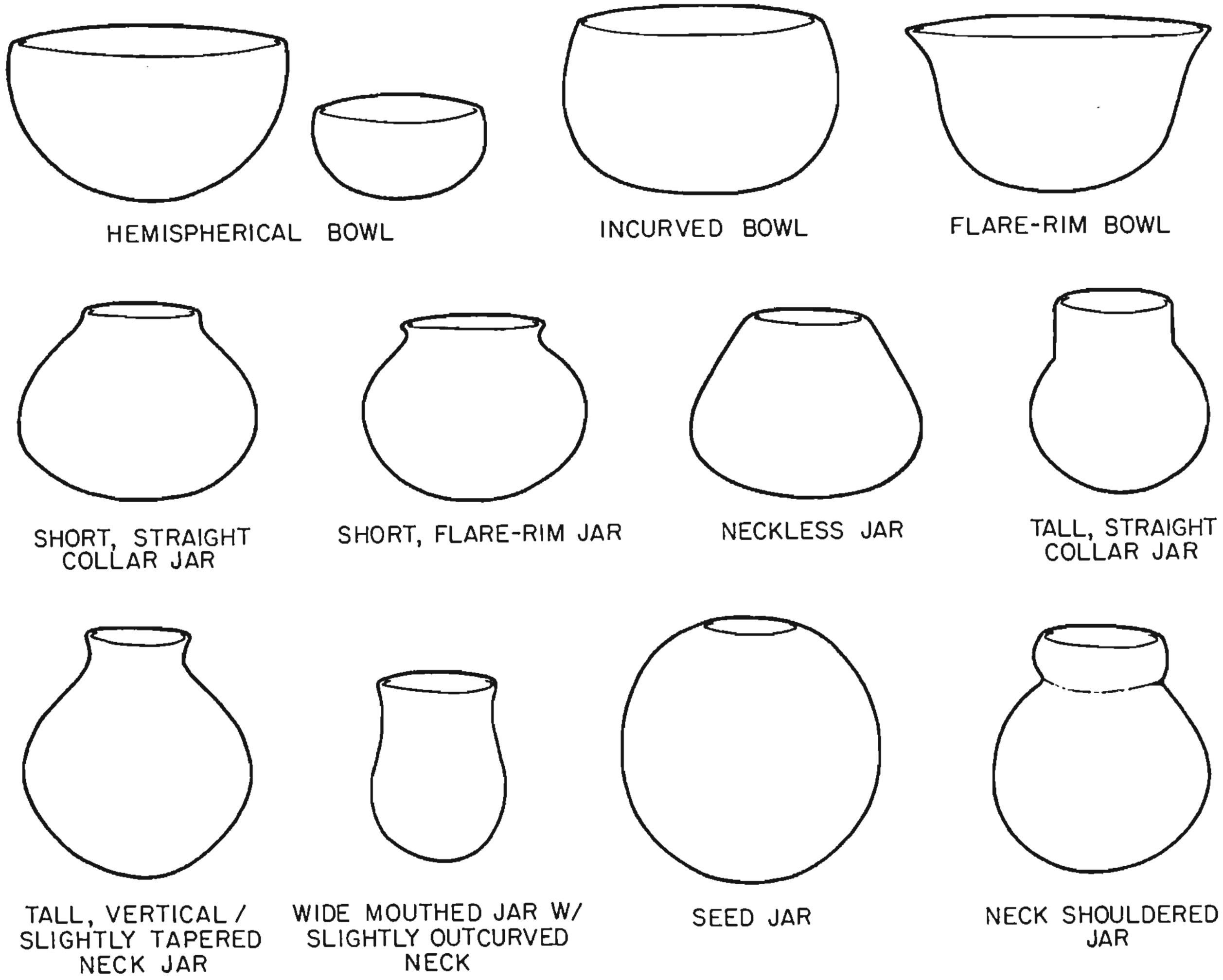

Figure 13.33. Vessel forms used in the Gila Butte vessel form study.

TB-77 on the mountain's bajada. In the second sample only 7.5 percent of the sand grains represented micaceous source rocks. Because Slate Creek is more than 10 km from Deer Creek village it is unlikely that the potters residing there would have utilized resources in its drainage. However, two sand samples were analyzed from Deer Creek (TB-69 and TB-72). Sixteen percent of the sand grains in sample TB-69 represented the types of micaceous source rocks used as temper by the Hohokam, while 21.5 percent of sample TB-72 represented those types of micaceous source rocks. We can therefore hypothesize, by analogy with the example from Slate Creek, that there are probably minor tributaries of Deer Creek that also contain much higher percentages of micaceous source rocks in their sands. Had the potters residing at Deer Creek village wished to utilize such a resource they could have collected either those sands or pieces of the micaceous rocks. Finally, recent evidence from the Tucson Basin (Wallace et. al. 1991) suggests that even when micaceous rock tempers were not available to Hohokam potters as a local resource, intraregional exchange networks established by early Colonial times were capable of circulating this raw material throughout the basin. We note, however, that Wallace and others (1991) believe that the intraregional distribution of gneiss was facilitated by the ballcourt system, and that there are no known ballcourts in the Tonto Basin.

Table 13.42. Frequency of temper types during the Gila Butte phase.

Region	Site	% Sand Temper	% Artificial Temper[1]	Total
Upper Tonto Basin	Deer Creek	96.1	3.9	152
Lower Tonto Basin	Hedge Apple[2]	17.1	70.6	146[3]
Salt-Gila Basin	La Ciudad (Moreland Locus SO2)[4]	52.6	47.4	95
Tucson Basin	Redtail[5]	30.9	69.1	123
Tucson Basin	ANAMAX-Rosemont sites[6]	50.0	42.0	N/A

Notes: [1] The artificial temper category includes gneiss-, schist-, phyllite-, and muscovite mica-tempered sherds.
[2] Data on file at Desert Archaeology.
[3] Remaining 12.3% of sherds exhibited a mixture of sand and one or more artificial tempers.
[4] Data from B. Stark and Heller 1987:Table 2.8.
[5] Data from Heidke 1989a:Table 5.24.
[6] Data from Deaver 1984:Figure 4.69.
N/A Indicates total was not reported.

The Gila Butte phase plainware assemblage, in its absence of flare-rimmed plainware bowls and low frequency of micaceous-tempered ceramics, has important implications with respect to the original inhabitants of the Upper Tonto Basin. The Deer Creek site simultaneously contains the best evidence for local ceramic production and the least evidence of Hohokam domination. We suggest that the relationship between the Upper Tonto and Phoenix basins during the early Colonial time period was one of loose affiliation, rather than one of colonization. Debates over the initial settlement of the Tonto Basin and the cultural affiliation of the later Salado occupation continue to surface in the literature (e.g., Hohmann and Kelley 1988; Rice 1985, 1990; Wood 1989b). Our findings do not necessarily challenge those of previous researchers who concentrated their efforts in the lower Tonto Basin, where Gila Butte phase sites such as Roosevelt 9:6 contain distinctively Hohokam traits. Instead, we encourage other projects throughout the basin to adopt a comparative approach. The patterning we observed at the Deer Creek site indicates clinal variation in culture traits. Sharp, ethnically bounded zones are absent in the Upper Tonto Basin, and its proximity to the Mogollon area accounts for some of the patterning observed at the Deer Creek site.

We believe that the Preclassic Upper Tonto Basin was a transition zone in both environmental and cultural respects. That the Upper Tonto Basin is a cultural transition zone should come as no surprise. The data suggest the existence of some indigenous population, although constraints imposed by the archaeological data preclude estimation of population size for these inhabitants. The data also suggest substantial interaction between the Tonto Basin and its four neighboring "culture areas" of the Hohokam, Mogollon, Anasazi, and

Sinagua (Figure 13.31). We find no convincing evidence that suggests a strictly Hohokam "colonization" of the Upper Basin. Instead, the area reflects an agglomeration of different influences.

Our analysis of RCM plainwares and redwares does not pretend to address the theoretical issue of how these influences interacted during the Preclassic period. We only offer observations on the process from a ceramic viewpoint that we believe effectively questions the previous colonization model, first presented by Gladwin and Gladwin and more recently developed by Wood and McAllister (1980). One well-articulated statement of the colonization model has been presented by Wood and McAllister (1980) and forms the basis of our comments here. In their reconstruction, Colonial settlement of the Tonto Basin resulted from an expansion of Hohokam populations into upland and riverine localities in the "Northeastern periphery" (including the Tonto Basin) by the Gila Butte phase (1980:190-191). Critical to their model is the notion of directed colonialism:

> The interaction between the Hohokam populations of the core area and those of the Northeastern Periphery was . . . to take the form of an active territorial and administrative expansion by a chiefdom-level hierarchical economic/organizational system originating in the Salt-Gila Basin core area [Wood and McAllister 1980:198].

Hallmark traits of ceramics in the core area are used to support the colonization model: the presence of core-produced red-on-buff decorated wares, the presence/absence of Gila Plain pottery, and the presence/absence of a locally produced plainware. The authors conclude from their analysis that ceramics from the Hardt Creek-Deer Creek-Rye Creek locality are Hohokam in appearance (1980:194). Probably few Tonto Basin researchers today would subscribe wholesale to the administered colonization model that Wood and McAllister proposed in 1980 for at least two reasons. The first lies in the inappropriate use of analogy between the prehistoric Tonto Basin and some futuristic science fiction world (see Wood and Hohmann (1985). The second reason lies in the sheer volume of Tonto Basin data generated in the last decade. However, the issue of Colonial period settlement in the Tonto Basin remains unresolved. Researchers continue to debate the sources of cultural influence or interaction between Tonto Basin inhabitants and those of cultural traditions that surround the area.

If challenged, we would certainly agree that ethnicity is not osmosis. Following this thought, we would add that neither is colonization, as it has been proposed, another term for interaction (also see Doyel 1980). Myriad forms of interaction have been documented in the ethnographic literature: ritualized trade partnerships, intervillage marriage, specialized traders, migrations and periodic aggregations in which goods from different groups are exchanged are some examples of mechanisms by which goods might cross cultural boundaries. None of these requires the operation of administrative elite, nor of directed colonization, for its functioning. Although the tempo of Tonto Basin research has quickened, we still feel it is premature to propose broad models of Preclassic period settlement in the Tonto Basin. Much of the last decade's research focuses on the Lower Basin, where affinities with the Phoenix Basin are stronger than is the case in the Upper Basin. More research is needed in the Upper Basin and its environs to clarify differences in the archaeological patterning of these two subregions and to develop coherent models of Preclassic period settlement in the Tonto Basin.

Instead we propose a border area model to explain the plainware patterning solely in Gila Butte phase sites in the Upper Tonto Basin. The concept of a border area between different cultures entails a mixture of cultural traditions and subsistence patterns from neighboring regions. Material culture assemblages in border areas are by nature syncretic, reflecting the diversity of cultural influences that are represented. The material manifestations of ethnicity vary from case to case, and may be sensitive to demographic and subsistence pressures (e.g., Hodder 1979:447). In the Baringo District of western Kenya, for example, clothing and decoration reflect a mixture of traditions, as do portable items of material culture such as household items (Hodder 1979). Whether ethnicity is actively or passively expressed, and what the incentives are for displaying ethnicity, are not at issue in this discussion (but see Davis 1981:667) and warrant further study. Whether such distinctions will be expressed in pottery however, is a valid concern. The vessel form study provides a starting point for understanding cultural affiliation in the Tonto Basin. Future research on the subject in two directions would be useful. Understanding what forms stylistic-ethnic expression assumes -- and across what types of media -- is the first direction requiring research. Predictive models, to be applied to specific archaeological data sets, might be developed using ethnoarchaeological data. DeBoer's (1991) analysis of Shipibo-Conibo decoration, for example, illustrates how ethnicity (in the form of decorative styles) is expressed across media: "Flattened heads, tattooed skin, embellished weapons and pretty pots constitute a forest (and river) of messages that communicate much about a geopolitical landscape in which boundaries can be accentuated or blurred (DeBoer 1990:87)."

Second, we must refine a multivariate approach to cultural affiliation and ethnicity that examines a range of material expressions to understand patterning, rather than simply relying on one artifact class such as ceramics. Crown's (1990:247) analysis has done this for the Hohokam area by plotting distributions of ball courts, red/buff ceramics and shell. Each category displayed a slightly discrete distribution. What the differences in these trait distributions signify merits further study.

From a morphological viewpoint, the Deer Creek plainware assemblage indicates closer affinities with the Mogollon area during the Gila Butte phase than elsewhere. We believe that further inspection of Upper Basin assemblages (e.g., Ushklish) will strengthen the connections observed with Mogollon sites to the east. Having recognized the directionality of cultural affinities, however, we are a little closer to understanding cultural affiliation than before. Archaeologists lack the means for distinguishing between migration into the area by particular ethnic groups and the effects of trade between an indigenous population and neighboring populations. Perhaps these similarities reflect proximity as much as ethnic affiliation. Colonial occupation of the lower Tonto Basin, as represented by Roosevelt 9:6 (Haury 1932), most resembles Hohokam culture, also the nearest cultural neighbor. At the same time we observe affinities between particular sites in the Tonto Basin and neighboring areas, however, we recognize a large degree of homogeneity in vessel forms between the eighth and tenth centuries in the study area. Stephen Plog (1980:137) described this phenomenon as a "broad style horizon over northeastern Arizona during the period between A.D. 400 to 900." With the development of boundary maintenance in the Classic period, one should see a differentiation in vessel form by area. Future research will address the nature of social integration and interaction during the Preclassic period, as well as developing models for use of the area by divergent groups. We hope to address both of these issues in the Roosevelt Community Development Study (Doelle et al. 1991).

Vessel Form and Function with Respect to Site Type

Pottery function recently has gained prominence in archaeological research for several reasons. Understanding how specific vessel forms were used in a particular site is especially important in estimating site duration, site size, and related population estimates, as well as subsistence practices. Earlier research indicates that pottery function studies can successfully link vessel forms to vessel uses. What varies between studies is the level of specificity at which such identifications have been made. Earlier work by Braun (1980) and Steponaitas (1983), for example, simply distinguished cooking from dry-goods storage and water storage vessels, while more recent efforts (e.g., Hally 1986; Smith 1988) have delineated as many as nine different food-related functions. Establishing vessel function provides a foundation for modeling systemic ceramic assemblages. Mills (1989:134) lists eight variables that affect the formation of archaeological ceramics assemblages: 1) the size of ceramic assemblages in systemic context, 2) the frequency distribution of vessels in each functional class, 3) breakage rates for discrete functional vessel classes, 4) an estimation of site abandonment rates, 5) an estimate of vessel curation rates, 6) an estimate of vessel replacement rates, 7) an identification of the stage in the domestic cycle of a given deposit, and 8) an understanding of patterns of site reoccupation. Some of these estimates can be developed using ethnoarchaeologically based models, such as vessel breakage, replacement and curation rates, and site abandonment rates. Other variables are site-specific, and best understood through rigorous excavation strategies designed to characterize the entire site. In the project area and its environs, previous ceramic studies have examined the relationship between site function and ceramic assemblages with respect to ceramic technology and function (e.g., Doyel 1976; Hammack 1969b; Howard 1990; Jewett 1986; O'Brien et al. 1985; Simon and Burton 1989; B. Stark and Heller 1987). Findings from these studies have been instructive regarding site duration and site function.

Although particular site types are rarely identified on the basis of ceramics alone, differences between short-term and long-term site use have been suggested in previous analyses using assemblages in the project area's environs. Doyel (1976:252) contends that site permanence in the Miami-Cherry Creek-Hardt phases is indicated by a diversified ceramic assemblage, a tool kit reflecting a variety of activities, storage pits, quantities of refuse, and numerous burials. In the Upper Tonto Basin, at AZ O:15:28, Hammack (1969b) noted that a greater abundance and diversity of intrusive types seemed to correlate with larger site size and, therefore, with longer site occupation. Jewett's (1986) analysis of surface materials from Roosevelt Lake area sites identified technological differences in ceramics from small (i.e., 2-5 room) versus large (i.e., > 5 room) sites. Our project data are not entirely comparable with those of Jewett for two reasons: 1) the Rye Creek Project ceramic assemblage consists of excavated, rather than surface-collected, materials, and 2) the Rye Creek Project ceramics were recovered from sites that span a longer period of time than do ceramics from Jewett's analysis. Jewett's (1986:124) correlation of smudged interior surfaces and large sites warrant consideration. On the Pine Creek Project, Howard (1990:241) concluded that the dominance of large vessels at AZ U:3:83 (ASM) suggests the presence of long-term storage activities while the dominance of medium-sized bowls and jars at AZ U:3:89 (ASM) may reflect less permanent occupation. At New River, west of the Rye Creek Project area, Doyel and Elson (1985:481) noted that large jars (such as ollas) were indicative of long-term storage activities that are most common at permanent habitation sites.

Site type diversity and small sample sizes preclude us from a thorough exploration of correlations between ceramic assemblages and Rye Creek Project sites. The former reason lies in the heterogeneous nature of sites that were excavated, ranging from fieldhouses (e.g., AZ O:15:71) and farmsteads (e.g., the Boone Moore site, AZ O:15:55) to pithouse villages (the Deer Creek site, AZ O:15:52) and large pueblos (Rye Creek Ruin, AZ O:15:1). Opinions differ regarding optimal site types for analyzing ceramic function. Mills (1989:143) believes that formalized trash middens in sites occupied for extensive durations provide the most representative ceramic assemblages. Formal trash middens at the Rye Creek Ruin and at least one midden at the Cobble site (AZ O:15:54) should yield optimal data, based on Mills' specifications. In contrast, Deal (1985:283) suggests that short-term, single occupation sites are ideal in this respect, since ceramic refuse patterning reflects the last configuration of residences on a site. Numerous sites conforming to Deal's criterion are present in the form of fieldhouses and farmsteads or hamlets, but at least two excavated fieldhouses have almost no trash deposits (AZ O:15:71, and AZ O:15:96), and several of the fieldhouse-farmsteads have multiple occupations that blur the patterning--for example, the Hilltop site (AZ O:15:53); the Arby's site (AZ O:15:99); and the Clover Wash site (AZ O:15:100).

Regardless of one's criteria, the diversity of Rye Creek Project site types precludes a general examination of this issue. Extensive damage from highway construction (at the Arby's site) and from root-plowing (at the Cobble site and the Rooted site) made for smaller sample sizes, as did the rigorous contextual analysis. Two types of measures were calculated with the intent of understanding aspects of the ceramic assemblage-site type relationships in the project area: bowl:jar ratios and diversity measures for vessel forms. We rely here on site types assigned to Rye Creek Project sites in Volume 1 (see also Elson, Chapter 26 and 28, Volume 3). Assignments reflect a variety of variables, including architecture, ethnobotanical data and miscellaneous archaeological features. Ceramically based measures are examined by site type and degree of site permanence in the following section.

Table 13.43 presents plainware-redware information by site for the Rye Creek Project. Sites are presented in numeric order, with bowl:jar ratios (excluding sherds classified as "indeterminate" in shape), number (or diversity) of bowl and jar forms recorded at each site, and aspects of site type and seasonality. Subsequent tables on site type and degree of site permanence utilize information contained in this table. The ceramic sample size was not sufficiently large for using ceramics as determinants of site type. Rather, the information serves as an additional line of evidence. Organized to evaluate site type assignments, and assignments of seasonality, presented in Chapter 26 of Volume 3, data from different site types and from seasonal (vs. permanent) sites do appear to support these assignments. As a cursory examination of site type with respect to ceramic assemblage, no effort was made to develop "blind" measures by site, in order to test the assignments. We recommend that such a task be undertaken in future studies that produce larger reliable sample sizes. The data presented in this section should be viewed as exploratory or preliminary in nature, and we present this section with the intent of suggesting alternative directions for future research. We begin by discussing site types with respect to utilitarian assemblages, combining plainware and redware information as a single utility ware. Variability in vessel types is examined at the gross level of shape (i.e., bowl-jar distinctions). More detailed discussions of relationships between particular vessel forms in related areas are presented by Crown (1983) and Lindauer (1989).

Table 13.43. Ceramic data by site with respect to site function.

ASM Site Number	PW/RW Bowl:Jar Ratio	Richness of PW/RW Bowls[1]	Richness of PW/RW Jars[1]	Site Type	Multiple Occuption	Sedentary vs. seasonal	Site Function
AZ O:15:1	1.8:1 (85)	7	7	Village		Sedentary	General habitation, agriculture
AZ O:15:52	1.9:1 (158)	5	8	Hamlet		Sedentary	Agriculture, wild resource procurement
AZ O:15:53	1.4:1 (12)	2	3	Farmstead/ Fieldhouse	X	Seasonal	Agriculture
AZ O:15:54	1.2:1 (106)	7	6	Hamlet		Sedentary	General habitation, agriculture
AZ O:15:55	1.5:1 (200)	8	8	Farmstead	X	Sedentary/ Seasonal	Mixed subsistence, agave cultivation
AZ O:15:71	1.0:0 (2)	2	N/A	Fieldhouse		Seasonal	Agriculture
AZ O:15:89	7.0:1 (8)	4	1	Fieldhouse	X	Seasonal	Wild resource procurement
AZ O:15:90	9.0:1 (10)	1	1	Farmstead	X	Seasonal?	Pithouse component: mixed subsistence; later component: agave cultivation
AZ O:15:91	2.0:1 (39)	4	6	Farmstead/ Homestead	X	Sedentary	Preclassic: mixed subsistence; Classic: agave cultivation
AZ O:15:92	3.9:1 (44)	4	4	?Ag./Habitation	?	Sedentary	Agriculture? Damaged
AZ O:15:99	5.0:1 (6)	2	N/A	Fieldhouse	X	Seasonal	Agriculture
AZ O:15:100	3.1:1 (53)	4	5	Farmstead	X	Sedentary/ Seasonal	Agriculture, esp. agave cultivation

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[1] Excluding counts from "Indeterminate" category.

Note: 2 mitigated sites (AZ O:15:70 and AZ O:15:96) were excluded from table because each lacked diagnostic (i.e. rims) plainware and redware sherds.

N/A = not applicable.

Patterning by Site Type

We initially intended to group all sites in the project area into aggregate site type categories; however, results of our ceramic analysis indicated that significant changes through time were evident in relative bowl:jar frequencies, and that bowls were more highly represented in later time periods. Consequently, we relied on a sample of securely dated early Classic period sites to examine ceramic patterning by site type ("indeterminate" Classic period sites were not used in this analysis). Sites were grouped according to site types contained in the site descriptions for the Rye Creek Project (Volume 1). Three reasonably unambiguous site types were examined: fieldhouse, farmstead, and hamlet-pueblo. These categories are considered relatively unambiguous because the site types are believed to be functionally discrete and therefore distinctive from one another. Hamlets and pueblos were lumped together because we assumed that the two were functionally equivalent, although differing in size or scale. Early Classic data were grouped by site type, and the results are presented in Table 13.44. Restricting our focus to one time period out of the three phases considered in the our overall analysis was necessary for two reasons. First, the small sample size for the Gila Butte phase (i.e., one site) precluded use of the earliest time period under consideration. Second, a larger number of Sacaton phase sites were excluded because they were all assigned to a narrow range of site types and lacked large hamlet-village sites for comparison.

We consider bowl:jar ratios, with respect to site type first in examining Table 13.44. Bowl:jar ratios are somewhat misleading because of differential breakage patterns across the functional categories. Bowl rims are overrepresented in the archaeological record because bowl rim sherds represent a larger portion of the vessel than do jar rim sherds. Given these caveats, however, substantial differences exist between the three site types under consideration here. These differences do not line up neatly from the most limited activity site type (i.e., fieldhouse) to those that display the greatest range of activities (i.e., aggregated or communal habitation sites like hamlets and pueblos). This pattern in part reflects inadequate sample sizes (no jars were recorded at the single early Classic fieldhouse site), variability in the nature of contexts sampled (e.g., trash deposits vs. floor assemblages), or meaningful functional differences. If differences in the bowl:jar ratios are meaningful, then relatively minor distinctions exist between bowl:jar ratios at farmsteads and at hamlet-village sites. That the latter site type would require greater ceramically based storage facilities is not surprising. It the patterning in farmstead-homestead ratios is meaningful, then more work needs to be done on differences in function between the farmstead-homestead site types and the longer-inhabited pueblos and hamlets. Alternately, the ambiguity in the "farmstead-homestead" site type may highlight genuine problems in this site type category.

Table 13.44. Patterning by site type: early Classic plainware and redware rim/body sherd and restorable vessel assemblages.

Site Type	Bowl: Jar Ratio	Mean Bowl Forms/ Category[4]	Mean Jar Forms Category[4]
Fieldhouse[1]	N/A (No Jars)	2.0 (2)	0.0 (0)
Farmstead/Homestead[2]	1.5:1	8.0 (80)	8.0 (68)
Hamlet/Village[3]	1.4:1	7.0 (72)	6.5 (69)

[1] O:15:99.
[2] O:15:55.
[3] O:15:1, O:15:54.
[4] Excludes indeterminate vessel forms.

We expected that the longer the settlement's occupation, the higher the mean number of vessel forms represented in bowls and jars. Two approaches were applied to the grouped site type ceramic data to measure the relative diversity of vessel forms by site type. The term "diversity," as used here, refers to "richness" as it has been used by Kintigh (1984) and others (e.g., McCartney and Glass 1990). McCartney and Glass (1990: 522) describe richness as "the number of different nominal classes of items observed in a sample regardless of their individual frequencies. . . . *Richness* is simply the number of classes present." We examined the relative richness of assemblages by site type.

As discussed previously, sampling procedures used in the analysis to obtain temporally reliable deposits resulted in small sample sizes for the plainware-redware assemblage. The instability inherent in small samples in applying the richness statistic (McCartney and Glass 1990:523, 529) precluded use of simulation with the Rye Creek Project plainware-redware assemblage. To explore the utility of examining richness within a Tonto Basin ceramic assemblage, we employed proxy measures. The number of vessel forms represented by shape (i.e., bowl vs. jar) was tallied for each site. Sites were aggregated by type (i.e., fieldhouse, farmstead-homestead, or hamlet/pueblo), and the counts of forms added by shape. The total was divided by the number of sites within the category to derive a mean number of forms per site type within the project area. We assumed that small, limited-activity sites such as fieldhouses would be used for a narrower range of activities (and would therefore contain a narrower range of vessel forms) than would longer-term occupation settlements such as hamlets or villages. Significant differences were evident in the mean number of bowl forms present at fieldhouses in contrast to farmsteads-homesteads and hamlets or villages. Differences also were clear in the mean number of jar forms among site types. Although these figures are admittedly gross, the patterning within them conforms to Mills' (1989:143) observation that short-duration sites as a group will display low variety (i.e., few numbers of classes) and high variance (i.e., high variability around in the mean) in the relative frequencies of vessel classes. The data presented in Table 13.44 illustrate the clear differences in ceramic assemblages between limited activity sites such as fieldhouses and longer-term sites such as farmsteads-homesteads and hamlets and villages. Distinguishing between the latter two is problematic, and this research avenue will be explored in the Roosevelt Community Development Study, now underway (Doelle et al. 1991).

Patterning by Degree of Site Permanence. Because the topic of seasonality occupies an important place in the Rye Creek studies, we also attempted to evaluate the relationship between ceramic assemblages and the degree of site permanence. The apparent redundancy in comparing site types and degree of site permanence, upon further consideration, is minor due to particularities in the Rye Creek plainware-redware data set. Whereas several sites straddled two site types, almost every site had been examined with respect to seasonality. In addition, some sites within single, functional type categories were classified differently. To assess the relationship between ceramic assemblages and site permanence, sites were dichotomized into "seasonal" and "year-round" categories, based on Elson's analysis in Chapter 26 of Volume 3. As seen in Table 13.45, differences in the bowl:jar ratios between "seasonal" and "year-round" sites are not substantial. Striking differences also exist in the diversity of bowls and jars represented in sites of two different occupational regimes. Predictably, those sites that were probably occupied on a seasonal basis contained a lower diversity of bowl and jar forms. Assemblages from sites within the "Seasonal-Sedentary" category appear intermediate in most respects. This finding in some respects dovetails conclusions drawn in the previous section that examines site types. Although more research will be conducted in this area during the Roosevelt Community Development Study, we suspect that seasonality is less accessible through ceramic avenues than is degree of site permanence.

Significant distinctions were identified among different site types and between proposed year-round versus seasonal sites in the foregoing examination of assemblages. Results of these attempts to measure vessel-form richness among and within site types suggest that more rigorous measures be applied to utilitarian ceramic assemblages in future Tonto Basin research. Planned research during the Roosevelt Community Development Study will, hopefully, yield sufficiently large sample sizes for simulation modeling of the utilitarian ceramic assemblage.

SUMMARY

Our first research goal was to document technological variability in the utility ceramic tradition of the Tonto Basin, one component of the central Arizona ceramic tradition. Until now, utility wares in the Tonto Basin have been widely cited but poorly understood. Cultural affiliation arguments have leaned heavily on technological aspects of plainwares and redwares to further particular research agendas (e.g. Whittlesey and Reid 1982; Wood 1987; Wood and McAllister 1980 and others). This analysis of plainwares and redwares from the RCM project provides a firm foundation for future ceramic studies throughout the Tonto Basin. The bulk of research results presented in this chapter fill gaps in our knowledge of technological variability in the utility wares of the Tonto Basin and of the Upper Tonto Basin in particular. To this end, we have devoted considerable attention to describing variability in certain ceramic attributes, ranging from rim shape and orifice diameter to petrofacies assignment and surface treatment. We have presented attribute data from these two groups separately because many analysts distinguish plainwares from redwares. We use a diachronic framework to examine these data; understanding technological variability requires a knowledge of temporal trends. Ceramic measures form part of the sampling strategy for selecting temporally unmixed deposits (also discussed in Chapter 11), and we discuss relevant aspects of this process in our chapter.

Table 13.45. Patterning by degree of site seasonality: plainware and redware rim/body sherd and restorable vessel assemblages (Gila Butte phase, Sacaton phase, and early Classic period).

Degree of site seasonality	Bowl:Jar Ratio	Mean Bowl Forms/Category[1]	Mean Jar Forms/Category[1]
Seasonal[2]	5.0:1	2.5	1.8
Seasonal/Sedentary[3]	1.75:1	5.5	2.0
Year-round[4]	1.7:1	5.8	8.3

Note: 2 mitigated sites (AZ O:15:70 and AZ O:15:96) were excluded from table because each lacked diagnostic (i.e., rims) plainware/redware sherds.

[1] Excluding counts from "indeterminate" shape sherds.
[2] Includes AZ O:15:53; AZ O:15:71; AZ O:15:89; AZ O:15:90; AZ O:15:91; AZ O:15:99.
[3] Includes AZ O:15:55 and AZ O:15:100.
4Includes AZ O:15:1; AZ O:15:52; AZ O:15:54; AZ O:15:91; AZ O:15:92.

Our second research goal was to examine cultural affiliation in the Upper Tonto Basin. Many previous Tonto Basin researchers have offered opinions regarding the cultural identity of prehistoric Tonto Basin inhabitants. While this corpus of opinions has stimulated useful intellectual debate, more baseline data are needed to select among conflicting research claims. The results of our study make a contribution to Upper Tonto Basin research. We reiterate that our findings (derived from Upper Basin ceramics) should not be extended to the Lower Basin without additional study. Ongoing research by Arizona State University and Statistical Research should fill considerable gaps in our understanding of these same time periods in the Lower Basin. Temporal trends, site function, spatial patterning in resource availability and technology all affect the assemblage under study, and we have concentrated our efforts on understanding these factors. Controlling for all of these factors, we have suggested that a comparative study of vessel form may inform on issues of cultural identity. Research in the Tonto Basin has just gotten underway, and studies like our own supply information that is needed for future ceramic research.

CONCLUSIONS

This chapter has presented results of our plainware-redware ceramic analysis for the Rye Creek Project. To discuss the results of our attribute-based analysis, we have focused on aspects of ceramic technology in the Upper Tonto Basin through time. Our primary objective in this analysis was to identify basic characteristics of Upper Tonto utility wares, because little previous research in the area concentrated on the plainwares and redwares. Our analysis of early redwares in the Upper Tonto Basin produced equivocal results and indicate that more work is needed on the topic. Using multiple lines of evidence, we have argued that locally produced utilitarian wares -- including both plainwares (especially in the Preclassic period) and redwares -- comprise a single tradition through time that transcend ware distinctions.

Our analysis of temper and sand data from the project area also suggests that previous attempts to identify subgroupings within the Tonto plainwares are problematic. We believe that it is only through detailed, systematic studies of temper sources that meaningful subgroupings can be identified and variation within subgroups (perhaps as potting communities) examined. A series of directions explored in this analysis suggest shifts in the organization of ceramic production in the greater Tonto Basin area. Trends in surface treatment attributes, in temper resource utilization, and in vessel form all indicate a trend toward diversification and, perhaps, some degree of specialization in the Upper Tonto Basin. Increased labor investment is reflected in the ceramic technology that we have documented in this analysis. How ceramic production -- and, likely, other realms of economic production -- changed from the Preclassic through the Classic period is a subject of much interest, to be explored in ongoing research. By the Classic period, Tonto Basin communities may have participated in a regional system of community-based productive specialization. Findings from the Ash Creek Project suggest the movement of resources between lowland and upland areas during the Classic period (Rice 1985:15). Community specializations, for the most part, would have been based on the use of nearby resources and could compensate for uneven distributions of subsistence resources (see also Simon and Redman 1990:76), as is the case cross-culturally today (Arnold 1985). The Upper Basin sites included in the Rye Creek Project might well have participated in a regional system, not as peripheral or satellite communities, but as important components to the larger system of interdependence. Ceramic specialization could easily have been one aspect of a regional exchange system, although arguments to date for evidence of ceramic specialization are weakened by small sample sizes and a simplistic approach to comparing vessel statistics by size class (e.g., Hohmann and Kelley 1988) and require further exploration in future research.

A second goal of our analysis was to identify salient research topics for future ceramic analysis as part of the Roosevelt Community Development Study, now underway by Desert Archaeology (Doelle et al. 1991). A number of subtopics presented in this chapter warrant more extensive examination in future research. These include temper characterization research, relationships between vessel form and cultural affiliation, and relationships between ceramic assemblage and site type. Although preliminary in nature, we believe that the results of the Rye Creek analysis will prove a valuable foundation for future research in the Tonto Basin.

CHAPTER 14

CHIPPED STONE ARTIFACTS

Douglas B. Craig

The Rye Creek Project produced 13,534 chipped stone artifacts from 14 sites (13 project sites plus Rye Creek Ruin). One site, the Deer Creek site (AZ O:15:52), accounted for over 50 percent of this total; it contained 7,000 pieces of chipped stone. The next largest sample came from the Boone Moore site (AZ O:15:55) with 1,583 pieces, followed by Rye Creek Ruin (AZ O:15:1) with 1,304 pieces, the Redstone site (AZ O:15:91) with 899 pieces, the Hilltop site (AZ O:15:53) with 726 pieces, and the Clover Wash site (AZ O:15:100) with 610 pieces. The other eight sites make up the remaining 10 percent or so of the sample.

This chapter presents basic descriptive information on the Rye Creek chipped stone assemblage. This information is then used to address several general research issues. Special attention is directed here to the issue of how lithic debitage can be used to study site formation processes.

CONCEPTUAL CONCERNS

Prior to 1975, most studies of prehistoric Southwestern chipped stone focused on chronological issues, with analysis directed at characterizing temporal variability in formal tool morphology. The resulting tool types then were used as "index fossils" to date particular sites and assemblages (e.g., Haury 1940, 1975; Sayles 1938, Sayles and Anteus 1941). Because projectile points were considered the most temporally sensitive tool type, they received the majority of attention. Other tool types were analyzed in accordance with their potential for informing upon temporal issues. Debitage, not surprisingly, was largely ignored.

Several things happened in the mid-1970s to change this situation. First, as a result of environmental legislation enacted to protect archaeological resources, funding for most research was provided through contract archaeology projects. It became increasingly difficult, given the data requirements of most contract projects, to justify excluding debitage from consideration, because it typically accounts for 90 percent or more of the chipped stone assemblage. Further impetus for change was provided by a broadening of research interests to include nonchronological issues, in particular, issues related to site function, community structure, and exchange. Debitage, because of its ubiquity, has the potential to inform on many of these issues more directly than other, less common classes of chipped stone.

The mid-1970s also saw the development of a new conceptual framework for dealing with lithic debitage. This framework was structured around the idea that individual flakes could inform on discrete behavioral events. Operating under this assumption, two approaches to debitage analysis were developed and applied to Southwestern chipped stone assemblages. The first is generally referred to as the "production stage" approach, because it attempts to assign each flake to a discrete stage in the lithic production process. Flakes are coded as being either primary, secondary, or tertiary, based on the amount of cortex present. Additional attributes often recorded include use wear, edge damage, raw material texture, type of percussion, and edge shape and angle. Within the general project area, studies that have adopted such an approach include Rice (1985), Proper (1990), and Dosh et al. (1987).

A number of problems with the production stage approach have been identified (see especially Ahler 1989:86-87; Sullivan and Rozen 1985:756-757). First, and perhaps most important, the assumption that the debitage typology accurately reflects discrete stages in lithic production probably is unwarranted. There is now good evidence to suggest that cortical variation, the basis for the debitage typology, is only indirectly related to specific stages of lithic reduction (Stafford 1979; Sullivan and Rozen 1985). Second, the approach tends to be selective in that it deals with only a small subset of the debitage, usually just complete flakes. The reason for this is that one can never be sure how representative the percentage of cortex on broken flakes is of the flake as a whole. Third, because cortical percentage is not an easy variable to measure, the debitage typology is highly subjective. Oftentimes, one analyst's primary or secondary debitage is considered secondary or tertiary debitage by another analyst. Finally, because of the number of other attributes usually recorded, the production stage approach can be very time-consuming, especially when small and intermediate-sized flakes are involved.

In an effort to correct for some of these deficiencies, an alternative approach to debitage analysis was developed by Alan Sullivan and Kenneth Rozen (Rozen 1979, 1981, 1984; Sullivan 1980, 1983; Sullivan and Rozen 1985). Their alternative approach is referred to here as a "taxonomic" approach, because it is based on a hierarchically related set of dichotomous variables -- the presence of one or more interior surfaces, the presence or absence of platforms, and the presence or absence of distal margins. One advantage of the taxonomic approach over the production stage approach is that it is able to deal with the full range of flaking debris, not just complete flakes. In addition, the taxonomic approach makes no a priori assumptions about the stage of lithic production represented by individual flakes; that is, it treats the issue of technology as a matter of empirical concern rather than as something to assume at the outset. Finally, the taxonomic approach is operationally unambiguous; hence, it is more replicable.

One problem with the taxonomic approach, at least as it is currently defined, is that the debitage types lack any intrinsic behavioral meaning (Ahler 1989:87). It is unclear, for example, why an assemblage characterized by a high percentage of complete flakes and cores is indicative of nonintensive core reduction, or why a high percentage of broken flakes and a low percentage of cores is indicative of tool manufacture (cf. Sullivan and Rozen 1985:762-763). Other plausible explanations for the same patterns can be hypothesized and it is difficult, if not impossible, to choose from among the various alternatives without additional data, which currently are lacking.

An alternative to the kind of "individual flake analysis" represented by both the taxonomic and production stage approaches is provided by "mass analysis," or "flake aggregate analysis" (after Ahler 1989). In mass analysis, the emphasis is on flake size and shape data that are studied *en masse* rather than individually. The general procedure is to size-grade a sample of flakes from discrete recovery or analytical contexts. The relative contribution of different size grades to the various contexts is then examined (Ahler 1989:87-90).

As an approach for characterizing lithic debitage, mass analysis has several advantages over individual flake analysis. First, like the taxonomic approach, it can accommodate the full range of flaking debris. But unlike the taxonomic approach, mass analysis is fast and relatively easy to implement. Moreover, because the size-grades can be easily standardized, mass analysis provides a high degree of replicability without the need for highly trained specialists. Virtually anyone trained in basic lab procedures can record data in a replicable manner (Ahler 1989:88). Finally, there are numerous experimental studies to support the interpretations of mass analysis, including studies of a variety of lithic reduction technologies and raw material types (see discussion in Ahler 1989).

A problem with mass analysis that has yet to be fully resolved involves the identification of mixed samples. Because mass analysis considers deposits as composites, it is difficult, if not impossible, to distinguish between various natural and cultural processes that may have contributed to the formation of a particular deposit. A deposit characterized by uniformly small flakes, for example, could just as easily be the result of trampling or sweeping behavior (see e.g., Deal 1985; Nielsen 1991) as the result of activities associated with tool manufacture and maintenance.

To get around some of these problems, we combined a mass analysis approach with a simplified version of the taxonomic approach. Mass analysis was used to obtain information on flake size variability between different archaeological contexts. A simplified version of Sullivan and Rozen's debitage typology was then used to further subdivide the various size-grades (for a similar approach see Baumler and Downum 1988).

RESEARCH GOALS

Two general research questions were addressed by the Rye Creek chipped stone analysis. The first of these involved the characterization of lithic production and use at each site, taking into account possible temporal, functional, and spatial differences. Specific questions that guided analysis were:

1. Do the relative frequencies of different tool types vary through time?

2. To what extent is tool type variability between sites the result of differences in site function?

3. Does the diversity of tool types change over time? Does it vary by site?

4. Do the relative frequencies of different raw material types vary with different temporal, functional, or spatial components?

The second general research issue that was addressed during analysis involved the degree to which lithic debitage could be used to monitor site formation processes. In Chapter 11 of this volume, background information on formation processes was presented and an approach used to study some of the processes that might affect ceramic deposition was discussed. The focus of that discussion was on how ceramic data can be used to identify relatively intact secondary refuse deposits. Because the main refuse types associated with ceramic deposition are either *de facto* refuse or secondary refuse -- primary refuse (e.g., workshop or firing areas) is generally not a consideration -- focusing attention on the degree to which the deposit has been transformed makes logical sense. But, when dealing with chipped stone, where primary refuse is a real possibility, before considering the issue of transformation, one must first be able to identify the various deposits that are being transformed. The following analysis was designed to address these basic concerns. Specific questions addressed include:

1. Can different refuse types (i.e., primary, secondary, and de facto, after Schiffer 1976, 1987) be identified based on the debitage data?

2. Can mixed or transformed deposits (e.g., contexts with more than one refuse type represented) be distinguished from relatively "pure" deposits?

3. If distinct refuse types can be identified, how can this information be used to address other research issues and aid in site interpretation?

METHODOLOGY

All chipped stone artifacts were sorted into basic artifact classes and raw material types by Lisa Eppley, Laboratory Director at Desert Archaeology, using a coding system used on numerous other Desert Archaeology projects (Bernard-Shaw and Huntington 1990; Eppley 1986a, 1986b, 1989). Eppley further subdivided the flake and core tools into tool types following standard Southwestern nomenclature (see below). This information was entered into a computer database. That database provides the baseline information for the discussion that follows.

Artifact Class and Type

Three artifact classes and 14 artifact types were recorded. Definitions for these classes and artifact types are provided in Table 14.1. The definitions are derived mainly from Dart (1990), Sullivan and Rozen (1985), and Young and Harry (1989). The coding of tool types was done as part of the initial lab sorting; the coding of a sample of debitage was done by the author as part of the mass analysis.

Table 14.1. Artifact class and type definitions.

Debitage: Unutilized chipped stone waste material.

- *Complete Flakes*: A flake containing a platform, bulb of percussion, and flake margins.

- *Broken Flakes*: A flake containing a discernible interior surface, and possibly a platform, bulb of percussion, and/or flake margins, but not all three.

- *Shatter*: A flake that does not contain a platform, bulb of percussion, or discernible interior surface.

Flake Tools: Tools made from flakes.

- *Utilized Flake*: A flake or piece of shatter exhibiting macroscopic edge damage thought to be the result of use rather than intentional retouch.

- *Informal Tool*: A flake with marginal, discontinuous, intentional retouch.

- *Scraper and Plano-Convex Scraper*: A scraper is a flake with continuous, deep, unifacial retouch along one or more edges; a plano-convex scraper is a special type of scraper that has a flat base with a unifacially flaked edge of steep angle and a height equal to or greater than the maximum basal dimensions.

- *Biface*: A flake tool exhibiting bifacial retouch along all sides, but without evidence of a hafting element; in some instances it may represent an unfinished projectile point.

- *Projectile Point*: A bifacially worked flake tool with probable evidence of a hafting element.

- *Chopper*: A large, heavy flake with a bifacially worked edge and at least some evidence of battering.

- *Miscellaneous Formal Tool*: Any other flake tool for which there seems to have been some standardized concept of manufacture or intended function. Varieties of miscellaneous tools recovered during this project include drills, perforators, gravers, punches, and possible knives.

Cores/Core Tools: Cores or tools made from cores.

- *Core*: A chipped stone artifact containing no bulb of percussion but with evidence of one or more negative flake scars.

- *Core/Hammerstone*: A core with battering marks not associated with the negative flake scars.

- *Core Tool*: A core from which a continuous set of retouch flakes has been removed along at least one edge.

Debitage Analysis

Only the debitage from control units was examined as part of the mass analysis. As discussed by Elson (Chapter 5, Volume 1), each excavated structure and a number of extramural features initially were sampled with a screened 1-m by 2-m or 2- m by 2-m control unit. The rationale behind using just the control units in the analysis is that the recovery strategy is known to be fairly constant and the volume of sediment per excavation unit could be easily computed. In all, 223 bags, totaling 5,779 pieces of debitage, were examined. This total represents roughly 46 percent of the overall debitage assemblage. As indicated previously, a mass analysis approach was used in conjunction with a simplified taxonomic approach. The mass analysis consisted of screening the debitage from each provenience unit *en masse* through a series of nested screens. Three screen sizes were used: 3/4 inch (19.1 mm), 1/2 inch (12.7 mm), and 1/4 inch (6.4 mm). Counts were then made for each size-grade by debitage type (complete flake, broken flake, shatter) and the number of cortical flakes per size-grade also was recorded. For the purposes of this analysis, the provenience unit data were combined by feature and stratum. Three broad stratum groupings were defined: upper fill (Stratum 10 and 11), lower fill/floor (Stratum 19 and 20), and extramural feature fill (Stratum 50) (see Chapter 5, Volume 1, for a discussion of strata designations). As a result of this process, the 223 provenience units were collapsed down to 93 analytical units.

Small Debitage

As a check on some of the macrodebitage results, a sample of small debitage was examined. For the purposes of this analysis, small debitage was defined as any debitage smaller than 1/4 inch, the size of the screen used during the excavation of most control units. The small debitage sample was obtained from nine unprocessed flotation samples that were dry-screened through a series of nested screens. Three screen sizes were used: 1/4 inch (6.4 mm), 1/8 inch (3.2 mm), and 2 mm. Similar to the macrodebitage analysis, flakes were sorted by debitage type (after Sullivan and Rozen 1985) and then tabulated by size-grade.

Raw Material Types

Although many different rock types have been identified in different parts of the Tonto Basin, undifferentiated metavolcanic, metasedimentary, and gneissic rocks are the main types found in the immediate vicinity of the project area (Lombard 1989; see also Elson and Huckleberry, Chapter 2, Volume 1, and Miksa, Appendix A, this volume). These rock types generally are found in cobble form either eroding out of the stream terraces and pediment surfaces or along the drainages. A local source for argillite, a soft, carveable, red metasediment used in the manufacture of beads, pendants, and other small artifacts, is also present in the project area. The results of a preliminary sourcing analysis of this material by Elson and Gundersen are presented in Chapter 22 of this volume.

Raw material identifications were made by Eppley as part of the initial sorting process. Most of these identifications were made macroscopically, using a comparative collection obtained from the general project area. A 10-X hand lens was used to examine problematic specimens. The only clearly nonlocal rock type is obsidian. Although the source for the obsidian is unknown, the presence of several nodules in the form of Apache tears suggests that at least some of it was being procured from the Superior (Picketpost Mountain) source (Shackley 1988:760), approximately 50 miles (80 km) south of the project area. Interestingly, given the presence of a local argillite source, some of the argillite now also appears to be intrusive, stemming from the Del Rio area in the Upper Verde Valley, some 80 miles (130 km) northwest of the project area (Elson and Gundersen, Chapter 22).

DATA SUMMARY

This section presents a basic descriptive summary of the Rye Creek chipped stone data. Discussion focuses on the data at the assemblage, or site-specific, level. These data, in turn, provide the baseline information for some of the analyses discussed later in the chapter.

Artifact Class and Type

Similar to most other ceramic period sites in the prehistoric Southwest, the Rye Creek chipped stone assemblage reflects an expedient core reduction technology (Bernard-Shaw 1984; Parry and Kelly 1987; Rozen 1984; Young and Harry 1989). Flakes and tools typically were manufactured and used for the task at hand and then discarded. Formal tool percentages are low, and debitage typically accounts for over 90 percent of the overall assemblage. This figure was 92.9 percent for the Rye Creek assemblage, with individual sites ranging from 89.6 percent to 100 percent (Table 14.2). The lone exception in this regard is AZ O:15:70, a small, extremely disturbed, fieldhouse site, which produced a single chipped stone artifact, a scraper. Flake tools account for 4.9 percent of the overall sample (n=652). Cores and core tools account for the remaining 2.2 percent (n=304).

A range of flake and core tool types were found at most sites (Table 14.2). Two sites, AZ O:15:71 and AZ O:15:96, produced only debitage, and AZ O:15:70, as noted above, had only one tool. These three sites, all single-room fieldhouses, are the smallest sites in the project area. They are also the only sites with fewer than 100 chipped stone artifacts. This raises an important point. One of the research goals stated at the outset of this chapter was to see if tool type diversity varied among sites and types, the implication being that diversity is related to site function. Unfortunately, other factors also can affect diversity, perhaps the most critical of which is sample size (Kintigh 1984). That is, for probabilistic reasons alone, sites with large samples of chipped stone will tend to have a greater range of tool types present, whereas smaller sites will tend to have fewer. In considering the issue of diversity, therefore, it is important to control for the influence of sample size.

For the Rye Creek chipped stone assemblage, this was accomplished by using a diveristy program developed by Keith Kintigh (1985). The program employs a Monte Carlo type simulation in order to assess the effects of sample size on two dimensions of diversity: richness, the relative number of different categories present; and evenness, the relative evenness of the distribution of counts across categories (Kintigh 1985:1). The measure of richness used was simply the number of tool type categories identified (N=12). The measure of evenness used was H/Hmax, also known as a J-score. H/Hmax values range from 0.0, when all cases belong to a single category, to 1.0 when each category is present and represented in equal proportions. The results of the richness and evenness tests for the Rye Creek sites are shown in Figures 14.1 and 14.2; they suggest that all sites are within the expected diversity range given their sample size. In other words, no site stands out as having a significantly high or low diversity. The results also suggest that for evenness values (i.e., J-scores), a minimum sample of about 50 tools is necessary before sample size considerations can be ruled out; the richness curve follows a similar trend.

Projectile Points

Sixty-six projectile points were recovered from eight of the Rye Creek sites. Twenty-eight of the points (42.4 percent of the assemblage) were complete or nearly complete; the rest were fragmentary. Raw material type and gross temporal period were recorded for all cases when possible; however, metric measurements were taken only on complete flakes.

Table 14.2. Site-by-site breakdown of Rye Creek Project chipped stone assemblage.

	Site Number (AZ O:15:______)														
Lithic Type	01	52	53	54	55	70	71	89	90	91	92	96	99	100	Total (%)
Flake Tools:															
Informal Tool	26	107	17	9	32	0	0	5	5	15	2	0	1	18	237 (1.8)
Scraper	22	116	5	6	51	1	0	1	3	9	3	0	7	10	234 (1.7)
Biface	6	28	1	5	12	0	0	1	2	4	0	0	0	0	59 (0.4)
Projectile Point	3	28	4	3	19	0	0	0	0	7	1	0	0	1	66 (0.5)
Plano Scraper	1	5	0	0	2	0	0	0	0	1	0	0	1	1	11 (0.1)
Chopper	1	2	1	0	2	0	0	0	0	2	0	0	0	2	10 (0.1)
Misc. Tool	1	25	2	0	4	0	0	1	0	0	0	0	0	2	35 (0.3)
Core Tools:															
Core	8	29	8	1	19	0	0	0	3	1	0	0	5	3	77 (0.6)
Exhausted Core	1	9	1	1	1	0	0	0	0	2	0	0	0	0	15 (0.1)
Core/Hammerstone	7	31	14	1	9	0	0	0	0	4	3	0	1	5	75 (0.6)
Core Tool	13	37	3	1	11	0	0	1	1	1	2	0	3	4	77 (0.6)
Hammerstone	5	25	4	0	3	0	0	0	2	4	8	0	1	8	60 (0.4)
Debitage:															
Debitage	1210	6558	666	402	1418	0	12	117	238	849	298	4	250	556	12578
% Debitage	92.8	93.7	91.7	93.7	89.6	0	100	92.9	93.7	94.4	94	100	92.9	91.1	(92.9)
Total	1304	7000	726	429	1583	1	12	126	254	899	317	4	269	610	13534 (100.1)
Total %	9.6	51.7	5.4	3.2	11.7	*	0.1	0.9	1.9	6.6	2.3	*	2.0	4.5	99.9

*Less than 0.1 percent

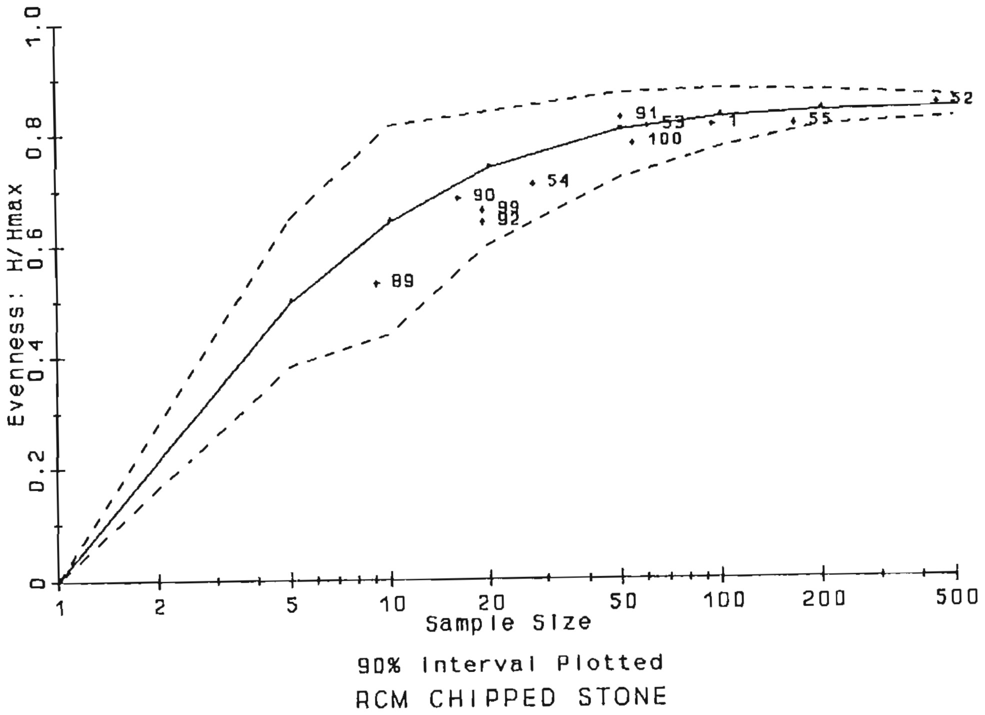

Figure 14.1. Diversity plot for lithic assemblage evenness.

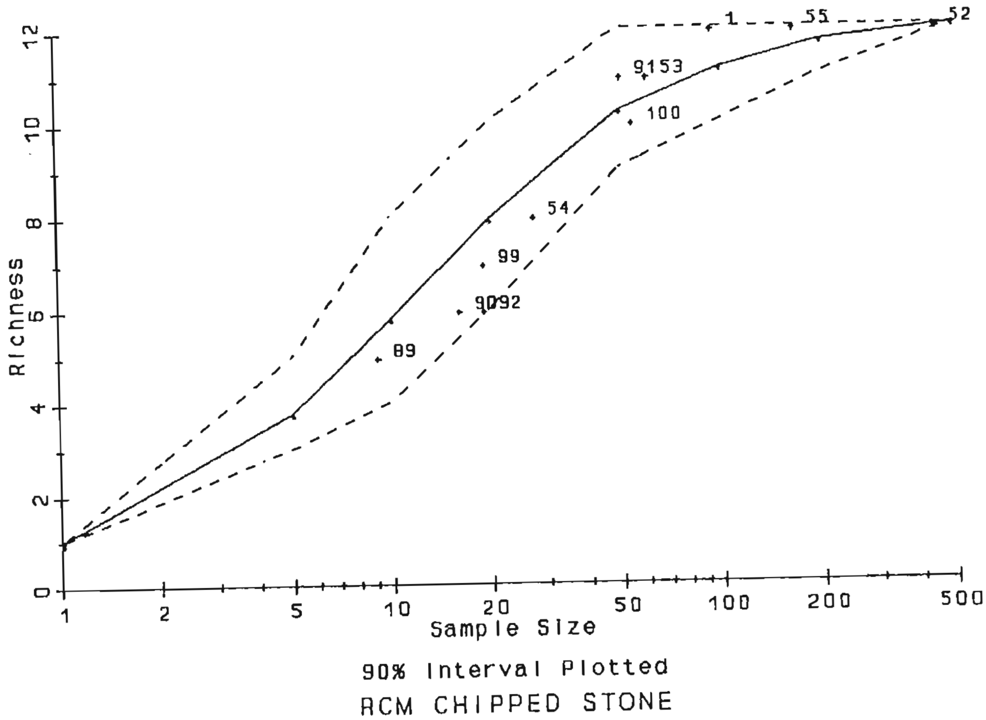

Figure 14.2. Diversity plot for lithic assemblage richness.

A site-by-site breakdown of projectile points is provided in Table 14.3. Note that the relative frequencies of projectile points are close but not exact to the relative frequencies for the overall chipped stone assemblage from each site. For example, the Deer Creek site (AZ O:15:52) accounts for 51.7 percent of the total assemblage and 42.4 percent of the projectile point sample, whereas the Boone Moore site (AZ O:15:55) accounts for 11.7 percent of the overall assemblage and 28.8 percent of the projectile point sample. This pattern may be related to the specific activities occurring at the Boone Moore site, which other analyses (see Craig and Eppley, Chapter 15, and Szuter, Chapter 21, this volume) suggest are possibly hunting-related. Similarly, but on a somewhat smaller scale, the Redstone site (AZ O:15:91) accounts for 6.6 percent of all the chipped stone recovered but 10.6 percent of the projectile point sample, whereas Rye Creek Ruin (AZ O:15:1) accounts for 9.6 percent of the chipped stone total but only about 4.6 percent of the projectile point sample. The testing of Rye Creek Ruin only involved the sampling of three trash mounds, which probably accounts, at least in part, for the pattern observed.

Table 14.3. Projectile points by site and estimated time period.

Site No.	Middle Archaic		Late Archaic		Preclassic Period		Classic Period		Non-diagnostic/ Unknown		Total (%)	
O:15:001	0		0		0		1		2		3	(4.5)
O:15:052	4		0		14		0		10		28	(42.4)
O:15:053	0		0		1		0		3		4	(6.1)
O:15:054	0		0		2		0		1		3	(4.5)
O:15:055	0		0		5		8		6		19	(28.8)
O:15:091	0		2		2		0		3		7	(10.6)
O:15:092	0		0		0		0		1		1	(1.5)
O:15:100	0		0		0		0		1		1	(1.5)
Total (%)	4	(6.1)	2	(3.0)	24	(36.4)	9	(13.6)	27	(40.9)	66	(100.0)

Not surprisingly, there was a strong preference for fine-grained materials in the making of projectile points. Almost 64 percent of the points recovered were made from chert, another 14 percent from chalcedony, 9 percent from fine-grained metavolcanics, and 6 percent from obsidian. As noted previously, obsidian is the only chipped stone lithic material that clearly came from nonlocal sources.

Table 14.3 also presents a breakdown of the projectile points by gross temporal period. Classifications were made by Eppley using the standard nomenclature for southern Arizona as defined by a variety of authors (Haury 1975, 1976; Huckell 1984; Sayles 1937, 1941). These temporal types are believed to be roughly applicable to the Rye Creek material, although given the overall lack of research in central Arizona on projectile point styles, further clarification is undoubtedly needed. As can be seen, the majority of points date to the Hohokam Preclassic period; twenty-four Preclassic points were recovered. Nine Classic period and six Archaic period points also were recovered. Within the Archaic period, four Middle Archaic and two Late Archaic points were identified. The Middle Archaic points all came from AZ O:15:52, the Deer Creek site; the two Late Archaic points came from AZ O:15:91, the Redstone site. Only Preclassic period points were recovered at AZ O:15:52, AZ O:15:53, AZ O:15:54, and AZ O:15:91, whereas AZ O:15:55 and AZ O:15:1 were the only sites to produce Classic period points; AZ O:15:55 also produced a few Preclassic points. Because neither Preclassic period ceramics nor absolute dates were recovered from this site, the significance of this is unknown; it may be related to curation, a limited earlier use of the site area, or to problems with the point typology. With the exception of the Archaic points, which may also represent curated materials, and the Preclassic points at AZ O:15:55, the projectile point styles correlate well with the dating of the sites as determined through the decorated ceramic analysis (see Clark, Chapter 12, this volume) and other chronometric methods (see Elson, Chapter 25, this volume). Figure 14.3 illustrates some of the diagnostic points recovered from the Rye Creek Project.

Debitage

The following section provides an assemblage level summary of the macrodebitage data. A more detailed discussion of the data is provided in a later section that discusses the results of the contextual assessment. As noted above, debitage was analyzed only from control units, resulting in an analyzed sample ranging from 100 percent at Rye Creek Ruin (AZ O:15:1) to around 20 percent at the Clover Wash site (AZ O:15:100). Overall, 45.9 percent of the total recovered debitage was analyzed. Due to the emphasis on control units, five sites, AZ O:15:70, AZ O:15:71, AZ O:15:89, AZ O:15:96, and AZ O:15:99, all containing small masonry fieldhouses, were excluded from this analysis due to their small control-unit debitage sample sizes.

Debitage Type. There were 2,461 complete flakes identified as part of the debitage analysis, 2,631 broken flakes, and 687 pieces of shatter. Most sites averaged 33 to 40 percent complete flakes, 47 to 55 percent broken flakes, and 7 to 15 percent shatter (Table 14.4). The major exception in this regard is the Deer Creek site (AZ O:15:52), which has over 50 percent complete flakes and less than 40 percent broken flakes.

Debitage Size. Large flakes (greater than 3/4" in maximum width) account for 18.1 percent of the flakes examined, medium flakes (between 1/2" and 3/4" in maximum width) account for 47.2 percent, and small flakes (between 1/4" and 1/2" in maximum width) account for 34.7 percent. There is considerable variability between sites with regard to flake size (Table 14.5). Rye Creek Ruin (AZ O:15:1) and the Clover Wash site (AZ O:15:100), for example, have relatively high percentages of large- and medium-sized flakes but low percentages of small flakes. In contrast, the Compact site (AZ O:15:90) and the Rooted site (AZ O:15:92) have relatively low percentages of large flakes and high percentages of small flakes. Both of these sites were highly disturbed, however, and in a later section of this chapter it is suggested that this variability is the result of differential site formation processes rather than differences in site function.

Cortical Percentage. Variability in cortical percentage is closely tied to differences in size-grade. In other words, contexts with larger flakes tend to also have more cortical flakes. In total, 41.7 percent of the large flakes were cortical, 19.8 percent of the medium flakes were cortical, and only 7.8 percent of the small flakes were cortical. Cortical percentages for most of the sites range between 16.5 and 21.5 percent (Table 14.5). The two major exceptions in this regard were Rye Creek Ruin (AZ O:15:1) and the Clover Wash site (AZ O:15:100), both of which had relatively high percentages of cortical flakes. Not surprisingly, these two sites also had the highest relative percentage of large flakes.

Small Debitage

Nine flotation samples were screened from seven different features, resulting in the recovery of 136 flakes smaller than 1/4 inch in size. Seventy-one of the flakes were recovered from the 1/8 inch screen, the other 65 were recovered from the 2 mm screen. For the small debitage sample as a whole, 27.9 percent of the flakes were complete, 61.8 percent were broken, and 10.3 percent were considered shatter. As can be seen in Table 14.6, the majority of the samples were dominated by broken flakes; the main difference among samples was with respect to density, with a range from 1 flake per liter to 11.5 flakes per liter. These data are significantly different from the macrodebitage data where there were approximately equal numbers of broken and complete flakes and a relatively higher percentage of shatter (see Table 14.4). As with some of the larger flake site data, contextual considerations are thought to best account for these differences (see below), although the small sample size of the microdebitage analysis may also be a factor.

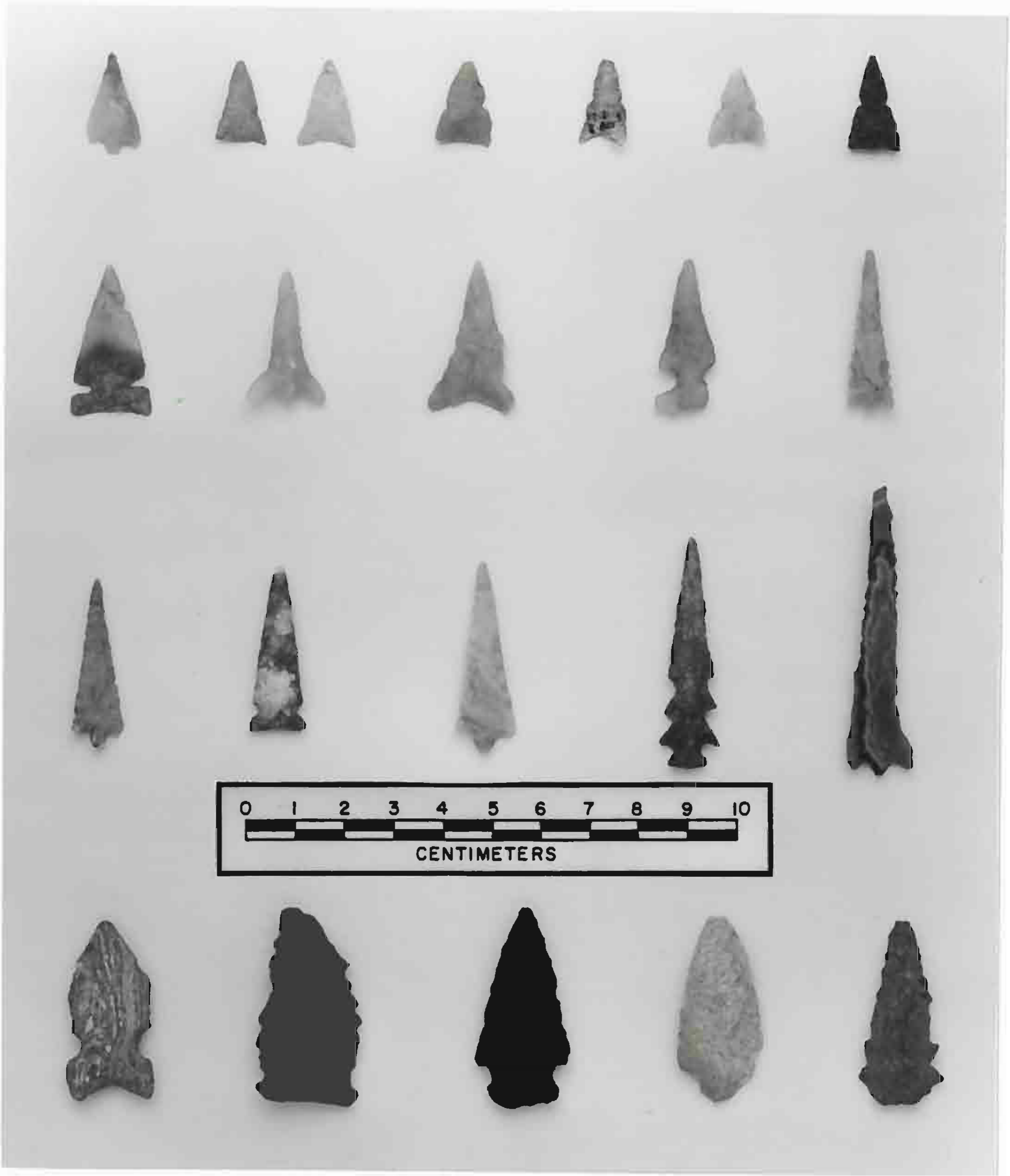

Figure 14.3. Projectile points recovered from Rye Creek Project sites.

Table 14.4. Lithic debitage totals by site (control units only).

ASM Site	Complete Flakes	(%)	Broken Flakes	(%)	Shatter	(%)	Total	(%)
O:15:1	404	(33.4)	652	(54.0)	152	(12.6)	1,208	(20.9)
O:15:52	1,369	(51.4)	1,022	(38.3)	274	(10.3)	2,665	(46.1)
O:15:53	61	(32.3)	113	(59.8)	15	(7.9)	189	(3.3)
O:15:54	106	(31.7)	173	(51.8)	55	(16.5)	334	(5.8)
O:15:55	265	(38.2)	331	(47.8)	97	14.0)	693	(12.0)
O:15:90	56	(35.4)	76	(48.1)	26	(16.5)	158	(2.7)
O:15:91	81	(35.1)	110	(47.6)	40	(17.3)	231	(4.0)
O:15:92	76	(40.0)	94	(49.5)	20	(10.5)	190	(3.3)
O:15:100	43	(38.7)	60	(54.1)	8	(7.2)	111	(1.9)
Total	2,461	(42.6)	2,631	(45.5)	687	(11.9)	5,779	(100.0)

Table 14.5. Debitage site classes and cortical percentage by site (control units only).

Site	Large Cortical	Medium Cortical	Small Cortical	Total Cortical (%)	Large Total (%)	Medium Total (%)	Small Total (%)	Total Analyzed Debitage
O:15:1	149	145	15	309 (25.6)	327 (27.1)	618 (51.2)	263 (21.8)	1,208
O:15:52	145	217	85	447 (16.8)	381 (14.3)	1,200 (45.0)	1,084 (40.7)	2,665
O:15:53	12	17	8	37 (19.6)	31 (16.4)	86 (45.5)	72 (38.1)	189
O:15:54	27	30	8	65 (19.5)	61 (18.3)	175 (52.4)	98 (29.3)	334
O:15:55	64	64	21	149 (21.5)	135 (19.5)	323 (46.6)	235 (33.9)	693
O:15:90	5	15	6	26 (16.5)	14 (8.9)	74 (46.8)	70 (44.3)	158
O:15:91	19	16	3	38 (16.5)	59 (25.5)	100 (43.3)	72 (31.2)	231
O:15:92	6	19	9	34 (17.9)	17 (8.9)	85 (44.7)	88 (46.3)	190
O:15:100	10	18	2	30 (27.0)	22 (19.8)	65 (58.6)	24 (21.6)	111
Total	437	541	157	1135 (19.6)	1,047 (18.1)	2,726 (47.2)	2,006 (34.7)	5779

Raw Material

Metamorphosed rhyolite and andesite and other metavolcanics make up 38.5 percent of the overall assemblage (Table 14.7). Miscellaneous metamorphics are the next most common rock type (28 percent), followed by chert (12.4 percent), and miscellaneous metasedimentary rocks (9.9 percent). Rock types present in lower frequencies include limestone (4.6 percent), chalcedony (2.4 percent), and jasper (2.4 percent). No other rock type accounts for more than 1.0 percent of the assemblage. All of the above types are available locally, within a 5 km to 10 km radius of the project area, and most are available within 1 km of each site. This is particularly true for the metamorphosed rhyolite and andesite, the metavolcanics, and the miscellaneous metamorphics, which commonly are found in cobble form within the numerous stream beds and arroyos that crosscut the project area. Obsidian, the only clearly nonlocal chipped stone lithic material, accounts for about 0.3 percent of the overall assemblage, but about 1.8 percent of the flake tool total. As noted previously, although the exact source for the obsidian is unknown, the presence of several nodules in the form of Apache tears suggests that at least some of it was obtained from the Superior (Picketpost Mountain) source (Shackley 1988:760), located roughly 50 miles (80 km) south of the project area.

Table 14.6. Small debitage analysis.

Site	Feature Number	Strata	Size	Number/ Type	Density Flakes/Liter
AZ O:15:52	9	10	⅛ in	3C, 5B, 2S	5.0
			2 mm	1C, 2B	1.5
	11	19	⅛ in	5C, 9B, 6S	10.0
			2 mm	4C, 16B, 3S	11.5
	21	10	⅛ in	4C, 1B	2.5
			2 mm	3B, 1S	2.0
	21	19	⅛ in	4C, 7B	5.5
			2 mm	1C, 2B	1.5
	25	19	⅛ in	2C, 1B	1.5
			2 mm	2B	1.0
	59	10	⅛ in	3C, 8B, 1S	6.0
			2 mm	1C, 8B, 1S	5.0
AZ O:15:54	2	50	⅛ in	1C, 2B	1.5
			2 mm	1C, 5B	3.0
AZ O:15:55	11	19	⅛ in	3C, 1B	2.0
			2 mm	1C, 4B	2.5
AZ O:15:90	4	10	⅛ in	2C, 1B	1.5
			2 mm	2C, 7B	4.5

Key: C = Complete flake; B = Broken flake; S = Shatter

Although rock types varied somewhat from site to site, metavolcanic, metamorphic, and metasedimentary rocks consistently predominate. With respect to other rock types, AZ O:15:53 and AZ O:15:89 have a relatively high percentage of rhyolite/andesite, whereas AZ O:15:55, AZ O:15:90, AZ O:15:92, and AZ O:15:99 have relatively low percentages. Moreover, AZ O:15:55, AZ O:15:90, and AZ O:15:92 have high relative percentages of chert, whereas AZ O:15:53 has a relatively low percentage. The sites with high percentages of chert also have high relative percentages of limestone, probably a byproduct of chert procurement because the two are often found within the same geologic formation. Rye Creek Ruin (AZ O:15:1) has the highest relative percentage of obsidian, 1.5 percent as opposed to 0.3 percent for the assemblage as a whole. Finally, most of the sites fall within the expected range for metamorphic rocks, although AZ O:15:54, AZ O:15:90, AZ O:15:91, and AZ O:15:99 are somewhat low.

The correspondence between raw material type and tool class fits general expectations. Coarser-grained materials were used primarily for informal tools, and there was a preference for finer-grained materials in making formal tools (Table 14.8). Thus, debitage accounts for 92 to 96 percent of all metavolcanic, metamorphic, and metasedimentary materials recovered, but only about 88 percent of the chert and chalcedony recovered. Conversely, flake tools account for about 10 to 11 percent of the chert recovered, in contrast to only 4.8 percent of the overall assemblage. This pattern is even more striking with obsidian. Although flake tools account for 32.4 percent of the obsidian recovered, no obsidian cores were found.

ANALYSIS

Temporal Trends

Artifact Type

Temporal trends with respect to artifact type were examined at two levels of specificity, period and phase. At the period level, Preclassic (ca. A.D. 750-1150) contexts were distinguished from Classic (ca. 1150-1450) contexts. At the phase level, four discrete phases and two nondiscrete phases were defined: Gila Butte (A.D. 750-850), Sacaton (A.D. 950-1150), early Classic or Roosevelt phase (A.D. 1150-1300), late Classic or Gila phase (A.D. 1300-1450), Indeterminate Preclassic, and Indeterminate Classic. Note that not enough contexts could be unambiguously assigned to the Santa Cruz phase (A.D. 850-950) to warrant inclusion in the phase-level analysis.

Debitage was the most common artifact type for all time periods. For nondebitage, though, variability was evident at both the period and phase level. At the period level, 638 flake and core tools came from Preclassic contexts, 318 flake and core tools came from Classic period contexts. Generally similar tool types were present for both time periods, although there were some slight differences with respect to particular tool types. For example, Preclassic contexts had more miscellaneous flake tools -- for example, drills, punches, gravers, and burins -- than Classic period contexts (by a ratio of about 2.4:1), as well as more hammerstones (by a ratio of about 2.9:1), but Classic period contexts had slightly more cores and core tools (by a ratio of about 1.4 to 1).

Table 14.9 shows the breakdown of tool types by phase. If nondiscrete phases are omitted from consideration, due to low sample sizes and the gross level of temporal resolution provided, some clear differences between phases can be recognized. For example, Gila Butte phase contexts have a relatively high percentage of miscellaneous flake tools and a relatively low percentage of choppers. The Sacaton phase, in contrast, has a relatively high percentage of choppers, core/hammerstones, and hammerstones, and a relatively low percentage of scrapers. The early Classic period is characterized by a relatively high percentage of scrapers, bifaces, projectile points, and cores, but a relatively low percentage of hammerstones. And, finally, the late Classic period has a relatively high percentage of core tools and a relatively low percentage of projectile points. Given that the late Classic period is represented by only one trash mound, (Feature 1 at Rye Creek Ruin), it is probably not representative of the full range of activities for that time period.

To test the diversity of tool types associated with each time period, a series of diversity tests were run using the methods described previously. No significant differences among phases were noted. Each phase had at least 11 of the 12 tool types represented in the sample, J-scores ranged from 0.80 for late Classic period contexts to 0.85 for Sacaton phase contexts; the J-score for early Classic period contexts was 0.81 and for Gila Butte phase contexts it was 0.84. This pattern is consistent with long-term stability in lithic technology. Alternatively, the tool typology may be at too gross a level to be sensitive to fine-scale temporal changes.

Table 14.7. Lithic raw material distribution by site.

Site No.	Basalt	Ves. Basalt/ Rhyolite	Rhyolite/ Andesite	Granite	Schist/Gneiss	Misc. Sedimentary	Quartzite	Quartz	Chert	Silicified Limestone/ Mudstone	Limestone	Misc. Igneous	Chalcedony	Jasper	Obsidian	Argillite	Unspecified Metamorphic	Unknown	Total No.
AZ O:15:001	1	0	374	0	0	162	1	3	177	0	61	91	33	9	19	10	363	0	1,304
AZ O:15:052	4	1	2,452	0	32	647	4	22	725	0	32	415	164	219	12	16	2,255	0	7,000
AZ O:15:053	2	0	399	0	1	59	3	0	18	5	7	52	6	0	1	0	173	0	726
AZ O:15:054	0	0	146	0	0	52	0	1	59	0	13	32	15	28	1	2	80	0	429
AZ O:15:055	2	0	194	0	0	147	0	3	363	0	270	143	51	32	3	3	372	0	1,583
AZ O:15:070	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
AZ O:15:071	0	0	2	0	0	0	0	1	2	0	0	1	1	2	0	0	3	0	12
AZ O:15:089	0	0	58	0	0	8	0	1	3	0	0	8	1	12	0	6	29	0	126
AZ O:15:090	0	0	28	0	0	25	0	3	62	0	44	25	10	1	0	2	53	1	254
AZ O:15:091	5	0	279	0	4	85	6	6	108	0	51	108	18	18	0	33	178	0	899
AZ O:15:092	0	0	42	1	1	28	0	2	59	0	60	37	7	1	0	5	74	0	317
AZ O:15:096	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	4
AZ O:15:099	0	0	19	0	0	52	0	0	40	0	64	43	1	3	0	1	46	0	269
AZ O:15:100	0	0	203	0	1	69	1	0	59	0	21	53	15	4	1	25	158	0	610
Total No.	14	1	4,196	1	39	1,334	16	42	1,675	5	623	1,008	322	329	37	103	3,788		13,534
Total %	0.1	*	31.0	*	0.3	9.9	0.1	0.3	12.4	*	4.6	7.5	2.4	2.4	0.3	0.8	28.0		100

*Less than 0.1 percent

Table 14.8. Lithic tool type by raw material classification.

Lithic Type	Basalt	Ves. Basalt/ Rhyolite	Rhyolite/ Andesite	Granite	Schist/Gneiss	Misc. Sedimentary	Quartzite	Quartz	Chert	Silicified Limestone/ Mudstone	Limestone	Misc. Igneous	Chalcedony	Jasper	Obsidian	Argillite	Unspecified Metamorphic	Unknown	Total No.
Informal Tool	1	0	61	0	1	11	0	1	44	0	6	21	13	5	4	1	68	0	237
Scraper	0	0	57	0	0	19	0	2	35	0	16	11	5	7	0	1	81	0	234
Biface	0	0	0	0	0	0	0	0	33	0	0	5	7	4	3	0	7	0	59
Projectile Point	2	0	1	0	0	0	0	0	42	0	0	5	9	1	4	0	2	0	66
Plano Scraper	0	0	2	0	0	0	0	0	1	0	1	2	0	0	0	0	5	0	11
Chopper	0	0	1	0	0	2	0	0	0	0	0	1	0	2	0	0	4	0	10
Misc. Formal Tool	0	0	6	0	0	2	0	0	14	0	0	2	2	0	1	0	8	0	35
Core	0	0	14	0	0	9	0	0	21	0	9	3	2	3	0	2	14	0	77
Exhausted Core	0	0	3	0	0	0	1	0	6	0	1	0	1	1	0	0	2	0	15
Core/Hammerstone	0	0	14	0	0	9	3	0	1	0	0	16	0	1	0	0	31	0	75
Core Tool	0	0	9	0	0	12	0	0	10	0	1	14	0	1	0	0	30	0	77
Cobble Hammerstone	0	0	9	0	0	12	4	0	0	0	0	15	0	0	0	1	19	0	60
Debitage	11	1	4,019	1	38	1,258	8	39	1,468	5	589	913	283	304	25	98	3,517	1	12,578
Total No.	14	1	4,196	1	39	1,334	16	42	1,675	5	623	1,008	322	329	37	103	3,788	1	13,534
Total %	0.1	*	31.0	*	0.3	9.9	0.1	0.3	12.4	*	4.6	7.4	2.4	2.4	0.3	0.8	28.0	*	100

*Less than 0.1 percent

Table 14.9. Percent of lithic tools by time period.

Lithic Type	Gila Butte	Sacaton	Indet. Preclassic	Early Classic	Late Classic	Indet. Classic	Total No.
Informal Tool	24.2	28.2	24.0	21.1	26.0	53.9	237
Scraper	26.5	14.9	26.0	29.4	24.7	15.4	234
Biface	5.9	3.6	10.0	7.9	6.5	7.7	59
Projectile Point	5.9	6.7	10.0	10.1	2.6	-	66
Plano Scraper	1.3	1.0	-	1.8	-	-	11
Chopper	0.3	2.6	2.0	0.9	1.3	-	10
Misc. Tool	5.6	2.1	6.0	1.8	1.3	7.7	35
Cores	7.1	7.2	2.0	11.8	7.8	7.7	77
Exhausted Core	2.3	1.5	-	0.9	1.3	-	15
Core/Hammerstone	6.9	13.3	8.0	5.3	7.8	-	75
Core Tool	9.2	5.6	2.0	7.0	15.6	7.7	77
Hammerstone	5.1	13.3	10.0	2.2	5.2	-	60
Total No.	393	195	50	228	77	13	956

Projectile Points

There was a general trend towards smaller projectile points over time. The mean weight decreased from 4.4 gm during the Archaic period (n=3) to 0.99 gm during the Preclassic period (n=18) to 0.30 gm during the Classic period (n=5). The mean size ratio (length-width-thickness) also decreases from 11.95 cm for Archaic points to 9.4 cm for Preclassic points to 6.6 cm for Classic points (Figure 14.4). The relatively tight clustering of Classic period points in Figure 14.4 is interesting, and perhaps indicative of increased standardization or specialization during that time period. Similar trends towards increased Classic period standardization in the plainware and redware ceramic assemblages were noted by Stark and Heidke in Chapter 13 of this volume.

Out of the 28 complete points examined, 9 had side notches, 5 were serrated, 14 had stem bases, 11 had concave bases, and 3 had flat bases (Table 14.10). Although both side-notching and serration are relatively uncommon for the sample as a whole, when they do occur they tend to be mutually exclusive. The only exception in this regard was a Middle Archaic point from the fill of Feature 21 at the Deer Creek site (AZ O:15:52). Side-notching was generally associated with Archaic and Classic period points, serration was associated with Preclassic (and sometimes Archaic) points.

Raw Material

Variability in raw material utilization is apparent at both the period and phase levels. At the period level, there were roughly 2.5 times more chipped stone artifacts from Preclassic period contexts than from Classic period contexts, something that probably is related to the fact that most of the Classic period contexts were from small fieldhouse sites. Nonetheless, with respect to specific rock types, there was a 50 percent decrease in the relative percentage of rhyolite between Preclassic and Classic contexts, a 61 percent increase in the relative percentage of chert, and a fivefold increase in the relative percentage of limestone (Table 14.11). The

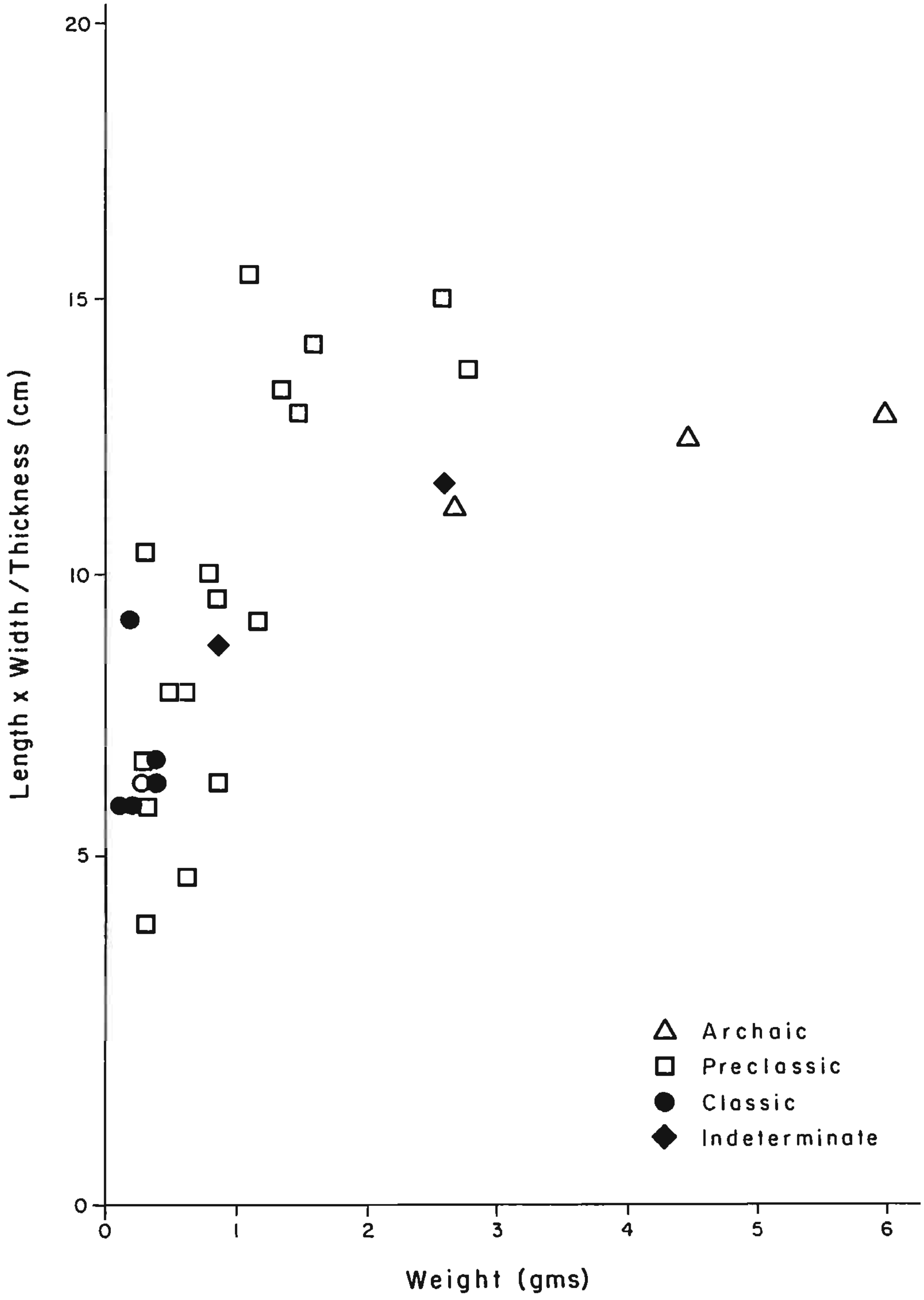

Figure 14.4. Plot of projectile point size by weight through time.

Table 14.10. Descriptive data on complete projectile points.

Site	Feat No.	Stratum	Material	Length (cm)	Width (gm)	Thick (cm)	Size ratio	Weight (gm)	SN	Base	Serrated	Style
01	3	50	1	3.70	1.69	0.55	11.37	2.6	0	1	1	12
52	9	19	10	3.67	1.66	0.55	11.08	2.7	1	2	0	4
52	18	19	10	1.93	1.44	0.36	7.72	0.6	0	4	0	10
52	20	10	10	3.32	0.95	0.50	6.23	0.9	0	4	1	10
52	21	9	10	3.28	0.95	0.50	6.23	0.9	0	4	1	10
52	21	10	22	3.89	2.12	0.66	12.50	6.0	1	1	1	4
52	21	10	10	3.87	1.26	0.37	13.18	1.4	0	4	0	10
52	21	9	15	2.00	1.10	0.28	7.86	0.5	0	4	0	10
52	32	11	15	5.84	1.34	0.57	13.73	2.8	0	4	0	10
52	34	19	15	3.06	1.15	0.40	8.80	1.2	0	4	0	10
52	71	50	10	3.43	1.05	0.37	9.73	0.8	0	4	1	10
52	87	50	10	4.70	1.20	0.41	13.76	1.6	0	4	0	10
53	6	19	10	2.25	0.92	0.47	4.40	0.6	0	4	0	10
53	8	2	10	2.70	1.63	0.51	8.63	0.9	0	4	1	13
53	9	20	10	3.04	1.77	0.43	12.51	1.5	0	2	0	7
54	2	50	14	1.80	0.70	0.35	3.60	0.3	0	2	0	7
54	5	12	10	1.75	1.17	0.20	10.24	0.3	0	2	0	10
54	5	12	10	1.62	1.04	0.30	5.62	0.3	0	2	0	10
55	5	19	10	1.68	1.14	0.30	6.38	0.4	1	2	0	11
55	5	19	17	1.72	0.97	0.28	5.96	0.3	1	2	0	11
55	5	9	10	2.05	0.95	0.30	6.49	0.3	1	2	0	10
55	5	11	10	3.74	1.79	0.45	14.88	2.6	0	4	0	7
55	6	19	10	1.55	1.16	0.20	8.99	0.2	1	2	0	11
55	15	80	14	1.93	1.04	0.33	6.08	0.4	1	1	0	11
55	18	80	10	1.50	0.86	0.23	5.61	0.2	1	2	0	11
55	18	19	10	1.61	0.94	0.26	5.82	0.2	0	2	0	7
91	0	9	3	4.07	1.93	0.64	12.27	4.5	0	4	0	5
91	11	40	15	3.07	1.47	0.30	15.04	1.1	0	4	0	10

Key: Material type - 1=Basalt, 3=Rhyolite/Andesite, 10=Chert, 14=Misc. Igneous, 15=Chalcedony, 17=Obsidian, 22=Misc. Metamorphic
SN (side-notch): 0=absent, 1=present
Base: 1=flat, 2=concave, 3=convex, 4=stem
Serrated: 0=absent, 1=present
Style: 4=Middle Archaic, 5=Late Archaic, 7=Hohokam (unspecified), 10=Preclassic period, 11=Classic period, 12=Unknown, 13=Nondiagnostic

increase in chert and limestone utilization is most evident at the Boone Moore site (AZ O:15:55), which accounts for only 11.7 percent of the total chipped stone assemblage but over 21 percent of the recovered chert and 43 percent of the limestone. Given that this site also produced a relatively large number of projectile points (most of which were made from chert), it seems reasonable to suppose that projectile point manufacture (and/or use) was one of the activities that took place at the site. As noted elsewhere in this report, an

Table 14.11. Percent of lithic raw material types by time period (percents reflect column totals).

Material Type	Preclassic	Classic	Total %	Total No.
Basalt	0.1	0.1	0.1	14
Ves. Basalt	*	-	*	1
Rhyolite	34.6	21.9	31.0	4,196
Granite	*	-	*	1
Schist/Gniess	0.4	-	0.3	39
Misc. Sedimentary	9.4	11.1	9.9	1,334
Quartzite	0.1	0.1	0.1	16
Quartz	0.3	0.2	0.3	42
Chert	10.6	17.0	12.4	1,675
Silicified Limestone/Mudstone	*	*	*	5
Limestone	2.2	10.7	4.6	623
Misc. Igneous	7.0	8.6	7.5	1,008
Chalcedony	2.3	2.7	2.4	322
Jasper	2.5	2.3	2.4	329
Obsidian	0.1	0.6	0.3	37
Argillite	0.8	0.6	0.8	103
Unspecified Metamorphic	29.5	24.1	28.0	3,788
Unknown	*	*	*	1
Total	9,726	3,808		13,534

*Less than 0.1 percent

emphasis on hunting at this site is supported by the analysis of the faunal material (Chapter 21) and the ground stone assemblage (Chapter 15). Although there was a slight increase in obsidian utilization during the Classic period, it still represents only a minor part of the overall chipped stone assemblage.

A finer-grained resolution of many of these patterns can be derived by considering raw material usage at the phase level (Table 14.12). For example, it is possible to see that the decrease in rhyolite/andesite utilization is mainly an early Classic period phenomenon; its relative frequency jumps back up during the late Classic period. Similarly, the increase in chert and limestone utilization also appears to have been mainly an early Classic period phenomenon, while the increase in obsidian is connected mainly with the late Classic period. It is not overly clear, however, whether specific site level idiosyncracies are influencing the apparent patterning, particularly in the trends seen for the early Classic period; the early Classic period sample is largely composed of the Boone Moore site and two of the trash mounds at Rye Creek Ruin, while the late Classic period is represented primarily by a single trash mound at Rye Creek Ruin. The phase level data do suggest that there was a general decrease in the utilization of metamorphic rocks after the Gila Butte phase, while the Sacaton phase is characterized by a relatively low percentage of jasper.

Table 14.12. Percent of lithic raw material types by phase (percents reflect column totals).

Material Type	Gila Butte	Sacaton	Ind. Preclassic	Early Classic	Late Classic	Ind. Classic	Indet.	Total %	Total No.
Basalt	0.1	0.3	-	0.1	-	-	-	0.1	14
Ves. Basalt	*	-	-	-	-	-	-	*	1
Rhyolite	35.0	33.4	35.1	16.9	29.6	45.7	-	31.0	4,196
Granite	-	*	-	-	-	-	-	*	1
Schist/Gneiss	0.5	0.3	-	-	-	-	-	0.3	39
Misc. Sedimentary	8.9	9.7	11.9	11.2	12.5	4.0	-	9.9	1,334
Quartzite	0.1	0.3	-	*	-	0.9	0.2	0.1	16
Quartz	0.4	0.4	-	0.2	0.3	0.9	-	0.3	42
Chert	10.5	11.1	9.1	19.4	13.7	4.5	-	12.4	1,675
Silicified Limestone/Mudstone	-	0.2	-	-	-	0.5	-	*	5
Limestone	0.5	6.7	0.3	13.8	5.0	-	-	4.6	623
Misc. Igneous	6.0	9.7	4.9	9.5	6.2	8.5	-	7.5	1,008
Chalcedony	2.5	2.1	1.3	2.8	2.7	0.9	-	2.4	322
Jasper	2.9	0.9	5.1	2.5	0.7	6.3	-	2.4	329
Obsidian	0.2	0.1	0.1	0.2	1.9	-	-	0.3	37
Argillite	0.2	2.4	0.4	0.4	0.6	2.7	-	0.8	103
Unspecified Metamorphic	32.3	22.5	31.8	22.9	26.8	25.1	0.80	28.0	3,788
Unknown	-	*	-	-	-	-	-	*	
Total No.	6,287	2,721	713	2,589	996	223	5		13,534

*Less than 0.1 percent

Site Function

Functional considerations were examined for the five generalized site types hypothesized by Elson (see Chapter 28). The site types, going from least to most complex, are fieldhouse sites, farmstead-homestead sites, hamlet sites, hamlet-agricultural sites, and village sites. For this analysis, AZ O:15:71, the Overlook site (AZ O:15:89), the Arby's site (AZ O:15:99), and Features 5 and 16 at the Hilltop site (AZ O:15:53) were considered fieldhouse sites; the remainder of the features at the Hilltop site, the Boone Moore site (AZ O:15:55), the Compact site (AZ 15:O:90), the Redstone site (AZ 15:O:91), and the Clover Wash site (AZ O:15:100) were considered farmstead-homestead sites; the Deer Creek site (AZ O:15:52) and the Cobble site (AZ 15:54) were considered hamlets, although the Cobble site was disturbed severely through root-plowing; the Rooted site (AZ O:15:92) was considered a hamlet-agricultural site, although again severely disturbed through root-plowing; and Rye Creek Ruin (AZ O:15:1) was considered a village site. Features 9, 20, 34, 59, and 66 from the Deer Creek site were considered "indeterminate," due to uncertainty regarding their temporal assignment, contextual integrity, and function.

Debitage was the most common lithic class at all site types, ranging from 91.5 percent at farmstead-homestead sites to 94 percent at hamlet-agricultural sites (Table 14.13). With respect to the tool types discussed previously, there are only minor differences between the farmstead-homestead, hamlet, and village sites. All three of these site types are believed to be used for habitation purposes, although the intensity and the duration of habitation varied. The similarity in tool types, however, underscores their somewhat similar function. Perhaps most notably, farmstead-homestead sites have a higher relative frequency of projectile points and choppers, and a lower relative percentage of miscellaneous tools and core tools. Hamlets, on the other hand, have a higher relative percentage of miscellaneous tools and a lower relative percentage of choppers. Both of these factors suggest the more functionally specific nature of the farmsteads/homesteads as compared to the more generalized hamlets. Rye Creek Ruin, the only village site included here, had a relatively low percentage of projectile points and miscellaneous tools, but a relatively high percentage of core tools. Once again, though, it bears mentioning that the artifacts from Rye Creek Ruin came from the limited testing of three formal trash mounds.

Table 14.13. Lithic types by presumed site types.

Lithic Type	Indeterminate	Fieldhouse	Farmstead/ Homestead	Hamlet	Agricultural Site/Hamlet	Village	Total
Informal Tool	12	8	85	104	2	26	237
Scraper	14	9	77	109	3	22	234
Biface	5	1	19	28	0	6	59
Projectile Point	5	0	31	26	1	3	66
Plano Scraper	0	1	4	5	0	1	11
Chopper	1	0	7	1	0	1	10
Misc. Flake Tool	3	1	8	22	0	1	35
Core	1	6	33	29	0	8	77
Exhausted Core	0	0	4	10	0	1	15
Core/ Hammerstone	4	1	32	28	3	7	75
Core Tool	1	4	20	37	2	13	77
Hammerstone	5	1	21	20	8	5	60
Debitage	892	460	3,646	6,072	298	1,210	12,578
Total	943	492	3,987	6,491	317	1,304	13,534

Differences in tool types between habitation sites and fieldhouse-specialized agricultural sites are more apparent. Although this may be partly due to some of the small sample sizes involved, functional factors are probably involved as well. Fieldhouse sites are characterized by a relatively high percentage of scrapers, cores, and core tools, but relatively low percentages of bifaces, projectile points, and core/hammerstones. Although the single agricultural site was characterized by a relatively high percentage of hammerstones and core/hammerstones and a relatively low percentage of just about everything else, no conclusions can be drawn from this due to the extremely disturbed nature of the site and the small excavated sample.

Logistical Considerations

Given that the overwhelming majority of chipped stone artifacts were made from locally available materials--in many instances cobbles obtained from nearby stream beds were probably used--the possibility that raw material utilization corresponded to the bedrock geology of the area was examined. The main geologic division within the project area is along Deer Creek, with the area to the south characterized by higher percentages of metavolcanic and metasedimentary rocks, and the area to the north characterized by a higher percentage of metamorphics and quartzite (see Lombard 1989; Miksa, Appendix A, this volume). The expectation was that sites within each of these areas would contain lithic assemblages that reflected the bedrock geology. Interestingly, this expectation was only partially met. For example, the Deer Creek site (AZ O:15:52), a site that should have fallen somewhere in the middle because it is situated just north of Deer Creek in proximity to both raw material types, supported the model because it had the highest relative percentage of metamorphic rocks in the project area, as well as a relatively high percentage of metavolcanics; conversely, the Boone Moore site (AZ O:15:55), one of the northernmost sites investigated, had relatively high percentages of metasedimentary rocks, including chert. This is contrary to the model since the site is within the zone of metamorphic rocks and quartz. These data suggest that while immediatedly available lithic resources were used most readily, in many instances technological concerns appear to have overridden expediency concerns.

CONTEXTUAL ASSESSMENT AND FORMATION PROCESS ANALYSES

As discussed in Chapter 11 of this volume, the assessment of archaeological context represents a method for studying site formation processes. The goal of these analyses is to identify and understand the effects of different formation processes on the archaeological record and to then apply this knowledge to the investigation of specific research issues. In what follows, my main concern is with the use of debitage to distinguish between primary and secondary refuse deposits (as defined in Chapter 11). Analysis also sought to identify de facto deposits to the extent they were present, but given that only 22 out of 5,779 pieces of debitage examined were found in direct floor contexts (Stratum 20), the expectation was that de facto deposits were generally absent. Finally, analysis sought to identify potential research avenues that a contextual analysis of chipped stone artifacts might profitably address.

The model of formation processes used in the following analysis was developed for dealing with an expedient core reduction technology, the technology most commonly found at Southwestern ceramic-period sites (Bernard-Shaw 1984; Young and Harry 1989). It is unclear at this point the extent to which the model can be applied to other nonexpedient technologies (e.g., biface production, bipolar core reduction). The critical part of any contextual assessment is the development of a series of data points to which the other data points can be calibrated. Although several calibration points for an expedient core reduction technology are available in the literature, the model presented here is based on the results of an experimental study by Baumler and Downum (1988). The reasons for this are that Baumler and Downum (1988:103) started with medium-sized cores from which they sought to produce "blades or elongated flakes between 4 and 8 cm long." A similar production goal is envisioned for the prehistoric flintknappers responsible for the Rye Creek chipped stone assemblage. In addition, Baumler and Downum followed a similar methodology in recording data, even though the focus of their study was on small debitage between 2 mm and 4 mm in size.

Numerous variables were considered in setting up the model, including lithic density (per cubic meter) and cortical percentage, but the variables found to be most useful were the ratio of large ($\geq$1.2 inch) to small (<1/2 inch) flakes per analytical unit and the ratio of complete to broken flakes per analytical unit. The 1/2 inch cutoff point for the size variable is based on Baumler and Downum's (1988) experimental study; it was the largest size-grade used in their study. In calculating the complete flake to broken flake ratio, the broken flake total is based on all noncomplete flakes, including shatter.

A hypothetical model of the relationship between flake size and flake completeness with respect to refuse types is shown in Figure 14.5. The actual plot for the 93 analytical units from the Rye Creek Project are shown in Figure 14.6. Also shown in Figure 14.6 are the results from the experimental studies of Baumler and Downum (1988). Although the published version of their work contained only the data from the small debitage analysis, the data from the larger debitage was kindly made available to the author; it is presented here for the first time in Table 14.14. The trash mounds at Rye Creek Ruin and AZ O:15:54 were used to model secondary refuse. The de facto model is based on hypothetical expectations in conjunction with patterns evident with the Stratum 20 artifacts.

Table 14.14. Macrodebitage results of experimental replication study by Baumler and Downum (1988).

Experiment 88-11	>½ in		¼ in - ½ in		
	Complete	Broken	Complete	Broken	Shatter
Raw Material: Wreford Chert	5	0	11	13	4
Weight: 126.9 gms	(22.6 gms)		(10.02)	(8.65)	(6.72)
Experiment 88-12	>½ in		¼ in - ½ in		
Raw Material: Wreford Chert	19	6	3	16	5
Weight: 218.5 gms	(90.75 gms)	(23.43)	(2.55)	(7.01)	(3.27)
Raw Material: Gov. Mt. Obsidian	12	8	17	37	13
Weight: 199.9 gms	(50.42 gms)	(36.60)	(16.62)	(21.05)	(7.65)

Note: 39.6 percent of flakes >¼" in size are complete; 29.6 percent of all flakes are >½" in size; Ratio of big/small flakes 0.42; Ratio of complete/broken 0.66.

Key elements of the proposed model are summarized as follows:

1) Flake size and density are the main criteria for identifying primary refuse areas associated with tool manufacture and maintenance. Flakes produced by tool manufacture and maintenance tend to be uniformly small, in fact, usually smaller than the 1/4 inch mesh used to screen most fill sediments at Southwestern sites. Moreover, it is the presence of small flakes in conjunction with the absence of large flakes that sets tool manufacture and maintenance apart from core reduction activities. In Baumler and Downum's (1988) experimental attempts to produce 16 medium-sized scrapers (averaging 3-7 cm in maximum length and 5-20 gm in weight), only 39 out of 1,811 flakes were larger than 1/4 inch in size. Given these results, attempts to identify tool manufacture and maintenance areas based solely on debitage larger than 1/4 inch in size are probably inherently flawed (cf. Rice 1985, 1987, 1988).

2) Core reduction is the main form of primary refuse that lithic analysts working with macrodebitage need to consider. The results of Baumler and Downum's (1988) experimental study suggest that flakes produced by an expedient core reduction technology will be both large and small, but that in terms of the macrodebitage (i.e., >1/4 inch), most flakes (about 70 percent) will fall somewhere between 1/4 inch and 1/2 inch in size. Baumler and Downum's study also suggests that large broken flakes will outnumber large complete flakes by a ratio of about 1.5:1, or perhaps less (Table 14.16). Note that the pattern for large flakes differs somewhat from the pattern for small flakes reported in the published version of their paper. Moreover, although there is some variation between the experimental and archaeological results

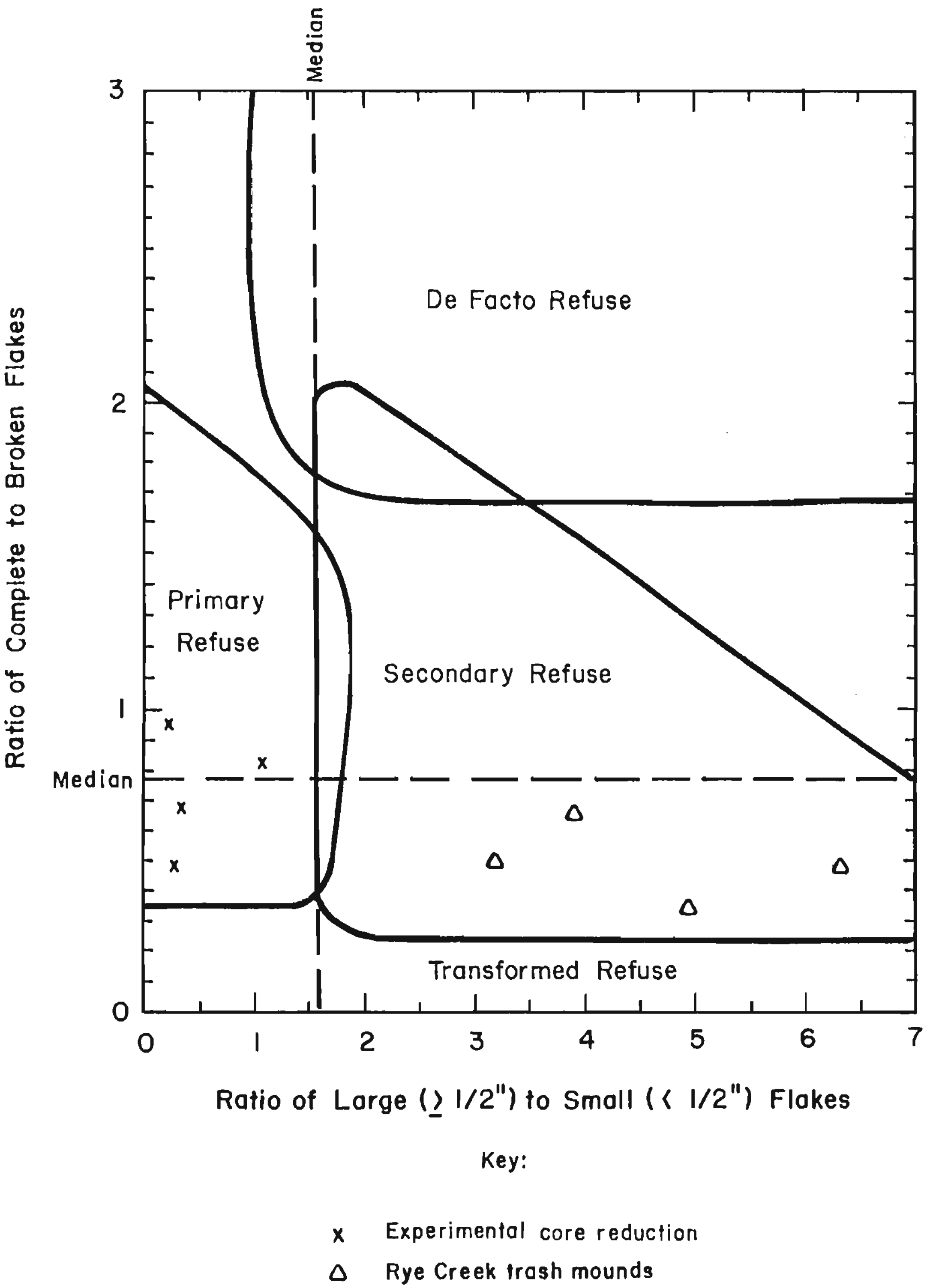

Figure 14.5. Proposed model for refuse types determined by plotting flake size by flake condition.

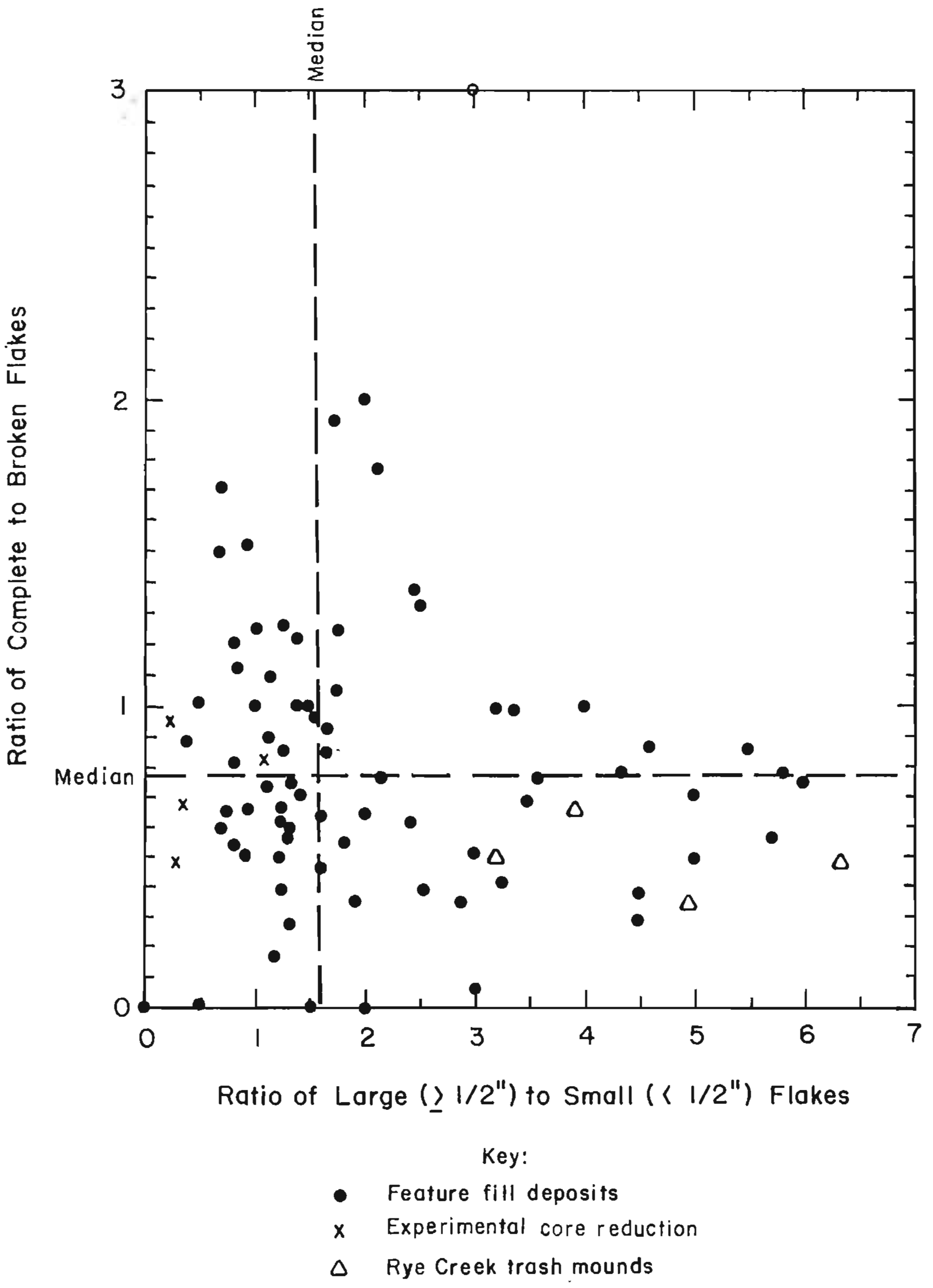

Figure 14.6. Plot of Rye Creek Project lithic assemblage flake size by flake condition.

as shown in Figure 14.6, this is probably due to differences in the raw material being used. The experimental cores consisted of two chert and one obsidian cores, which are finer-grained materials than most of the Rye Creek cores and flakes. With coarser-grained materials it is expected that the flaking debris will be larger in size, although additional experimental studies are clearly needed to test this idea further.

3) Secondary refuse, as indicated by the Rye Creek Ruin trash mounds and Feature 2 at AZ O:15:54 is characterized by a variable ratio of complete to broken flakes (but generally less than 1:1) and a high ratio of large to small flakes (>1.6:1). The four trash mounds had complete to broken flake ratios of between 0.35:1 and 0.7:1, and large to small flake ratios in excess of 3:1.

4) De facto refuse is expected to be characterized by a relatively high ratio of complete to broken flakes (>2:1) and a relatively high ratio of large to small flakes (>2:1). Out of the 22 pieces of debitage found in direct contact with house floors, 15 pieces (68.2 percent) were complete and 21 (95.5 percent) were larger than 1/2 inch in maximum width. Additional calibration points for this refuse type are clearly needed.

5) Transformed refuse is characterized by a very low ratio of complete to broken flakes; the ratio of large to small flakes is variable, however.

Small Debitage

As mentioned above, nine flotation samples were examined (see Table 14.6), three from presumed secondary refuse deposits and six from presumed primary refuse deposits (five core reduction, one possible tool manufacture-maintenance). All deposits tended to have a preponderance of broken flakes, but primary refuse deposits tended to have higher flake densities, with tool manufacture and maintenance having the highest densities of all. The average density for secondary refuse deposits was between one and two 1/8 inch flakes and two to four 2-mm flakes per liter of fill. The average density for core reduction deposits was between two and six 1/8 inch flakes and two to five 2 mm flakes per liter. The possible tool manufacture/maintenance context (the lower fill/floor levels of Feature 11 at AZ O:15:52) averaged 10 1/8 inch flakes and 11.5 2 mm flakes per liter, this despite the fact that it only contained three flakes larger than 1/4 inch in size. All this suggests that small debitage is a useful check on the macrodebitage results; however, given that it took between 1 and 1.5 hours to process each 2 liter sample, it is probably not a feasible approach in and of itself. One procedure that would speed things up, though, is if only density information was recorded.

Applications of the Model

Given that the study of formation processes is a means to an end rather than an end in itself, it is important to consider how such studies can be applied to broader research interests. In what follows, I consider how an understanding of chipped stone formation processes can help in interpreting site structure. The basic assumption that guided the study is that a relative sequence of feature use and abandonment at a site is reflected, at least in part, by the spatial distribution of various refuse types. For example, if there were two pithouses at a site and one was filled with secondary trash while the other contained de facto or primary refuse on the floor and few or no artifacts in the fill, it is reasonable to infer that the trash-filled house was occupied first and that the other house was occupied later. The secondary trash had to come from somewhere, and the simplest solution is that it came from the occupants of the later house. Reid (1973) has followed a similar line of reasoning in distinguishing between "early" and "late" abandoned rooms at Grasshopper Pueblo, although his methods for making the distinction are different.

Applying the model to the Rye Creek sites consisted of two steps. First, the 93 cases from the contextual analysis, which consisted mainly of Stratum 10 (upper fill) and Stratum 19/20 (lower fill/floor) deposits from structures, were plotted as a bivariate scatter plot, with the X axis being the ratio of complete to broken flakes and the Y axis being the ratio of large to small flakes (Figure 14.6). By then comparing the actual distribution of points against the hypothetical model shown in Figure 14.5, refuse types were assigned to individual analytical units. The main dividing point used in distinguishing between primary and secondary refuse was the median ratio of large to small flakes, 1.6:1. A ratio of complete to broken flakes of 0.3:1 was used as the rough dividing line for identifying transformed refuse. One point not shown on the plot is the fill from Feature 12 and AZ O:15:100, which had a large to small flake ratio of 11:1; it, too, should be considered indicative of secondary refuse.

A number of additional considerations bear mentioning with respect to the contextual analysis. First, sample size must be taken into account in making interpretations. It was found that a minimum sample size of 5 to 10 flakes was necessary to guard against potential sampling biases. Fortunately, this requirement was fairly easily met with the current sample. Only 13 cases had sample sizes of 5 or less, and another 5 had sample sizes of between 5 and 10. Second, it should be kept in mind that only fill sediments from known features were included in this analysis; control data from general sheet trash and extramural areas were not available for comparison. They should be included in future analyses in order to assist with the calibration process.

The Deer Creek Site (AZ O:15:52)

The Deer Creek site was the largest and most completely excavated site in the project area; hence, it presented an excellent opportunity to test the utility of the lithic formation process study. The site contained 17 pithouses. All of those that could be reliably dated were assigned to the Gila Butte phase. It was unclear, however, whether this meant that all of the houses were occupied contemporaneously or whether there were episodes of house replacement during the Gila Butte phase. Resolving the issue had important implications for understanding the developmental history of the site as well as for understanding prehistoric demography in the Upper Tonto Basin. Unfortunately, the ceramic data were problematic in this regard (see Wallace et al., Chapter 11, and Clark, Chapter 12, this volume). They indicated that some houses were filled with untransformed secondary refuse whereas others were filled with transformed secondary refuse, and the extent to which natural or cultural factors caused these transformations was unclear.

To address the issue of site structure we examined the chipped stone data. The basic assumption that guided analysis was that a relative sequence of feature use and abandonment could be identified, at least in part, through an examination of the spatial distribution of various chipped stone refuse types. Thus, earlier houses at the site were expected to contain fill deposits characterized by secondary refuse, whereas later houses were expected to contain more primary refuse, or a mixture of primary and secondary refuse.

In Figure 14.7, the spatial distribution of different chipped stone refuse types is plotted for the fill deposits of Deer Creek pithouses. Figure 14.8 presents a similar distribution of refuse types for the floor/floor fill deposits. As can be seen, the fill deposits from the northern half of the site are characterized by primary refuse, whereas those from the southern half are characterized by secondary refuse overlying, in most instances, primary refuse. This pattern is consistent with other lines of evidence (such as the distribution of incised Gila Butte Red-on-buff sherds) that suggest that the southern houses were occupied earlier (see Clark, Chapter 12, this volume). It also accounts for why the fill levels from the northern features contained refuse from core reduction, and also why the contexts plotted so poorly in the ceramic size-density plots as discussed in Chapter 11. If core reduction and other activities were taking place in and around the depressions formed by collapsed pithouses, as suggested by the debitage and ground stone contextual analyses (see Craig and Eppley, Chapter 15, this volume), it is not surprising that any associated ceramics would be quite small and possibly even temporally mixed. The floor/floor fill deposits from Feature 12 may represent an instance of de facto refuse; nine out of nine flakes were larger than 1/2" in size and six of the nine were complete. The floor level from Feature 11, as noted previously, may represent an instance of tool manufacture-maintenance activities.

The Hilltop Site (AZ O:15:53)

The Hilltop site contained five pithouses and a single masonry room. The upper fill levels of most houses on top of the ridge appear to have been disturbed to some extent. The exceptions in this regard were Feature

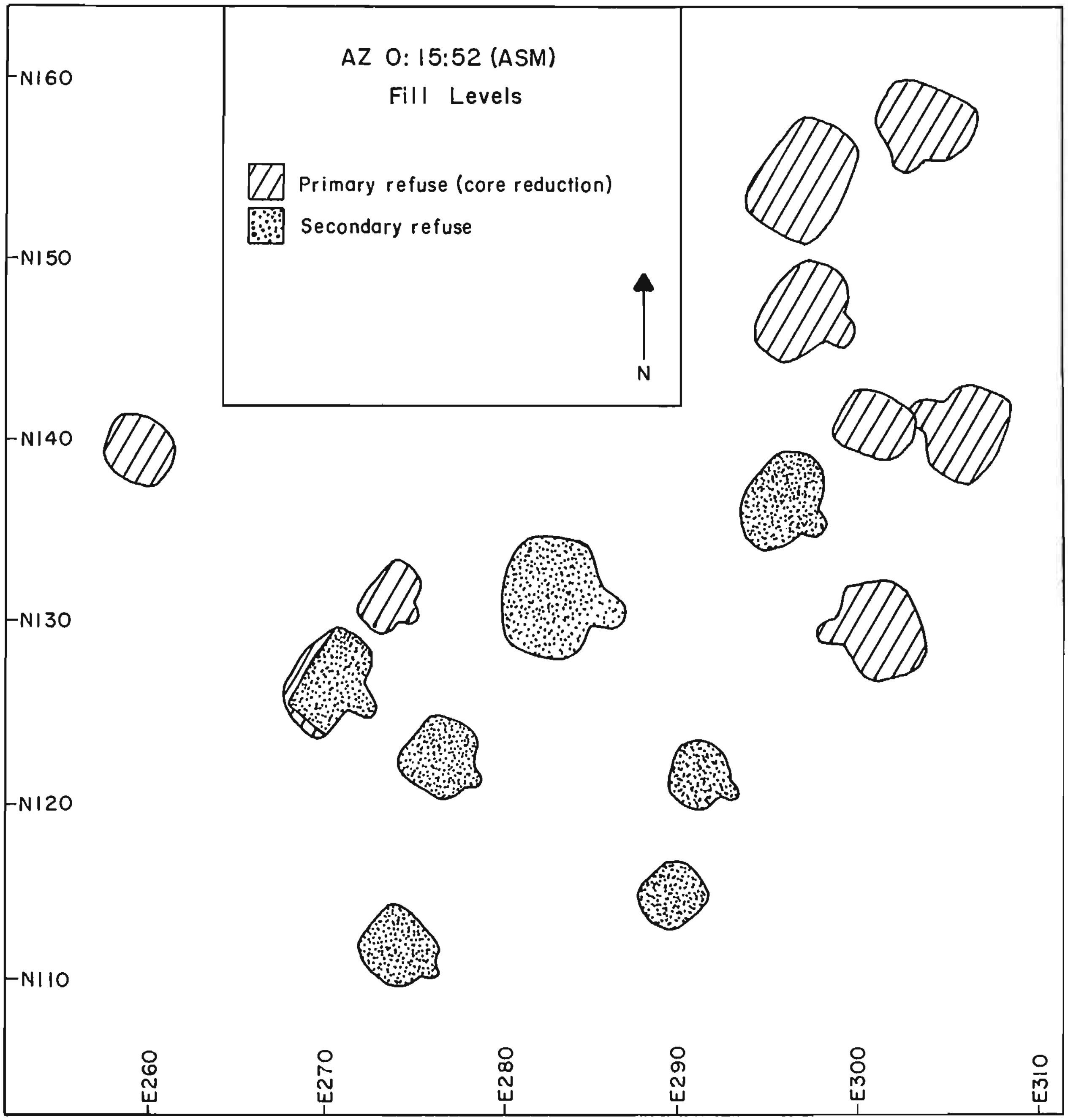

Figure 14.7. Fill refuse type deposits at the Deer Creek site (AZ O:15:52).

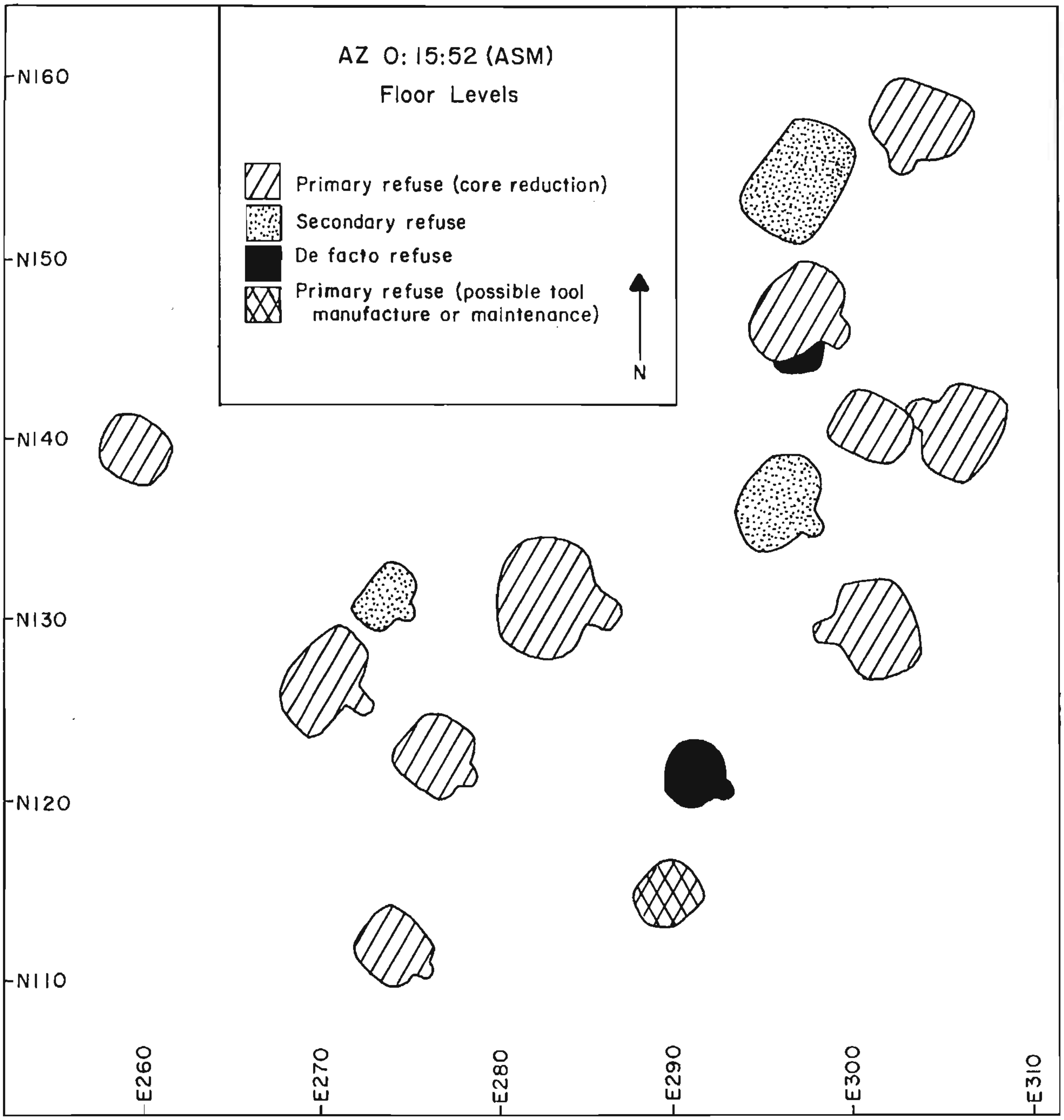

Figure 14.8. Floor/floor fill refuse type deposits at the Deer Creek site (AZ O:15:52).

15, which contains indications of primary refuse in the fill (perhaps associated with occupation of Features 14 and/or 20), and Feature 1, which contained secondary refuse in the fill. In contrast, the lower fill/floor levels of Feature 1 look disturbed, whereas the lower fill/floor levels of most other houses appear to contain primary refuse. This pattern supports the idea (see Chapter 7, Volume 1) that Features 1 and possibly 15 were occupied first, followed by Features 6 and 9, and then 14 (and 20). The masonry structure at the bottom of the ridge contained primary refuse overlying secondary refuse. The secondary refuse was found in the fill directly above the floor of the inner structure, whereas the primary refuse was associated with a possible activity surface. Based on this evidence, it is hypothesized that the inner structure was occupied, abandoned, and filled in with secondary trash, and that a later activity surface was then built on top of the secondary refuse and used in association with the outer structure.

The Cobble Site (AZ O:15:54)

The Cobble site, which was probably one of the largest pueblos in the project area, was extremely disturbed through root-plowing and road construction. Excavated features included three masonry pitrooms and a trash mound. Not much can be said about this site other than Feature 9, a masonry pitroom, appears to contain secondary trash, whereas Feature 5, a heavily disturbed masonry room, contained primary refuse. This pattern tentatively suggests that Feature 9 predates Feature 5.

The Boone Moore Site (AZ O:15:55)

The Boone Moore site contained three pithouses, two masonry-adobe pitrooms, and two surface masonry structures. The site is believed to date to the early Classic period, although the structures are not all contemporaneous, and, as noted earlier, there is an emphasis on hunting and wild plant procurement. This site presents an interesting refuse disposal pattern as indicated by Figures 14.9 and 14.10. Features 1 and 18, both masonry structures, contain only primary refuse, Features 9 and 19, both pithouses, contain only secondary refuse, and the other features contain a mixture of primary and secondary refuse. Feature 5, an adobe-masonry pitroom, contains primary refuse overlying secondary refuse; Feature 6, another pitroom, contains secondary refuse overlying transformed refuse; and Feature 11, a pithouse, contains secondary refuse overlying primary refuse. Based on this evidence, the suggested sequence of occupation is Features 9 and 19 first, Features 1 and 18 last, and Features 5, 6, and 11 in between. This suggested sequence is consistent with other lines of evidence (see Chapter 9, Volume 1), which indicate that architecturally the pithouse features are the earliest, followed by the masonry-adobe pitrooms, and the above-ground masonry structures are the latest features occupied.

The Compact Site (AZ O:15:90)

The Compact site contained four pithouses and a large horno and was extremely disturbed through road construction. It is believed to possibly represent the earlier (Preclassic period) component of the Boone Moore site. The site is difficult to gauge contextually because the horno (Feature 6) intruded into two of the pithouses and the postoccupational compacting of the site that took place. Nonetheless, the results of the contextual analysis suggest that Features 3 and 5 contain primary refuse whereas Feature 4 contained secondary refuse. It is unclear if this means that Feature 4 was occupied before Features 3 and 5 or whether Feature 4 was the feature most disturbed by the construction of the horno. Given the number of intrusive features associated with Feature 4, the latter possibility is considered the most likely.

The Redstone Site (AZ O:15:91)

The Redstone site contained two extremely large pithouses, one of which (Feature 11) was remodeled into a smaller structure. A major question that arose during the course of excavations was which of the two pithouses, Feature 5 or Feature 11, came first. The results of the contextual analysis suggest that Feature 5 was occupied first, based on the fact that it contained secondary refuse in both the upper fill and lower fill/floor deposits, whereas Feature 11 contained primary refuse in the upper fill and a mixture of primary, secondary, and possibly de facto refuse in the lower fill/floor levels. Some of the primary refuse from Feature

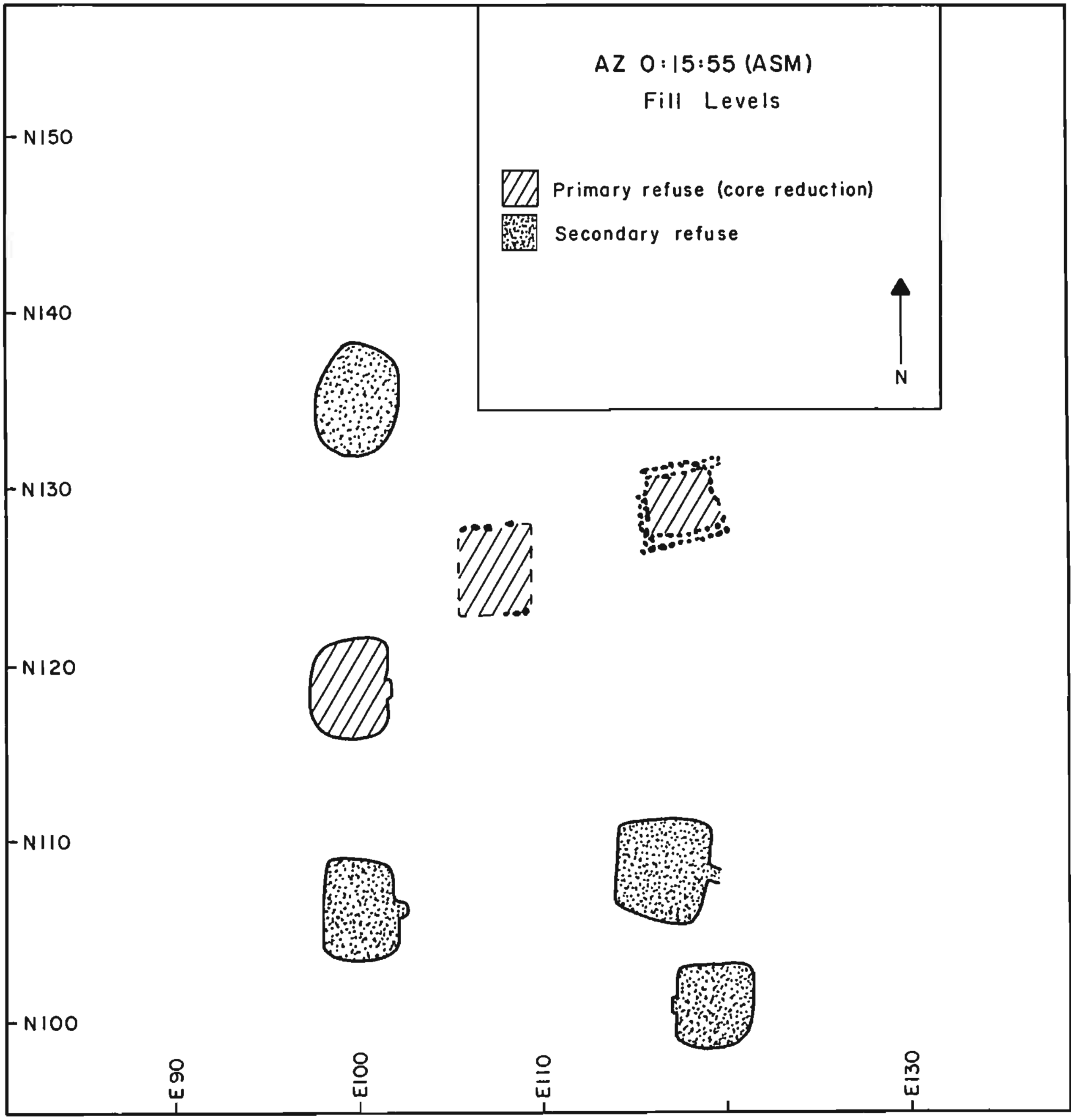

Figure 14.9. Fill refuse type deposits at the Boone Moore site (AZ O:15:55).

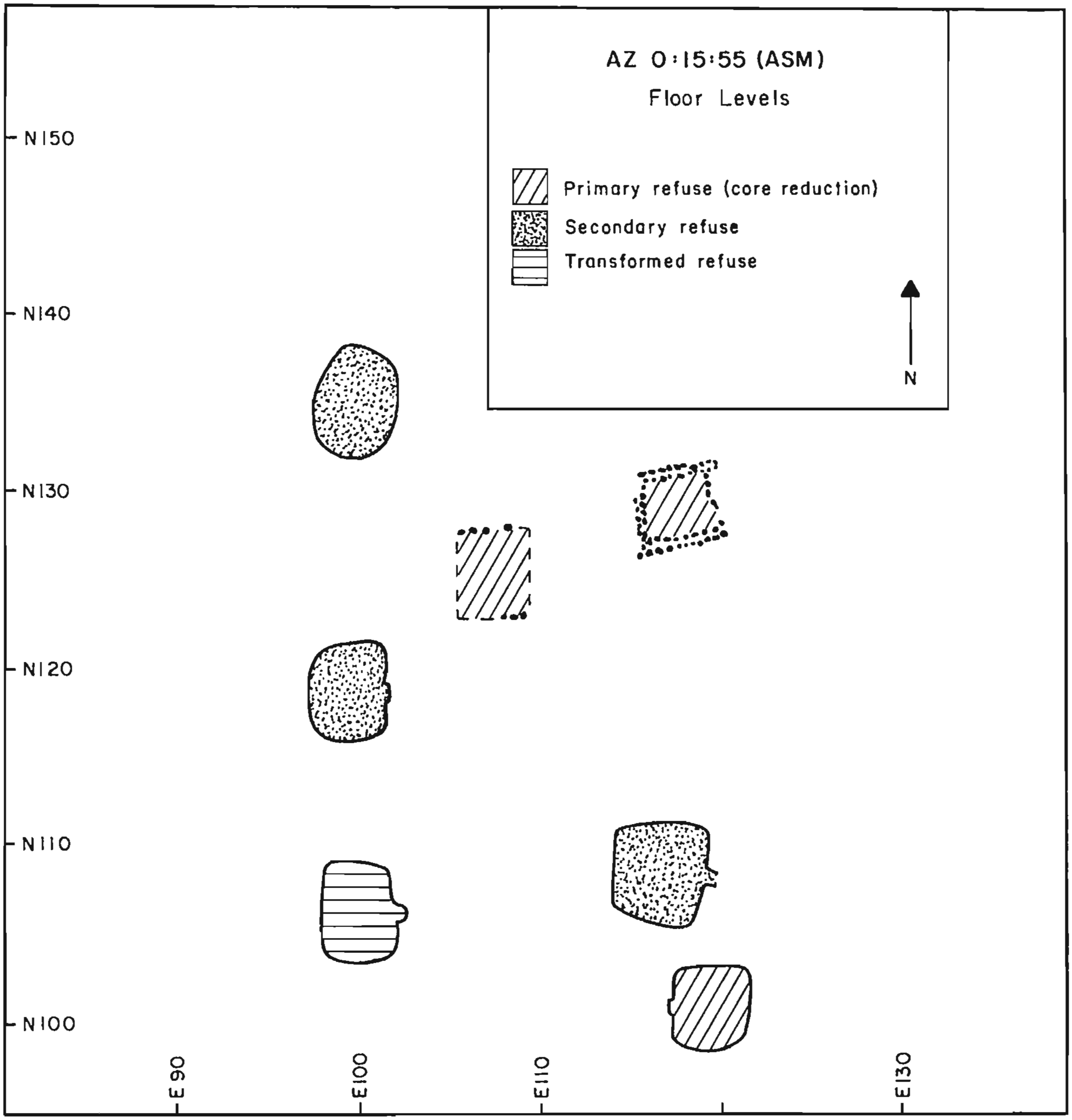

Figure 14.10. Floor/floor fill refuse type deposits at the Boone Moore site (AZ O:15:55).

11 may be associated with the occupation of the remodeled house; parts of it may also be associated with a component that postdates the pithouse occupation of the site.

The Rooted Site (AZ O:15:92)

The Rooted site was an extremely disturbed, possible pithouse village, with an agricultural field system. The majority of the site was destroyed through root-plowing; the only excavated features were a pithouse (Feature 14) and a possible ramada (Feature 15), both located outside of the root-plowed zone. Both the fill and floor levels of Feature 14 contained primary refuse deposits.

The Clover Wash Site (AZ O:15:100)

The Clover Wash site consisted of five pithouses. Due to the small number of lithics recovered from most features at this site, it was not possible to accurately gauge the spatial distribution of refuse types. Features 3, 4, and 12 contained secondary refuse in the upper fill but there was insufficient data from the lower fill/floor levels to make an assessment. In contrast, Feature 6 contained primary refuse on the floor but insufficient data were available to assess the upper fill characteristics.

SUMMARY AND CONCLUSIONS

The Rye Creek chipped stone analysis provides further documentation for a pattern that has now been reported at ceramic period sites throughout the American Southwest, namely, that the inhabitants relied primarily on an expedient core reduction technology. This technology has been described (Haury 1976:293) as one in which "the simple tasks of cutting, scraping, crushing, and the like were done with the nearest rock at hand, modified as needed, and then discarded." Formal tools were relatively rare and when present appear to reflect fairly standardized forms (e.g., projectile points, bifaces, drills).

Given the degree to which this pattern seems to cross-cut known geographic and cultural boundaries in the prehistoric Southwest, it is reasonable to ask how much more will be gained through the continued intensive analysis of individual pieces of lithic debitage. It has been suggested here that a potentially more productive research strategy would be to focus on the characteristics of an entire assemblage of debitage from discrete recovery units. Not only is "mass analysis" faster and easier to implement than most individual flake analyses, but there are advantages in terms of both experimental and analytical replicability. Moreover, the results can be applied to a wide variety of research questions, not just those pertaining to lithic production and use. In this study, for example, I have tried to show how an understanding of the size characteristics of lithic debitage can help in interpreting site formation processes and, in turn, site structure. Other applications of the approach can be envisioned, and it is anticipated that future research will be able to pursue some of these further.

CHAPTER 15

GROUND AND PECKED STONE ARTIFACTS

Douglas B. Craig and Lisa G. Eppley

The Rye Creek Mitigation Project produced 1,643 ground and pecked stone artifacts. These can be divided into three broad analytical categories: 1) utilitarian tools, which includes milling equipment (manos, metates, mortars, pestles), cutting tools (tabular knives and axes), and manufacturing tools (polishing stones, reamers, whetstones), 2) nonutilitarian artifacts, such as stone bowls, palettes, medicine stones, and jewelry, and 3) indeterminate artifacts, consisting of all artifacts too small or fragmentary to assign to one of the other categories. The main concern in this chapter is with the 1,110 artifacts classified as "utilitarian tools." The 434 "nonutilitarian" artifacts are discussed in Chapter 16 of this volume. The 99 "indeterminate" artifacts are not discussed other than to note the provenience and raw material type.

RESEARCH QUESTIONS

Although ground and pecked stone tools were not specifically discussed in the research design for the Rye Creek Project (Elson and Doelle 1989), several of the research questions that were proposed can be examined using the materials recovered. These include questions related to food production, site function, and exchange and interaction. In addition, as it became apparent that contextual control was of critical importance in dealing with many of the research issues, an analysis of the depositional characteristics of pithouse fill sediments was undertaken using the ground stone data.

Food Production and Processing

Traditional approaches to the study of ground and pecked stone artifacts are based on the assumption that an artifact's morphology is closely related to its function. Thus, variability in artifact morphology is viewed largely in functional terms, and groups of functionally related artifacts (i.e., "tool kits") have been identified and linked to particular subsistence strategies (Bartlett 1933:26-28; Woodbury 1954). A ground stone assemblage dominated by trough metates and rectangular, two-handed manos, for example, is generally considered strong indirect evidence for corn agriculture (Martin and Rinaldo 1946:316; Sayles 1965:117; Haury 1976:281). Conversely, basin metates and one-handed manos and handstones are more often associated with wild plant processing (Martin and Rinaldo 1947:291; Goodyear 1975:88-89; Greenwald 1988; Haury 1975:317-319). Other instances where the form-function relationship has been shown to hold include tabular knives, which are usually associated with agave procurement and processing (Bernard-Shaw 1983, 1984; Greenwald 1988), and mortars and pestles, which are usually associated with mesquite processing (Goodyear 1975; Doelle 1976).

Given these considerations, a measure of food production and processing was devised for the Rye Creek Project sites based on the relative contribution of different ground stone tool kits to the total plant processing assemblage. For the purposes of this analysis, three tool kits were defined: 1) specialized corn grinding equipment (trough metates and rectangular manos), 2) more generalized grinding equipment (basin and slab metates, nonrectangular manos, and mortars and pestles), and 3) tabular knives. As indicated above, each of these tool kits is thought to have been associated with a particular food production and processing strategy. The expectation, therefore, was that interassemblage variability should reflect differences in food production and processing between sites.

A second measure of food production and processing was applied to the Rye Creek ground stone data based on the recent work of R. J. Hard (1986). Hard (1986:9) argues that because corn grinding requires a substantial investment of time and labor, the natural tendency for groups relying heavily on corn is to increase the efficiency of the grinding process. One way of doing this, according to Hard, is to increase the grinding surface area so that more material can be ground in less time. Mean mano length is proposed as a fairly straightforward measure of grinding surface area. Applying this measure to both ethnographic and archaeological data, Hard (1986:10) concludes, "A low mean mano length of about 11 cm indicates a hunting and gathering population and lengths greater than 20 cm indicate a largely agrarian economy. Intermediate values indicate intermediate levels of dependence." In an attempt to evaluate these conclusions, mean mano length was computed for each of the Rye Creek Project sites and then tested against the results of the "tool kit" analysis.

Knowing what foods were produced and processed at a particular site does not, of course, inform directly on how that site functioned within local and regional settlement systems. Nonetheless, it provides information that can be used to test various models of site function. Perhaps most importantly, an increased reliance on agriculture is usually associated with increased residential stability (Rafferty 1985:144-147; Young 1990:6-8).

Exchange and Interaction

Recent research has demonstrated that ground stone artifacts were exchanged over considerable distances during at least some periods of Southwestern prehistory (Hoffman and Doyel 1985; Hoffman et al. 1985). Artifacts petrographically determined to have been made out of andesite found in the New River area, for example, make up between 25 and 35 percent of the ground stone assemblage from Preclassic contexts at Las Colinas, located roughly 30 km to the south (Euler 1988). Similarly, manos and metates made from basalt found near the western edge of the Tucson Basin are regularly found at sites in the northern and eastern parts of the basin, a distance of 20 to 30 km (Eppley and Craig 1987; Simpson and Wells 1983, 1984). Given these examples, and the fact that the Tonto Basin is thought to have served as a major trade route for a variety of prehistoric exchange items (Wood 1985, 1986; see Elson and Gundersen, Chapter 22, this volume), two obvious questions arise. First, what ground stone materials, if any, were being imported into the Upper Tonto Basin? Second, what materials, if any, were being exported to other areas?

Contextual Assessment

The general goal of contextual assessment, as described in Chapter 11, is to understand the depositional history of individual features. This understanding is then used to assess the integrity of the deposits for addressing specific research questions. The aim is to ensure that interepretations of the data match the character of the data.

At a conceptual level, depositional contexts can be divided into three broad categories: de facto refuse, primary refuse, and secondary refuse (after Schiffer 1976:30-33; see Chapter 11, this volume, for definitions). In attempting to pinpoint the processes responsible for a given deposit, close attention must be paid to general depositional principles. It can be predicted based on the principles of sedimentology, for example, that redeposited or transformed secondary refuse will contain smaller artifacts and fewer of them than the deposits from which they were derived. Similarly, based on general patterns of trash disposal behavior, it is expected that artifacts in de facto refuse will be larger than those in primary and secondary refuse, although the artifact density will usually be lower (Schiffer 1976, 1987).

There are a number of artifact-specific considerations to keep in mind when dealing with ground stone. First, ground stone usually is found in low frequencies, especially in relation to other artifact classes such as sherds and chipped stone. This means that sample sizes are often low, and many potentially important contexts may have no ground stone at all. For this reason, ground stone should not be the sole basis for assessing context.

Nonetheless, because ground stone tools tend to be large and heavy, they may actually be better depositional indicators than more common, but also more easily transportable, artifact classes.

The issue of context is examined here through an analysis of the size characteristics of manos. The reason for selecting manos is that they constitute the largest single class of ground stone artifacts. Furthermore, because of size considerations, it is fairly easy to develop a set of expectations for the various depositional contexts. De facto refuse should be characterized by a high percentage of complete manos, transformed secondary trash by a high percentage of small mano fragments (or no manos at all), and untransformed secondary trash by a combination of small and large fragments and possibly a few "exhausted" complete manos. Given the lack of evidence for mano production at any of the project sites, it is not expected that primary refuse will be encountered.

METHODOLOGY

Attributes recorded for each artifact include tool class, tool type, raw material type, evidence for secondary usage, and overall condition (i.e., how complete the artifact was). Basic metric measurements (length, width, thickness, weight) were taken for all complete manos (n=124) from floor (Stratum 20) contexts. The number of use surfaces was also recorded for the sample of complete floor manos.

Raw Material

Although many different rock types have been identified in different parts of the Tonto Basin, undifferentiated metavolcanic, metasedimentary, and gneissic rocks are the main types found in the immediate vicinity of the project area (Lombard 1989; see Miksa, Appendix A). These rock types generally are found in cobble form either eroding out of the stream terraces and pediment surfaces or along the drainages.

Raw material classification was based primarily on macroscopic examination of the artifact. A 10-X hands lens was used to examine problematic specimens. No attempt was made to identify specific source areas, but it stands to reason that artifacts made from easily accessible materials were locally produced. The reverse does not necessarily hold. Just because an artifact is made from a rock type that is less accessible does not mean the artifact is nonlocal in origin. Until more complete sourcing studies are done and the production and distribution zones of ground and pecked stone artifacts are more fully documented, the possibility that these artifacts were produced locally should not be ruled out. Nonetheless, regardless of where these artifacts were produced, they should be present in lower frequencies than those made from more easily accessible materials.

Artifact Class and Type

Ground and pecked stone artifacts were first classified as belonging to a general class of artifacts, and then further evaluated as to specific artifact type. Such an approach allowed for analysis to be undertaken at several levels. The ground and pecked stone classes and corresponding types are listed in Appendix F. More complete descriptions are provided here.

Manos. A total of 240 complete manos and 227 mano fragments were recovered during the project. These can be subdivided into five types: 1) cobble manos are unmodified river cobbles with one or more grinding surfaces; 2) unshaped and shaped rocker manos are one-handed manos, usually cobbles, with a use surface that is flat on one side and convex on the opposite, transverse side; 3) unshaped flat-faced manos are variable in size, thin and rectangular or subrectangular in shape, and typically have a single flat wear surface; 4) shaped flat-faced manos are similar to the unshaped variety except that the edges show signs of pecking and chipping, which gives them somewhat of an "unfinished" appearance; and 5) rectangular manos are similar to flat-faced manos in that they tend to be thin, rectangular, and one- or two-handed, but they have been shaped by chipping and grinding to achieve a fairly standardized form; they also tend to have only one wear surface, which is often flat except at the ends where the ground surface turns "up" and is well polished. The lateral edges of most rectangular manos (i.e., where they came in contact with the sides of the metate) are also often highly polished. Typical examples of each of these mano types are presented in Figure 15.1.

Metates. Sixteen complete metates and 89 metate fragments were recovered during the project. These were subdivided into four types: 1) Slab metates are generally unmodified, relatively thin boulders with flat grinding surfaces, which in most instances covered the entire workable surface of the boulder; 2) Basin metates are made from thick river boulders and have wear surfaces that vary from shallow depressions to deep elliptical basins; 3) Formal trough metates have shaped exterior edges that have been chipped and ground to form; the interior walls of these metates have also been shaped by chipping and grinding to achieve a surface that is nearly perpendicular to the flat base; and 4) Informal trough metates are more roughly shaped, narrower, and rounder across the base than formal trough metates. Examples of each of these metate types are shown in Figure 15.2.

Mortars and Pestles. One mortar and 20 pestles were recovered during the project. The mortar was slightly less than 50 percent complete. Twelve of the pestles were complete; the other eight were fragmentary.

Tabular Knives. The tabular knives recovered during the Rye Creek Project typically are made from thin pieces of platy material that have been chipped and ground to create an unhafted knife-like tool. The knife generally has a single working edge, often with wear striations that run parallel to the cutting edge. Wear polish usually is visible along the working surface. Pieces of unmodified tabular knife material were coded separately from those pieces that showed clear evidence of working. Thirty-three complete tabular knives and 82 tabular knife fragments were recovered during the project; 164 pieces of unmodified tabular knife material also were recovered.

Polishing Stones. Polishing stones are formal tools, typically river pebbles, with clearly defined polishing facets. Often these facets exhibit wear striations running perpendicular to the working edge. Polished stones differ from polishing stones in that they lack facets or other indications of deliberate modification (after Huntington 1986). Ninety-two polishing stones were recovered during the project, of which 77 were complete. Many of these were made out of argillite, and may have been used in pigment manufacture rather than in the more commonly assumed polishing of ceramic vessels (see Elson and Gundersen, Chapter 22, this volume). One hundred and nineteen polished stones were recovered, of which 100 were complete. One specimen was too fragmentary to assign to type. Figure 15.3 illustrates the differences between the two types.

Information on other types of ground stone artifacts, such as axes, palettes, and stone bowls, for example, can be found in Chapter 16.

DATA SUMMARY

In this section, basic descriptive information at the assemblage level is presented for the Rye Creek ground and pecked stone artifacts. Both general and site-specific trends are discussed. The intent is to set the stage for the various analyses carried out in the next section.

Artifact Class and Type

Table 15.1 presents the artifact class data by site, and Table 15.2 does the same for the artifact type data. As can be seen, manos represent the largest single class of artifacts recovered, accounting for 42.7 percent of the assemblage as a whole. Tabular knives constitute the next most common class (25.5 percent), followed by polishing/polished stones (20.3 percent), metates (9.6 percent), and mortars and pestles (1.9 percent). Shaped flat-faced manos and rectangular manos account for roughly 63 percent of the manos that could be identified to type; cobble manos account for another 27 percent. Almost 30 percent of the manos could not be identified beyond the class level, a figure that more than doubles for metates. Of the metates that could be typed, there

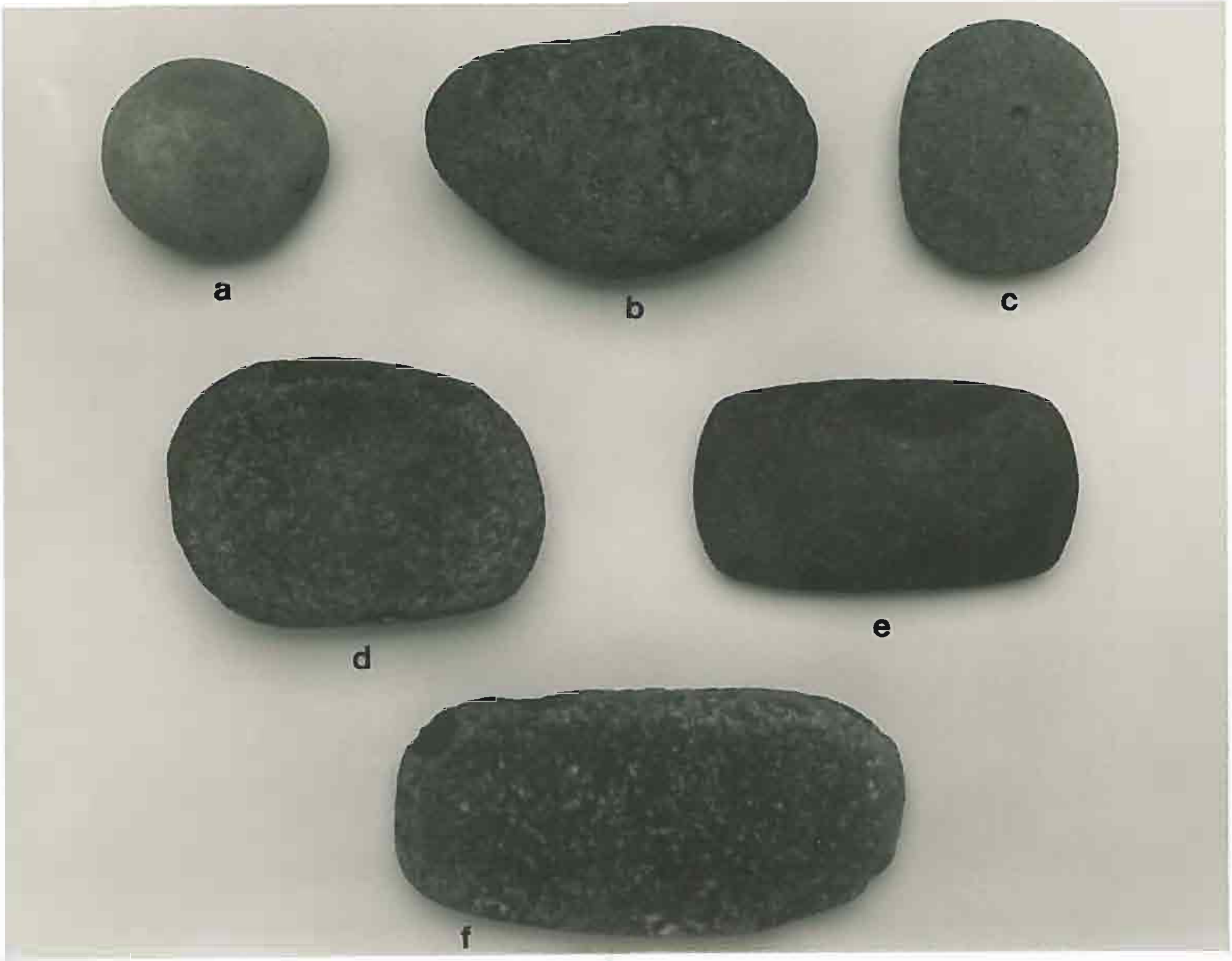

Figure 15.1. Examples of mano types coded for the Rye Creek ground stone assemblage: a) cobble mano, b) unshaped rocker mano, c) shaped rocker mano, d) unshaped flat-faced mano, e) shaped flat-faced mano, and f) rectangular trough/basin mano.

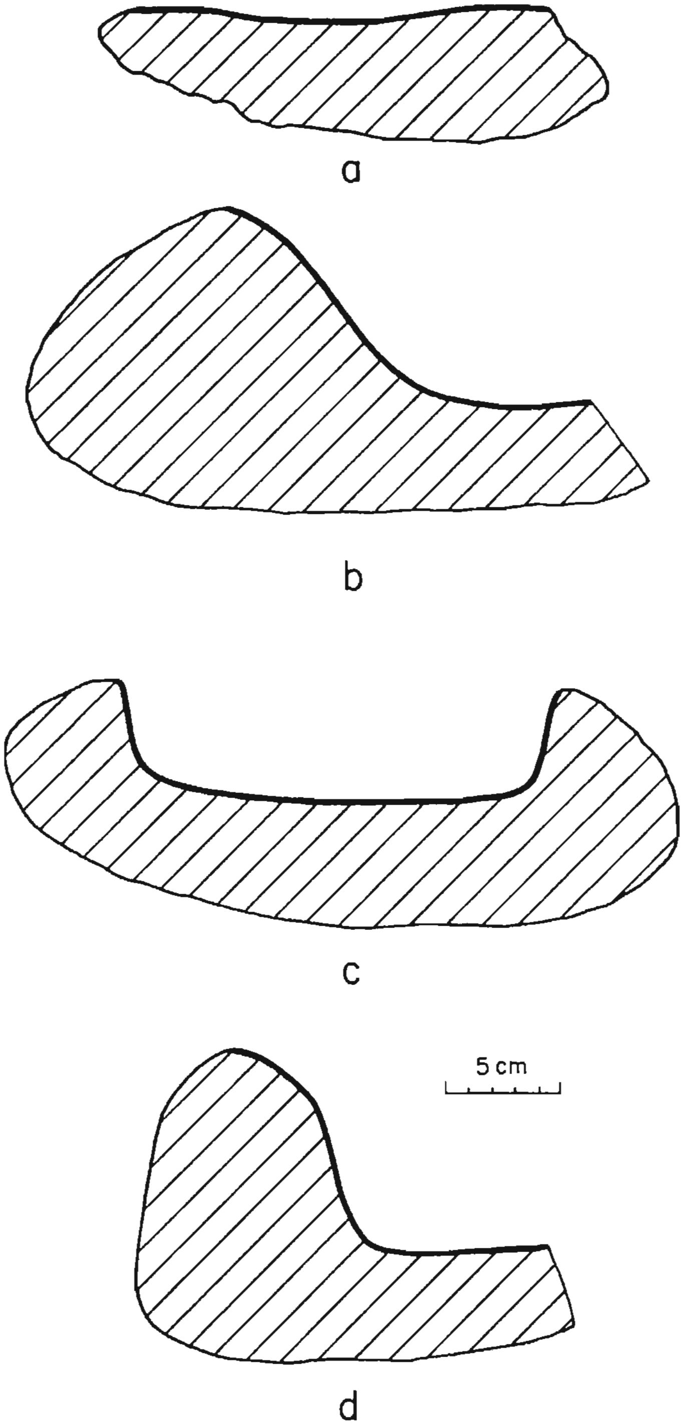

Figure 15.2. Cross sections of metate types coded for the Rye Creek ground stone assemblage: a) slab metate, b) basin metate, c) informal trough metate, d) and formal trough metate.

is a roughly even split between slab and basin metates and trough metates. Pieces of tabular material outnumber knives and knife fragments by a margin of about 1.4:1, and polished stones outnumber polishing stones by a similar margin.

The five largest sites in the sample produced most of the artifacts, with the Deer Creek site (AZ O:15:52) and the Boone Moore site (AZ O:15:55), the two largest (undisturbed and completely excavated) sites, accounting for nearly 60 percent of the total assemblage. The Boone Moore site is noteworthy for the amount of tabular material recovered, as well as for having a relatively high percentage of cobble manos. Possible behavioral implications of these patterns are examined later. Also of note, the two sites along Deer Creek, the Deer Creek site and the Hilltop site (AZ O:15:53), account for 80 percent of the pestles recovered, suggesting that a mesquite bosque may have been present nearby during prehistoric times. This is somewhat supported by the fact that although the areas surrounding these sites have been root-plowed, a large number of mesquite trees are present today.

Table 15.1. Frequency of ground stone classes by site.

GROUND STONE CLASS	O:15:1	O:15: 52	O:15: 53	O:15: 54	O:15: 55	O:15: 70	O:15: 71	O:15: 89	O:15: 90	O:15: 91	O:15: 92	O:15: 99	O:15: 100	Total
Manos	14	181	41	13	76	0	1	3	13	53	24	7	41	467
Metates	3	46	10	0	18	0	0	1	2	12	4	2	7	105
Mortar/ Pestle	0	11	6	0	0	0	0	0	0	2	1	0	1	21
Tabular knife	20	50	10	15	129	0	1	0	2	14	21	2	15	279
Polishing stone	23	97	17	4	26	1	1	5	2	25	2	2	17	222
Total	60	385	84	32	249	1	3	9	19	106	52	13	81	1094

Roughly 44 percent of the ground stone assemblage consists of complete artifacts, but this figure varies considerably from site to site. A number of factors undoubtedly have contributed to this variability. For example, the low percentage of complete artifacts from the Cobble site (AZ O:15:54) is most easily explained as the result of postoccupational disturbances, in particular, root-plowing and road construction (Elson and Swartz 1989; see Swartz, Chapter 9, Volume 1). The low percentage at Rye Creek Ruin (AZ O:15:1), on the other hand, is most likely the result of sampling biases, because data recovery efforts focused only on three secondary trash deposits (i.e., trash mounds). A different kind of sampling bias is evident at the Boone Moore site, where the presence of numerous pieces of unworked tabular material serve to "inflate" the incomplete artifact totals.

Raw Material

Tables 15.3 and 15.4 present the raw material data by artifact class and site, respectively. It is clear from these data that the overwhelming majority of artifacts were made from locally available materials. Most of the manos, metates, pestles, and polishing stones are made from pebbles and cobbles similar to those observed eroding out of the lower terraces and along the drainages. Although no outcrops of tabular material are known in the immediate vicinity of the sites, several excellent sources are known from the Mazatzal Mountains, located about 7 km west of the project area.

The low occurrence of vesicular volcanic materials in the assemblage is somewhat surprising considering that large basalt cobbles are plentiful on Black Mountain, located about 2.5 km northeast of the project area. A

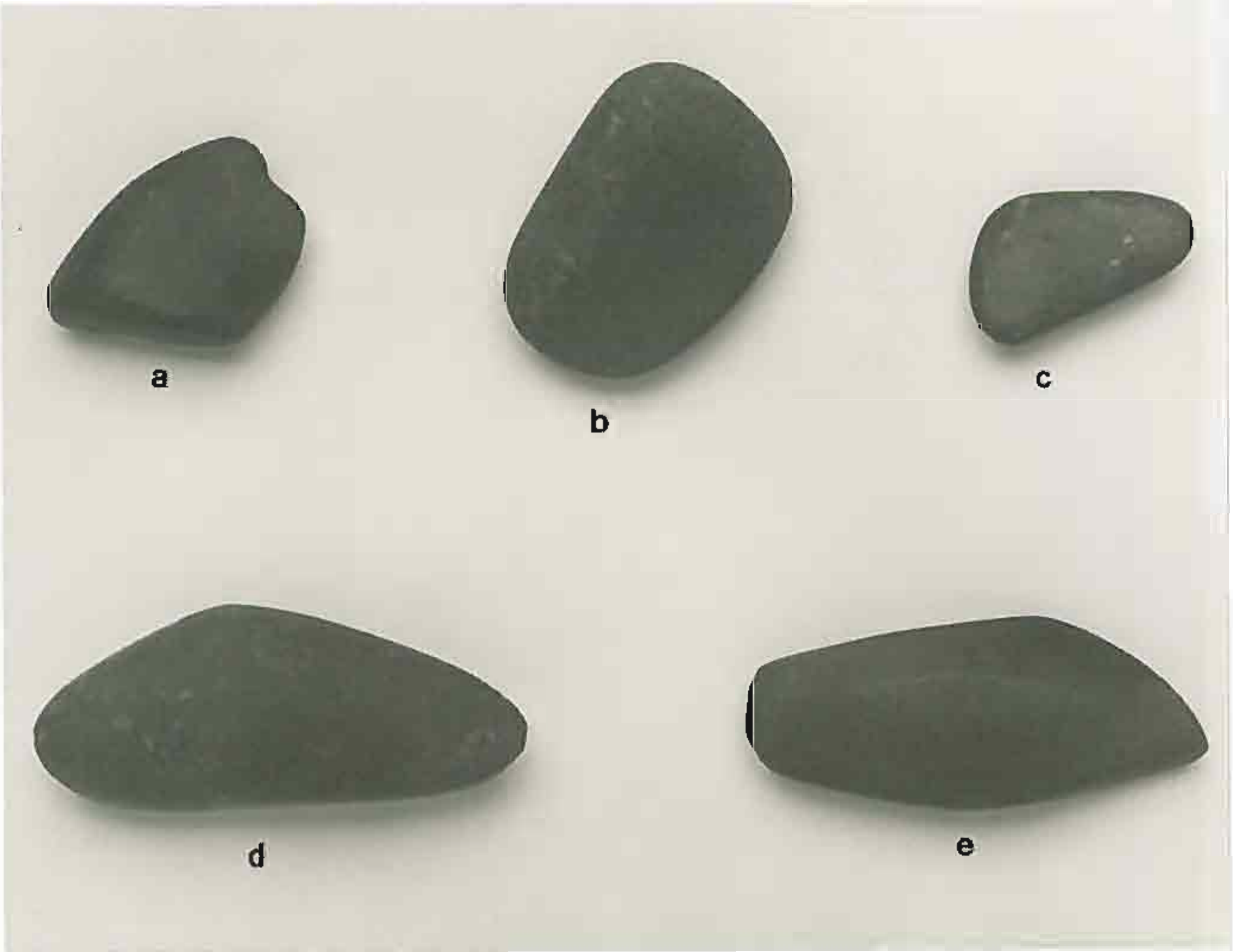

Figure 15.3. Examples of polishing stones recovered from Rye Creek Project sites.

medium-sized pueblo of approximately 20 rooms is located on top of Black Mountain, which may have been for defensive purposes. For some reason the Black Mountain basalt must not have been suitable for manufacturing ground stone tools. Most of the basalt manos and metates recovered during the project appear to be made out of nonlocal materials. It is interesting to note in this regard that the Deer Creek site produced 70 percent of the vesicular basalt recovered. This suggests that even though the inhabitants of the Upper Tonto Basin did not figure prominently in the regional exchange of ground stone, they did participate to some extent during the early Preclassic period, when ties were strongest with the Hohokam of the Phoenix Basin (cf. Euler 1988; Hoffman and Doyel 1985).

Table 15.2. Frequency of ground stone tools by site.

GROUND STONE TYPE	O:15:1	O:15: 52	O:15: 53	O:15: 54	O:15: 55	O:15: 70	O:15: 71	O:15: 89	O:15: 90	O:15: 91	O:15: 92	O:15: 99	O:15: 100	Total
Shaped rocker handstone	0	1	1	0	0	0	0	0	0	0	0	0	0	2
Unshaped rocker handstone	0	1	2	0	0	0	0	0	0	0	0	0	0	3
Shaped flat-faced mano	1	60	17	4	15	0	0	0	8	23	10	0	16	154
Unshaped flat-faced mano	0	6	0	2	10	0	0	0	2	7	0	1	0	28
Rectangular trough/basin mano	5	20	5	0	8	0	0	0	0	4	5	3	6	56
Indeterminate	5	59	14	6	23	0	0	1	2	7	6	2	8	133
Cobble mano	3	34	2	1	20	0	1	2	1	12	3	1	11	91
Slab metate	0	1	0	0	4	0	0	0	1	4	1	1	1	13
Basin metate	0	2	0	0	0	0	0	1	0	0	0	0	0	3
Trough metate	0	1	0	0	0	0	0	0	0	1	0	0	2	4
Indeterminate metate	3	35	8	0	11	0	0	0	1	6	3	1	4	72
Indeterminate trough metate	0	7	2	0	3	0	0	0	0	1	0	0	0	13
Mortar	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Pestle	0	10	6	0	0	0	0	0	0	2	1	0	1	20
Tabular knife	6	44	8	3	20	0	1	0	2	14	6	1	10	115
Tabular knife material	14	6	2	12	109	0	0	0	0	0	15	1	5	164
Polishing stone	9	45	10	3	5	0	1	2	0	9	1	1	6	92
Polished stone	14	51	7	1	21	1	0	3	2	16	1	1	11	129
Indeterminate	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Total	60	385	84	32	249	1	3	9	19	106	52	13	81	1094

Table 15.3. Lithic raw material by ground stone class.

Raw Material Type	Manos	Metates	Mortars/ Pestles	Tabular knives	Polishing stones	Total
Basalt	22	9	0	0	0	31
Vesicular basalt/ rhyolite	16	7	0	0	0	23
Rhyolite/andesite	29	11	3	13	2	58
Granite	22	4	1	0	1	28
Schist/gneiss	12	1	0	114	0	127
Misc. sedimentary	191	39	6	0	34	270
Quartzite	12	0	1	0	13	26
Chert	0	0	0	0	2	2
Indurated limestone	1	0	1	0	0	2
Limestone	0	0	0	0	8	8
Misc. igneous	23	6	1	6	5	41
Unknown	1	0	0	0	1	2
Argillite	4	0	1	0	134	139
Misc. metamorphic	134	28	7	146	22	337
Total	467	105	21	279	222	1094

The strong association between argillite and polishing stones in the Rye Creek sample deserves brief mention here, even though it is discussed more fully by Elson and Gundersen in Chapter 22. Nearly 80 percent of the formal polishing stones and slightly less than half of the less formal polishing stones are made out of argillite. Moreover, polishing stones account for two-thirds of all the argillite recovered. Given that argillite tends to be a fairly soft material, its apparent use as an abrading tool is somewhat surprising. It may be that the argillite used for polishing stones is harder than the kind used for jewelry and other nonutilitarian artifacts. Alternatively, the facets on the polishing stones and the wear striations on the less formal polished stones may actually represent surfaces that have been abraded by harder materials (e.g., manos, metates). If so, it strongly suggests that argillite was the material being processed rather than the material doing the processing. This is supported by x-ray diffraction research by Elson and Gundersen, who suggest that argillite was being processed as a pigment to be used in ceramic manufacure. Additional mineralogical and use-wear studies are necessary to further test these alternative explanations.

ANALYSIS

In this section, the data are examined with reference to the research questions discussed previously. The section begins by taking a closer look at the assumption that ground stone tool kits reflect plant production and processing activities. Although the assumption is widely held, it seldom has been tested against other lines of evidence that inform upon similar issues, in particular, flotation and pollen data. The correspondence between ground stone tool kits and archaeobotanical data is examined here for three main activity sets: 1) corn production and processing, 2) wild plant harvesting and processing, and 3) agave cultivation and processing. The results of a comparative analysis of these data are first discussed at a regional level, then they are applied to the project area sites.

The last part of this section presents the results of a pilot study in which ground stone is used to assess the archaeological recovery context. The aim of this study was to determine the contextual integrity of individual features. Although the methods used to accomplish this goal are similar to ones used in the ceramic (Chapters 11, 12, and 13) and chipped stone analyses (Chapter 14), the ground stone contextual analysis was designed to function independently of the other analyses.

Table 15.4. Lithic raw material frequencies by site.

Raw Material Type	0:15:1	O:15: 52	O:15: 53	O:15: 54	O:15: 55	O:15: 70	O:15: 71	O:15: 89	O:15: 90	O:15: 91	O:15: 92	O:15: 99	O:15: 100	Total
Basalt	2	16	9	0	1	0	0	1	0	1	0	0	1	31
Vesicular basalt/ rhyolite	2	16	1	0	2	0	0	0	0	0	0	0	2	23
Rhyolite/andesite	0	36	14	0	1	0	0	0	1	2	2	1	1	58
Granite	0	11	5	0	9	0	0	0	0	0	3	0	0	28
Schist/gneiss	11	15	3	9	77	0	1	0	0	5	4	0	2	127
Misc. sedimentary	12	88	25	7	48	0	0	3	6	36	14	6	25	270
Quartzite	0	6	1	0	8	0	0	0	1	7	0	0	3	26
Chert	1	0	0	0	1	0	0	0	0	0	0	0	0	2
Indurated limestone	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Limestone	0	2	1	0	1	0	0	0	0	1	1	0	2	8
Misc. igneous	0	21	7	2	3	0	0	0	1	3	2	0	2	41
Unknown	0	1	0	0	0	0	0	0	0	1	0	0	0	2
Argillite	16	67	7	4	12	1	2	5	1	13	1	2	8	139
Misc. metamorphic	16	104	11	10	86	0	0	0	9	37	25	4	35	337
Total	60	385	84	32	249	1	3	9	19	106	52	13	81	1,094

Food Production and Site Function

Tool Kit Analysis

The correspondence among certain groups of ground stone artifacts (i.e., tool kits) and specific plant processing activities has long been assumed but seldom tested. A notable exception in this regard is Teague (1984:214-216), who examined the relationship between tabular knives and agave in her discussion of Hohokam food production along the Salt-Gila Aqueduct. Unfortunately, there are serious methodological problems with her analysis that serve to undermine her conclusions. In particular, her relative measure of tabular knife abundance is based on a ratio of tabular knives to total lithics, a category which is so broad as to have little behavioral meaning.

It makes more sense from our perspective to relate the activity set in question to other comparable activity sets. In this instance, because we are interested in the relative contribution of certain plants to the total vegetal diet, we focus on three critical plant processing activities: corn processing, wild plant processing, and agave processing. Based on general notions of opportunity costs, it is hypothesized that the three activity sets will be related inversely to each other, and that both the ground stone and botanical data will follow similar trends. Thus, a site with a relatively high percentage of trough metates and rectangular manos (i.e., corn processing equipment) is also expected to have a relatively high percentage of corn in the botanical samples.

To test this hypothesis, ground stone and flotation data were compiled from 14 sites outside the project area. These sites were selected because they span a broad range of space, time, and function. In addition, the sites selected are among the few sites for which the necessary data for such an analysis are available. For example, most site reports just present the ground stone data by class, thus making it impossible to compare specific tool kits. Moreover, it has only been in recent years that archaeobotanists have standardized their identification and reporting methods. Prior to 1985, agave was rarely found in archaeological assemblages in southern Arizona; now it is rare not to find it. Contextual considerations must also be taken into account. The sites in the current sample consist primarily of domestic trash contexts with a mix of other contexts thrown in as well.

The regional sample includes an almost even split between Preclassic (n=8) and Classic (n=6) period sites. It also covers a wide geographic range (Figure 15.4), including sites from the Phoenix Basin (5), the Tucson Basin (4), the Mimbres Valley (2), the New River area (1), the Mazatzal piedmont (1), and near the Picacho Mountains (1). Site types represented in the sample include ballcourt villages (2), platform mound communities (2), medium-sized pueblos (2), pithouse villages (2), hamlets (3), farmsteads-homesteads (2), and a resource procurement site (1).

Relative percentages of the three ground stone tool kits were calculated for each site by dividing the number of artifacts in the tool kit in question by the combined artifact total (see Greenwald [1988] for a similar approach). For example, if a site had 100 ground stone artifacts, of which 60 were corn processing tools, 30 wild plant processing tools, and 10 agave processing tools, then the relative tool kit percentages for the site are 60, 30, and 10, respectively. For the purposes of this analysis, specialized corn processing tools include only rectangular manos and trough metates. All other mano and metate forms, as well as all mortar and pestle forms, are considered more generalized plant processing equipment. Tabular knives are the only artifacts included here within the specialized agave processing tool kit.

The relative frequency of different plant taxa was calculated for each site, following methods described by Miksicek (1984b), Minnis (1978), and Gasser (1988). Frequency in this instance refers to the number of samples that contained a particular plant taxon. It is expressed as a percentage of the total number of samples analyzed. For example, if corn was found in 75 percent of the flotation samples from one site but only in 30 percent of the samples from another site, then the frequency of corn at the first site would be said to be 2.5 times greater than at the second site. It should be emphasized, however, that these figures are simply relative measures of plant taxa frequency. Given the range of formation processes known to operate on archaeobotanical remains (Miksicek 1989), the degree to which frequency measures accurately reflect prehistoric dietary practices is still not altogether clear.

Table 15.5 summarizes the tool kit data for the 17 sites in the regional sample. Table 15.6 summarizes the botanical data for the same sites. The correlation between the paired data sets is shown graphically in Figures 15.5, 15.6, and 15.7. As can be seen, the correlation is strong between agave and tabular knives ($r = 0.92$), moderately strong between corn and corn processing equipment ($r = 0.69$), and weak between wild plant resources and generalized grinding equipment ($r = 0.41$).

Given how many factors were not controlled for in this analysis, we find the results encouraging. It does seem that there is a close connection between an artifact's morphology and its function, with the possible exception of the generalized grinding equipment. In light of this, we feel fairly confident about applying the basic approach to the Rye Creek Project sites. In Table 15.7 the relative percentages of the three tool kits are

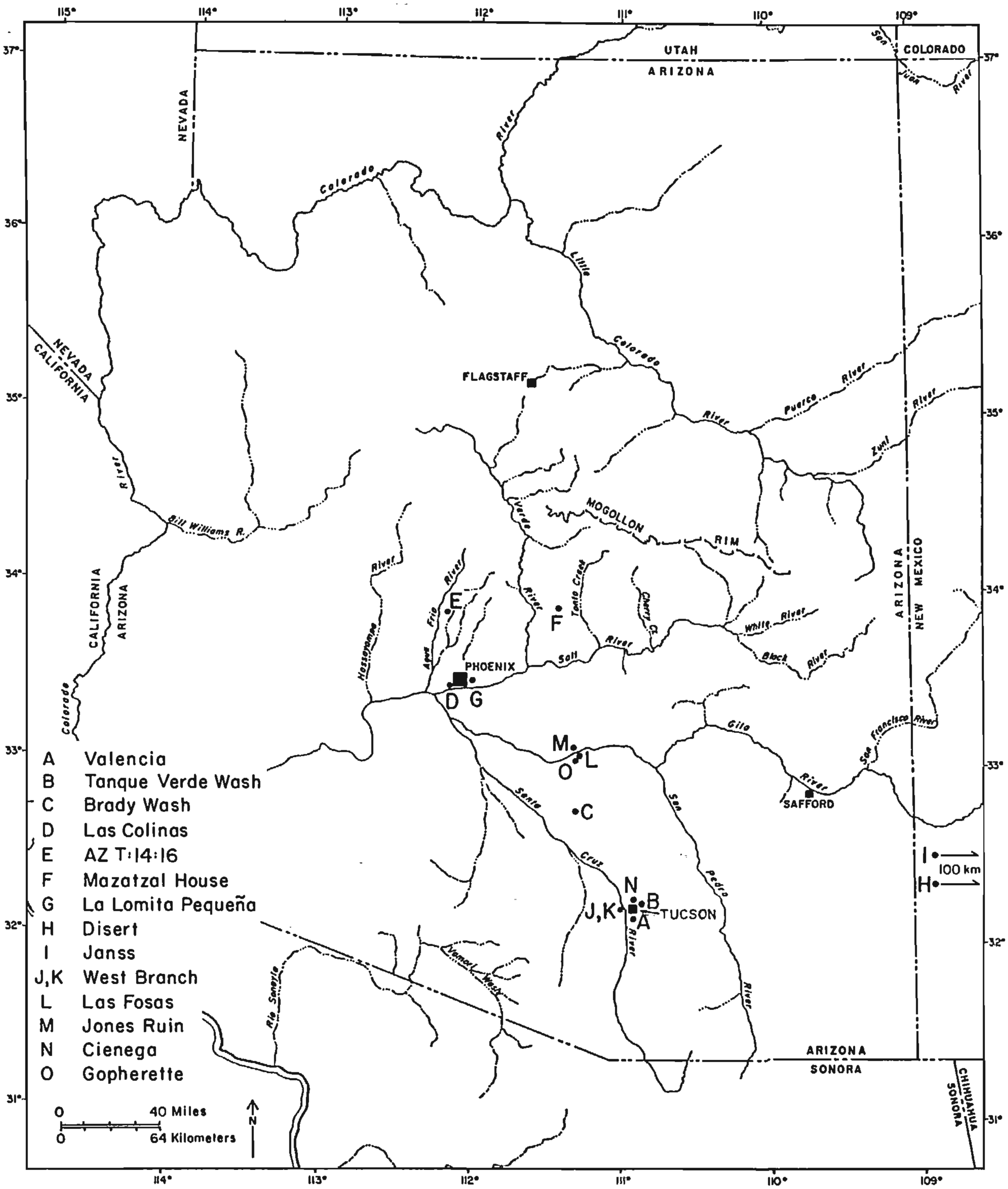

Figure 15.4. Location of sites outside the Rye Creek Project area used in the ground stone tool kit analysis.

provided for the Rye Creek sites, and this information is presented in graphic form in Figure 15.8. As can be seen, most of the sites fall into a tight cluster that contains 40 to 60 percent corn processing equipment, 10 to 30 percent agave processing equipment, and 20 to 40 percent general grinding equipment. We interpret this pattern to be consistent with a mid-level reliance on corn agriculture. It is interesting to note that the pattern crosscuts all time periods and site types, suggesting that: 1) the basic adaptive strategy was in place by the early Colonial period, and 2) functional differences between sites may not be as great as initially thought, at least with respect to plant processing activities.

Table 15.5. Relative percentages of ground stone tool kits at regional sites.

Site	N	% Corn Processing Tools	% Agave Processing Tools	% Generalized Plant Processing Tools	Reference
Valencia	89	23.6	6.7	69.7	Doelle 1985
Tanque Verde Wash	255	63.9	14.9	21.2	Eppley 1986a
Brady Wash Platform Mound	123	27.6	30.1	42.3	Greenwald 1988
Las Colinas, Area 4	200	82.0	16.0	2.0	Euler and Gregory 1988
New River AZ T:14:16	106	79.2	9.4	11.3	Hoffman and Doyel 1985
Mazatzal House NA16, 486	51	76.5	2.0	21.6	Halbirt 1987
La Lomita Pequeña	107	47.7	35.5	16.8	Mitchell 1988
Disert Site	36	83.3	-	16.7	Nelson and LeBlanc 1986
Janss Site	52	80.8	-	19.2	Nelson and LeBlanc 1986
West Branch, (E. Rincon)	25	36.0	12.0	52.0	Huntington 1986
West Branch, (M. Rincon)	112	29.5	22.3	48.2	Huntington 1986
Las Fosas	171	33.9	39.2	26.9	Teague and Crown 1984
Jones Ruin	24	50.0	8.3	41.7	Teague and Crown 1984
Cienega Site	112	32.1	21.4	46.4	Bernard-Shaw 1990
Gopherette Site	32	46.9	34.4	6.3	Teague and Crown 1984

There are several exceptions to this general pattern. In the case of sites O:15:71, O:15:89, and O:15:99, all small masonry fieldhouse sites, the differences may be the result of sampling biases caused by low sample sizes; alternatively, the sites may be more functionally specific than the others. Although the relatively high percentage of tabular knives in the Rye Creek Ruin assemblage might also be the result of sampling biases, it could just as easily be the result of an increased reliance on agave during the Classic period. Additional data are needed to test these possibilities. A more clear-cut example is at the Boone Moore site (AZ O:15:55), where sampling biases do not appear to be a problem. The low percentage of specialized corn processing equipment at the site probably does reflect the fact that a more generalized plant processing strategy was followed. This pattern is consistent with the results of the analysis of mean mano length.

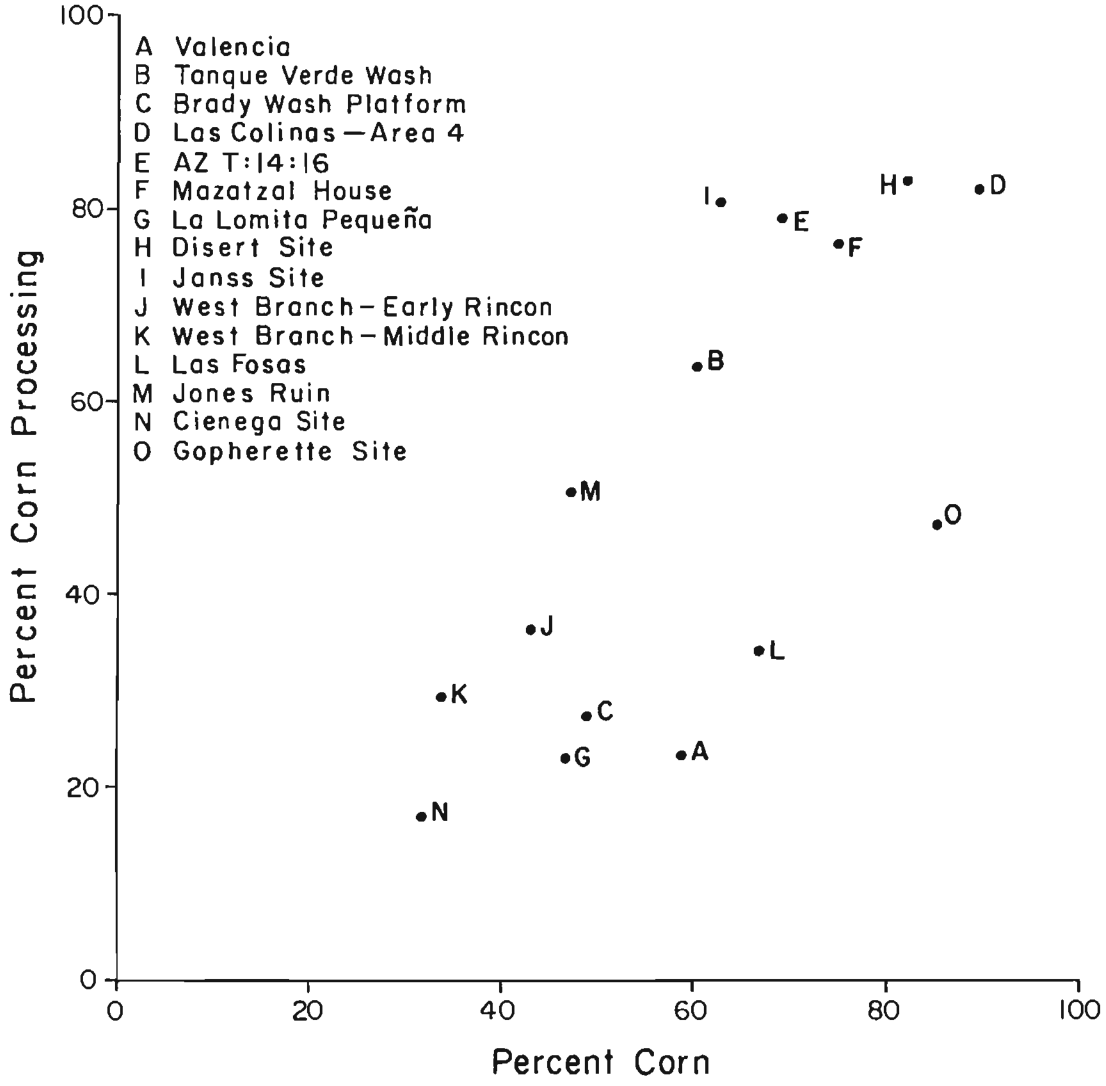

Figure 15.5. Percent of corn processing tools versus percent of corn recovered in flotation samples.

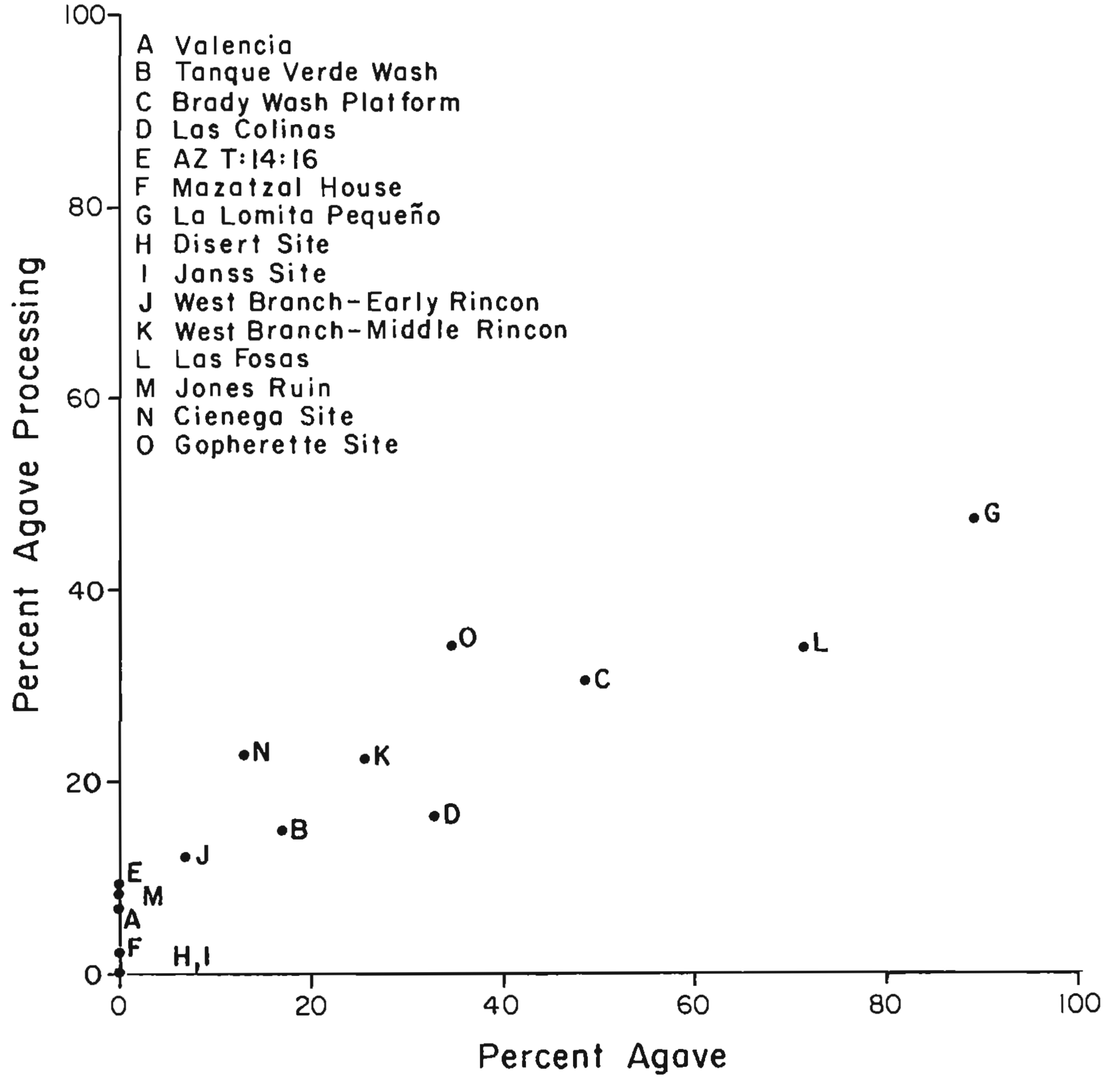

Figure 15.6. Percent of agave processing tools versus percent of agave recovered in flotation samples.

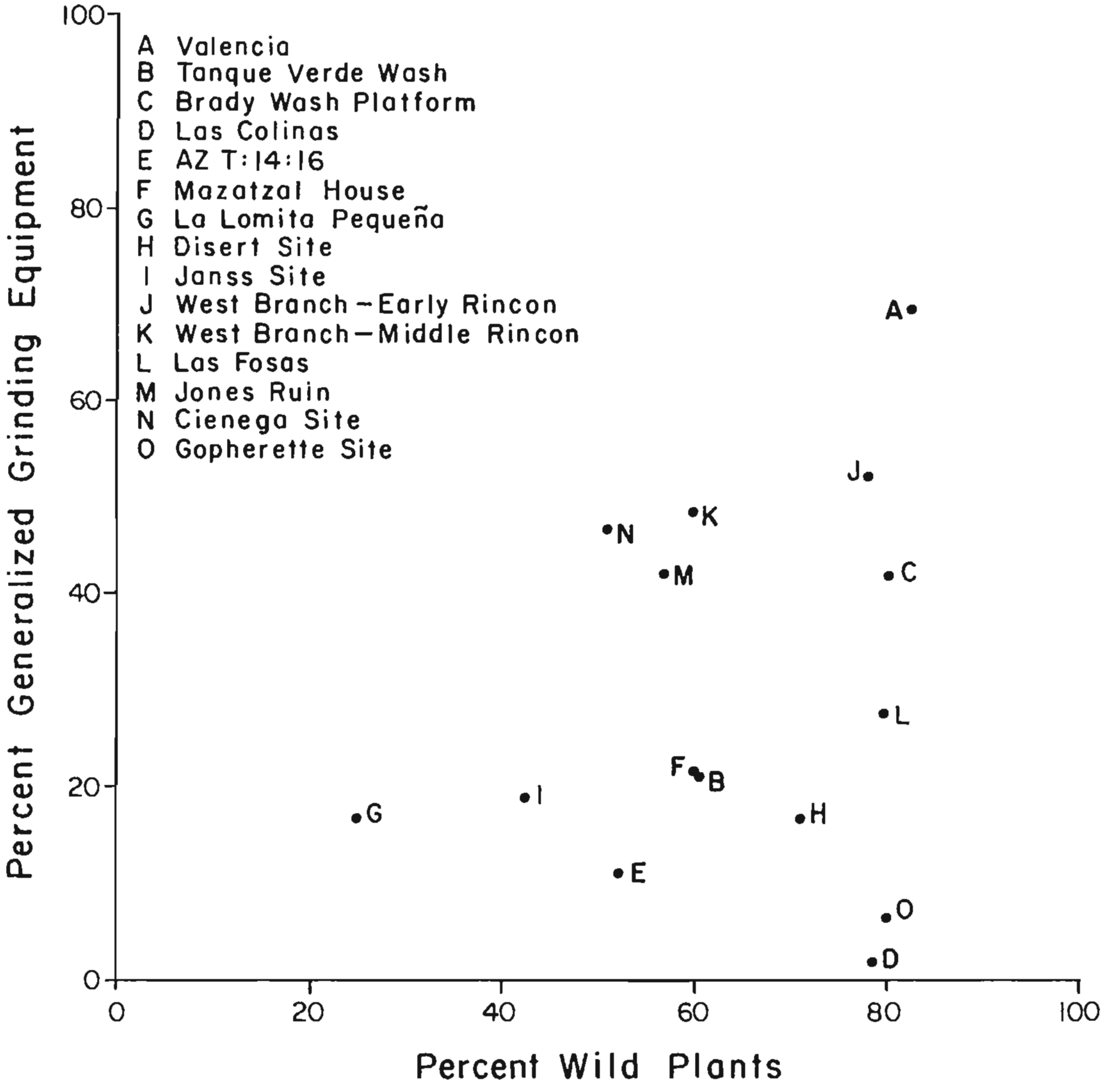

Figure 15.7. Percent of general plant processing tools versus percent of wild plants recovered in flotation samples.

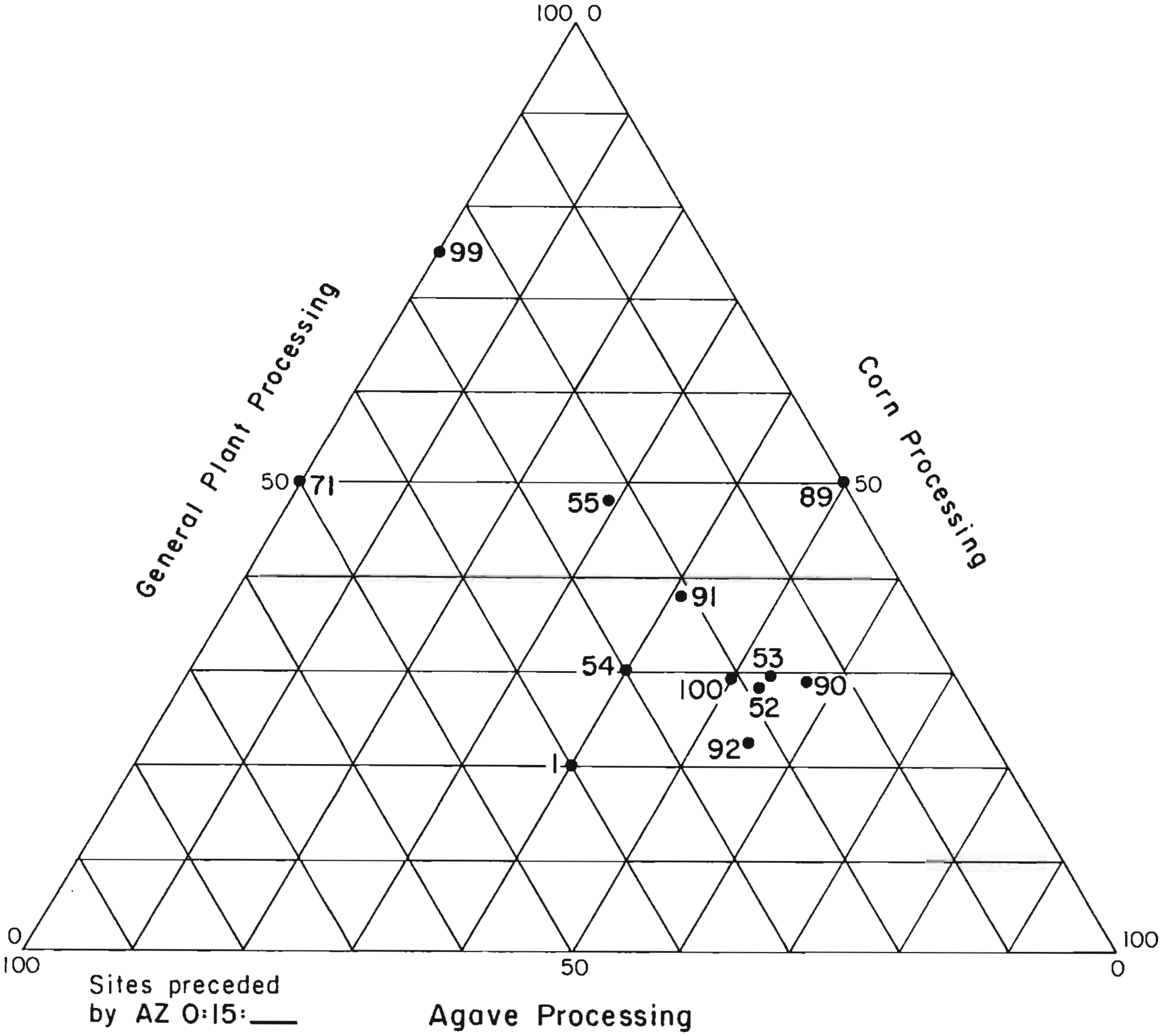

Figure 15.8. Percentage of corn processing by agave processing by general plant processing ground stone tool kits at Rye Creek Project sites.

Table 15.6. Relative percentages of botanical samples at regional sites.

Site	Number	% Samples w/Corn	% Samples w/Agave	% Samples w/Wild Plants	References
Valencia	34	58.8	-	82.4	Gasser 1985
Tanque Verde Wash	186	60.2	17.7	69.9	Miksicek 1986
Brady Wash Platform Mound	41	48.8	48.8	80.5	Gasser 1988
Las Colinas, Area 4	174	89.4	33.3	79.3	Miksicek 1989
New River AZ T:14:16	19	68.4	-	52.6	Gasser 1985
Mazatzal House	20	75.0	-	60.0	Gasser 1987
La Lomita Pequeña	47	23.4	89.4	25.5	Kwiatkowski 1988b
Disert Site	28	82.1	-	71.4	Minnis 1986
Janss Site	19	63.2	-	42.1	Minnis 1986
West Branch, (E. Rincon)	14	43.0	7.0	78.0	Miksicek 1986
West Branch, (M. Rincon)	69	34.0	26.0	60.0	Miksicek 1986
Las Fosas	64	67.2	71.9	79.9	Miksicek 1984b
Jones Ruin	42	47.6	-	57.1	Miksicek 1984b
Cienega Site	98	17.3	13.3	51.0	Miksicek 1990
Gopherette Site	20	85.0	35.0	80.0	Miksicek 1984b

Mean Mano Length Analysis

Metric measurements were taken of all complete manos from floor contexts. The reason that only manos found in floor contexts were considered is that at the time the meaurements were taken they were the only manos whose contextual integrity was clear (i.e., they signified de facto refuse). In retrospect it would have been preferable to have based selection upon the results of the contextual analysis. We do not believe, however, that we have seriously biased the results here. As it was, nearly 50 percent of the complete manos were examined (111 out of 240).

In Table 15.8 basic descriptive statistics on mano length, width, thickness, and weight are provided for the sample as a whole (N=111). In Table 15.9 the mean mano length for each site is presented. If Hard (1986) is correct in his belief that a mean mano length of 20 cm reflects a reliance on agriculture and a mean mano length of about 11 cm reflects a hunting and gathering way of life, then most of the Rye Creek Project sites would appear to fall somewhere in between, although much closer to the agricultural end of the continuum. The major exception in this regard is the Boone Moore site (AZ O:15:55), with a mean mano length of just under 12 cm.

Table 15.7. Relative frequencies of plant processing tools by site and site type.

Site	General Plant Processing (%)	Corn Processing (%)	Agave Processing (%)	Total
Fieldhouses				
O:15:70	0	0	0	0
O:15:71	1 (50.0)	0	1 (50.0)	2
O:15:89	3 (50.0)	3 (50.0)	0	6
O:15:96	0	0	0	0
O:15:99	3 (75.0)	0	1 (25.0)	4
Homestead/ Farmstead				
	14 (29.8)	25 (53.2)	8 (17.0)	47
O:15:53	4 (28.6)	8 (57.1)	2 (14.3)	14
O:15:90	26 (38.2)	28 (41.2)	14 (20.6)	68
O:15:91	6 (22.2)	15 (55.6)	6 (22.2)	27
O:15:92	14 (29.2)	24 (50.0)	10 (20.8)	48
O:15:100				
Hamlets				
O:15:52	62 (27.9)	116 (52.3)	44 (19.8)	222
O:15:54	3 (30.0)	4 (40.0)	3 (30.0)	10
O:15:55	41 (47.1)	26 (29.9)	20 (23.0)	87
Village				
O:15:001	3 (20.0)	6 (40.0)	6 (40.0)	15
Total	180 (32.7)	255 (46.4)	115 (20.9)	550

Note: General plant processing tools include nonrectangular manos, slab and basin metates, and mortars and pestles.
Corn processing tools include rectangular manos, trough metates, and hoes.
Agave processing tools include tabular knives.

Table 15.8. Descriptive statistics for complete manos from floor contexts.

Variable	Number	Mean	St. Dev.	Median	Mode	Minimum	Maximum
Length (cm)	111	15.2	4.2	15.5	16.0	7.4	27.8
Width (cm)	111	9.4	1.6	9.3	9.1	5.2	13.8
Thickness (cm)	111	4.9	1.8	4.4	3.8	1.8	11.7
Weight (gms)	109	1,147.0	581.6	1094.4	664.3	205.1	2,829.0

Table 15.9. Mano length (gms) statistics by site.

Site	Number	Mean	St. Dev.	Median	Minimum	Maximum
O:15:52	39	16.2	3.9	16.0	7.7	25.0
O:15:53	8	14.7	3.3	14.7	10.3	19.8
O:15:54	3	18.8	1.6	19.5	17.0	20.0
O:15:55	21	11.9	3.2	10.8	7.4	18.5
O:15:90	8	15.9	2.3	15.8	12.1	19.0
O:15:91	11	16.1	4.7	16.9	8.2	22.0
O:15:92	8	13.7	2.0	13.2	11.9	17.0
O:15:99	1	19.0	-	-	19.0	19.0
O:15:100	12	16.5	5.9	16.9	7.4	27.8
Total	111	15.2	4.2	15.5	7.4	27.8

Discussion

Both measures of food production gave essentially similar results. It appears that the prehistoric inhabitants of the Rye Creek sites relied upon a mixed-subsistence strategy. Agriculture played an important role, but so did a variety of other plant resources, including agave. The Boone More site differs somewhat from this general pattern in its apparent greater reliance on wild plants.

Contextual Assessment

Each mano was coded as belonging to one of three size categories (the categories actually reflect the degree of completeness, but for our purposes they also can be used as a proxy measure of mano size): 1) small mano fragments, less than half complete, 2) large mano fragments, greater than half complete but not complete, and 3) complete manos. This information was then tabulated by strata for each feature that produced manos. The strata were grouped into two broad recovery contexts: fill levels (Strata 9, 10, 11, and 12) and floor/floor fill levels (Strata 19 and 20). Strata 80 data were not considered in this analysis, due to their disturbed nature, and other miscellaneous strata (e.g., 20A, 40, 49, 50) were treated on a case-by-case basis (see Elson, Chapter 5, Volume 1, for a discussion of strata designations).

Table 15.10 presents the mano condition data for the control units by site, feature, and strata. Table 15.11 does the same for the noncontrol units. Because different collection strategies were used to obtain the control and noncontrol samples, the two samples are not directly comparable (see Chapter 5, Volume 1). In particular, the upper fill sediments of noncontrol units were judgmentally collected. It is not surprising, therefore, that the noncontrol fill units have a disproportionately high number of complete manos -- 53.5 percent in comparison to about 28 percent for the control fill units. Clearly, the noncontrol sample is not representative of the deposits from which they were obtained. This is not a problem in dealing with the samples from floor levels, though, because all fill from Stratum 19 levels (always 5 cm above the floor) was

Table 15.10. Control unit mano condition by site, feature, and stratum.

Site	Small Mano Fragments	Large Mano Fragments	Complete Manos	Total
AZ O:15:1				
Feature 1	5	3	0	8
Feature 2	1	2	1	4
Feature 3	1	0	0	1
AZ O:15:52				
Feature 6				
Stratum 9/10	3	1	0	4
Feature 9				
Stratum 9/10	2	1	2	5
Stratum 19/20	1	2	1	4
Feature 11				
Stratum 11/20	0	0	4	4
Feature 12				
Stratum 10	0	1	0	1
Stratum 20	1	1	1	3
Feature 14				
Stratum 9/10	2	0	1	3
Stratum 20	0	0	2	2
Feature 21				
Stratum 10	2	0	0	2
Stratum 20	0	0	1	1
Feature 22				
Stratum 10	2	0	0	2
Stratum 20	0	0	1	1
Feature 25				
Stratum 10	0	0	1	1
Stratum 20	0	0	1	1
Feature 32				
Stratum 11	1	0	1	2
Feature 34				
Stratum 9/80	0	1	0	1
Stratum 10	0	0	1	1
Stratum 20	0	0	6	6
Feature 36				
Stratum 9	1	0	0	1
Feature 59				
Stratum 10	3	1	0	4
Feature 62				
Stratum 9/10	1	0	1	2
AZ O:15:53				
Feature 6				
Stratum 10	0	1	0	1
Feature 8				
Stratum 9	1	0	0	1
Feature 14				
Stratum 19	0	0	1	1
AZ O:15:54				
Feature 9				
Stratum 10/11	3	1	1	5
Stratum 19	0	0	1	1

Table 15.10. Continued.

Site	Small Mano Fragments	Large Mano Fragments	Complete Manos	Total
AZ O:15:55				
Feature 1				
Stratum 10	3	0	0	3
Stratum 20	1	0	0	1
Feature 5				
Stratum 10	0	0	2	2
Feature 6				
Stratum 10/11	2	1	1	4
Stratum 49	1	0	0	1
Feature 11				
Stratum 19	0	0	1	1
Feature 18				
Stratum 20	0	0	2	2
AZ O:15:91				
Feature 5				
Stratum 9/10	1	1	1	3
Feature 11				
Stratum 10	1	1	1	3
AZ O:15:92				
Feature 14				
Stratum 10	1	1	1	3
Stratum 19/20	1	1	2	4
AZ O:15:100				
Feature 1				
Stratum 0	1	0	1	2
Feature 3				
Stratum 20	0	0	2	2
Feature 4				
Stratum 10	1	0	0	1
Feature 12				
Stratum 10	0	0	1	1
TOTAL	43	20	43	106

screened, regardless of whether the recovery unit was a control or noncontrol unit. That the samples are roughly comparable can be demonstrated by looking at the relative percentage of different size categories represented. Small mano fragments make up 25 percent of the floor manos from control contexts, large mano fragments another 20.8 percent, and complete manos the remaining 54.2 percent (n=48). The figures for noncontrol floor contexts are 20.8 percent small mano fragments, 16.8 percent large mano fragments, and 62.4 percent complete manos (n=149). Given that the majority of complete floor manos were recovered along the inside walls of houses and that most control units were placed in the approximate center of the house, we find the close fit between the two samples highly encouraging (chi square = 1.04, d.f. = 2, p = 0.41). It suggests, among other things, that the control sample is representative of the feature as a whole.

Table 15.11. Noncontrol unit mano condition by site, feature, and stratum.

Site	Small Mano Fragments	Large Mano Fragments	Complete Manos	Total
AZ O:15:52				
Feature 2				
Stratum 9/80	0	0	3	3
Stratum 19	0	0	1	1
Feature 5				
Stratum 9	3	1	0	4
Feature 6				
Stratum 9/10	1	1	0	2
Feature 9				
Stratum 9/10	0	2	8	10
Stratum 19/20	2	1	1	4
Feature 11				
Stratum 9/10/11	0	2	1	3
Stratum 19/20	0	0	2	2
Feature 13				
Stratum 9/10	1	0	0	1
Stratum 20	0	0	1	1
Feature 14				
Stratum 9/10	0	2	0	2
Stratum 19/20	2	2	11	15
Feature 18				
Stratum 9	5	3	0	8
Stratum 19/20	1	0	2	3
Feature 20				
Stratum 10/11	0	0	2	2
Feature 21				
Stratum 9/10/11	6	1	6	13
Stratum 20	0	2	3	5
Feature 32				
Stratum 11	0	0	1	1
Stratum 20	0	0	1	1
Feature 34				
Stratum 19/20	0	1	3	4
Feature 36				
Stratum 9/10	1	0	0	1
Feature 37				
Stratum 9	1	1	0	2
Feature 43				
Stratum 50	2	1	0	3
Feature 44				
Stratum 9	1	1	0	2
Feature 46				
Stratum 50	0	0	1	1
Feature 54				
Stratum 50	1	0	0	1
Feature 56				
Stratum 50	1	0	0	1
Feature 59				
Stratum 9/10	1	0	3	4
Stratum 19/20	2	2	0	4
Feature 61				
Stratum 50	1	0	1	2
Feature 63				
Stratum 50	0	0	2	2

Table 15.11. Continued.

Site	Small Mano Fragments	Large Mano Fragments	Complete Manos	Total
AZ O:15:53				
Feature 1				
Stratum 19/20	1	0	2	3
Feature 2				
Stratum 2	1	0	1	2
Feature 6				
Stratum 9/10	0	1	3	4
Stratum 20	1	1	0	2
Feature 9				
Stratum 20	1	1	6	8
Feature 15				
Stratum 2	0	0	2	2
Feature 16				
Stratum 11	0	1	1	2
Feature 17				
Stratum 50	0	1	0	1
AZ O:15:54				
Feature 8				
Stratum 11	0	1	0	1
Feature 9				
Stratum 19/20	1	1	2	4
AZ O:15:55				
Feature 1				
Stratum 10	0	0	2	2
Feature 5				
Stratum 9/10	0	0	7	7
Stratum 19	0	0	1	1
Stratum 49	0	1	3	4
Feature 6				
Stratum 9/10/11	1	0	3	4
Stratum 19/20	2	1	6	9
Feature 8				
Stratum 9	0	0	1	1
Feature 9				
Stratum 10	0	0	1	1
Feature 10				
Stratum 50	0	1	0	1
Feature 11				
Stratum 10	0	1	0	1
Stratum 19/20	4	2	4	10
Feature 18				
Stratum 19/20	2	0	3	5
Stratum 19a/20a	1	0	3	4
Feature 19				
Stratum 9/10	0	0	3	3
Stratum 19/20	2	2	0	4
Feature 20				
Stratum 50	0	0	1	1
AZ O:15:71				
Feature 1				
Stratum 10	0	0	1	1

Table 15.11. Continued.

Site	Small Mano Fragments	Large Mano Fragments	Complete Manos	Total
AZ O:15:89				
Feature 1				
Stratum 10/11	0	1	1	2
Stratum 11/19	0	1	0	1
AZ O:15:90				
Feature 3				
Stratum 20	0	1	4	5
Feature 4				
Stratum 20	0	0	2	2
Feature 5				
Stratum 20	0	0	2	2
AZ O:15:91				
Feature 3				
Stratum 9	0	1	2	3
Feature 5				
Stratum 10/11	0	1	0	1
Stratum 19/20	0	0	4	4
Feature 11				
Stratum 9/10/11	1	2	3	6
Stratum 19/20	2	1	6	9
Stratum 20A	1	0	1	2
Stratum 40	1	0	1	2
Feature 13				
Stratum 30/51	0	1	3	4
Feature 21				
Stratum 50	0	0	1	1
Feature 22				
Stratum 50	0	0	1	1
AZ O:15:92				
Feature 14				
Stratum 10	0	1	3	4
Stratum 19/20	3	2	6	11
Feature 15				
Stratum 10/19	1	0	1	2
AZ O:15:99				
Feature 1				
Stratum 19	1	0	0	1
Feature 3				
Stratum 20	0	0	1	1
AZ O:15:100				
Feature 1				
Stratum 19/20	1	0	3	4
Feature 2				
Stratum 50	0	0	1	1
Feature 3				
Stratum 10/11/19	0	0	2	2
Stratum 20	0	1	1	2
Feature 4				
Stratum 10	0	2	2	4
Stratum 20	0	0	1	1

Table 15.11. Continued.

Site	Small Mano Fragments	Large Mano Fragments	Complete Manos	Total
AZ O:15:100				
Feature 6				
Stratum 19/20	0	0	3	3
Feature 12				
Stratum 10	0	1	4	5
Stratum 19/20	0	1	2	3
Feature 13				
Stratum 50	5	0	0	5
Feature 17				
Stratum 50	0	2	0	2
Feature 27				
Stratum 50	0	1	0	1
TOTAL	65	58	170	293

Figure 15.9 presents a scatter plot of mano density by size for all control units that produced manos. Density was calculated as the number of manos per cubic meter of dirt excavated. Mano size was calculated as the percentage of complete manos in a given recovery unit. Only control units are plotted here because they are the only recovery units for which volumetric information could be obtained. This is the primary data set used to assess context. The data from noncontrol units also are used, but mainly in a supporting role; that is, in making sure that the sample from the control unit is not at odds with the rest of the recovery unit. As it turns out, the concordance rate between control and noncontrol units is extremely high. In 17 of the 19 instances where samples are available for both units from the same strata, the two samples are in basic agreement as to the contextual integrity of the deposits (Table 15.12). This is viewed as further evidence that the control units are representative of the larger recovery unit.

The following discussion reviews in greater detail the depositional characteristics of each of the features plotted in Figure 15.9. Keep in mind that these assessments are based only on the ground stone evidence. They do not take into consideration the results of the contextual analyses for other artifact classes presented in Chapters 11, 12, and 13 (ceramics) and Chapter 14 (lithics) or the in-field assessments of the feature. A final assessment of the contextual integrity of the feature must take into account all relevant lines of evidence.

Rye Creek Ruin (AZ O:15:1)

All three features sampled from this site (Features 1, 2, and 3) are secondary trash deposits. They are characterized by a combination of small and large mano fragments. Out of 13 manos recovered from the three features, only 1 was complete.

The Deer Creek Site (AZ O:15:52)

The Deer Creek site was the largest excavated site in the sample; it contained 17 pithouses. The site is believed to date largely to the Gila Butte phase, although some earlier and later occupations are present.

Feature 6. A low-density mix of small and large mano fragments was recovered from the fill units of this feature. No complete manos were recovered. This in conjunction with the fact that two-thirds of the manos in the fill were small, strongly suggests that the fill represents sheet-trash deposits.

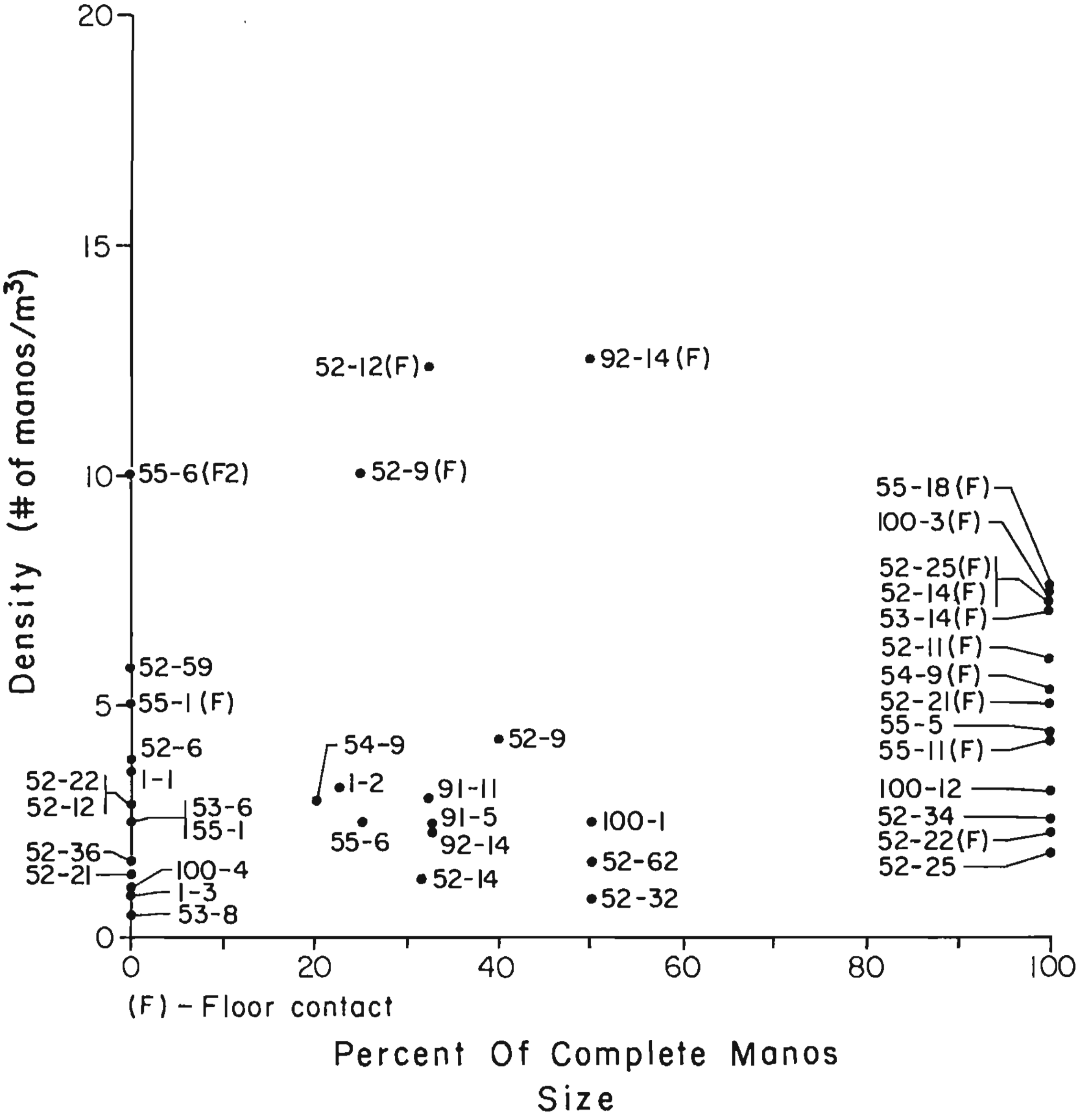

Figure 15.9. Scatter plot of mano density by degree of completeness from Rye Creek Project control units.

Feature 9. Both the fill and the floor of this feature contained a relatively high-density mix of complete and fragmentary manos. Although this pattern usually is indicative of secondary refuse deposits, in this particular instance there is reason for believing that this is not the case. For one thing, two-thirds of the manos in the fill are complete (N=15), a figure that is much higher than usual for secondary refuse (compare it with the trash mound figures from Rye Creek Ruin in Table 15.10). In addition, the number of complete manos in the fill is considerably higher than on the floor, in fact, so high as to make one wonder how it all got there. Although the fill sediments are described as uniform, there may be an activity surface associated with the upper fill units, perhaps connected with the Sedentary period occupation of Feature 59.

Feature 11. Six complete manos were recovered from the floor level of this feature. The floor level thus appears to represent a good de facto context. The fill levels appear mixed, however, based on the low density and fragmentary nature of the sample.

Feature 12. The high-density mix of complete and fragmentary manos on the floor is suggestive of secondary refuse. Given that the fill levels produced only a single large mano fragment, they, too, may represent secondary refuse deposits, although sheet erosion is another possibility that cannot be ruled out.

Feature 14. The fill units of this feature contained a low-density mix of complete and fragmentary manos, most likely the result of secondary refuse deposits. Based on the presence of 13 complete manos and four mano fragments, (along with three whole metates) the floor levels appear to represent a strong case for de facto refuse.

Feature 21. The fill sediments from the control units contained a low density of small mano fragments, suggestive of sheet-trash deposits. The remaining fill sediments contained a much higher density mix of complete and fragmentary manos. This is the only apparent instance at the site where control and noncontrol units do not correspond to each other. It is unclear what factors may account for this situation. One possible explanation is that the whole manos from noncontrol units were either on the roof or leaning up against the house when the structure burned. Support for this hypothesis comes from the fact that evidence for burning is pronounced throughout the fill levels. In addition, most of the manos from the fill were recovered from just inside the outer walls of the structure. Based on the recovery of five complete manos on the floor of the house, the lower fill and floor levels appear to represent good de facto contexts.

Feature 22. The sample of manos from this feature is identical to the control sample from Feature 21; however, unlike Feature 21, no manos were recovered from noncontrol units. Based on this limited information, it appears that the fill deposits represent sheet trash and the floor contexts represent de facto refuse.

Feature 25. Although the sample size is small (n=2), the presence of only complete manos in the fill and on the floor is suggestive of de facto refuse.

Feature 32. The fill from the control units of this feature contained a low-density, mixed assemblage, suggestive of secondary trash deposits. Although not associated with the control unit, a single complete mano was recovered from the floor of the house.

Feature 34. Both the fill and the floor levels of this feature appear to be good de facto contexts. This assessment is based on the large number of complete manos found on the floor (n=9) and the presence of a complete mano and no mano fragments in the control fill units.

Feature 36. Based on the low density of small mano fragments in the fill and the complete lack of manos on the floor, this feature appears to be characterized by sheet-trash deposits.

Feature 59. The fill from the control units of this feature contained a moderate density, mixed assemblage, suggestive of secondary refuse. The noncontrol fill units support this assessment, as only fragments were recovered from floor contexts.

Feature 62. The fill from the control units of this feature contained a low-density mix of complete and fragmentary manos, suggestive of secondary refuse. No manos were recovered from floor levels.

The Hilltop Site (AZ O:15:53)

The Hilltop site contained five pithouses and a single masonry structure. The masonry structure is believed to represent a reoccupation of the site area.

Feature 6. The control unit of this pithouse produced a single large mano fragment from the fill levels and nothing from the floor levels. The noncontrol floor units contained a mix of small and large mano fragments. Three complete manos and a large mano fragment were recovered from the noncontrol fill units. Based on these varied lines of evidence, both the fill and floor of this feature appear to represent secondary refuse deposits.

Feature 14. A single complete mano was recovered from the Stratum 19 level of this pithouse. This is viewed as tentative support for a de facto refuse context.

Table 15.12. Correspondence of contextual data between control unit and noncontrol unit.

Site/Feature (Level)	Control	Noncontrol	Correspondence
O:15:52-6	-	-	+
O:15:52-9	?	?	+
O:15:52-9 (F)	-	-	+
O:15:52-11 (F)	+	+	+
O:15:52-14	-	-	+
O:15:52-14 (F)	+	+	+
O:15:52-21	-	?	-
O:15:52-21 (F)	+	+	+
O:15:52-34 (F)	+	+	+
O:15:52-36	-	-	+
O:15:54-9 (F)	+	+	+
O:15:55-5	+	+	+
O:15:55-11 (F)	+	+	+
O:15:55-18 (F)	+	+	+
O:15:91-5	-	-	+
O:15:91-11	-	-	+
O:15:92-14 (F)	+	+	+
O:15:100-3 (F)	+	?	-
O:15:100-12	+	+	+

F = Floor context

The Cobble Site (AZ O:15:54)

The Cobble site, perhaps the largest pueblo in the project area, was severely disturbed through root-plowing and road construction. Three masonry pitrooms and a trash mound were excavated.

Feature 9. The control fill units produced a moderate-to-high density, mixed assemblage, characteristic of secondary refuse. The floor may represent a de facto context based on the recovery of a complete mano from the control unit and two complete manos from noncontrol units.

The Boone Moore Site (AZ O:15:55)

The Boone Moore site contained three pithouses, two masonry-adobe pitrooms, and two surface masonry structures. It is believed to date to the early Classic period.

Feature 1. The control units in this feature, both fill and floor, produced only small mano fragments, suggestive of sheet trash or low-density, secondary refuse deposits.

Feature 5. Two complete manos were recovered from the fill levels of the control unit and seven additional complete manos were recovered from the noncontrol fill levels. This in conjunction with the four complete manos recovered from the Stratum 19 and 49 levels leads us to characterize both the fill and floor deposits as de facto refuse.

Feature 6. The control unit fill levels contained a low-density, mixed assemblage. No manos were recovered from the control floor levels, but six complete manos and several mano fragments were recovered from noncontrol floor contexts. Based on this evidence, the fill of the feature is characterized as secondary refuse and the floor as a mix of secondary and de facto refuse.

Feature 11. A single complete mano was recovered from the control unit Stratum 19 level. Four more complete manos and several mano fragments were recovered from the floor of noncontrol units. It thus appears that the floor levels represent good de facto contexts, with the possibility of some mixing, perhaps associated with the burial.

Feature 18. Two complete manos were recovered from the floor of the control unit, and six complete manos and three small mano fragments were recovered from noncontrol floor contexts. Based on this evidence, the floor levels seem to represent good de facto contexts.

The Redstone Site (AZ O:15:91)

The Redstone site contained two large pithouses. One of the pithouses (Feature 11) was remodeled extensively into a smaller structure.

Feature 5. The control unit fill levels contained a moderate-density, mixed assemblage, suggestive of secondary refuse. No manos were recovered from the floor of the control unit, but four complete manos were found in noncontrol floor contexts. Undisturbed portions of the floor thus appear to represent good de facto contexts.

Feature 11. The control unit fill levels contained a moderate density, mixed assemblage, suggestive of secondary refuse. The floor levels are characterized by de facto refuse, based on the presence of seven complete manos and three mano fragments.

The Rooted Site (AZ O:15:92)

The Rooted site was extensively disturbed through root-plowing. Based on the density and extent of the artifact scatter the site may have represented a small pithouse hamlet or village. An agricultural field system is also present. Only a single pithouse (Feature 14) and a possible ramada (Feature 15) were excavated.

Feature 14. Both the fill and floor levels from the control units contained mixed assemblages, but the density of manos on the floor was much greater than in the fill. A similar pattern holds for the noncontrol levels. Six complete manos and five mano fragments were recovered from noncontrol floor levels. The floor may thus represent a mix of de facto and secondary refuse.

The Clover Wash Site (AZ O:15:100)

The Clover Wash site contained five pithouses.

Feature 1. The fill levels from the control unit of this feature contained a low-density, mixed assemblage, suggestive of secondary trash. No manos were found on the floor of the control unit, but three complete manos were recovered from noncontrol floor contexts. The floor levels thus appear to represent de facto refuse.

Feature 3. Two complete manos were recovered from the floor of the control unit, and another was recovered from noncontrol floor contexts. Based on this evidence, the floor levels are tentatively characterized as de facto refuse. Two complete manos also were recovered from noncontrol fill levels, which suggests that they may also represent de facto refuse.

Feature 4. The fill levels of this feature appear to represent sheet trash deposits with some secondary refuse mixed in. Although no manos were recovered from control floor contexts, one complete mano was recovered from noncontrol floor contexts, suggesting the possibility of de facto refuse.

Feature 12. The control unit fill levels contained a single complete mano, and four more complete manos were recovered from noncontrol fill levels. Two complete manos and one large mano fragment were recovered from noncontrol floor contexts. It thus appears that both the fill and floor represent de facto refuse.

SUMMARY AND CONCLUSIONS

The analysis of the Rye Creek ground and pecked stone artifacts was productive on several counts. First, support was provided for the long-held assumption that ground stone morphology is a good indicator of different food processing activities, and, indirectly, site function. This support includes the direct correlation of ground stone morphology with archaeobotanical data and an analysis of the mean mano length at project area sites (after Hard 1986). Both of these analyses indicate that the prehistoric inhabitants of the Rye Creek sites relied on corn agriculture to a moderate degree during most time periods. One exception to this general pattern is the Boone Moore site (AZ O:15:55), which produced only minimal evidence for corn processing, but fairly strong evidence of agave processing and hunting (see Chapters 18, 19 and 21 of this volume).

The Rye Creek ground stone analysis also suggested ways in which ground stone can be used to monitor site formation processes. In particular, by examining the spatial distribution of complete and broken manos, it may be possible to identify hard-to-detect use surfaces and activity areas.

CHAPTER 16

MISCELLANEOUS ARTIFACTS, ROCKS, AND MINERAL SPECIMENS

Lisa G. Eppley

This chapter provides descriptive information for all miscellaneous small or unusual ground stone artifacts, rocks, and minerals recovered from the sites within the Rye Creek project area. Four hundred and thirty seven ground stone artifacts and 46 various rock and mineral specimens fall into this category. Complete descriptive information for each artifact is provided in Table 16.12 at the end of this chapter. This information is summarized in the following discussion which is organized by site and feature. Individual tables for each site also are provided; they list artifact type by similar feature type and strata designation. Ground stone artifacts are discussed first, followed by a brief section on rocks and minerals.

MISCELLANEOUS GROUND STONE

Rye Creek Ruin: AZ O:15:1 (Table 16.1)

Feature 1

Five small ground stone artifacts were recovered from Feature 1, a large trash mound. These items include a complete bi-lobed pendant (Figure 16.1e), a possible pendant fragment, and two pendants or fetishes. One of the pendants or fetishes is oblong-shaped with a groove encircling the tip (Figure 16.1j). There is no hole for attachment. The other pendant or fetish may be a phallic effigy having a groove circling the tip of the artifact and a second small groove running horizontal to the tip. Three of these four artifacts are made of argillite. The fifth ground stone item is a whetstone made from a reworked mano. It has one deep groove and one incipient groove.

Deer Creek Site: AZ O:15:52 (Table 16.2)

Feature 2

One small ground stone artifact, a punch, was recovered from the fill of this pithouse. The object is tapered and the tip is polished.

Feature 6

An indeterminate, incised argillite object was recovered from the fill of this feature. The item appears to be roughed out and may have broken during manufacture.

Feature 9

A slate pendant (Figure 16.1d) and an argillite awl (Figure 16.1o) were recovered from the floor of this pithouse. The pendant is roughly triangular in shape and resembles those illustrated by Haury (1965:Plate CVIIa) from Snaketown. It is broken at the top of the hole used for attachment. The awl is nearly complete and well polished at its tapered end.

Table 16.1. Distribution of artifact types by feature type at Rye Creek Ruin (AZ O:15:1).

Artifact Type	Feature Type Trash Mound
Pendant	2 (1)
Fetish	2 (2)
Shaft straightener	1
Quartz crystal	3
Malachite	1

Note: Items in parenthesis are made out of argillite.

Feature 12

A very crude palette prototype was recovered from the fill of pithouse Feature 12. It has ground and chipped edges. Pigment is present on the pecked surface.

Feature 14

Two miscellaneous ground stone artifacts were recovered from this feature. The first, a nutting stone, was recovered from the fill of the pithouse. This item was made from a reworked mano. The second item is a pendant (Figure 16.1c) recovered from the floor level of the pithouse. It is made of a sedimentary material, has an irregular shape, and may represent an animal. It has two drill holes with a break occurring at one.

Feature 18

An argillite whetstone was recovered from the fill of pithouse Feature 18. The stone is oval-shaped with two thin parallel grooves. A very crude axe or hoe also was recovered from the level immediately above the floor of the pithouse. It appears to have been hafted and has a chipped and battered edge.

Feature 21

An extremely fragmentary argillite pendant was recovered from the fill of this pithouse. There is a break occurring at the hole for attachment.

Feature 45

An unusual censer with a phallic handle was recovered from this extramural pit or posthole (Figure 16.2). The censer is made from argillite. It has an intricately carved bowl with a grooved and incised rim and geometrically carved back. The handle, 7.76 cm in length, tapers down to the tip to an incised, realistically carved, phallic head. In terms of overall dimension and form the censer resembles ones illustrated by Haury (1965:Figure 41 and Plate LIXa) from Snaketown that dates to the Pioneer and Colonial periods. Censers with phallic handles also were recovered during the second Snaketown excavation (Haury 1976:Figure 11.26).

Feature 46

An argillite phallic effigy or pendant was recovered from this crematorium. The object is incomplete. It tapers to a point at one end with a vertical groove at the tip.

Figure 16.1. Rye Creek Project miscellaneous small or ground stone artifacts (see text for key to artifacts).

Table 16.2. Distribution of artifact types by feature type at Rye Creek Ruin (AZ O:15:1).

	Feature Type							
Artifact Type	Pithouse Fill	Pithouse Floor	Extramural Pit	Trash Pit	Crematorium	Secondary Cremation	Inhumation	Non-feature
Pendant	2 (2)	3 (2)	-	-	-	-	-	-
Bead	-	-	-	-	1	349	-	-
Fetish	-	-	-	-	1 (1)	-	-	-
Nose Plug	-	-	-	-	1 (1)	-	-	-
Phallic dipper	-	-	1 (1)	-	-	-	-	-
Censer	-	-	-	-	1	-	-	-
Nutting Stone	1	-	-	-	-	-	-	-
Palette	1	-	-	-	-	-	-	-
Awl	-	1 (1)	-	-	-	-	-	-
Punch	1	-	-	1	-	-	-	-
Whetstone	1	-	-	-	-	-	-	-
Ax/Hoe	-	1	-	-	-	-	-	-
In-process Ornament	2 (2)	-	-	-	-	-	-	-
Quartz Crystal	1	-	-	-	-	-	-	-
Specular Hematite	4	3	-	-	3	-	1	1
Red Ocher	1	-	-	-	-	-	-	-
Yellow Ocher	1	-	-	-	-	1	-	-
Azurite/ Malachite	2	-	-	-	-	-	1	-
Pyrite	-	-	1	-	-	-	-	-
Chert	-	1	-	-	-	-	-	-

Note: Items in parenthesis are made out of argillite.

Feature 50

A cylindrical argillite artifact, possibly a nose plug, was recovered from this crematorium (Figure 16.1m). It is smooth and slightly larger at one end. Unlike nose plugs illustrated by Haury (1965:Plate CVIII), this object is not perforated and does not have flanges.

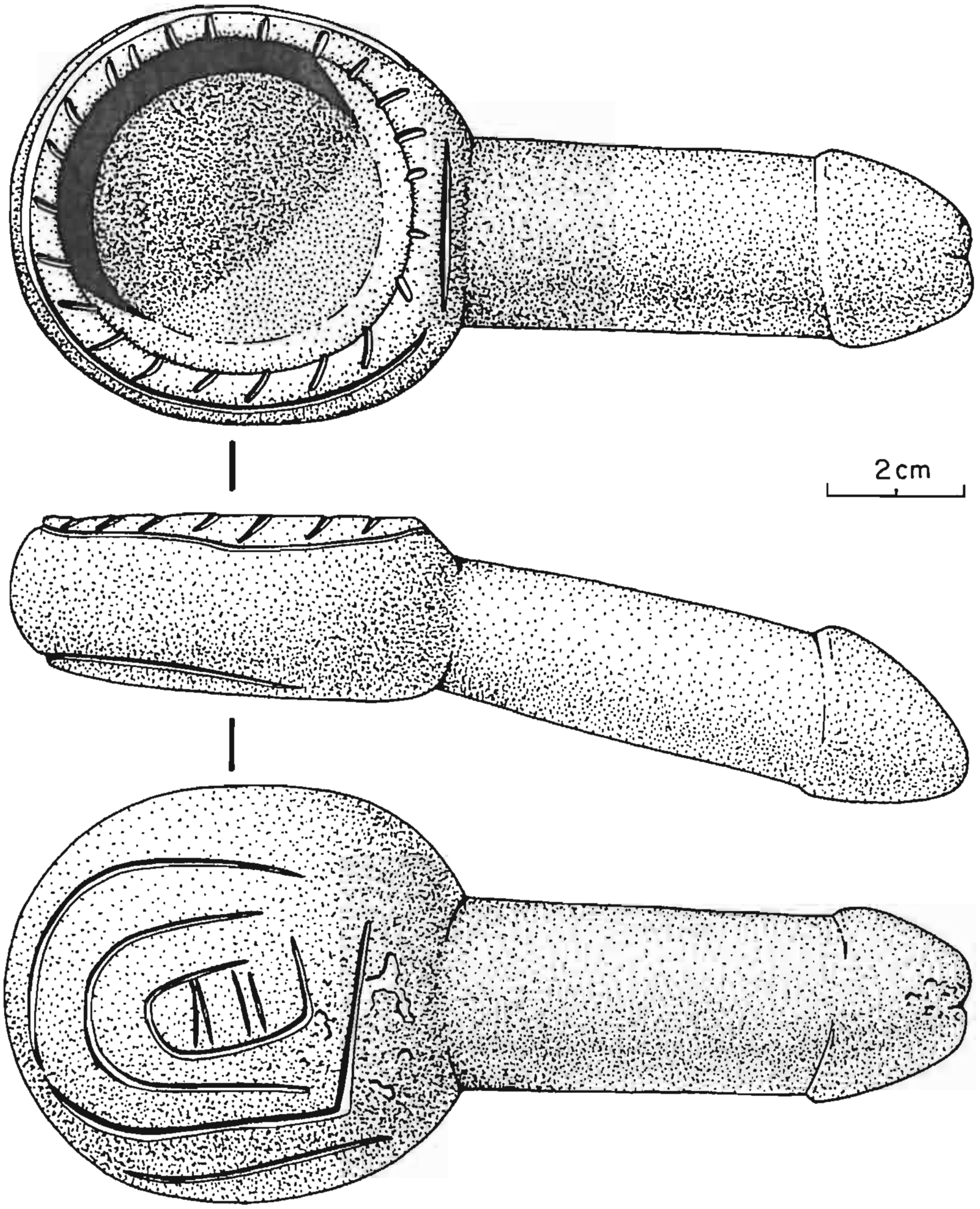

Figure 16.2. Phallic-shaped censer from the Deer Creek site (AZ O:15:52).

Feature 59

A complete slate pendant was recovered from the floor of pithouse Feature 59 (Figure 16.1a). It is oblique in shape and resembles those illustrated by Haury (1965:Plate CVIIa). These pendants were recovered from contexts dating primarily to the Sacaton and Santa Cruz phases at Snaketown.

Feature 62

Two argillite pendants were recovered from the fill or disturbed contexts of this pithouse. One of these, Figure 16.1h, appears to be a carved, stylized "thunderbird." The other pendant is unfinished. It has a triangular shape with incomplete drill holes on opposite sides.

Feature 63

A schist punch or awl was recovered from the fill of this extramural trash pit. It is a long, narrow object which tapers to a point at one end. Polish is present at the tip.

Feature 70

Two miscellaneous ground stone artifacts were recovered from this crematorium. One of these is a very small bead made from a black, unidentified material. The other item is a censer. The censer is made from vesicular basalt. It is small, only 4.55 cm in diameter, and has a carved zig-zag line (or snake design) near the top of the bowl. The zig-zag line does not overlap or close at the end.

Feature 89

A total of 369 beads was recovered from the fill of this secondary cremation. Only 13 of the beads were broken. The beads are extremely small and made of an unidentified material. The color of the beads ranges from light gray to black, the variation probably a result of burning.

The Hilltop Site: AZ O:15:53 (Table 16.3)

Feature 1

A stone ball was recovered from the floor of pithouse Feature 1. The naturally round shape of the cobble has been augmented with polishing. One end has a more noticeably ground surface than the others.

Feature 6

Recovered from the floor of this pithouse was an argillite tool or ornament (Figure 16.1n). It appears to be a tool in that it has two parallel grooves on opposite sides of the piece, which meet at one edge forming a sharp notch, similar to a seam splitter.

Feature 9

A carved argillite ornament or fetish was recovered from the floor of pithouse Feature 9. It is a fragmentary rectangular object, slightly tapered at one end, with criss-cross carvings. No method of attachment is apparent.

Nonfeature

Two artifacts were recovered from nonfeature contexts. One of these is a slate ornament fragment with a single scalloped edge. The other item recovered is a hoe. It is a large rectangular object with the sides ground, possibly for hafting, and a chipped edge with wear polish on one face above the edge.

Table 16.3. Distribution of artifact types by feature type at the Hilltop site (AZ O:15:53).

	Feature Type		
Artifact Type	Pithouse Fill	Pithouse Floor	Non-feature
Ornament	-	1 (1)	1
Stone ball	-	1	-
Hoe?	-	-	1
Tool?	-	1 (1)	-
Specular hematite	1	-	-
Red ocher	1	-	-

Note: Items in parenthesis are made out of argillite.

The Cobble Site: AZ O:15:54 (Table 16.4)

Feature 2

Recovered from this trash mound was a "fire starter." It is a small flat stone with a drill hole partially through the center of the rock. The object quite possibly served as a base to balance a spindle used in the process of spinning fibers.

An argillite bracelet fragment was recovered from this feature during the testing phase (testing items are not included in the tables). The object was carved to resemble a shell bracelet, complete with a perforated umbonal projection.

Feature 9

A stone awl was recovered from the floor level of this slab-lined pitroom.

Nonfeature

A thin, grooved handstone made of basalt was recovered from a nonfeature, disturbed context. The handstone has a shallow groove circling the side and an irregularly shaped pit on one surface.

During the testing phase, two miscellaneous ground stone artifacts were recovered from the surface of the site. One of these is a slate whetstone fragment. It has a long deep groove along one face and a shallow, shorter groove on the opposite surface. Another item recovered is a stone spindle whorl fragment. It is made out of tuff and resembles a ceramic modeled spindle whorl.

Table 16.4. Distribution of artifact types by feature type at the Cobble site (AZ O:15:54).

Artifact Type	Feature Type Pithouse Fill	Pithouse Floor	Non-feature
Awl	1	-	-
Fire starter	-	1	-
Grooved Handstone	-	-	1
Red ocher	1	-	-
Quartz crystal	-	-	1

Boone Moore Site: AZ O:15:55 (Table 16.5)

Feature 1

A possible slate ornament fragment was recovered from the floor of this masonry structure. It is made of slate and is of an indeterminate form.

During the testing phase an argillite loom weight or fetish (Figure 16.1k) was recovered from the fill of the structure. It is a long, bi-lobed object, measuring 3.86 cm in length and 1.46 cm in diameter. It is roughly bell-shaped with the upper "lobe" or top carved so that it is slightly narrower than the base.

Feature 5

Several small ground stone artifacts were recovered from the fill of this slab-lined pitroom. Two, a ring fragment and a perforated stone disk, were carved out of argillite. The stone disk (Figure 16.1p) is very thin, 1.21 cm wide, with pecking on both faces around the outside of the perforation. On one face the pecking appears to be patterned. Two vesicular basalt shaft straighteners and a long slate rod were also recovered from the fill. Both of the shaft straighteners have at least two parallel grooves. The slate rod is 11.98 cm long, tapered on both ends, and may have served as a needle or hairpin.

A hoe, a pendant (Figure 16.1b), and a very shallow stone bowl were recovered from the floor level of this feature. The hoe is rectangular-shaped, ground on one end and battered on the opposite end. The pendant is oval-shaped and made of a metamorphic material.

Feature 6

Two miscellaneous ground stone artifacts were recovered from this slab-lined pitroom. A shaft straightener was found within the fill in a disturbed context. It is made out of an oval cobble with three grooves of varying size extending the width of the cobble. The second item is an argillite ornament recovered from the roof fall level. It is oblong-shaped with a three-quarter groove approximately one-third of the way down from the tip.

Feature 11

A beautiful slate needle (Figure 16.1q) and a very fragmentary slate ornament or whetstone were recovered from the fill of this pithouse. The needle is perforated at the end opposite the point. There is no apparent wear at the tip. A shaft straightener was recovered from the floor of this feature. It has a single large groove and several smaller "cuts" at the tip resembling a whetstone.

Feature 17

A single small ground stone artifact was recovered from this inhumation. It is a turquoise pendant fragment. The pendant appears to have been round or oval.

Table 16.5. Distribution of artifact types by feature types at the Boone Moore site (AZ O:15:55).

	Feature Type				
Artifact Type	Structure Fill	Structure Floor	Roof Fall	Inhumation	Non-feature
Pendant	-	-	-	1	-
Bead	-	2	-	-	-
Ring	1 (1)	1 (1)	-	-	1 (1)
Ornament	1 (1)	1	1 (1)	-	-
Disk	-	1 (1)	-	-	-
Fetish	-	1 (1)	-	-	-
Perforated stone	1 (1)	-	-	-	-
Needle	1	-	-	-	-
Rod	2	-	-	-	-
Ax	-	1	-	-	-
Stone bowl	1	-	-	-	-
Shaft straightener	3	1	-	-	1
Hoe	-	1	-	-	-
Specular hematite	-	1	-	-	-
Ground argillite	1 (1)	1 (1)	-	-	-
Malachite	1	-	-	-	-
Turquoise/Malachite	-	1	-	-	-

Note: Items in parenthesis are made out of argillite.

Feature 18

All of the small ground stone artifacts recovered from this masonry structure were located in either the level immediately above the floor or at floor contact. An argillite ring fragment, a triangular argillite object (possibly a fetish), and an unperforated argillite disk were recovered from the level above floor. The disk may be an unfinished bead but it is completely ground on all sides and there is no indication that a perforation was intended. Also recovered from this level was a complete crynoid bead. A three-quarter grooved ax was recovered from floor contact. It is a wedge-shaped type with an irregularly shaped head. A low ridge is present below the groove. The bit is short and thick and the edges are slightly convex.

Feature 19

A piece of what appears to be a graphite rod was recovered in the fill of this pithouse. It may be part of a nose plug or labret but its condition is too fragmentary to determine its use.

Nonfeature

An argillite ring fragment and a shaft straightener were recovered from nonfeature contexts at this site. The shaft straightener is made from a partially grooved handstone. In addition to the shallow groove circling approximately three-fourths of the stone, there is a deep groove running across the width, and a low, short ridge that has been carved into the tip which runs perpendicular to the middle groove.

Overlook Site: AZ O:15:89 (Table 16.7)

Feature 1

Two argillite ring fragments were recovered from this masonry structure, one from the fill level and one from roof fall-floor context.

Compact Site: AZ O:15:90 (Table 16.8)

Feature 3

An argillite disk and an incomplete argillite pendant were recovered from the fill of this pithouse. The disk has seven sides and appears to be a finished artifact. The incomplete pendant is roughly rectangular-shaped. It has three ground edges and may have broken during manufacture. Another seven-sided argillite disk was recovered from a mixed fill and floor context.

Feature 4

An argillite pendant fragment was recovered from the mixed fill and floor context of this pithouse. It is triangular-shaped with one complete drill hole and one incipient drill hole.

Redstone Site: AZ O:15:91 (Table 16.9)

This site contained one of the largest collections of argillite artifacts of any site in the project area. Ground argillite or hematite pigment was also found on house floors and mano surfaces.

Feature 3

Two argillite artifacts were recovered from the fill above this extramural activity area. One is a seven-sided perforated disk bead and the other is a pendant or weight (Figure 16.1l). The pendant or weight is bi-lobed with a medial groove. An eight-sided argillite disk was recovered from the activity surface itself.

Feature 5

Feature 5, a pithouse, also is dominated by argillite artifacts. An argillite bead and an argillite pendant (Figure 16.1g) were recovered from the fill. The pendant is very interesting in that it closely resembles a

Mesoamerican copper bell (although no copper bells were recovered from the project area). Two cylinder-shaped beads, one seven-sided bead, and one bead fragment were recovered from the floor of the pithouse. All are made from argillite.

Feature 11

Feature 11, a pithouse, has an unusually large number of small ground stone artifacts, including both complete and "in process" pieces. One argillite cylinder-shaped bead, one six-sided argillite disk, and one bead of a dark metamorphic material were recovered from the fill or disturbed contexts. From the mixed fill and roof fall context came two incomplete beads. One of these is of a gray metamorphic material. It is roughly seven-sided with drill holes begun on opposite sides. The bead appears to have broken during the process of completing the drill holes. The other bead or disk is made out of argillite. It is ground on four sides and broken on two. Another "in process" argillite bead or disk was recovered from the roof fall level. It is broken on one side and ground on three. Also from this level is a punch, a small river pebble, which naturally tapers to a blunt point. The tip is lightly polished.

A number of interesting artifacts were recovered from the levels assigned to floor context. Three tubular-shaped marble beads were recovered. One complete triangular pendant; one seven-sided disk; a crude, multisided disk; and one bead, all made of argillite, were also recovered. A thin round stone of sedimentary material with one well-polished surface was located on the floor. Its thinness, 0.69 cm, would seem prohibitive for its use as a polishing stone. Its function is undetermined.

Feature 22

Located in this extramural pit was what may have been intended as a preform for marble beads. The object alternatively has been described as a pipe. This possible preform is a single, narrow stone with what appears to be two natural creases, accentuated by grinding, which divide the stone into three cylinders. One of the cylinders is broken. Drill holes are located at one end in all three cylinders. One hole is present in the opposite end of one of the cylinders. The drill hole does not go all the way through the tube. As with the creases, the holes seem to be an accentuation of natural openings.

Nonfeature

Five argillite artifacts were recovered from nonfeature contexts. Two seven-sided disks, one five-sided cylinder-shaped disk, and a pendant were recovered in strata not associated with particular features. None of these disks have perforations and all appear to be finished artifacts. The pendant is oblong with a groove circling a tapered tip. A ground argillite stone bowl was also recovered from a nonfeature context. There is no incising and it has a pecked "dimple" on its base.

Rooted Site: AZ O:15:92 (Table 16.10)

Feature 13

A single stone bead made of a dark metamorphic material was recovered from this inhumation.

Feature 14

The fill of pithouse Feature 14 contained an incised argillite ring fragment. A schist palette fragment was recovered from the floor. The palette was probably rectangular in shape. It has a narrow high border, a medial groove and an incised edge, all characteristic of the Santa Cruz phase (Haury 1965). This was the only formal palette recovered from the project area.

Clover Wash Site: AZ O:15:100 (Table 16.11)

Feature 1

Two miscellaneous ground stone artifacts were recovered from the floor of this pithouse. One of these is a broken, seven-sided bead made of a dark metamorphic material. The other item is a large argillite core. The argillite is extremely fine-grained and soft. It is banded and has a distinct contact surface indicating that the parent source is a bedded material, not one of the locally abundant cobbles. All the worked surfaces of the core exhibit chipping rather than grinding.

Feature 3

Two argillite artifacts were recovered from the fill of pithouse Feature 3. One of these, Figure 16.1f, resembles a copper bell. It is very similar to the other copper bell look-alike recovered from Feature 5 at site O:15:91 (Figure 16.1g). Also recovered from the fill was a beautiful spiral-armed sun pendant made out of argillite (Figure 16.1i). Although there is nothing to indicate that either artifact was made on site, the sun pendant material closely resembles that of the core from Feature 1.

Feature 5

One cylinder-shaped argillite bead was recovered from this extramural pit.

Feature 6

A punch was recovered from the floor of this pithouse. It is made from a naturally tapering cobble. The blunt tip and sides of the object are ground, apparently the result of much use.

Feature 12

Two miscellaneous objects were recovered from this pithouse. A 19.8-cm-long schist rod or awl was found in the fill. It tapers to blunt points at both ends. One end is very polished. Recovered from the floor of the pithouse was an awl or punch. It was made from a small pebble that tapers naturally to a point. The tip has wear polish.

Nonfeature

An argillite bead was recovered from a disturbed context not associated with any feature.

ROCKS AND MINERALS

Rye Creek Ruin: AZ O:15:1 (Table 16.1)

Feature 1

One quartz crystal was recovered from this trash mound.

Feature 3

One quartz crystal was recovered from this trash mound.

Deer Creek Site: AZ O:15:52 (Table 16.2)

Feature 2

Several pieces of specular hematite were recovered from the floor of this pithouse.

Feature 9

One piece of specular hematite was recovered from the floor of this pithouse.

Feature 11

Specular hematite and a quartz crystal were recovered from the fill of this pithouse.

Feature 18

A rock containing a small stain of red ocher was recovered from the fill of this pithouse.

Feature 21

From the fill and a disturbed context of this pithouse a piece of yellow ocher and azurite/malachite were collected. A piece of specular hematite was recovered from the fill/roof fall level.

Feature 36

A piece of malachite was recovered from the fill of this pithouse.

Feature 49

A piece of malachite was recovered from this inhumation.

Feature 54

A piece of pyrite was recovered from this ash pit.

Feature 59

A piece of specular hematite was recovered from the fill of this pithouse. Another piece of specular hematite was recovered from the floor. A small piece of unmodified chert was recovered from a floor feature.

Feature 67

A very small piece of specular hematite was recovered from this child inhumation.

Feature 71

Many small pieces of specular hematite, totalling over 80 grams, were recovered from this crematorium. The field notes indicate that the hematite was dispersed throughout the soil, so much so that the soil appeared to glisten as it was being excavated.

Feature 87

One small piece of yellow ocher was recovered from this secondary cremation.

Nonfeature

A piece of specular hematite was recovered from the surface of the site.

Hilltop Site: AZ O:15:53 (Table 16.3)

Feature 14

One piece of specular hematite was recovered from the fill of this pithouse.

Feature 15

Red ocher was recovered from the fill of this pithouse.

Cobble Site: AZ O:15:54 (Table 16.4)

Feature 2

A quartz crystal was recovered from the lower levels of the trash mound.

Feature 5

Powdered red ocher was recovered from the floor of this pithouse.

Boone Moore Site: AZ O:15:55 (Table 16.5)

Feature 5

One piece of malachite and some very fine-ground argillite powder were recovered from the floor of this pithouse.

Feature 18

Five pieces of a turquoise and malachite conglomerate were recovered from the floor of this structure. The material is predominately malachite with small inclusions of turquoise. A large piece of specular hematite also was recovered from the floor.

Feature 19

Powdered pigment was recovered from the floor of this pithouse. It is within a dirt matrix making it difficult to determine if the material is argillite or hematite.

AZ O:15:70 (Table 16.6)

Feature 2

One small piece of red ocher was recovered from the fill of this pit.

Table 16.6. Distribution of artifact types by feature type at site AZ O:15:70.

	Feature Type
Artifact Type	Pithouse Fill
Red ocher	1

Table 16.7. Distribution of artifact types by feature type at the Overlook site (AZ O:15:89).

	Feature Type	
Artifact Type	Pithouse Fill/ Roof Fall	Roof Fall/ Floor
Ring	1 (1)	1 (1)

Note: Items in parenthesis are made out of argillite.

Table 16.8. Distribution of artifact types by feature type at the Compact site (AZ O:15:90).

	Feature Type	
Artifact Type	Pithouse Fill	Pithouse Fill/Floor
Pendant	-	1 (1)
In-process pendant	1 (1)	-
Disk	1 (1)	1 (1)

Note: Items in parenthesis are made out of argillite.

Redstone Site: AZ O:15:91 (Table 16.9)

Feature 11

All of the rock and mineral samples recovered from this site were found in floor context of pithouse Feature 11. Several pieces of azurite and one calcite crystal were recovered. Pieces of pigment-stained burnt dirt clumps were collected from the floor. The burned condition and dirt matrix makes it difficult to determine if the pigment is argillite or hematite. Red pigment was also found on the surfaces of several manos. Given the evidence for intensive argillite processing at the site, it is considered likely that the pigment is argillite.

Table 16.9. Distribution of artifact types by feature type at the Redstone site (AZ O:15:91).

	Feature Type					
Artifact Type	Pithouse Fill	Pithouse Floor	Roof Fall	Extramural Activity Area	Extramural Pit	Non-feature
Pendant	1 (1)	1 (1)	-	-	-	1 (1)
Bead	3 (2)	7 (5)	-	1 (1)	-	-
In-process bead	1	-	-	-	-	-
Disk	1 (1)	1 (1)	-	2 (2)	-	3 (3)
Disk or Bead blank	1 (1)	1 (1)	1 (1)	-	-	-
Pendant or weight	-	-	-	1 (1)	-	-
Pipe or Bead blank	-	-	-	-	1	-
Stone bowl	-	-	-	-	-	1 (1)
Punch	-	-	1	-	-	-
Red ocher	-	1	-	-	-	-
Pigment (unspecified)	-	3 (?)	-	-	-	-
Azurite	-	3	-	-	-	-
Calcite	-	1	-	-	-	-

Note: Items in parenthesis are made out of argillite.

However, a single piece of red ocher was recovered from the floor of the structure as well, making the identification of the red pigment equivocal.

Clover Wash Site: AZ O:15:100 (Table 16.11)

Feature 1

A piece of petrified wood was recovered from the fill of this pithouse.

Feature 3

Mixed chunks and powder of red ocher were recovered from the fill-roof fall context of this pithouse.

Feature 6

Several pieces of yellow ocher were recovered from the floor of this pithouse.

Table 16.10. Distribution of artifact types by feature type at the Rooted site (AZ O:15:92).

Artifact Type	Pithouse Fill	Pithouse Floor	Inhumation
Bead			1
Ring	1 (1)		
Palette		1	

Note: () Items made of argillite.

Table 16.11 Distribution of artifact types by feature type at the Clover Wash site (AZ O:15:100).

Artifact Type	Pithouse Fill	Pithouse Fill/Roof	Pithouse Floor	Extramural Pit	Nonfeature
Pendant	2 (2)				
Bead			1	1 (1)	1 (1)
Punch or Awl			2		
Rod or Awl	2				
Core			1 (1)		
Red Ocher			1	1	
Yellow Ocher		1			
Petrified Wood	1				1

Note: () Items made of argillite.

Feature 8

A very small piece of yellow ocher was recovered from this extramural pit.

Nonfeature

One piece of petrified wood was recovered from a disturbed context not associated with a feature.

Table 16.12. Metric data for the Rye Creek miscellaneous small artifact assemblage.

ASM Site	Feature I.D. No.	Artifact	Material	Length	Width	Thickness	Diameter	Depth	Weight	Comments
O:15:1	F.1 8.10	Pendant	Argillite	3.45	1.81	0.36	N/A	N/A	4.8	Oblong shaped with hole for attachment, Fig. 1e
O:15:1	F.1 12.03	Shaft straightener	Quartzite	10.64	7.43	4.02	N/A	N/A	522.9	1 deep groove, 1 incipient groove made from reworked mano
O:15:1	F.1 12.10	Pendant? fragment	Limestone	NA	NA	0.65	N/A	N/A	2.5	Half-moon shaped with incised band circling approximate middle of piece
O:15:1	F.1 13.13	Pendant or fetish	Argillite	3.62	2.20	0.79	N/A	N/A	13.6	Oblong shaped object with tapering end groove encircling tip, Fig. 1j
O:15:1	F.1 13.13	Pendant or fetish	Argillite	2.44	1.15	0.42	N/A	N/A	2.1	Half-moon shaped object with a groove encircling tip and a small groove perpendicular to tip
O:15:1	F.1 9.12	Crystal	Quartz	1.85	1.80	1.35	N/A	N/A	7.1	-
O:15:1	F.1 14.12	Crystal	Quartz	2.26	1.03	0.87	N/A	N/A	2.7	-
O:15:1	F.1 8.12	Mineral	Malachite	1.07	1.02	0.36	N/A	N/A	0.5	-
O:15:1	F.3 2.06	Crystal	Quartz	1.91	1.03	0.92	N/A	N/A	2.0	-
O:15:52	F.2 389.03	Punch	Misc. Metamorphic	9.48	1.64	0.82	N/A	N/A	19.3	Taperer object with polished tip
O:15:52	F.6 190.03	Indet. fragment	Argillite	N/A	1.63	.94	N/A	N/A	8.0	Oblong shaped incised object; probably broken during manufacture
O:15:52	F.9 296.05	Pendant	Slate	3.36	2.75	.41	N/A	N/A	5.0	Roughly triangular shaped; broken at hole use for attachment, Fig. 16.1d
O:15:52	5.9 329.05	Awl	Argillite	5.02	.94	.68	N/A	N/A	3.8	Well polished at tapered end, Fig. 16.10
O:15:52	F.12 229.03	Palette	Schist	7.68	3.31	.80	N/A	N/A	45.7	Very crude palette prototype; chipped at both ends with ground edges; pecking and pigment on face
O:15:52	F.14 141.03	Nutting stone	Argillite	10.16	9.61	6.39	5.23	.70	906.9	Diameter of pecked out area; made from reworked mano
O:15:52	F.14 172.05	Pendant	Sedimentary	2.05	1.53	.29	N/A	N/A	1.3	Irregularly shaped object, possibly an animal; two drill holes, one broken, Fig. 16.1c
O:15:52	F.18 162.04	Whetstone	Argillite	8.02	5.88	1.64	N/A	N/A	133.1	Oval shaped stone with two thin parallel grooves
O:15:52	F.18 275.03	Ax/Hoe	Misc. Metamorphic	18.03	8.56	3.84	N/A	N/A	794.8	Very crude rectangular shaped stone with notched sides for hafting; edge is chipped and battered
O:15:52	F.21 254.07	Pendant fragment	Argillite	N/A	N/A	.69	N/A	N/A	1.5	Very fragmentary; broken at hole used for attachment
O:15:52	F.54 239.06	Phallic dipper	Argillite				4.39	1.42	267.2	The handle tapers at the tip to an incised, phallic head; the bowl has a grooved and incised rim and geometrically carved back, Fig. 16.2
		Phallus:		7.76	2.83	2.32				
		Bowl:		6.35	5.97	2.79				

Table 16.12. Continued.

ASM Site	Feature I.D. No.	Artifact	Material	Length	Width	Thick-ness	Dia-meter	Depth	Weight	Comments
O:15:52	F.46 315.06	Phallic effigy or pendant	Argillite	N/A	1.82	.61	N/A	N/A	6.1	Incomplete oblong shaped object tapering end with small vertical groove at tip
O:15:52	F.50 312.08	Nose plug	Argillite	2.33	1.12	.88	N/A	N/A	4.4	Slightly larger at one end, Fig. 16.1m
O:15:52	F.59 438.03	Pendant	Slate	2.92	3.51	.33	N/A	N/A	6.0	Complete oblique shaped, Fig. 16.1a
O:15:52	F.62 411.04	Pendant	Argillite	3.23	1.22	.24	N/A	N/A	1.1	Thunderbird pendant, Fig. 16.1h
O:15:52	F.62 381.01	Unfinished pendant	Argillite	2.58	1.72	.57	N/A	N/A	3.5	Triangular shaped object with drill holes on reverse sides not completely through object
O:15:52	F.63 436.04	Punch	Schist	9.41	2.38	.92	N/A	N/A	37.8	Long narrow object tapered at end with polish
O:15:52	F.70 464.03	Bead	Unidentified	.42	N/A	.32	.07	N/A	.1	Interior diameter provided; made of unidentified black material; complete
O:15:52	F.70 465.08	Censer	Vesicular Basalt	7.02	6.92	4.08	4.55	3.5	114.6	Interior diameter given; carved zig-zag open-ended line bordering top
O:15:52	F.89 490.03	Beads	Unidentified	.47	N/A	.16	.06	N/A	.02	354 complete beads, 15 broken beads of an unidentified burned gray-black material; measurements are average for single bead
O:15:52	F.0 306.01	Mineral	Specular hematite	3.50	2.15	1.27	N/A	N/A	16.0	-
O:15:52	F.2 392.07	Mineral	Specular hematite	2.56	1.72	1.06	N/A	N/A	16.5	Length, width, thickness measurements of largest piece
O:15:52	F.9 339.04	Mineral	Specular hematite	1.00	.78	.40	N/A	N/A	.6	-
O:15:52	F.11 321.02	Crystal	Quartz	1.80	1.77	1.58	N/A	N/A	7.3	-
O:15:52	F.11 368.04	Mineral	Specular hematite	.50	.40	N/A	N/A	N/A	.1	-
O:15:52	F.11 365.07	Mineral	Specular hematite	2.04	1.49	1.40	N/A	N/A	4.9	-
O:15:52	F.18 162.05	Mineral	Hematite	N/A	N/A	N/A	N/A	N/A	N/A	Red ocher; small stain on larger rock
O:15:52	F.21 215.07	Mineral	Azurite/ Malachite	.87	.86	.64	N/A	N/A	.5	-
O:15:52	F.21 255.03	Mineral	Hematite	7.76	5.79	5.35	N/A	N/A	280.8	Yellow ocher
O:15:52	F.21 279.09	Mineral	Specular hematite	1.81	1.61	1.50	N/A	N/A	6.3	-
O:15:52	F.36 235.04	Mineral	Malachite	1.25	1.21	.63	N/A	N/A	1.0	-
O:15:52	F.49 308.03	Mineral	Malachite	1.48	1.21	.42	N/A	N/A	1.2	-
O:15:52	F.54 352.08	Mineral	Pyrite	1.39	1.03	.75	N/A	N/A	1.9	-

Table 16.12. Continued.

ASM Site	Feature I.D. No.	Artifact	Material	Length	Width	Thick-ness	Dia-meter	Depth	Weight	Comments
O:15:52	F.59 357.06	Mineral	Specular hematite	2.33	1.54	.76	N/A	N/A	4.1	-
O:15:52	F.59 473.01	Mineral	Chert	2.17	1.68	.94	N/A	N/A	5.0	-
O:15:52	F.59 474.05	Mineral	Specular hematite	2.03	1.81	.58	N/A	N/A	3.8	-
O:15:52	F.67 423.05	Mineral	Specular hematite	.4	.3	.2	N/A	N/A	.1	-
O:15:52	F.71 478.04	Mineral	Specular hematite	N/A	N/A	N/A	N/A	N/A	7.5	Many small pieces
O:15:52	F.71 480.02	Mineral	Specular hematite	N/A	N/A	N/A	N/A	N/A	7.0	Many small pieces
O:15:52	F.71 499.06	Mineral	Specular hematite	N/A	N/A	N/A	N/A	N/A	65.8	Many small pieces
O:15:52	F.87 483.05	Mineral	Hematite	.30	.28	.09	N/A	N/A	.01	Yellow ocher
O:15:53	F.0 184.04	Ornament fragment	Slate	N/A	1.28	.18	N/A	N/A	.60	Very fragmentary piece with one scalloped edge
O:15:53	F.0 208.02	Hoe?	Misc. metamorphic	13.08	6.94	3.31	N/A	N/A	372.1	Rectangular shaped object; edges ground for hafting; polish above chipped edge on one surface
O:15:53	F.1 108.02	Ball	Quartzite	N/A	N/A	N/A	6.54	N/A	366.6	One end has light polish
O:15:53	F.6 141.03	Tool or ornament	Argillite	3.73	2.04	.85	N/A	N/A	10.8	Oblong object with parallel grooves on opposite sides meeting at one edge in sharp notch, Fig. 16.1n
O:15:53	F.9 156.02	Ornament or fetish	Argillite	N/A	1.23	.58	N/A	N/A	3.4	Incomplete rectangular object; slightly tapered at one end with criss-cross carvings
O:15:53	F.14 191.04	Mineral	Specular hematite	1.19	1.14	.63	N/A	N/A	1.8	-
O:15:53	F.15 190.04	Mineral	Hematite	5.25	3.9	2.08	N/A	N/A	52.2	Red ocher
O:15:54	F.0 133.01	Grooved handstone	Basalt	N/A	N/A	3.30	12.22	N/A	791.1	Thin handstone with shallow groove encircling sides; irregular shaped pit in upper surface
O:15:54	F.2 115.05	"Fire starter"	Misc. sedimentary	5.29	4.66	.78	N/A	N/A	25.3	Small flat stone with shallow, narrow drill hole in center; possibly used for spinning fibers
O:15:54	F.2 115.04	Crystal	Quartz	2.03	1.22	1.10	N/A	N/A	3.1	-
O:15:54	F.9 121.03	Awl	Misc. metamorphic	5.74	.86	.41	N/A	N/A	3.9	-
O:15:54	F.5 139.02	Mineral	Hematite	N/A	N/A	N/A	N/A	N/A	28.7	Red ocher powder
O:15:55	F.0 154.01	Ring	Argillite	N/A	N/A	.38	1.53	N/A	.5	Incomplete

Table 16.12. Continued.

ASM Site	Feature I.D. No.	Artifact	Material	Length	Width	Thick-ness	Dia-meter	Depth	Weight	Comments
O:15:55	F.0 252.04	Shaft straightener	Misc. sedimentary	N/A	N/A	5.32	8.49	1.1	496.8	Incomplete; partially grooved handstone with groove running full length across the middle of the stone; low ridge perpendicular to groove at one end (depth of groove)
O:15:55	F.1 244.03	Ornament? fragment	Slate	N/A	1.89	.38	N/A	N/A	3.2	Indeterminate form
O:15:55	F.5 159.04	Perforated stone disk	Argillite	8.4	5.75	1.21	.83	N/A	132.8	Stone spindle shorl; patterned pecking around the edge of the hole on one side (diameter of hole), Fig. 16.1p
O:15:55	F.5 160.07	Shaft straightener	Vesicular basalt	N/A	5.55	4.44	N/A	1.3	163.5	Ground triangular shaped stone with two parallel grooves; deposit groove runs full width of stone (depth of deepest groove)
O:15:55	F.5 160.07	Shaft straightener	Vesicular basalt	N/A	5.64	4.47	N/A	.7	217.2	Oval-shaped stone with at least two grooves running the width of the stone (depth of deepest groove)
O:15:55	F.5 161.06	Rod	Slate	11.98	.54	.48	N/A	N/A	9.6	Needle or hairpin?
O:15:55	F.5 163.03	Ring fragment	Argillite	N/A	N/A	.30	1.89	N/A	.6	-
O:15:55	F.5 144.05	Hoe	Misc. metamorphic	26.5	15.0	5.4	N/A	N/A	3000+	Rectangular shaped stone ground at end; battered at opposite end
O:15:55	F.5 185.07	Pendant	Misc. metamorphic	2.4	1.49	.39	N/A	N/A	2.1	Complete oval shaped, Fig. 16.1b
O:15:55	F.5 159.05	Stone bowl	Basalt	25.0	19.0	6.38	14.17	.8	3000+	Very shallow
O:15:55	F.6 239.01	Shaft straightener	Misc. metamorphic	6.87	3.42	3.15	N/A	.6	109.3	Oval cobble with three grooves extending the width of the stone (depth of deepest groove)
O:15:55	F.6 132.06	Ornament	Argillite	2.2	.87	.58	N/A	N/A	2.3	Oblong shaped object with 3/4 groove just below tip; no hole for attachment
O:15:55	F.11 126.02	Grooved ornament or whetstone	Slate	N/A	N/A	.45	N/A	N/A	1.0	Very fragmentary piece of slate with two shallow parallel grooves
O:15:55	F.11 150.05	Needle	Slate	9.28	.79	5.7	N/A	N/A	6.2	Broken; has hole for thread, Fig. 16.1q
O:15:55	F.11 203.05	Shaft straightener	Misc. metamorphic	9.07	6.67	5.67	N/A	N/A	448	Cobble with single large groove; multiple cuts at one end like a whetstone
O:15:55	F.17 241.11	Pendant fragment	Turquoise	N/A	N/A	.22	N/A	N/A	.3	Possibly round or oval
O:15:55	F.18 151.04	Ring fragment	Argillite	N/A	N/A	.43	2.11	N/A	.7	-
O:15:55	F.18 151.04	Fetish?	Argillite	1.63	1.17	.65	N/A	N/A	1.7	Triangular shaped object
O:15:55	F.18 180.10	Disk	Argillite	N/A	N/A	.33	1.0	N/A	.8	-
O:15:55	F.18 220.08	Bead	Crynoid	N/A	N/A	.24	.33	N/A	.1	-

Table 16.12. Continued.

ASM Site	Feature I.D. No.	Artifact	Material	Length	Width	Thick-ness	Dia-meter	Depth	Weight	Comments
O:15:55	F.18 184.12	Ax	Diorite	13.22	6.27	6.16	N/A	N/A	783	Polished tip
O:15:55	F.19 157.04	Rod	Graphite?	2.46	N/A	N/A	.8	N/A	1.7	Incomplete
O:15:55	F.5 185.11	Mineral	Malachite	1.5	.9	.5	N/A	N/A	.8	-
O:15:55	F.5 248.04	Mineral	Argillite powder	N/A	N/A	N/A	N/A	N/A	8.2	Very fine
O:15:55	F.18 220.12	Mineral	Turquoise/ Malachite	1.95	1.46	.65	N/A	N/A	7.4	Length, width, thickness of largest piece
O:15:55	F.18 184.34	Mineral	Specular hematite	7.08	6.43	5.2	N/A	N/A	544.2	-
O:15:55	F.19 178.16	Mineral	Ground pigment	N/A	N/A	N/A	N/A	N/A	6.4	Red ocher or argillite
O:15:70	F.2 100.04	Mineral	Hematite	1.56	1.40	.83	N/A	N/A	1.8	Red ocher
O:15:89	F.1 102.03	Ring frag.	Argillite	N/A	N/A	.33	2.26	N/A	.9	-
O:15:89	F.1 105.03	Ring frag.	Argillite	N/A	N/A	.44	1.97	N/A	1.1	-
O:15:90	F.3 114.06	In process pendant	Argillite	N/A	1.23	.29	N/A	N/A	1.5	Broken irregular rectangular shape with three ground edges
O:15:90	F.3 114.06	Disk	Argillite	N/A	N/A	.54	1.0	N/A	1.1	Roughly heptagonal shape
O:15:90	F.3 119.04	Disk	Argillite	N/A	N/A	.25	.8	N/A	.3	Heptagonal shape
O:15:90	F.4 120.04	Pendant frag.	Argillite	2.05	1.26	.32	N/A	N/A	.7	Triangular shaped object with one complete drill hole and one incipient hole
O:15:91	F.0 128.03	Pendant	Argillite	2.7	1.66	.44	N/A	N/A	3.5	Oblong shaped object tapered at one end with groove; no hole for attachment
O:15:91	F.0 142.05	Disk	Argillite	N/A	N/A	.43	.8	N/A	.6	Roughly heptagonal shape
O:15:91	F.0 214.06	Disk	Argillite	N/A	N/A	.38	.93	N/A	.6	Roughly heptagonal shape
O:15:91	F.0 187.01	Disk or plug	Argillite	N/A	N/A	.88	.9	N/A	1.5	Hexagonal shape
O:15:91	F.0 214.08	Bowl	Argillite	N/A	N/A	2.71	5.02	1.8	76.4	Ground bowl; no incising pecked "dimple" on base
O:15:91	F.3 133.02	Bead	Argillite	N/A	N/A	.36	.73	N/A	.3	Heptagonal shape with hole
O:15:91	F.3 133.02	Pendant or loom weight	Argillite	2.42	1.70	.64	N/A	N/A	5.0	Figure-eight shaped object with groove encircling middle, Fig. 16.1L
O:15:91	F.3 121.04	Disk	Argillite	N/A	N/A	.58	1.03	N/A	1.0	Octagonal shaped
O:15:91	F.5 122.03	Bead	Argillite	N/A	N/A	.55	1.02	N/A	.9	Round irregular shape with hole

Table 16.12. Continued.

ASM Site	Feature I.D. No.	Artifact	Material	Length	Width	Thick-ness	Dia-meter	Depth	Weight	Comments
O:15:91	F.5 162.03	Pendant	Argillite	1.04	.72	.6	N/A	N/A	.6	Resembles a copper bell; broken at top of hole; used for attachment, Fig. 16.1g
O:15:91	F.5 180.05	Tubular bead	Argillite	1.00	N/A	N/A	.74	N/A	.8	Tubular shape
O:15:91	F.5 180.05	Bead	Argillite	N/A	N/A	.63	.84	N/A	.8	Very thick
O:15:91	F.5 180.05	Bead frag.	Argillite	N/A	N/A	.42	.78	N/A	.2	-
O:15:91	F.5 169.04	Disk	Argillite	N/A	N/A	.43	.88	N/A	.7	Heptagonal shape
O:15:91	F.11 141.01	Bead	Misc. Metamorphic	N/A	N/A	.19	.5	N/A	.2	Dark colored material
O:15:91	F.11 104.03	Bead	Argillite	N/A	N/A	.5	.6	N/A	.4	Elongated
O:15:91	F.11 117.06	Disk	Argillite	N/A	N/A	.33	.88	N/A	.5	Hexagonal
O:15:91	F.11 158.04	Bead	Misc. metamorphic	N/A	N/A	.62	.8	N/A	.6	Heptagonal shape; gray colored material; drill hole incomplete, possible broken during manufacture
O:15:91	F.11 175.02	Disk or bead blank?	Argillite	N/A	N/A	.21	N/A	N/A	.3	Broken along 2 edges, ground on 4; no hole
O:15:91	F.11 124.06	Disk or bead blank?	Argillite	.8	N/A	.21	N/A	N/A	.3	Broken along 1 edge, ground on 3; no hole
O:15:91	F.11 217.03	Punch	Misc. metamorphic	11.3	1.85	1.79	N/A	N/A	54.6	River pebble tapering to blunt point at one end; light polish at tip
O:15:91	F.11 136.04	Bead	Marble	4.08	N/A	N/A	.9	N/A	5.0	Tabular complete
O:15:91	F.11 136.05	Disk	Argillite	N/A	N/A	.34	.87	N/A	.5	Heptagonal
O:15:91	F.11 140.05	Pendant	Argillite	1.30	1.0	.35	N/A	N/A	.7	Triangular shape with hole for attachment; complete
O:15:91	F.11 189.04	Bead	Marble	2.66	N/A	N/A	1.12	N/A	4.0	Tubular
O;15:91	F.11 189.04	Bead	Marble	2.40	N/A	N/A	1.16	N/A	4.1	Tubular
O:15:91	F.11 137.03	Disk	Argillite	N/A	N/A	.78	1.23	N/A	1.8	Very crude, multisided object; edges not ground; possibly in proces of manufacture
O:15:91	F.11 205.09	Disk	Sedimentary	N/A	N/A	.69	4.79	N/A	23.9	Well ground on one face; polishing stone?
O:15:91	F.11 217.06	Bead	Argillite	N/A	N/A	.1	.45	N/A	.1	-
O:15:91	F.22 181.06	Pipe or tubular bead preform?	Marble	10.2	2.26	1.54	N/A	N/A	45.8	Small stone with natural creases accentuated by grinding forming two attached cylinder shapes built with drill holes at the ends, not full length
O:15:91	F.11 189.11	Mineral	Azurite	2.05	1.06	.72	N/A	N/A	2.1	-

Table 16.12. Continued.

ASM Site	Feature I.D. No.	Artifact	Material	Length	Width	Thick-ness	Dia-meter	Depth	Weight	Comments
O:15:91	F.11 205.15	Mineral	Pigment	N/A	N/A	N/A	N/A	N/A	6.4	Burned; very oxidized; possibly argillite or hematite; in dirt matrix
O:15:91	F.11 205.16	Mineral	Pigment	N/A	N/A	N/A	N/A	N/A	29.4	Possibly argillite or hematite; burned in dirt matrix
O:15:91	F.11 205.17	Mineral	Pigment	N/A	N/A	N/A	N/A	N/A	N/A	Small stain of argillite or hematite in burned dirt clod
O:15:91	F.11 206.06	Mineral	Azurite	.78	.55	.18	N/A	N/A	.1	-
O:15:91	F.11 217.10	Crystal	Calcite	2.08	1.38	1.19	N/A	N/A	4.2	-
O:15:91	F.11 217.11	Mineral	Azurite	1.58	1.20	.78	N/A	N/A	2.1	Several pieces; length, width, thickness of largest piece
O:15:91	F.11 217.12	Mineral	Hematite	1.63	1.50	.9	N/A	N/A	2.4	Red ocher
O:15:92	F.13 104.04	Bead	Misc. metamorphic	N/A	N/A	.09	.25	N/A	2.1	Dark material; complete
O:15:92	F.14 114.07	Ring frag.	Argillite	N/A	N/A	.43	2.02	N/A	1.3	Incised
O:15:92	F.14 120.04	Palette frag.	Schist	N/A	N/A	.49	N/A	N/A	5.3	Probably rectangular shape; recessed inner area; groove around border; incised edge
O:15:100	F.0 253.01	Bead	Argillite	N/A	N/A	.45	.7	N/A	.4	Thick
O:15:100	F.1 124.05	Bead	Misc. metamorphic	N/A	N/A	.54	.84	N/A	.5	Heptagonal with hole broken
O:15:100	F.1 184.07	Core	Argillite	10.92	9.74	7.07	N/A	N/A	1052.9	Very fine-grained material; appears to be from a bedded source
O:15:100	F.3 193.04	Pendant	Argillite	1.3	.86	.84	N/A	N/A	1.1	Resembles a copper bell, Fig. 16.1f
O:15:100	F.3 194.04	Pendant	Argillite	1.9	1.66	.3	N/A	N/A	1.3	Spiral-armed sun, Fig. 16.1i
O:15:100	F.5 158.03	Tubular bead	Argillite	.74	N/A	N/A	.58	N/A	.4	Tubular
O:15:100	F.6 202.05	Punch?	Misc. metamorphic	10.88	5.71	2.42	N/A	N/A	185.7	Tapered on one end with grinding wear on tip and ground edges
O:15:100	F.12 200.04	Rod or awl	Schist	19.8	N/A	N/A	1.56	N/A	75.3	Long, tapered object; blunt at both ends; one end well polished
O:15:100	F.12 192.04	Punch or awl	Misc. metamorphic	4.22	1.07	.45	N/A	N/A	2.4	Small pebble tapered at one end with polished tip
O:15:100	F.0 112.05	Mineral	Petrified wood	2.88	1.6	.63	N/A	N/A	2.6	-
O:15:100	F.1 106.03	Mineral	Petrified wood	7.89	4.3	2.26	N/A	N/A	129.2	-
O:15:100	F.3 175.02	Mineral	Hematite	N/A	N/A	N/A	N/A	N/A	10.7	Red ocher; mixed chunks and powder
O:15:100	F.6 198.09	Mineral	Hematite	3.18	2.12	1.09	N/A	N/A	51.1	Yellow ocher; length, width, thickness of largest piece
O:15:100	F.8 221.04	Mineral	Hematite	N/A	N/A	N/A	N/A	N/A	.3	Yellow ocher; powdery

CHAPTER 17

THE RYE CREEK SHELL ASSEMBLAGE

Arthur W. Vokes

Shell artifacts have been sought after by local populations throughout the prehistoric occupation of the Southwest. To acquire these objects along with other exotic materials, exchange systems developed that interconnected the diverse cultural groups that occupied the region. That the inhabitants of the Tonto Basin were part of this system of exchange was recognized from the earliest excavations in the region (Haury 1932; Hohmann and Kelley 1988).

The Rye Creek Project excavations along State Route 87 permit an examination of the nature of the Tonto Basin shell trade. Nine of the 13 project sites produced shell materials ranging from a single artifact to nearly a hundred fragments. Shell also was recovered from the testing of three of the trash mounds at Rye Creek Ruin (AZ O:15:1). The resulting picture is one of a population that initially was a consumer of finished products traded into the region from Hohokam centers situated to the south and southwest. Over time the population began to import limited amounts of raw materials and produce some of the items themselves. The bulk of the material was imported in finished form. During the early Classic period (A.D. 1150-1300) there appears to have been a shift in the structure of the system. New artifact forms, along with new genera, were introduced and emphasized over the traditional forms. The degree of this shift suggests that influences other than just local preference may have been at work.

METHODOLOGY

The artifact typology employed in this analysis is essentially that devised by Haury (1945, 1965, 1976) for the Snaketown assemblages and the material from Los Muertos. Modifications of or additions to this basic typology will be referenced in the text where appropriate. The designations for genera and species employed are in conformity with Keen's (1971) *Seashells of Tropical West America: Marine Mollusks from Baja California to Peru.*

All artifacts were measured using a digital vernier caliper. The interior diameter of the bracelets was recorded whenever possible. If the fragments were large enough, an approximation was made using a concentric arc board at 2-mm increments.

GENERA AND SPECIES

Eight genera were identified in the sample (Table 17.1). Seven of these genera are marine, one is freshwater. All of the marine genera are endemic to the Pacific Ocean. With the exception of *Laevicardium elatum*, the species identified in the sample are restricted to the Gulf of California. Several have related species to the north along the California coastline; however, these are distinctive enough to be eliminated from the list of possible species employed. Much of the material has been naturally bleached white and in some instances it has begun to deteriorate. As a result, many of the distinctive characteristics used to identify different species were obscured. This was especially true for the *Olivella* shells. These were often in mortuary contexts where the deterioration appears to have been accelerated. However, all of the *Olivella* valves have a shape that is very consistent with *Olivella dama* and distinctly different from *Olivella biplicata*, the species common to the

California province. *Olivella dama* originates in the warmer waters of the Panamic province of the Gulf of California and is a species commonly recovered from archaeological contexts in the Hohokam region.

Laevicardium elatum is the only species that occurs in both the Panamic and Californian biotic zones. It is reported as far north as San Pedro, California (Abbott 1972: 486), but it is most common on the mud flats of the Gulf of California (Keen 1971:160). Because the species does not appear to have been extensively used as a raw material by the indigenous cultures of southern California (Gifford 1947), the most likely source for this material is also the Gulf of California.

Table 17.1. Genera and species of shell collected from the Rye Creek Project sites.

Genera and Species	MNI	Number of Fragments	Frequency by MNI
Marine Pelecyopoda			
Glycymeris	69	69	28.6%
G. gigantea			
c.f. *G. multicostata*			
Laevicardium elatum	24	24	10.0%
Marine Gastropoda			
Olivella	56	56	23.2%
c.f. *O. dama*			
Turritella	1	1	0.4%
Cerithidea	1	1	0.4%
Nassarius	1	1	0.4%
Conus	15	15	6.2%
C. regularis			
c.f. *C. princeps*			
Unidentified Marine Shell	27	27	11.2%
Freshwater Pelecypoda			
Anodonta californensis	47	85	19.5%
TOTAL	241	279	99.9%

MNI = Estimated minimum number of individuals

It would therefore seem that all of the marine shell was derived from the Gulf of California. This suggests that the local Rye Creek population was, at least initially, involved with or a part of the Hohokam exchange system. This system, based on the procurement and exchange of shell from the Gulf, developed early in the desert regions of southern Arizona and was dominant throughout much of prehistory. Following the Sedentary period (post A.D. 1150), the system appears to have undergone some degree of restructuring (Vokes 1984: 544-550; Howard 1983, 1985a). Toward the end of the prehistoric era, the Hohokam procurement system appears to have undergone a considerable decline. Most of the current assemblage predates this period.

The freshwater species *Anodonta californensis* was endemic to nearly all of the perennial streams and rivers of Arizona prior to this century (Bequaert and Miller 1973: 220-223) and would have been locally available to the populations along Tonto Creek and possibly Rye Creek. It has nearly become extinct in the region with remnant populations only existing in the upper Black River drainage (Landye 1981:26). This decline is probably a result of the extensive construction of water control features that altered the natural environment. *Anodonta* has a nacreous shell and tends to be very fragile, deteriorating by separating along its layered structure. As a result there were far more fragments of *Anodonta* than there were originally valves. This accounts for the difference in Table 17.1 between the number of fragments and the number of projected specimens in the assemblage.

ARTIFACTS

Ten of the fourteen investigated sites (including Rye Creek Ruin) produced some shell materials. All of the sites without shell are thought to have been small, temporarily inhabited fieldhouse sites. The total sample numbered 241 specimens. One hundred and ninety of these were worked in some manner. The greatest number of artifacts in the collection were various types of beads (82) followed by bracelets (47 bands and band segments).

Beads

Eighty-two beads were found representing whole shell beads (spire-lopped beads, etc.), disk beads, cylindrical, and barrel forms. By far the most common were the spire-lopped form created by removing the apex of an *Olivella* valve, generally by grinding (Figure 17.1a). Fifty-five beads, from six different contexts, were recovered. Feature 7, an adult inhumation, at the Boone Moore Site (AZ O:15:55) accounted for 49 of these specimens. The shells were recovered from around the neck of the body and lay in an upright position, suggesting that they were not strung end to end as a simple necklace but rather may have been stitched to a fabric backing as choker or band. Many of these valves exhibited varying degrees of deterioration of the surfaces, possibly as a result of being in close proximity to the body. Overall, the specimens ranged from 10.29 mm to 14.46 mm in length with a mean value of 12.57 mm. While the shape of all of the specimens was consistent with *Olivella dama*, the lack of any true diagnostic traits requires this identification to remain uncertain. *Olivella* beads occurred in all of the temporal periods represented in the assemblage.

Other whole shell beads were produced using *Cerithidea*, *Nassarius*, and *Glycymeris* valves. *Cerithidea* and *Nassarius* were each represented by single occurrences. In both cases the suspension hole was punched through the back of the body whorl and then reamed out. The *Cerithidea* specimen (Figure 17.1b) was recovered from the roof fall of a pithouse (Feature 21) at the Deer Creek site (AZ O:15:52) and is thought to date to the Gila Butte phase occupation of this site. In contrast the *Nassarius* bead (Figure 17.1c) was recovered from the fill of an early Classic period structure (Feature 5) at the Boone Moore site.

Glycymeris proved to be the only pelecyopod employed to create whole shell bead forms (Figure 17.1d). Four examples were recovered from four different contexts. All of the specimens were perforated by grinding the umbo against a flat surface until a hole penetrated through the shell. Three of the specimens were recovered from the Boone Moore site and appear to date to the early Classic period. In one of these instances, the perimeter of the shell also was ground to shape. The fourth specimen was recovered from the Clover Wash site (AZ O:15:100) and is thought to be associated with Sedentary phase materials. Among the Hohokam, this artifact form did not become popular until the Classic period (Nelson 1981: 181, Vokes 1984:473). Larger, whole shell pendants made of *Glycymeris* are comparatively common in earlier periods.

Disk beads were recovered from two features at the Boone Moore site. One specimen was recovered from the fill of Feature 5 while 12 disk beads were recovered from a nearby inhumation, Feature 8 (Figure 17.1e). The former specimen was considerably smaller than the other examples, with a length of 0.55 mm and a diameter of 3.36 mm. The beads from Feature 8 ranged in length from 1.70 mm to 2.88 mm with the mean at 2.00 mm. The diameters of these disks ranged from 3.81 mm to a maximum of 4.37 mm with a mean of approximately 4.05 mm.

The disk beads recovered from Feature 8 at the Boone Moore site were mixed with a set of seven tubular beads (Figure 17.1f) that were similar in shape but were somewhat more extended. These appeared to have been shaped in the same manner as the disk beads but they had not been segmented. They ranged in length from 3.82 to 7.17 mm with a mean value of 4.90 mm. The specimen's diameter ranged from 3.50 mm to 4.16 mm with a mean diameter of 3.70 mm.

The final bead form was constructed from an *Olivella* valve and was formed by grinding away the apex and the anterior portion of the body whorl, thereby providing the specimen with a generally barrel-shaped profile. The specimen appears to be a development out of the spire-lopped form referred to above. Only one example of this form was recovered, from the inhumation (Feature 8) at the Boone Moore site. The length of the specimen was 7.59 mm with a maximum width of 5.29 mm.

Pendants

Twenty-five pendants were recovered. The most common type by far is the *Conus* tinkler. In addition, there are examples of whole shell pendants and carved forms including zoomorphic and geometric representations.

Whole Shell Pendants

This type of artifact is represented by a single specimen. The pendant is made from the midsection of a *Turritella* sp. valve (Figure 17.1g). The specimen has been extensively beach-worn so that the edges of the breaks are smooth; one side has been eroded away exposing the internal columella structure. In addition, what appears to be natural breccia is cemented into the corner of one of the internal cavities. The specimen could have been suspended through any one of several naturally formed perforations. There is no artificial perforation present. The designation of this piece as a pendant is therefore somewhat conjectural, although *Turritella* valves commonly were employed in this manner in other Hohokam communities at this same time. A specimen with similar beach-wear was recovered from a Santa Cruz phase context at Frogtown (Vokes 1984: 486).

Tinklers

Fourteen tinklers were recovered during the excavations. All of the specimens were associated with early Classic period deposits. A tinkler is formed by removing the spire of a univalve to form a cone of shell, which is perforated near the siphonal canal to permit suspension. The perforation is accomplished in one of two ways: either by cutting a groove across the axis of the valve until it penetrates the shell wall (Figure 17.1h) or drilling through the wall (Figure 17.1i). Both techniques are present in the current sample. Seven specimens were perforated using the groove technique while two were drilled. The latter were both from the Boone Moore site. The remaining tinklers were fragmentary and did not retain this portion of the artifact.

In all but one case, the genus employed was clearly *Conus*. One specimen retained sufficient coloration to permit species identification as *Conus regularis*. Another specimen appears to be *Conus princeps*; however, this is not a positive identification. One fragment was too small to permit identification of the genus

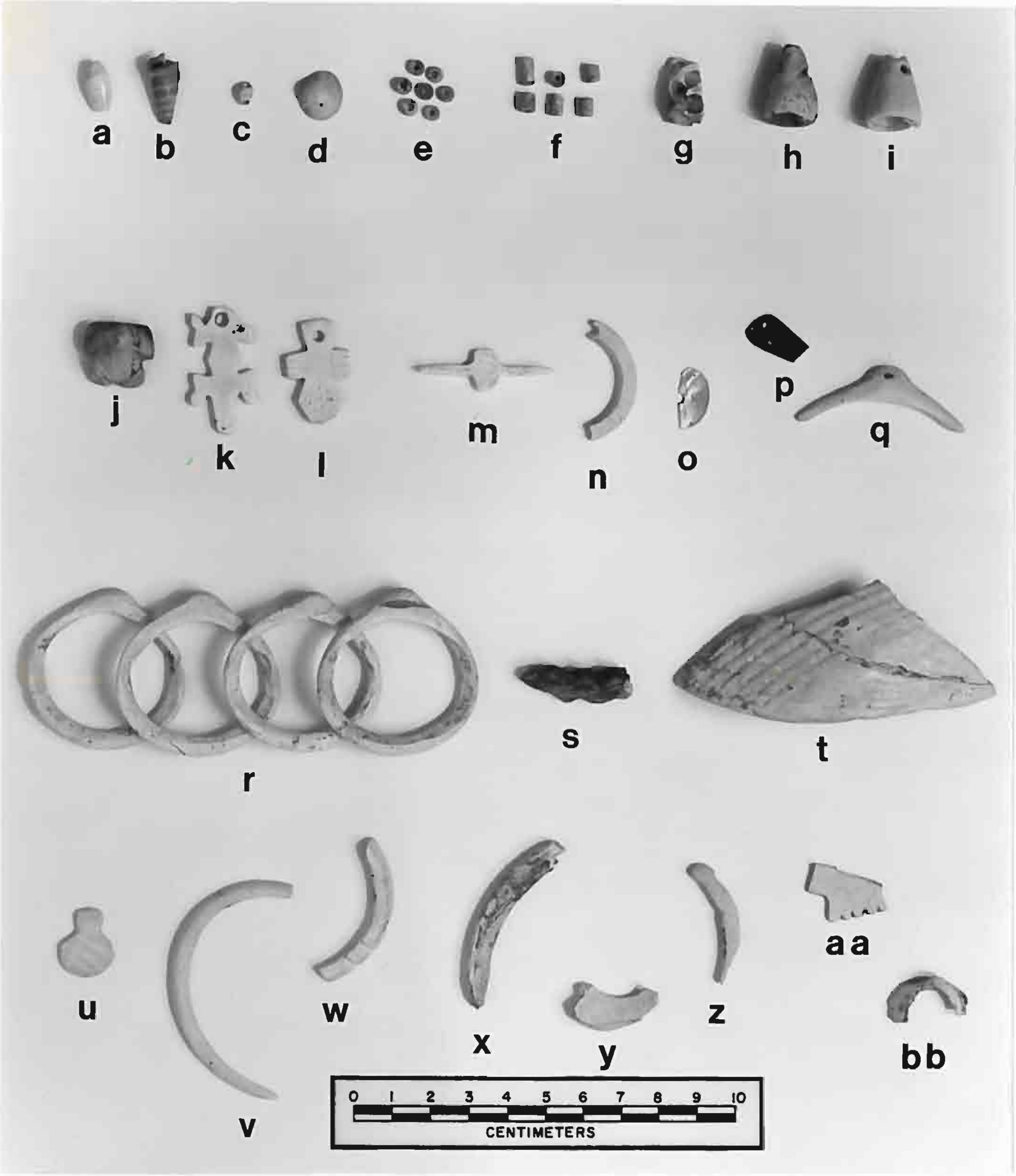

Figure 17.1. Examples of shell from the Rye Creek Project. a-d: whole shell beads, e: disk beads, f: tubular beads, g: whole shell pendant (?) h-i: tinklers, j-p cut shell pendants, q: reworked bracelet pendant, r: plain bracelets, s: decorated bracelet, t: perforated shell, u: geometric, v: awl, w-x: reworked bracelet fragments, y-aa: worked fragments of unknown form, and bb: ring in manufacturing process.

employed; however, it did not appear to be *Conus*. The shape of the siphonal canal was more comparable to that found on *Oliva* valves, although this identification could not be confirmed.

Cut Pendants

As previously discussed, the Rye Creek assemblage included both zoomorphic and geometrically shaped pendants. There were five examples of the former: a frog, three lizard pendants, and an abstract representation of a bird.

A frog pendant (Figure 17.1j) was recovered from the Gila Butte phase deposits in the roof fall material of a pithouse (Feature 11), at the Deer Creek site. Both the structure and the specimen were burned, suggesting it may be associated with the structure; however, two intrusive crematoriums were located in the structure's fill, raising alternative possibilities. The specimen is complete and provides a remarkably detailed representation of a frog. The eyes, spine, and legs are all carved in low relief. The specimen is cut from a heavy *Glycymeris* valve with the head and forelegs incorporating the beak and dorsal margin. The edges of the forelegs are somewhat less finished than the rest of the perimeter suggesting the specimen originally may have been a decorated motif on a bracelet with the band being removed subsequent to its creation. This latter observation is conjectural, although similar specimens are known to have existed at other Hohokam sites during the Colonial period (Haury 1965: 143, 1976: 314-315).

The three lizard forms were all manufactured from the lower back area of *Laevicardium* valves. All are from Sedentary period proveniences--two from the Clover Wash site and one from the Redstone site (AZ O:15:91). One of the specimens from the Clover Wash site is complete (Figure 17.1k) although it appears that the suspension perforation had been redrilled at some point in its history; the hole penetrates the head at the plane of the shoulders. The contiguous margin is noticeably indented; it might represent the residual curve of a previous perforation. One of the forepaws is broken away. Otherwise, the legs are clearly represented, with the toes of the one remaining forepaw indicated by a series of short incised lines. The legs are also incised by a single line that mirrors their general outline. The body of the animal is depicted in a roughly diamond form with the outline of a diamond incised into the body's trunk. The diamond encloses a series of shallow lines scored into the surface. The tail is curled tightly at the tip and has a shallow drilled depression in its center. Overall, the specimen is comparatively animated. The other two pieces are both fragments with only the head and portions of the upper body remaining. The other piece from the Clover Wash site is very abstract (Figure 17.1l). The specimen is similar to the first in that the body is roughly diamond-shaped with a diamond insert inscribed into it. In this case, there are 11 shallow drilled depressions within it. The head and arms are depicted by tabular projections with the perforation located in the center of the head. The specimen from the Redstone site is also quite abstract. The head and legs have a very faceted appearance with the sides cut into short straight segments. The head is separated from the body by a constricted neck. The perforation for suspension is centered in the expanded head area. The piece is broken just below the forelegs.

The final zoomorphic pendant is an abstract representation of the "thunderbird" motif (Figure 17.1m). The specimen, although very eroded, appears to be manufactured from a *Laevicardium* valve and is complete except for the perforation. The wings are quite thin while the body of the specimen is comparatively heavy with a rather square profile. The wings extend 34.46 mm from tip to tip. The fact that it was unperforated suggests it had not been finished prior to its loss. The specimen was recovered from the general layer of sheet trash that extended over the surface of the Boone Moore site. As this site appears to date to the early Classic period it is probable that this is the temporal placement for this specimen.

The three geometric pendants were all quite different from each other. One is a large washer or ring-style pendant cut from the back of a *Laevicardium* valve (Figure 17.1n). The specimen was recovered from the general fill of pithouse Feature 11 at the Redstone site. A portion of the perforation is visible along one of the broken ends. The arc of shell is quite narrow being only 4.77 mm wide and 3.23 mm thick. It is estimated that the internal diameter would have been approximately 24 mm.

Another washer pendant, but with a very different form, was recovered from the floor-fill of Feature 5 at the Boone Moore site. This is a carved disk of *Anodonta* with a small central perforation (Figure 17.1o). The specimen is too large (16 mm in diameter) to be considered a disk bead. It is quite possible that there was a second perforation for suspension closer to the perimeter but it is not present on the fragment.

The final cut pendant is subtriangular in shape (Figure 17.1p). It was perforated in the angle formed by one of the corners so that it would have hung asymmetrically. The specimen was created from an unidentified marine bivalve, probably *Laevicardium*. It was recovered from the fill just above the floor of a pithouse (Feature 4) at the Compact site (AZ O:15:90). It had been extensively burned and although it is largely complete, part of the exterior surface has spalled off.

Other Pendant Form

A pendant recovered from the Redstone site is a complete specimen constructed from the dorsal margin of a plain *Glycymeris* bracelet (Figure 17.1q). The umbo had been perforated by grinding and then the hole reamed out with a small drill-like tool. Both of the arms have been tapered and rounded off to blunt points. The specimen measured 43.57 mm across the arc.

Pendant of Unknown Form

A small fragment of *Laevicardium* was recovered from the sheet trash at the Redstone site. Two contiguous sides of the piece have been cut to form straight edges that form a perpendicular angle. The remaining two edges are breaks. Along one of the breaks there is evidence of a double, side-by-side perforation. It is impossible to determine what the original shape of the artifact was; however, it appears to have been some form of a cut pendant.

Bracelets

Forty-seven bracelet segments were recovered during the excavations. The majority (44) of these represented plain bracelets, 2 were decorated with a carved motif, and the other was still in the process of being manufactured. This last specimen is discussed with the other examples of shell manufacturing.

Plain Bracelets

Plain bracelets are defined as specimens that exhibit only the modifications required to fashion the basic bracelet band. These are generally well ground and polished but have no other decorative embellishments. It is quite possible that some of these were painted, although no evidence of the paint remains.

Of the 44 plain specimens recovered, 4 were complete bracelets (Figure 17.1r), all recovered from an infant inhumation (Feature 13) at the Rooted site (AZ O:15:92). The remaining specimens were fragments. The dorsal margin is present to some degree in 17 (38.6 percent) of these fragments. The ventral margin is also present in 17 pieces. Portions of the umbo were present in 16 cases. The great majority (75 percent) were left relatively unmodified except for grinding on the contiguous portions of the band. In four other instances the umbo had been ground. One was simply ground and polished, leaving the overall natural profile. In the remaining three cases, the umbos were shaped. One was ground to a moderately pointed profile, while the others were either ground to a tabular projection or given a distinctly faceted appearance. Four of the umbos were perforated by the grinding of the umbo and associated areas of the dorsal margin. In three cases the hole was widened by using a small reaming tool. Several suggestions have been made as to the function of such perforations, such as a means for attaching a tassel (Haury 1976:313) or as a means to suspend the bracelet as a pendant (Haury 1976:313; Officer 1978:116-117). The current specimens do not shed any light on the function of such perforations.

The exterior face of nearly 73 percent of the bands have been reduced and in many cases steepened by grinding. This would result in a flatter face when worn around the wrist or arm. In most cases, the resulting profile has a somewhat faceted appearance.

It is common, when dealing with shell bracelets, to refer to the band typology developed by Haury (1965:Plate CXVII, 1976:313) at Snaketown as a means to characterize the bracelet by the width of the band. Most of the specimens with nondorsal band segments (29 specimens) represent the Type II or III style. Only two specimens, one from the Deer Creek site and one from the Redstone site, conform to the criteria for the narrow, Type I bracelet. Overall, the width of the nondorsal segments averages about 5.6 mm with a range of 3.3 mm to 10.7 mm, while the band thickness ranges from 2.7 mm to 10.8 mm with a mean of 5.1 mm. There does not appear to be any temporal variability within the sample.

The four complete bands recovered from the infant burial (Feature 13) at the Rooted site were all quite small. Their diameters ranged from 32.74 mm to 34.42 mm with a mean of 33.37 mm. This may reflect their apparent affiliation with the infant in the burial. The position of the bracelets in the inhumation suggest that they may have been encircling the arm of the child; however, the bone preservation was very poor and no bone was found passing through the bands.

Decorated Bracelets

Two decorated bracelets were recovered from the Deer Creek site; one from the upper fill of pithouse Feature 9 and the other from the fill of a crematorium, Feature 1. Both of the specimens appear to be examples of bands carved to depict the undulating body of a snake. The segment recovered from Feature 9 is from the dorsal margin of the band, although it does not include the umbo. A series of notches have been cut into the band with those in the immediate area of the taxadontic teeth being shallow and closely spaced. Deeper and more widely-spaced alternating notches are located farther toward the side. It is quite possible that the pattern is intended to depict the tail of a rattlesnake with the closely spaced notches depicting the rattles.

The second specimen (Figure 17.1s) is from a much heavier, thicker band. It is a portion of the ventral-side margin with a series of pronounced, deeply cut notches alternating along the two margins. The specimen is badly burned and appears to have been a burial offering included with the body when it was cremated.

Rings

Five rings made of *Glycymeris* along with one cut from a *Conus* valve were recovered. All of the specimens were fragmentary. One of the *Glycymeris* specimens was still in the process of being manufactured and is discussed later.

Three of the four finished *Glycymeris* bands were in contexts that date to the Sacaton phase, two from the Redstone site and one from the Compact site. The fourth dates to the early Classic period occupation at the Boone Moore site. In all instances the exterior of the band has been reduced to a near-vertical face. The widths of these bands range from 2.3 mm to 4.3 mm with a mean of 3.4 mm. All of these specimens were recovered from the fill of various structures or from the overlying sheet trash. During the excavations at AZ O:15:28 (ASM), just north of the project area, Hammack (1966:156) reported finding several rings in a burial context that indicated they had been worn as pendants rather than as finger bands. In contrast, Fewkes (1896:362) stated that he had found several instances of rings being worn on the fingers of interments. It is impossible to say for certain which method of display was employed here. The diameter of at least one of the fragments could be measured directly. It was 11.2 mm across, small enough that it seems unlikely it would have functioned as a finger band.

The band made from the posterior portion of the body whorl of a *Conus* valve was recovered from the floor-fill levels of Feature 5 at the Boone Moore site. All surfaces of this specimen were well polished and the margins rounded. Its diameter is projected to have been approximately 16 mm. It would therefore have been possible for the band to have been worn either as a ring or a pendant.

Perforated Shells

In 1937, Haury (1965:Plate CXVIII) created the artifact category of "perforated shell." It encompassed a widely diverse set of objects that had certain morphological traits in common. The principal characteristic was the presence of a large perforation located in the back of a pelecypod's valve. A common form during the late Colonial and Sedentary periods involves *Laevicardium elatum* valves (Vokes 1984:541,544, 1988: 354). Two examples of these artifacts were recovered from the excavations, one from a sealed portion of the fill of pithouse Feature 11 at the Redstone site and the other from the floor-fill of Feature 14 at the Rooted site. Both of these deposits are associated with Sedentary period occupations. The piece from the Redstone site is a large segment including the dorsal margin and contiguous portions of the umbo. A large perforation is centrally located in the back. A smaller secondary perforation has been punched through the valve's beak and then subsequently reamed out. No other evidence of alteration was present.

The fragment recovered at the Rooted site was from the side and a portion of the back of the valve (Figure 17.1t). The interior perforation has been cut at an angle so that the projected plane of the edge would be nearly perpendicular to that of the natural margin of the shell. The exterior margin of the band segment also has been reduced extensively by grinding. This treatment is quite common for the larger perforated shells (Vokes 1984:521).

The function of these artifacts is uncertain. It is clear that some were worn as armlets, a burial found at the Westfall site had a specimen encircling the upper left arm (DiPeso et al. 1974: 194). Whether all such artifacts were used in this manner is currently unknown.

Geometrics

A specimen of unusual form was recovered from the general sheet trash of the Redstone site. This specimen, made from the back of a *Laevicardium* valve, had a rough "figure 8" shape with the lower portion considerably larger than the upper section (Figure 17.1u). The specimen is a total of 17.88 mm in height. It is quite possible that this was intended for use as a pendant; however, there is no evidence of any intention to perforate the piece. Haury (1965: Plate CXIX) has suggested that some of the geometric forms were intended for use in mosaics. The chief attribute of such pieces is the presence of beveled edges to permit the interlocking of the mosaic units. The current specimen lacks this characteristic. Similar specimens were recovered from Sacaton phase contexts at Las Colinas (Vokes 1988:365-366).

Awl

One reworked bracelet segment from the Redstone site appears to be an awl (Figure 17.1v). It is made from the nondorsal portion of a plain bracelet. One end has been ground so that it tapers down to a comparatively sharp point. The other end is also ground; however, this end is rounded and blunted.

Reworked Bracelet Fragments

Seven other bracelet fragments were worked subsequent to the breakage of the original band. Several of the specimens exhibit rounded or blunted ends while others have been reduced to a crude pointed wedge. The blunted specimens have been ground so that the end is characterized by short facets with some residual evidence of the original break. Single specimens from both the Deer Creek site and the Clover Wash site had been ground to form a blunted end. The intended function of such an artifact is unknown, the ground ends are too blunt to have functioned as a perforator and there are no visible wear patterns.

A similar specimen was recovered from the fill of pithouse Feature 11 at the Redstone site. This specimen appears to be undergoing segmentation (Figure 17.1w). At one end the band has been ground nearly flat across. Nearby, there are two evenly spaced grooves deeply incised into the band. These grooves extend across the exterior face and top. These segments would have been approximately 5 to 7 mm in length. It is possible that this is a decorative element associated with the original band, although it seems unlikely as the motif does not extend further along the remaining section.

The remaining four specimens have been ground so that one end is pointed, with three having a distinctly wedge-shaped profile. One is quite thick (6.98 mm) and probably sustained considerable pressure (Figure 17.1x). It is possible that it and the others could have functioned as crude awls or probes for use on relatively coarse material, such as baskets, but this is purely speculative.

Worked Fragments of Unknown Form

All shell assemblages of any size contain pieces that retain evidence of having been worked, although the initial form is indeterminate. These pieces are all fragments of the original artifact. They can be divided into two groups: carved fragments where there is some indication of shape, and pieces that exhibit worked edges or surfaces with no definable form.

There are four examples of the former. One is from the test excavations at Rye Creek Ruin (AZ O:15:1) while the remaining specimens were recovered from Sacaton phase deposits at the Redstone and Clover Wash sites. The first example is a curved fragment cut from the back of a large *Glycymeris* valve (Figure 17.1y). The interior edge of the arc is cut in a manner similar to that found on bracelets, a smooth arc that has been well finished. The exterior margin has been ground so that it possesses a distinct faceted profile. The edges are gradually tapered along the arc and then sharply angled to a point. The grinding facets of the point are beveled. The surface of the specimen is heavily weathered and relatively chalky, which would obscure any evidence of wear.

The second specimen, recovered from the floor-fill of Feature 11 at the Redstone site, may have been an appendage to some zoomorphic form (Figure 17.1z). It is a curved segment of the shell of an unidentified marine bivalve. One end terminates in a rounded blunt knob somewhat reminiscent of a paw. The "arm" has a series of notches cut along the internal side of the arc, possibly representing joints. A shallow groove has been cut into the top of the piece paralleling the sides and thereby dividing it into two lengthy sections. The base, where it would have attached to the larger object, is broken away.

The two remaining carved pieces were recovered from the Clover Wash site. One is from the fill of pithouse Feature 1 while the other was recovered from the floor-fill levels of Feature 3. The former may be a fragment of a perforated shell made from a *Glycymeris* valve similar to the specimen illustrated by Haury (1976: Fig. 15.23a). It is a small segment of the ventral-side margin and associated areas of the back. Both the interior and exterior edges have been ground. Unfortunately, the specimen is too small to determine if it was in fact a perforated shell fragment. The final carved fragment appears to be the tail segment of a possible bird effigy cut from the back of a *Laevicardium* valve (Figure 17.1aa). This is speculative, however, as the fragment is only a small portion of the original specimen. The tail segment is a small projection that is embellished by a series of four notches cut along one straight edge.

There are eleven fragments that exhibit some degree of modification but whose original form is unknown. Most of these have one or more cut or ground edges that appear to be from finished pieces. Two are fragments of *Anodonta*. This is a very fragile shell that breaks apart easily. These specimens may be pieces in the process of shaping although the edges appear finished. The remaining pieces are all marine shell, mostly *Laevicardium*. One other fragment is a portion of a univalve and may be a portion of a tinkler. It is from the Boone Moore site, which had several tinklers present in its assemblage. This specimen is too small to be identified as such. Another fragment is a sliver of a heavy-walled bivalve that has a portion of perforation present near a ground edge. It may represent an attempt to repair a bracelet or perforated shell.

Manufacturing Evidence

Indications of limited local shell artifact production can be found in the unfinished artifacts and the waste fragments from manufacturing. Fragments were recovered indicating the production of both bracelets and rings as well as carved forms.

One fragment of a bracelet, still in the manufacturing process, was recovered from the floor-fill levels of pithouse Feature 3 at the Clover Wash site. This segment of the dorsal margin was in a comparatively early state in the production process. Both the exterior and interior margins were chipped and some high point grinding was present along the inner surface. The band was 4.9 mm in width.

A single example of a ring (Figure 17.1bb) also was recovered from the test excavations at Rye Creek Ruin. Slightly less than half of the band remains. As with the bracelet, both margins are still rough from chipping. The umbo has been perforated by grinding with the resulting hole enlarged by the use of a reaming tool.

Four fragments of *Laevicardium elatum* were recovered that appear to be either in the earliest stages of shaping or waste from the initial shaping process. The primary method of working this bivalve was to cut a series of grooves that roughly portrays the intended form. The shell was then broken along the grooves and shaped by further carving and grinding. During the course of this grinding, the original grooved edges are obliterated and cut away. One of the pieces is triangular in shape and appears to be well into the process. Its edges, while still retaining some indications of the grooves, have been extensively worked and the exterior face polished. It was the only piece of shell recovered from the Hilltop site (AZ O:15:53), a small farmstead that dates to the Sacaton phase. Of the remaining specimens, only one appears to be a blank in the early stages of shaping. The other two are fragments with multiple raw edges present.

Unworked Fragments

Fifty-one shell fragments were recovered from the excavations that exhibit no evidence of purposeful modification. Forty-two of these are fragments, often multiple, of *Anodonta californensis*. It is possible that these specimens represent food residue or possibly raw material for the local artisans. The marine shell is dominated by unworked fragments of *Laevicardium*; *Glycymeris* and an unidentified univalve also were present. All but one of the seven fragments of *Laevicardium* where derived from the back of the valve. The one exception is from the dorsal margin.

DISCUSSION

Shell recovered from the Rye Creek Project sites spans the period beginning with the Gila Butte phase (A.D. 750-850) and extends through the early Classic period (A.D. 1150-1300). During the early Classic period, there appears to have been a number of changes in the nature of shell use in the region.

Intersite Distributions

Ten of the fourteen investigated sites produced shell materials. The four that lacked shell were all fieldhouse sites that were presumably occupied for short durations, involving limited types of activities. Therefore, it is not surprising that shell was not recovered from these sites. The sites that contained shell in their assemblages are all associated with more intensive occupations. This includes sites defined as farmsteads and small hamlets.

The single exception is the Arby's site (AZ O:15:99), which while classified as a fieldhouse site containing two masonry structures, appears to have been occupied at a more intensive level than the other fieldhouse sites in the project area. Within this functional set, though, there is still a tremendous amount of variation. Table 17.2 summaries the composition of each site's assemblage. The size of the assemblages ranges from 1 to 101 pieces with considerable compositional diversity. Part of this diversity is a reflection of the nature of the features sampled and the size of the sample. The Cobble site, for example, which is perhaps the largest site in the sample aside from Rye Creek Ruin, only produced four specimens. This site had been extremely disturbed by previous road construction and agricultural root-plowing, and very few features were excavated, thus the sample was restricted. In contrast, the Boone Moore site, which was a comparatively small farmstead, produced 101 pieces of shell. Here the sample is influenced by the nature of the features investigated; over half of these pieces were recovered from mortuary contexts and many of them were small beads. Of greater interest, however, is that this is one of the more diverse assemblages. Perhaps its location near the confluence of Rye Creek and Boone Moore Wash may have provided a greater access to the exchange system, although this is unclear. It is also slightly later than most of the other sites, dating to the early Classic period. The other site that is comparable with respect to the variety of forms is the Redstone site, which dates primarily to the Sedentary period. It is a short distance to the south and could have also benefitted from materials passing up or down Rye Creek. The evidence for argillite-working at this site suggests that the inhabitants were active participants in regional exchange systems, which may also explain the comparatively high incidence of shell at a farmstead. The earliest dated site, the Deer Creek site, is also the most southern site. Although this site is more than 2 km from Rye Creek, it has the greatest frequency of *Anodonta*, suggesting the inhabitants frequented or had ties to sites along Rye or Tonto Creeks since Deer Creek, the nearest source of water, probably would not have supported a viable population of this species. Its proximity to the Lower Tonto Basin may have provided greater opportunities for acquiring a variety of shell materials. Previous work in this region at Roosevelt 9:6 (Haury 1986:279-280) and, nearer to the project area, at the Slate Creek Ruin (Huckell 1977) and at Ushklish (Haas 1971b) has demonstrated that a stable supply of shell was available during the Colonial period.

Shell artifacts may have served several roles for the prehistoric population. The forms recovered during this project indicate that the primary function was for personal adornment. This is not to imply that the ornaments themselves did not have functional roles. The wearing of pendants or bracelets can provide symbols of social affiliation, wealth or status, or even be a symbol of an office within the community structure. Tinklers for example, while attractive when worn on clothing or about the ankle have a specific function, providing sound that punctuates movement, often during ceremonial dances or other rituals. Few utilitarian forms were present, generally consisting of reworked fragmentary materials. The best example is the awl or punch recovered at the Redstone site which was made from a fragment of a *Glycymeris* bracelet.

Temporal Development of Shell in the Tonto Basin

During the Colonial period the assemblages were heavily dominated by bracelets and related forms (Table 17.3). Of the finished artifacts, over two-thirds were bracelets; reworked bracelet fragments comprised an additional part of the assemblage. This emphasis on bracelets is reflected in contemporary assemblages throughout the Hohokam regions of southern Arizona. Along the Salt and Gila rivers in and near the Phoenix Basin bracelet forms comprise 60 percent (or greater) of the finished artifacts in Colonial period assemblages from farmsteads (Vokes 1984:542-543, 1988:378). This is not to imply that the inhabitants did not enjoy access to other forms of shell adornment. Indeed, beads and pendants also are found in the assemblages of this period although they are less frequent than in later periods. The presence of pendants and the single whole shell bead at the Deer Creek site are evidence that the Colonial period inhabitants of the Upper Tonto Basin had access to these other forms. However, there is some evidence to suggest that the frog pendant recovered at the Deer Creek site may have originally been part of a bracelet. One factor that may have been significant in terms of the types of artifacts common in the Colonial period is the relative absence of *Laevicardium*. There were two pieces that date to the early occupation and both of these are unworked fragments. Again this situation is reflected at a number of sites within the Hohokam region (Vokes 1984:533, 1989:197). A

Table 17.2. Shell assemblage by site.

Artifact	Rye Creek Ruin 0:15:1	Deer Creek 0:15:52	Hilltop 0:15:53	Cobble 0:15:54	Boone Moore 0:15:55	Compact 0:15:90	Redstone 0:15:91	Rooted 0:15:92	Arbys 0:15:99	Clover Wash 0:15:100	Total
Whole Shell Bead	1	1	0	0	55	1	0	1	0	2	61
Disk Bead	0	0	0	0	13	0	0	0	0	0	13
Cylindrical Bead	0	0	0	0	8	0	0	0	0	0	8
Whole Shell Pendant	0	1	0	0	0	0	0	0	0	0	1
Tinkler	6	0	0	1	6	0	0	0	1	0	14
Pendant - Zoomorphic	0	1	0	0	1	0	1	0	0	2	5
Pendant - Geometric	0	0	0	0	1	1	1	0	0	0	3
Pendant - Other Form	0	0	0	0	0	0	1	0	0	0	1
Pendant - Unknown Form	0	0	0	0	0	0	1	0	0	0	1
Plain Bracelet	4	14	0	0	2	1	11	6	0	6	44
Decorated Bracelet	0	2	0	0	0	0	0	0	0	0	2
Plain Ring	0	0	0	0	2	1	2	0	0	0	5
Perforated Shell	0	0	0	0	0	0	1	1	0	0	2
Geometric	0	0	0	0	0	0	1	0	0	0	1
Carved Shell	0	0	0	0	0	0	0	0	0	1	1
Reworked Bracelet	0	5	0	0	0	0	1	0	0	1	7
Awls/Punch	0	0	0	0	0	0	1	0	0	0	1
Manufacturing Evidence	0	0	1	0	1	0	0	2	0	0	4
Bracelet in Process	0	0	0	0	0	0	0	0	0	1	1
Ring in Process	1	0	0	0	0	0	0	0	0	0	1
Worked Frag. - Unk. Form	3	0	0	1	5	1	2	1	0	1	14
Unworked Fragment	7	26	0	2	7	1	4	4	0	0	51
Total	22	50	1	4	101	6	27	15	1	14	241

Table 17.3. Shell assemblage by time period.

Artifact	PERIOD Colonial	 Sedentary	 E. Classic	 Classic	 Total
Beads					
Whole Shell	1	4	(55) 7 *	1	(61) 13
Disk			(13) 2		(13) 2
Tubular			(7) 1		(7) 1
Cylindrical			(1) 1		1
Pendants					
Whole Shell	1				1
Tinkler			8	6	14
Cut Forms	1	6	2		9
Other		1			1
Bracelets					
Plain	14	24	2	4	44
Decorated	2				2
Perforated Shells		2			2
Rings					
Glycymeris		3	1		5
Conus			1		1
Geometric		1			1
Awls		1			1
Reworked Bracelet Frag.	5	2			7
Worked Fragments - Unknown					
Carved Fragments		3		1	4
Miscellaneous		4	5	2	11
Manufacturing Evidence					
Bracelet		1			1
Rings				1	1
Carved Pieces		3	1		4
Unworked Fragments					
Marine	2	2	5		9
Anodonta	24	7	4	7	42
Total	50	64	40	22	176

*Number of occurrences (total count)

"gaming piece" made from a *Laevicardium* shell was recovered at the Ushklish Ruin (Haas 1971). This appears to be the only reported formal artifact made of this species in the Upper Tonto Basin prior to the Sedentary period. In addition, the relatively high frequency of *Anodonta* may be a reflection of more restricted access to the imported marine shell genera.

During the Sedentary period the inhabitants appear to have had access to a greater diversity of shell artifacts. Although the frequency of bracelets is still quite high, making up nearly 55 percent of the assemblage, a number of cut shell pendants are present along with beads, rings, and perforated shells. Several of these artifacts were made from *Laevicardium* valves. Among the pendants, both geometric and zoomorphic forms were present. One factor that may have influenced the expansion of artifact forms is the apparent development of a limited local manufacturing tradition. It is during the Sedentary period that shell fragments in the process of being manufactured are first found in the assemblages. These include carved fragments of *Laevicardium* as well as an example of a bracelet in the production process. This is not to say that the local population was involved in anything but small-scale craft production. Indeed, all evidence indicates that most of the shell material was still entering the local market as finished goods suggesting that local production was occurring at a minimal level.

The composition of the Sedentary period assemblages in the Upper Tonto Basin is similar to many of the assemblages from the Hohokam region (Table 17.4). At Frogtown *Glycymeris* bracelets represented slightly more than 60 percent of the formal artifacts in the assemblage, with pendants adding an additional 9 percent (Vokes 1984:530). What is seen throughout the Hohokam region is a general expansion and expression of forms in the Sedentary period.

In the early Classic period there is a shift in the genera and artifact forms being emphasized in the Upper Tonto Basin region. Bracelets are reduced in frequency to less than 10 percent of the formal artifacts. Tinklers and beads replace bracelets in the assemblage. Beads were associated consistently with mortuary contexts (90.8 percent), while tinklers were associated exclusively with nonmortuary deposits. The increase in the frequency of bead forms may, in part, be a reflection of a changing mortuary complex in the Tonto Basin. The earlier practice of cremating the dead may have distorted the relative percentages of beads and other forms of shell artifacts; that shell was included as mortuary offerings in cremations is demonstrated by the presence of burned bracelet fragments in crematoriums at the Deer Creek site. The adoption of inhumation as a preferred treatment for the dead during the Classic period would have greatly increased the probability that the grave offerings would survive to the present. The reasons for the negative correlation between tinklers and mortuary context is not clear. The material recovered from Rye Creek Ruin by Haury revealed a high frequency of *Conus* tinklers in mortuary deposits (ASM Catalog Cards).

In Hohokam sites, artifacts made from *Conus* valves rarely are recovered in deposits that predate the Classic period, which is consistent with the current assemblage. During the Classic period artifacts manufactured from *Conus* increased markedly; however, their frequency with respect to the rest of the shell assemblage remains comparatively low in Hohokam sites until the late Polveron phase (ca. post A.D. 1450) (Vokes 1984:543).

The relative high occurrence of this form in the early Classic period (A.D. 1150-1300) Rye Creek assemblage may distinguish the inhabitants of the Upper Tonto Basin from the contemporary Hohokam. Material from later Classic period sites within the Lower Tonto Basin suggests this pattern is not an anomaly (Table 17.4). Both of the principal ruins at Tonto National Monument, which post-date the Rye Creek sites, had significant numbers of *Conus* tinklers in their assemblages (Pierson 1962). *Conus* tinklers were relatively common in the sites with Classic period components in the Miami Wash area (Urban 1978), although they do not appear to be quite as prevalent as they are in the Rye Creek area. These patterns suggest that there may have existed a new source for material or influence on the Rye Creek populations. One possible area may be to the north with the Sinagua and/or Anasazi. While most sites associated with the Anasazi occupation of the Coconino plateau in the P-II and P-III periods (ca. A.D. 900-1300) have little associated shell, there are several notable exceptions. The site of Wupatki (AZ I:7:1[ASM]), whose principle occupation extended from the late eleventh and throughout the twelfth centuries, produced 148 *Conus* and 7 *Olivella* tinklers (Stanislawski 1963). It is difficult to assess how this related to the overall shell assemblage as some classes were noted simply as present, but some indication is provided by the listing of only 176 *Glycymeris* bracelets for the entire Wupatki assemblage. Clearly, *Conus* and shell tinklers were a notable portion of this assemblage. Further evidence of *Conus* in the region around Flagstaff during the Elden phase (A.D. 1150-1250) was found with Burial #16 at the Ridge Ruin known as the Magician's Burial. This remarkable burial had several strands of tinklers (162 specimens) near a hand and along side one leg, indicating they may have been sewn to clothing (McGregor 1941, 1943). Although this interment is clearly unusual, the presence of such numbers of *Conus* tinklers in this region would support the claim that these were a known commodity and that they were available in the early Classic period at the time when the Rye Creek sites were occupied.

Table 17.4. Comparison of marine genera by regions. (Note - bead forms are not included in counts due to difficulty with counts vs. occurrence data.)

		Glycymeris		*Laevicardium*		*Conus*		Other Marine Shell		Total	
Region	Period	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Salt/Gila Basin	Sedentary (1)	356	50.71	323	46.01	3	0.43	20	2.85	702	100.00
	Early Classic (2)	55	41.67	59	44.70	7	5.30	11	8.33	132	100.00
	Late Classic (3)	115	39.66	146	50.34	26	8.97	3	1.03	290	100.00
Lower Tonto Basin	Sedentary (4)	11	57.89	5	26.32	-	-	4	21.05	20	105.26
	Classic (5)	35	35.71	29	29.59	29	29.59	5	5.10	98	99.99
Rye Creek Sites	Sedentary	33	68.75	15	31.25	-	-	-	-	48	100.00
	Early Classic	4	19.05	7	33.33	9	42.86	1	4.76	21	100.00
	Classic (all)	8	25.81	7	22.58	15	48.39	1	3.23	31	100.01

References for sites employed: (1) Howard 1985b, Vokes 1984; (2) Debowski 1974, Vokes 1984, Wasley and Benham 1968; (3) Vokes 1984; (4) Kelley et. al 1985; (5) Kelley et. al 1985, Pierson 1962, Urban 1978.

Table 17.5. Chi-square values for data in Table 17.4.

Regions	Period	Degrees of Freedom	Chi-squared Value	Significance at 0.05 level	Notes
Rye Creek/Salt-Gila	Sedentary	2	6.55	yes	barely significant
	Early Classic	3	27.28	yes	*Conus* is source of disparity
	Classic	3	41.07	yes	*Conus* is main source of disparity
Rye Creek/Tonto Basin	Sedentary	2	5.34	no	
	Classic	3	3.73	no	
Tonto/Salt-Gila Basins	Sedentary	2	17.40	yes	Mainly due to high "other" in Tonto
	Classic	3	35.16	yes	*Conus* is the main source of disparity

CONCLUSIONS

It would appear that the inhabitants of the Rye Creek area of the Upper Tonto Basin were associated with the general Hohokam tradition during a major portion of their occupational history. The forms and their relative frequency are comparable to sites in the lower Gila and Salt river basins. Following the Sedentary period, however, there appears to be a significant change in the nature of the shell assemblage suggesting the region may have come under the influence of new forces. It is difficult to identify the exact nature of this shift or specify the source of these influences on the basis of shell alone.

PART 4: SPECIALIZED ANALYSES

CHAPTER 18

THE RYE CREEK FLOTATION AND MACROBOTANICAL ANALYSES

Scott Kwiatkowski

This chapter presents the results of the analysis of 97 flotation and 8 macrobotanical samples collected from 9 of the 13 sites in the Rye Creek Project area. Seventy flotation samples were analyzed in detail, and the remaining 27 were intensively scanned for identifiable charred plant material. The results of the analysis of the wood charcoal present in the flotation samples are included in Chapter 19.

The samples selected for analysis represent about a 550-year time span from the Gila Butte phase of the Hohokam Colonial period (ca. A.D. 750-850) through the early Classic period (ca. A.D. 1150-1300). Although structures occurred at each of the sites examined, several of these loci appear to represent seasonal habitations while others may represent more long-term and perhaps permanent use (see Chapter 26).

ENVIRONMENTAL SETTING

The project area is located in a portion of the Upper Tonto Basin that is ecotonal between the interior chaparral (Pase and Brown 1982) and the Great Basin conifer woodland (Brown 1982; Lowe and Brown 1982:Figure 3; see also Chapter 2, Volume 1). It is characterized by several different plant associations existing together in a relatively limited space. Gasser (1987:18-30) has summarized these associations for the area immediately to the south. Although he found that interior chaparral and desert grassland vegetation were most common, pinyon-juniper and juniper woodlands also were prominent. Mixed riparian broadleaf associations and mesquite bosques were more limited. Transition zone pine forests occurred on the highest elevations of the surrounding mountains and lower Sonoran desertscrub was found in the lowest basin elevations.

RESEARCH OBJECTIVES

The data recovery plan (Elson and Doelle 1989) identified subsistence and settlement patterns as one of five thematic categories guiding research. The subsistence-related themes of food production strategies, wild resource procurement strategies, and changes in subsistence strategies were singled out for consideration. The goals were to establish the relative importance of food production at each site, to provide clues about site function, to identify and assess the contribution of wild-plant resources used in the diet, and to determine whether changes in subsistence occurred through time. This later question is addressed because there is speculation (e.g., Bohrer 1962) that the Classic period Salado may have relied on upland resources more heavily than their predecessors.

These goals are pursued by addressing the following research questions:

1. What plants were used, and how important may they have been in subsistence?
2. What is the evidence for site seasonality?
3. Do certain feature types contain different types or amounts of charred plant material, and if they do, what does this indicate about feature function or economic activities occurring within features?
4. Are there changes in the charred plant assemblages through time, and if there are, what do these indicate about changes in subsistence?
5. How do the Rye Creek area subsistence practices compare to patterns evident in adjacent areas?

FLOTATION ANALYSIS

Processing Technique

The flotation samples selected for analysis generally had a volume of 4.0 liters before processing (see Appendix G Tables 1 through 9 for exceptions). The samples were processed at Desert Archaeology, Inc. Each was poured into a 5-gallon (19-liter) bucket filled three-fourths full of water. The liquid was stirred with a wooden rod and all the suspended material was skimmed off using a tea strainer. The resulting "light fractions" were dried on newspaper and submitted to Soil Systems, Inc., for analysis.

Evaluation of the Processing Technique

One hundred charred poppy (*Papaver somniferum* L.) seeds were introduced into five soil samples before flotation to test the efficiency of the Desert Archaeology, Inc., processing technique (Wagner 1982). The number of charred poppy seeds recovered from each of the four samples that are part of the detailed analysis are presented in Appendix G.10. The processing technique consistently retained just under 80 percent of the introduced seeds ($\bar{x}$=78.75, range 74-80, s.d.=1.92). Although the recovery rate is consistent, better results usually are reported (e.g., Kwiatkowski 1989a:149-153; Matthews 1985:57; Wagner 1982, 1988). For comparison, four poppy seed tests conducted during the El Caserío flotation analysis exhibited a mean recovery of 93.3 seeds (range 88-96, s.d.=3.3) with no broken seeds (Kwiatkowski 1989a:Table 7.6).

Four of the 315 poppy seeds (1.3 percent) from the Rye Creek project recovered were broken, raising the possibility that some of the fragmentary seeds reported in this analysis were whole until they were floated. One poppy seed occurred unexpectedly in a sample from the fill of roasting pit F43 at the Deer Creek site. Feature 43 was not one of the samples where poppy seeds were introduced. This seed is unlike the others in that it is not charred and so it is believed that even though it is a modern contaminant, it did not enter the sample as part of the flotation processing technique test.

Analytical Methods

The total volume of the light fraction and the amount of wood charcoal was determined, in ml, using a graduated cylinder (Appendix G.16). The charcoal volumes should be viewed as estimates because the large amount of detritus in each sample made volumetric measurements difficult. The sample was next passed through a series of geological screens with 2.0-, 1.0-, 0.5-, and 0.25 mm mesh to facilitate sorting. The contents of each of these screens was then examined at 10X to 11X using a reflected light binocular microscope. Problematical specimens were examined at up to 140X.

Detailed Analysis

All recognizable material was either counted or estimated for the detailed analysis. Abundant material of a particular type was estimated by counting the number of that type in a fraction of one screen (e.g., one-ninth), and then multiplying the result (Miksicek 1986:383).

The first 12 samples analyzed were from the Redstone site (AZ O:15:91), the Arby's site (AZ O:15:99), and the Clover Wash site (AZ O:15:100). The light fraction finer than 0.25 mm was examined from each of these sites. Virtually no identifiable charred plant remains were found in residue this small and it was not examined in the remaining samples.

Intensive Scan Analysis

The intensive scan analysis was undertaken to increase the number of features and samples that could be observed. The methods used in the intensive scan were identical to the detailed analysis with two exceptions.

First, only identifiable charred plant remains were recorded. Taxa not identified include "cf.," "indeterminate," and "miscellaneous" level identifications, as well as uncarbonized plant remains and nonplant material. The second exception is that there were only three levels of quantification: One part present, between two and 50 parts per liter, and more than 50 parts per liter. The light fraction residue less than 0.25-mm mesh was not examined.

Criteria Used in Identifications

Identifications were made by comparison to the author's collection of modern and archaeological plant remains, identification manuals (Delorit 1970; Knight 1974; Martin and Barkley 1962; U.S. Forest Service 1974), comparison to reference specimens at the Arizona State University herbarium, and in consultation with the individuals credited in the acknowledgments.

Problematical Identifications

The identification of several plant taxa were problematical. Plant remains with the "cf." designation are comparable to a taxon but lack one or more criteria normally expected; this frequently was due to poor preservation. Because "cf." level identifications may be inaccurate, they are not included in quantitative analyses and little significance should be attached to them. "Indeterminate" parts were even less identifiable than "cf." level identifications.

"Miscellaneous" refers to plant parts that have little diagnostic value including endosperm fragments, epidermis fragments, spine fragments, and spiral twists. This category also includes "agavoid" remains such as fragments with white styloid or raphide crystals, and fibers with D-shaped, flat, or round cross sections as well as round fiber bundles scattered in parenchyma. Following Bohrer (1987:72), only fibers with trough-shaped cross sections are identified as agave.

Charred fibers with round cross sections and without white styloid or raphide crystals commonly occurred in flotation samples at approximately a 1:1 ratio compared to round fibers with these crystals. This pattern, which may extend to a 1:2 ratio, occurs commonly at Hohokam sites in the lower Salt River Valley (see Kwiatkowski 1988b, 1989a, 1989b, 1990). Three samples from burned pithouses at different sites in the Rye Creek assemblage contained over twice as many round fibers without crystals as fibers with crystals (i.e., a 2:1 ratio; Table 18.1). It is therefore believed that the fibers could have originated from another genus in the Agave family such as beargrass (*Nolina*), yucca (*Yucca*), or sotol (*Dasylirion wheeleri*).

Bromegrass-type grass grains were separated from wild rye type grains and *Bromus-Elymus*-type grain fragments following criteria proposed by Bohrer (1987:81-82). Identification of the smallest grass grain categories, the sprangletop and dropseed types, were particularly problematical. Although criteria proposed by Kwiatkowski (1989b:503-504) were used to separate these two types, a number of specimens appeared to exhibit intermediate characteristics. Many grains identified as *heptochloa* type, for example, looked much like *Sporobolus* type grains in facet view but had triangular cross sections. Therefore, these categories should be viewed as morphological types only and it is possible that several genera of small-grained grasses (perhaps not the ones listed) are actually represented.

All of the charred *Hordeum* grains identified lacked adherent paleas and lemmas; this characteristic is common for *Hordeum* grains at Hohokam sites. The current view (Adams 1986, 1987; Bohrer 1984:252; 1987:86-88) is that such "naked grains" are indicative of an incipient domesticate. Many of the Rye Creek flotation samples contained small fragments that are comparable to portions of sterile *Hordeum pusillum* spikelets; these were so small and fragmentary that they were considered to be a cf. level identification. Specimens identified as *Hordeum* rachis joint fragments resemble reference specimens of the bases of *Hordeum pusillum* spikes or "planting units" (Adams 1987).

Table 18.1. Flotation samples containing possible non-*Agave* fibers.

Site	Context	Archaeobotanical Evidence	Non-CaO Fiber: CaO Fiber Ratio[a]
Deer Creek	Pithouse F32 floor fill	109 round fibers[b]	37.3:1
Redstone	Pithouse F5 floor fill	ca. 32 round fibers	2.5:1
Clover Wash	Pithouse F3 floor fill	ca. 119 round fibers	3.1:1

Note: The samples contained other charred plant remains as well.
[a] CaO - white styloid and/or raphide crystals present.
[b] Round refers to shape in cross section.

Carbonized Cheno-am seeds generally had round outlines in facet view, sometimes with a slight bump near the hilum, central calyx scars visible on one seed face, and rims that either were poorly defined or absent. Surface punctations or reticulations were relatively rare but did occur. None of the seeds approached the size range characteristic of the domesticated Cheno-ams. Since these characteristics are usually associated with noncultivated goosefoot (*Chenopodium* spp.) (Bohrer 1987:Table 9.25), it is likely that the charred Rye Creek Cheno-am seeds are goosefoot. The more general category "Cheno-am" is used, however, because seeds of some species of goosefoot and pigweed (*Amaranthus* spp.) native to southern Arizona resemble each other so closely that they cannot be distinguished under low magnification (Bohrer 1987:99). The single exception to the dominance of goosefoot-like seeds occurred within pithouse hearth Feature 59.01 at the Deer Creek site, where 38 charred Cheno-am seeds with thick, distinct rims were found; these rims are more characteristic of pigweed.

Three types of charred plant disseminules defied all attempts at identification (Figure 18.1). The "globular unknown" (Figure 18.1a) is about 1.8 mm long and has a smooth surface. It is relatively spherical except for a minute but pointy projection reminiscent of the beak of a cotton (*Gossypium hirsutum* var. *punctatum*) seed but not as long or arched. It also has an indentation opposite the projection. It most closely resembles beargrass (*Nolina microcarpa*) seeds except that the unknown is half its size and has a sharper projection.

The Boraginaceae-like unknown (Figure 18.1b) has a crinkly surface and is about 1.4 mm in maximum length. It has an ovoid base in facet view that is irregular because of the surface crenulations. The base is an irregularly compressed ovoid in side view. This unknown also has a pronounced, arching projection terminating in a point. It is possible that they could be the interior of fiddlenenck (*Amsinckia* sp.) seeds. Although a few of the globular unknowns were difficult to separate from the Boraginaceae-like unknowns, two different plants seem to be represented.

Finally, the teardrop-shaped unknown (Figure 18.1c) is named for its shape in facet view. It also has a smooth surface and a relatively lenticular cross section except that a slight, rounded ridge runs down the center of its long axis in facet view. Its maximum length is about 2.1 mm.

Quantification

Two primary techniques are used to interpret the flotation data after multiple samples from the same context are pooled to create a single "sample locus." The first is a ubiquity measure, the "presence value," which is a particular taxon's percent of occurrence in a suite of samples (Hubbard 1980). For example, if charred Cheno-am seeds were found in 10 out of 100 analyzed samples (including unproductive ones), this taxon would

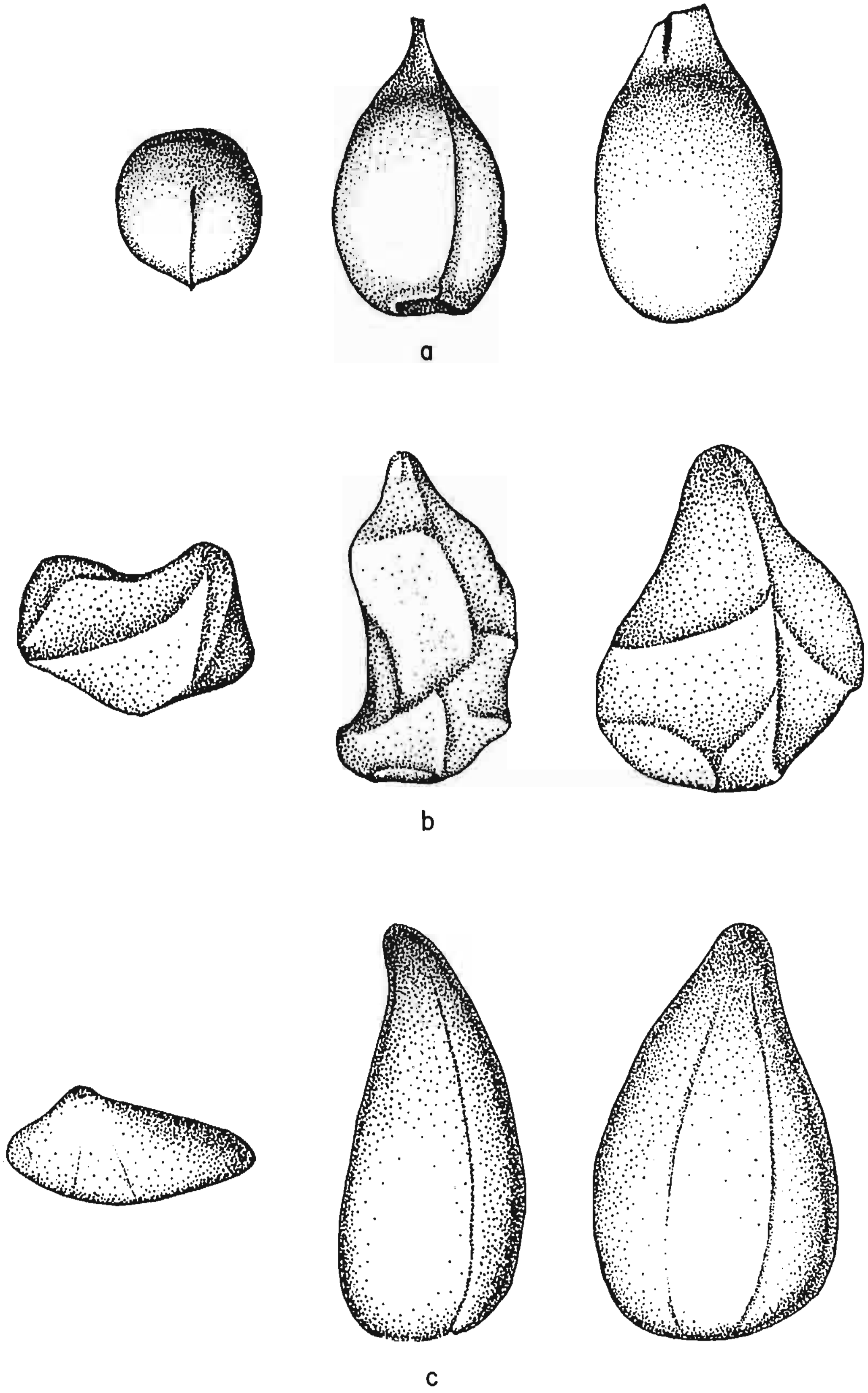

Figure 18.1. Unidentified charred plant disseminules.

have a presence value of 10 percent. The second is an abundance measure, "relative density," which is essentially a parts per liter measure except that multiple samples from the sample context are pooled and the results are expressed as percents of total (Kwiatkowski 1989b). For example, 40 charred Cheno-am seeds in two different 4-liter flotation samples from the same context, say a pithouse floor, would equal 5 (40÷8) relative parts. These five charred relative parts might comprise 2.5 percent of the total number of relative parts if 200 relative parts were recovered from the site. Nonparametric statistics are used for quantitative analyses because the charred plant data are not distributed normally and the sample sizes generally were small.

Results

Ninety-seven samples, representing a total of 363.0 l of sediment, were analyzed from nine sites (Table 18.2). Seventy samples (259.5 l), were part of the detailed analysis, and 27 samples (103.5 l) were analyzed during the intensive scan. The scientific names of the 62 nonwoody plant taxa identified in the flotation and macrobotanical samples are listed in Table 18.3 along with their common name equivalents and the parts present. Table 18.4 lists the contextual, chronological, and burning characteristics for all samples analyzed, and the charred plant densities, in parts per liter, for the samples analyzed in detail.

A total of 793 whole, 2,545 fragmentary, and 1,229 "cf. level" charred plant identifications was made during the detailed analysis (Appendix G.11). A summary of the actual counts of charred plant remains from each taxon grouped by time period and site is presented in Appendix Tables G.11 to G.14, and Appenidix G.15 is a summary of the results of the scan analysis.

Four out of the 70 detailed analysis samples and two of the intensive scan samples did not produce identifiable charred plant remains (Table 18.4, Appendix G.15). One of the unproductive intensive scan samples, from possible Apachean roasting pit Feature 15 at the Deer Creek site, is not listed in Appenidix G.15 but is instead discussed below.

Eight samples from similar contexts were combined to form three sample loci. Four samples from a trash mound (F2) at the Cobble site were grouped as were two from a possible Apachean roasting pit (F15) at the Deer Creek site. In addition, one sample from the floor fill of a pithouse (F12), also at the Deer Creek site, was combined with a sample of fill surrounding its trivet. This resulted in a total of 92 sample loci, 67 of which were part of the detailed analysis. Relative parts percentages and presence values were then calculated for the sample loci of each chronological period present at each site (Table 18.5). The presence values in Table 18.5 reflect both detailed analysis and intensive scan data, but only detailed analysis data could be used to calculate the relative parts percentages; as a result the two summary statistics are, in most cases, derived from two different sample sizes. The relative parts percentage data in Table 18.5 are depicted in pie charts (Figures 18.2 - 18.10); time periods represented by only a single sample locus per site are omitted from these figures.

Caramelized Plant Remains

Only charred plant remains from open-air sites usually are considered to be prehistoric (Asch and others 1972; Keepax 1977; Minnis 1981). A number of wood, seed, and grain specimens exhibited a brown or "caramelized" appearance that seemed intermediate between carbonized and uncarbonized. The possibility that these could be prehistoric uncharred remains seems enhanced because an unburned roof beam was found in situ in pithouse remnant Feature 6 at the Clover Wash site and unburned posts were recovered in situ at the Redstone site (see Chapter 8, Volume 1). However, charred examples of the same seed types accompanied the caramelized seeds in all but one case (Table 18.6), and although caramelized plant remains occurred in both burned and unburned features, they were twice as common in burned ones (cf. Tables 18.4, 18.6). This may indicate that the caramelized seeds are actually partially carbonized. Therefore, the caramelized plant remains are considered to be prehistoric and included with the carbonized plant material in the quantitative analyses.

Table 18.2. Features and contexts selected for flotation analysis.

Feature Type	n	Features Analyzed
THE DEER CREEK SITE, AZ O:15:52 (ASM)		
Crematoriums	5	46[a], 71, 82, 85, 117
Hearth under pithouse	1	14.03[a]
Pithouse floor fill	17	2, 6, 11, 12[a], 13[a], 14, 18 (upper)[a], 18 (lower), 21, 22, 25, 62[a], 65[a]
hearths	5	9.04, 14.04[a], 22.01, 34.01, 59.01
pits	3	9.06, 9.07[a], 9.08
trivet Fill	1	12.01[a]
Pits	7	45, 54, 56[a], 63, 75, 76, 81[a]
Roasting pits	8	15[b], 17, 28, 43, 60, 86, 118
Site total:	47	
THE HILLTOP SITE, AZ O:15:53 (ASM)		
Masonry pitroom floor fill	1	5
Pithouse floor fill	4	1, 6[a], 14[a], 15[a]
Site total:	5	
THE COBBLE SITE, AZ O:15:54 (ASM)		
D-shaped masonry pitroom floor fill	1	9
hearth	1	9.01
Trash mound	4	2
Site total:	6	
THE BOONE MOORE SITE, AZ O:15:55 (ASM)		
Cobble-lined adobe pitroom	2	5, 6
Masonry pitroom floor fill	3	1[a], 18 (upper), 18 (lower)
hearth	1	1.01[a]
Pithouse floor fill	2	11, 19[a]
hearths	2	11.01, 19.01
Pit	1	22
Roasting pit	1	20
Site total:	12	
THE COMPACT SITE, AZ O:15:90 (ASM)		
Horno	1	6[a]
Pithouse ash pit	1	4.02[a]
hearth	1	4.01
floor fill	2	3, 5
Roasting pit	2	8,9
Site total:	7	
THE REDSTONE SITE, AZ O:15:91 (ASM)		
Pithouse floor fill	2	5, 11
Pit	1	25
Roasting pit	2	17, 20[a]
Site total:	5	
THE ROOTED SITE, AZ O:15:92 (ASM)		
Pithouse floor fill	1	14
hearth	2	14.05, 14.08
Site total:	3	
THE ARBY'S SITE, AZ O:15:99 (ASM)		
Cobble brush structure hearth	1	5.01
Extramural hearth	1	4
Masonry structure floor fill	1	1
Slab-lined pitroom floor fill	1	3
Site total:	4	
THE CLOVER WASH SITE, AZ O:15:100 (ASM)		
Ash pit	1	22[a]
Pithouse floor fill	5	1, 3, 4[a], 6[a], 12
Roasting pit	2	13[a], 17
Site total:	8	

[a] Intensively scanned sample
[b] One detailed analysis and one intensive scan sample

Table 18.3. Nonwoody plant taxa identified in the flotation or macrobotanical samples.

Scientific Name	Common Name	Parts Present and Condition[a]
Acacia greggii	Catclaw acacia	Seed (C)
Agave	Agave, century plant	cf. caudexes (C), fibers (C), leaf fragments (C), marginal teeth (C,U)
Angiospermae	Angiosperm	Anthers (U)
Arctostaphylos sp.	Manzanita	Nutlets (C), nutlet aggregate fragment (C)
Argemone sp.	Prickly poppy	Seed (C)
Astragalus Nuttallianus type	Milk vetch	Seed (C,U)
Baccharis sp.	Desert broom	Achenes (U)
Boraginaceae-like unknown	Borage family-like unknown	Seeds (C)
Bromus type	Bromegrass type	Grains (C)
Bromus-Elymus type	Bromegrass-wild rye type	Grain fragments (C)
Bromus rubens[b] type	Red brome	Floret (U)
Cactaceae	Cactus family	cf. prickle (C), cf. seed fragment (U)
Caryophyllaceae cf. *Silene* sp.	Pink family cf. campion	Seeds (C,U)
Celtis sp.	Hackberry	Seeds (U)
Cercidium microphyllum	Foothill palo verde	cf. seed fragment (C)
Cheno-am (*Chenopodium* spp. or *Amaranthus* spp.)	Goosefoot or pigweed	Seeds (C,U)
Compositae	Sunflower family	Achenes (C,U)
Cupressus-Juniperus	Cedar-juniper	Branchlet fragments (U)
Cynodon dactylon[b]	Bermuda grass	Floret (U)
Daucus sp.	Wild carrot	Fruit (U)
Descurainia sp.	Tansy mustard	Seeds (C)
Dicotyledoneae	Dicot	Leaves (U)
Distichlis type	Saltgrass type	Grains (C)
Echinocereus sp.	Hedge-hog cactus	Seeds (C,U)
Elymus type	Wild rye type	Grains (C)
Erodium cicutarium[b]	Filaree	Fruits (U), seeds (U)
Erodium sp.	Heron bill	Fruit fragments (U)
Euphorbia sp.	Spurge	Seeds (C,U)
Ferrocactus sp.	Barrel cactus	cf. seed fragments (U)
Globular unknown	Globular unknown	Seeds (C)
Gramineae, indeterminate types	Grass family, indeterminate types	Culm fragments (C), florets (U), cf. grains (C,U)
Hordeum cf. *pusillum*	Barley cf. little barley	Grains (C), rachis joint fragments (C), cf. spikelet fragments (C)
Juglans major	Arizona walnut	Nut (C)
Juniperus sp.	Juniper	Seed fragments (C)
Lepidium sp.	Peppergrass	cf. seed (C)

Table 18.3. Continued.

Scientific Name	Common Name	Parts Present and Condition[a]
Leptochloa type	Sprangletop type	Grains (C,U)
Lotus sp.	Deer vetch	cf. seed (U)
Mentzelia albicaulis type	Stick leaf, small-flowered blazing star type	Seeds (C)
Mollugo sp.	Carpet weed	Seed (U)
Monocotyledoneae	Monocot	Stem fragments (C,U)
Nolina sp.	Beargrass	Leaf fragments (C)
Opuntia sp.	Cholla or prickly pear	Seed fragments (C,U)
Papaver somniferum[b,c]	Poppy	Seeds (C,U)
Phacelia ambigua type	Notched-leaved phacelia type	cf. seed fragment (C)
Phacelia grandiflora type	Phacelia	Seed fragment (C)
Phacelia sp.	Phacelia	cf. seed fragment (C)
Phalaris sp.	Canary grass	Grains (C)
Physalis sp.	Ground cherry	Seed (U)
Pinus edulis type	Pinyon	Seed (U)
Plantago sp.	Indian wheat	Seed (U), seed fragment (C)
Platyopuntia	Prickly pear	Seed fragments (C,U)
Portulaca sp.	Purslane	Seeds (C,U)
Prosopis cf. *velutina*	Mesquite cf. velvet mesquite	cf. pod fragment (U), seed (C)
Salvia sp.	Chia	Seed fragments (C)
Schismus[b] type	Mediterranean grass type	Grains (U)
Solanaceae	Potato family	Seed (C)
Sphaeralcea sp.	Globe mallow	Seeds (C,U)
Sporobolus type	Dropseed type	Grains (C,U)
Teardrop-shaped unknown	Teardrop shaped unknown	Seeds (C)
Unknown	Unknown	Fruits (U), seeds (U)
Zea mays	Maize, corn	Cupules (C), glumes (C), kernel fragments (C)

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[a] C - carbonized or caramelized; U - uncarbonized
[b] Introduced species
[c] All except probably the one uncarbonized seed were introduced into five flotation samples to test the recovery rate of the flotation processing technique.

Unusually Productive Samples

The 70 detailed analysis samples had a mean of 13.97 charred plant remains per liter (range 0-184.00; s.d. 26.26). Four samples had a charred plant density more than two standard deviations above the mean and can therefore be considered outliers. One intensively scanned sample, from horno Feature 6 at the Compact site, contained abundant charred agave fibers and may represent another outlier. In each case of high sample productivity one or two taxa accounted for at least 89.9 percent of the charred plant remains (Table 18.7).

Table 18.4. Flotation sample contexts, volumes, dates, burning conditions, and charred plant part per liter densities.

Site	Prov. No.	Feature and Context	Vol.[a]	Date[b]	Burning[c]	Parts per Liter
		DETAILED ANALYSIS SAMPLES				
Deer Creek	473-3	Pithouse hearth F59.01	2	PRE	Y	184.00
Cobble	123-3	D-shaped masonry pitroom F59.01	4	EC	Y	81.50
Redstone	209-3	Pit F25	4	SAC	Y	76.25
Cobble	110-4	Trash mound F2, level 4	4	EC	N	67.50
Deer Creek	369-5	Pithouse F11 floor fill	1	GB	B	47.00
Deer Creek	352-3, 353-2	Pit F54	4	GB	Y	39.00
Deer Creek	172-8	Pithouse F14 floor fill	4	GB	C	33.50
Deer Creek	406-2	Pithouse hearth F22.01	4	GB	Y	30.25
Cobble	109-5	Trash mound F2, level 3	4	EC	N	27.25
Rooted	139-3	Pithouse hearth F14.05	4	SAC	Y	26.25
Deer Creek	362-3	Pithouse hearth F9.04	4	GB	Y	20.00
Deer Creek	467-6	Pit F76	4	GB	Y	18.75
Deer Creek	360-2	Pithouse pit F9.08	1	PRE	N	18.00
Deer Creek	435-7	Pit F63	4	GB	N	16.75
Rooted	143-2	Pithouse hearth F14.08	4	SAC	Y	15.50
Deer Creek	291-12	Pithouse F21 floor fill	4	GB	C	15.00
Deer Creek	239-7	Pit F45	4	GB?	N	14.00
Deer Creek	359-3	Pithouse pit F9.06	4	PRE	N	13.00
Rooted	127-9	Pithouse F14 floor fill	4	SAC	B	11.50
Redstone	189-14	Pithouse F11 floor fill	4	SAC	C	11.25
Cobble	117-5	D-shaped masonry pitroom F9 floor fill	4	EC	B	10.75
Clover Wash	142-5	Pithouse F3 floor fill	4	SAC	B	10.50
Cobble	107-5	Trash mound F2, level 1	4	EC	N	10.25
Deer Creek	186-4	Pithouse F6 floor fill	4	GB	B	9.75
Deer Creek	310-6	Pithouse F32 floor fill	4	GB	B	9.50
Deer Creek	506-1, 575-1	Roasting Pit F28	4	GB	N	9.25
Redstone	193-8	Pithouse F5 floor fill	4	SAC	B	9.00
Deer Creek	499-5	Crematorium F71	4	GB	Y	7.75
Redstone	207-3	Roasting pit F17	4	SAC	Y	7.50
Cobble	108-5	Trash mound F2, level 2	4	EC	N	7.00
Compact	141-5	Pithouse F3 floor fill	4	SAC	B	6.75
Deer Creek	117-6, 125-3	Roasting Pit F17	4	GB	N	6.75
Clover Wash	127-6	Pithouse F12 floor fill	4	SAC	B	6.50
Deer Creek	413-4	Pithouse F25 floor fill	4	GB	A	6.50

Table 18.4. Continued.

Site	Prov. No.	Feature and Context	Vol.[a]	Date[b]	Burning[c]	Parts per Liter
Deer Creek	507-2	Roasting pit F86	4	GB	Y	6.50
Deer Creek	390-6	Pithouse F22 floor fill	4	GB	B	6.25
Deer Creek	438-5	Pithouse F59 floor fill	4	PRE	B	6.00
Boone Moore	174-4	Pithouse hearth F19.01	4	EC	Y	6.00
Boone Moore	207-8	Cobble-lined adobe pitroom F6 floor fill	4	EC	A	5.75
Clover Wash	205-2	Roasting pit F17	4	SAC	Y	4.75
Deer Creek	143-3	Pithouse F34 floor fill	4	PRE	B	4.25
Deer Creek	275-4	Pithouse F18 lower floor fill	4	GB	B	4.00
Deer Creek	392-12	Pithouse F2 floor fill	4	GB	B	4.00
Clover Wash	145-5	Pithouse F1 floor fill	4	SAC	B	3.50
Boone Moore	199-1	Pithouse hearth F11.01	2	EC	Y	3.50
Compact	137-4	Pithouse F5 floor fill	3.5	SAC	B	3.43
Boone Moore	170-13	Pithouse F11 floor fill	4	EC	A	3.25
Deer Creek	376-1	Roasting pit F60	4	GB	N	3.25
Boone Moore	185-13	Cobble-lined adobe pitroom F5 upper floor	4	EC	A	2.75
Hilltop	186-3	Masonry pitroom F5 floor fill	4	CLA	A	2.75
Hilltop	139-3	Pithouse F1 floor fill	4	SAC	A	2.75
Compact	127-2	Pithouse hearth F4.01	4	SAC	Y	2.75
Boone Moore	216-3	Pit F22	4	EC	N	2.75
Deer Creek	508-4, 516-1, 517-1	Roasting pit F118	4	GB	Y	2.75
Arby's	108-2	Cobble brush structure hearth F5.01	2.5	EC	Y	2.00
Deer Creek	501-6	Crematorium F85	4	GB	Y	2.00
Boone Moore	219-8	Masonry pitroom F18 lower floor fill	4	EC	A	1.75
Deer Creek	157-5, 251-5	Roasting pit F43	4	GB	N	1.25
Arby's	125-6	Slab-lined pitroom F3 floor fill	4	EC	B	1.25
Boone Moore	257-5	Roasting pit F20	4	EC	Y	1.00
Deer Creek	524-5	Crematorium F117	4	GB	Y	0.75
Deer Creek	488-2	Crematorium F82	4	GB	Y	0.75
Compact	131-2	Roasting pit F9	4	SAC	Y	0.75
Boone Moore	151-11	Masonry pitroom F18 upper floor	4	EC	A	0.50
Arby's	111-3	Masonry structure F1 floor fill	4	EC	B	0.50
Compact	126-3	Roasting pit F8	4	SAC	Y	0.50
Arby's	107-3	Extramural hearth F4	2	EC	Y	0.00
Deer Creek	193-1	Pithouse Hearth F34.01	0.5	PRE	Y	0.00
Deer Creek	485-2	Pit F75	1	GB	N	0.00
Deer Creek	459-3	Mescal roasting pit F15	4	APA	N	0.00

Table 18.4. Continued.

Site	Prov. No.	Feature and Context	Vol.[a]	Date[b]	Burning[c]	Parts per Liter
		INTENSIVE SCAN SAMPLES				
Deer Creek	364-3	Pithouse pit F9.07	4	PRE	N	--
Deer Creek	243-5	Pithouse F12 floor fill	4	GB	B	--
Deer Creek	250-3	Pithouse trivet F12.01	4	GB	B	--
Deer Creek	115-3	Pithouse F13 floor fill	4	GB	B	--
Deer Creek	178-1	Hearth F14.03 (under pithouse)	2	GB	Y	--
Deer Creek	174-4	Pithouse hearth F14.04	4	GB	Y	--
Deer Creek	227-11	Pithouse F18 upper floor fill	4	GB	B	--
Deer Creek	147-4	Pithouse F36 floor fill	4	GB	C	--
Deer Creek	324-9	Crematorium F46	4	GB	Y	--
Deer Creek	347-4	Pit F56	4	GB	Y	--
Deer Creek	408-3	Pithouse F62 floor fill	4	GB	N	--
Deer Creek	491-2	Pithouse F65 floor fill	4	GB	C	--
Deer Creek	497-2	Pit F81	4	GB	Y	--
Hilltop	141-4	Pithouse F6 floor fill	4	SAC	B	--
Hilltop	192-5	Pithouse F14 floor fill	4	SAC	A	--
Hilltop	193-4	Pithouse F15 floor fill	4	SAC	A	--
Boone Moore	196-5	Masonry pitroom F1 floor fill	4	EC	A	--
Boone Moore	218-1	Masonry pitroom hearth F1.01	4	EC	Y	--
Boone Moore	158-4	Pithouse F19 floor fill	4	EC	A	--
Compact	128-1	Pithouse ash pit F4.02	4	SAC	Y	--
Compact	144-6	Horno F6	4	SAC	Y	--
Redstone	208-2	Roasting pit F20	4	SAC	Y	--
Clover Wash	115-3	Pithouse F4 floor fill	4	SAC	B	--
Clover Wash	180-4	Pithouse remnant F6 floor fill	4	SAC	B	--
Clover Wash	234-1, 235-1, 236-2	Roasting pit F13	4	SAC	Y	--
Clover Wash	141-3	Ash pit F22	4	SAC	N	--

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[a] Sample volume before flotation
[b] APA = possibly Apachean; CLA = indeterminate Classic period EC = early Classic; GB = Gila Butte; PRE = indeterminate Preclassic; SAC = Sacaton
[c] Structure burning codes: A = abandoned without burning; B = burned after abandonment; C = catastrophic burning; Burning codes for other features: N = not burned; Y = burned

All of the unusually productive features except for the trash mound (Feature 2 at the Cobble site) exhibit evidence of in situ burning and it is likely that the abundant remains represent de facto refuse (Schiffer 1972) from food processing occurring within or over them. Preservation may have been enhanced by low oxygen levels during burning and rapid feature infilling.

Table 18.5. Relative parts percentages and presence values by site and time period.

Site:	Deer Creek		Hilltop	Compact	Redstone	Rooted	Clover Wash	Cobble	Boone Moore	Arby's	Project Totals
Date^a:	GB	PRE	SAC^b	SAC	SAC	SAC	SAC	EC	EC	EC	--
Relative parts totals^c:	315.25 n=26 8.0 l	225.25 n=6 15.5 l	2.75 n=1 4.0 l	14.18 n=5 19.5 l	104.00 n=4 16.0	53.25 n=3 12.0 l	25.25 n=4 16.0 l	120.25 n=3 24.0 l	27.25 n=9 34.0 l	3.75 n=4 12.5 l	893.93 n=67 259.5 l
Presence value totals:	n=37 144.0 l	n=7 19.5 l	n=4 16.0 l	n=7 25.0 l	n=5 20.0 l	n=3 12.0 l	n=8 32.0 l	n=3 24.0 l	n=12 46.0 l	n=4 12.5 l	n=92 363.0 l
Agave	22.44 75.7	4.00 85.7	54.55 25.0	25.19 57.1	85.82 80.0	23.47 100.0	54.46 100.0	85.55 100.0	91.74 100.0	10.67 25.0	36.76 75.3
fibers	(22.44) (75.7)	(4.00) (85.7)	(54.55) (25.0)	(25.19) (57.1)	(84.62) (80.0)	(23.47) (100.0)	(53.47) (87.5)	(84.46) (100.0)	(91.74) (100.0)	(10.67) (25.0)	(36.44) (74.2)
leaves	(--) (--)	(--) (--)	(--) (--)	(--) (14.3)	(--) (--)	(--) (--)	(--) (--)	(1.09) (66.7)	(--) (--)	(--) (--)	(0.15) (3.2)
marginal teeth	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(1.20) (20.0)	(--) (--)	(0.99) (25.0)	(--) (--)	(--) (--)	(--) (--)	(0.17) (3.2)
Arctostaphylos nutlets	0.24 8.1	0.22 14.3	-- --	-- --	0.24 20.0	-- --	-- --	0.21 33.3	-- --	-- --	0.20 6.5
Argemone seeds	-- 2.7	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- 1.1
Astragalus Nuttallianus type seeds	0.08 2.7	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.03 1.1
Boraginaceae-like unknown seeds	0.95 8.1	0.44 14.3	-- --	-- --	0.24 20.0	1.41 33.3	-- --	0.21 33.3	-- --	-- --	0.59 7.5
Caryophyllaceae cf. *Silene* seeds	0.08 2.7	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.03 1.1
Cheno-am seeds	22.05 89.2	25.75 85.7	18.18 75.0	30.23 85.7	7.21 80.0	33.33 100.0	20.79 75.0	0.78 66.7	-- --	32.00 25.0	18.76 69.9
Compositae achenes	0.08 2.7	0.22 14.3	-- --	--	-- --	-- --	-- --	-- --	-- --	-- --	0.08 2.2
Descurainia seeds	1.27 29.7	2.22 28.7	9.09 25.0	--	-- --	2.82 100.0	-- --	0.05 33.3	-- --	-- --	1.21 19.4
Echinocereus seeds	13.56 59.5	0.89 57.1	-- 50.0	16.88 28.6	1.44 60.0	7.98 66.7	2.97 50.0	0.05 33.3	0.92 8.3	6.67 25.0	6.06 45.2
Euphorbia seeds	0.08 2.7	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.03 1.1
Globular unknown seeds	0.56 10.8	2.22 14.3	-- --	-- --	-- --	-- --	1.98 50.0	-- --	1.83 8.3	-- --	0.87 10.8
Gramineae grains (except *Hordeum* and *Zea mays*)	7.22 59.5	58.04 85.7	9.09 25.0	3.78 28.6	1.44 60.0	19.71 33.3	13.86 62.5	0.88 66.7	-- --	-- --	19.11 43.0
Bromus type	(0.16) (2.7)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(0.06) (1.1)
Bromus-Elymus type	(1.11) (10.8)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(0.39) (4.3)
Distichlis type	(0.16) (5.4)	(0.33) (28.6)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(1.98) (25.0)	(--) (--)	(--) (--)	(--) (--)	(0.20) (6.5)

Table 18.5. Continued.

Site:	Deer Creek		Hilltop	Compact	Redstone	Rooted	Clover Wash	Cobble	Boone Moore	Arby's	Project Totals
Date[a]:	GB	PRE	SAC[b]	SAC	SAC	SAC	SAC	EC	EC	EC	--
Relative parts totals[c]:	315.25 n=26 8.0 l	225.25 n=6 15.5 l	2.75 n=1 4.0 l	14.18 n=5 19.5 l	104.00 n=4 16.0	53.25 n=3 12.0 l	25.25 n=4 16.0 l	120.25 n=3 24.0 l	27.25 n=9 34.0 l	3.75 n=4 12.5 l	893.93 n=67 259.5 l
Elymus type	(0.32) (5.4)	(--) (--)	(--) (--)	(--) (--)	(0.48) (20.0)	(--) (--)	(--) (--)	(0.05) (33.3)	(--) (--)	(--) (--)	(0.17) (4.3)
Leptochloa type	(4.52) (48.6)	(57.71) (57.1)	(9.09) (25.0)	(--) (--)	(0.24) (20.0)	(4.69) (33.3)	(3.96) (37.5)	(--) (--)	(--) (--)	(--) (--)	(16.58) (30.1)
Phalaris	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(0.24) (20.0)	(--) (--)	(--) (12.5)	(--) (--)	(--) (--)	(--) (--)	(0.03) (2.2)
Sporobolus type	(0.95) (18.9)	(--) (--)	(--) (--)	(3.78) (28.6)	(0.48) (40.0)	(15.02) (33.3)	(7.92) (50.0)	(0.83) (33.3)	(--) (--)	(--) (--)	(1.68) (18.3)
Hordeum	11.34	2.89	9.09 75.0	3.78 28.6	0.72 20.0	6.57 100.0	-- 12.5	0.31 66.7	-- --	-- --	5.33 41.9
grains	(6.42) (56.8)	(2.00) (71.4)	(9.09) (75.0)	(3.78) (28.6)	(0.72) (20.0)	(5.63) (100.0)	(--) (12.5)	(0.31) (66.7)	(--) (--)	(--) (--)	(3.32) (40.9)
rachis joints	(4.92) (8.1)	(0.89) (57.1)	(--) (--)	(--) (--)	(--) (--)	(0.94) (66.7)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(2.01) (9.7)
Juniperus seeds	0.08 2.7	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.03 1.1
Mentzelia seeds	6.26 18.9	0.78 28.6	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	2.41 9.7
Opuntia seeds	-- 5.4	-- --	-- --	-- --	-- --	-- --	0.99 25.0	-- --	-- --	-- --	0.03 4.3
Phacelia grandiflora type seeds	0.08 2.7	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.03 1.1
Plantago seeds	-- --	-- --	-- --	-- --	0.24 20.0	-- --	-- --	-- --	-- --	-- --	0.03 1.1
Platyopuntia seeds	0.24 5.4	-- --	-- --	-- --	-- --	-- --	-- 12.5	-- --	-- --	-- --	0.08 3.2
Portulaca seeds	1.19 13.5	0.22 14.3	-- --	5.79 28.6	0.72 40.0	0.47 33.3	0.99 50.0	11.02 66.7	-- 8.3	-- --	2.19 19.4
Prosopis seeds	0.08 2.7	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.03 1.1
Salvia seeds	0.63 2.7	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.22 1.1
Solanaceae seeds	0.08 2.7	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.03 1.1
Sphaeralcea seeds	0.24 8.1	-- --	-- --	-- --	-- --	0.94 33.3	-- --	-- --	-- --	-- --	0.14 4.3
Stem fragments	0.08 8.1	0.44 14.3	-- --	5.54 42.9	0.24 20.0	-- --	-- --	-- --	-- --	-- --	0.26 8.6
Gramineae culms	(0.08) (8.1)	(0.44) (14.3)	(--) (--)	(--) (14.3)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(0.14) (5.4)
Monocotyledoneae	(--) (--)	(--) (--)	(--) (--)	(5.54) (28.6)	(0.24) (20.0)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(0.12) 3.2
Teardrop-shaped unknown seed	0.16 5.4	0.44 14.3	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	0.17 3.2

Table 18.5. Continued.

Site:	Deer Creek		Hilltop	Compact	Redstone	Rooted	Clover Wash	Cobble	Boone Moore	Arby's	Project Totals
Date[a]:	GB	PRE	SAC[b]	SAC	SAC	SAC	SAC	EC	EC	EC	--
Relative parts totals[c]:	315.25 n=26 8.0 l	225.25 n=6 15.5 l	2.75 n=1 4.0 l	14.18 n=5 19.5 l	104.00 n=4 16.0	53.25 n=3 12.0 l	25.25 n=4 16.0 l	120.25 n=3 24.0 l	27.25 n=9 34.0 l	3.75 n=4 12.5 l	893.93 n=67 259.5 l
Zea mays	10.94 45.9	1.22 57.1	-- --	8.82 42.9	1.68 40.0	3.29 66.7	3.96 25.0	0.93 66.7	5.50 33.3	50.67 75.0	5.32 41.9
cupules	(9.60) (45.9)	(1.22) (57.1)	(--) (--)	(8.82) (42.9)	(1.20) (40.0)	(3.29) (66.7)	(2.97) (25.0)	(0.88) (66.7)	(5.50) (33.3)	(26.67) (50.0)	(4.65) (40.9)
glumes	(1.03) (8.1)	(--) (--)	(--) (--)	(--) (--)	(0.24) (20.0)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(--) (--)	(0.39) (4.3)
kernels	(0.32) (8.1)	(--) (--)	(--) (--)	(--) (--)	(0.24) (20.0)	(--) (--)	(0.99) (12.5)	(0.05) (33.3)	(--) (--)	(4.00) (75.0)	(0.28) (9.7)
Relative parts totals:	100.01	99.99	100.00	100.01	99.99	99.99	100.00	99.99	99.99	100.01	100.03

Note: Presence values are in boldface; numbers in parentheses are subtotals.

[a] EC = Early Classic, GB = Gila Butte, PRE = Indeterminate Preclassic, SAC = Sacaton

[b] One 4.0 l sample from Classic period F5 was also analyzed from this site. It contained 2.75 total relative parts, all of which were Cheno-am seeds.

[c] The first number is the relative parts total upon which the percentages are based.

Charred plant remains (primarily agave fibers, which accounted for at least 91% of the total in each sample) tended to increase with depth in trash mound Feature 2 at the Cobble site (Figure 18.11). Factors that may have led to the unusually high productivity in Level 4 of this feature are rapid burial, increased fiber breakage because of the weight of the mound, plus perhaps a relatively intense prehistoric occupation and the relatively young age of the site.

Other Material

Most of the samples yielded numerous (i.e., more than 50 parts per liter) insect-sized, and to a lesser extent, rodent-sized fecal pellets. Many also contained numerous insect exoskeleton fragments (Appendix G, Tables 1-9). Although fecal pellets and insect body parts were more common at the Rye Creek sites than in samples from many lower Salt River valley sites (see Kwiatkowski 1988a), they were also relatively common in another Upper Tonto Basin flotation study, the Ord Mine project (Halbirt and Gasser 1987:286). Although the increased number of these elements probably is a reflection of the greater biomass of the interior chaparral compared to the lower Sonoran desert, they also signal postoccupational insect and rodent bioturbations (Kwiatkowski 1988a). Some charred plant remains probably were displaced and some may have been broken as a consequence of these bioturbations.

Table 18.8 provides summary statistics for three uncarbonized plant variables from the detailed analysis flotation samples. For comparison, the Salt River valley sites of La Lomita Pequeña and the Grand Canal Ruins contained an average of 1.6 and 2.8 uncarbonized plant parts per liter, respectively (Kwiatkowski 1988a:Table 8.11). Samples exhibiting abundances of more than two standard deviations from the mean for these variables are listed on Table 18.9 along with samples containing plants native to the Old World. One sample, pit Feature 45 at the Deer Creek site, stands out because it contains multiple outliers and introduced taxa categories. The significance of this is unknown; the pit contained a phallic-handled argillite censer and was not noted to be disturbed except that the fill was unusually uncompacted.

Both samples from a possible Apachean roasting pit (F15) at the Deer Creek site contained uncarbonized florets that resemble the introduced grass *Bromus rubens*, and one sample had an unusually high diversity of uncarbonized plant taxa (Table 18.9). Although neither of these samples contained identifiable carbonized plant remains, each contained a single uncarbonized agave marginal tooth. The high diversity of uncarbonized plant remains, including an introduced taxon and the presence of uncarbonized agave marginal teeth in this feature, support its appraisal as an Apachean mescal processing feature.

MACROBOTANICAL ANALYSIS

Eight macrobotanical samples collected in the field were microscopically examined (Table 18.10). The relatively large charred seeds from arboreal legumes (i.e., catclaw acacia, cf. foothill palo verde, and velvet mesquite) are better represented in this data set than in the flotation data set. The single walnut recovered from the project was a macrobotanical specimen.

Table 18.6. Caramelized plant remains recovered from the Rye Creek Project.

Site	Feature and Context	Identification	Carbonized Specimens Also Present?
Deer Creek	Pithouse F6 floor fill	1 cf. *Hordeum* spikelet fragment	Y
Deer Creek	Pithouse pit F9.06	1 cf. Compositae achene	N
Deer Creek[a]	Pithouse F18 floor fill	1 Cheno-am seed	Y
Deer Creek	Pit F45	2 *Leptochloa* type grains	Y
Deer Creek	Pit F63	1 Cheno-am seed	Y
Hilltop	Trash mound F2, level 2	1 Indeterminate seed fragment	Y
Cobble	D-shaped masonry pitroom F9 floor fill	1 Indeterminate seed fragment	Y
Cobble	Hearth F9.01 in D-shaped masonry pitroom	3 cf. Cheno-am seed fragments	Y
		2 *Portulaca* seeds	Y
		2 *Portulaca* seed fragments	Y
		3 cf. *Portulaca* seed fragments	Y
		1 *Sporobolus* type grain	Y
Boone Moore	Pithouse hearth F11.01	1 Miscellaneous fragment (CaO)[b]	Y
Compact	Pithouse F3 floor fill	2 Miscellaneous fragments (CaO)[b]	Y
Compact	Pithouse F5 floor fill	1 Indeterminate seed fragment	Y
Redstone	Pithouse F11 floor fill	1 Cheno-am seed	Y
Rooted	Pithouse hearth F14.05	3 *Sporobolus* type grains	Y
Arby's	Slab-lined pitroom F3 floor fill	1 Indeterminate seed fragment	Y

[a] Intensively scanned sample; all others were analyzed in detail.
[b] White styloid and/or raphide crystals are present.

Field observations indicate that the sample from the floor fill of pithouse Feature 11 at the Redstone site was probably part of the structure's burned roof. It thus appears that beargrass leaves and either cottonwood (*Populus* sp.) or willow (*Salix* sp.) wood was used in the construction of this superstructure.

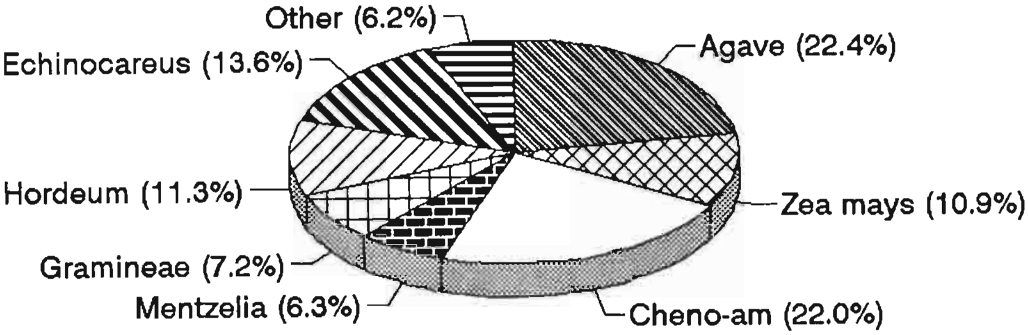

Figure 18.2. Relative parts percentages from the Deer Creek site, Gila Butte phase.

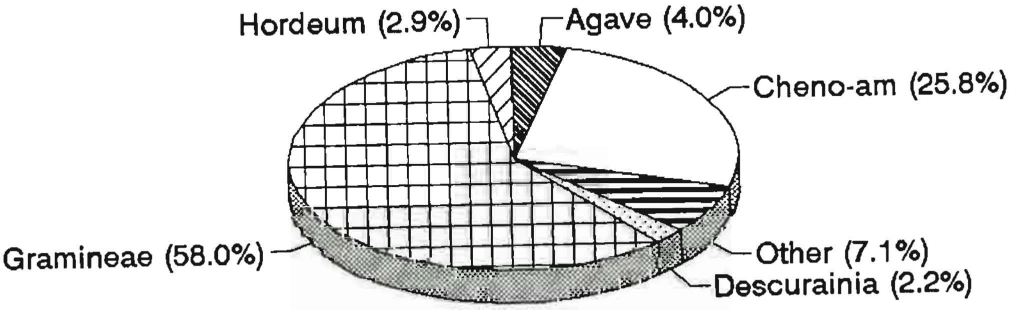

Figure 18.3. Relative parts percentages from the Deer Creek site, Indeterminate Preclassic period.

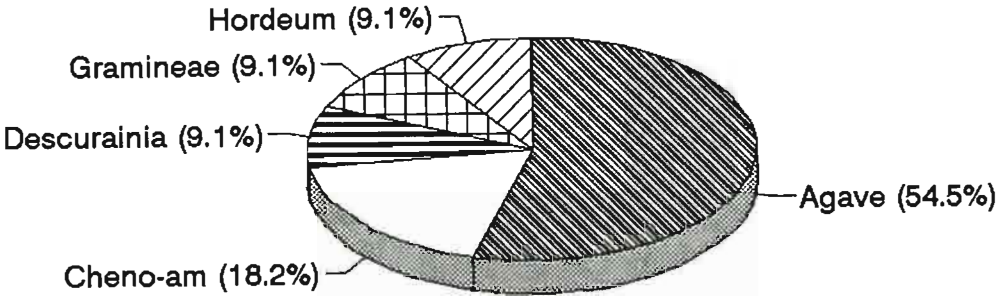

Figure 18.4. Relative parts percentages from the Hilltop site, Sacaton phase.

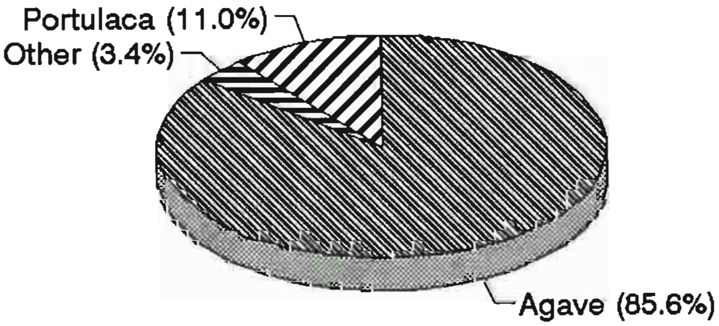

Figure 18.5. Relative parts percentages from the Cobble site.

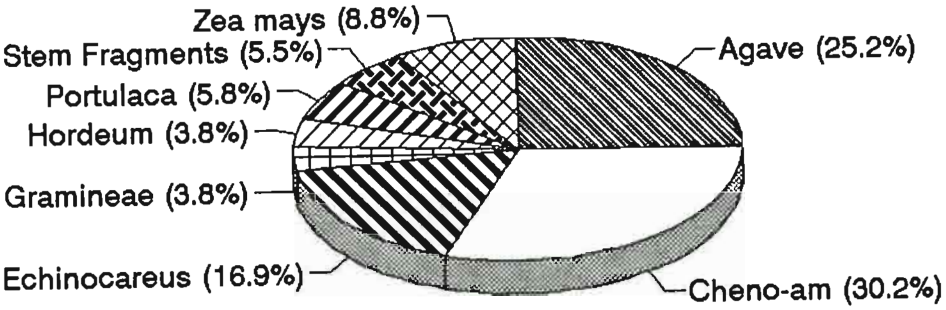

Figure 18.6. Relative parts percentages from the Compact site.

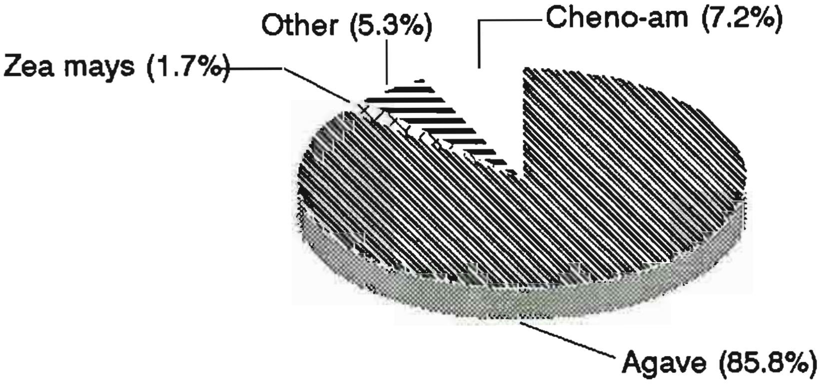

Figure 18.7. Relative parts percentages from the Redstone site.

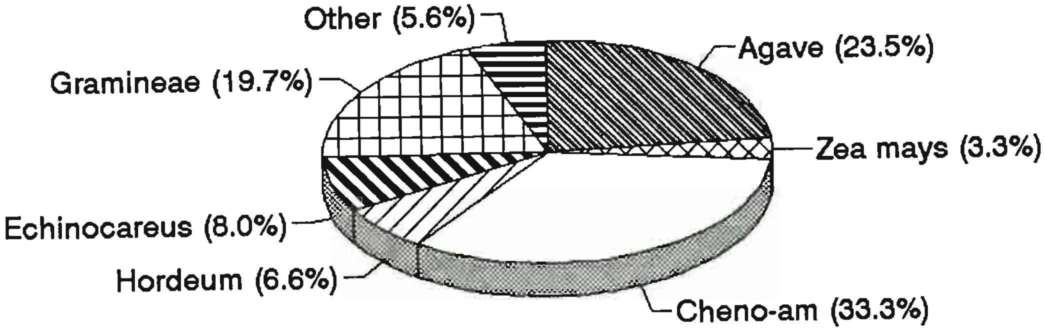

Figure 18.8. Relative parts percentages from AZ O:15:92 (ASM).

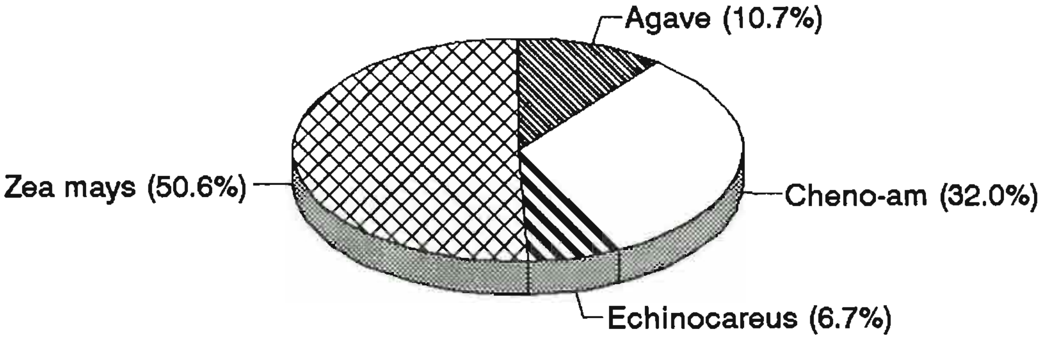

Figure 18.9. Relative parts percentages from the Arby's site.

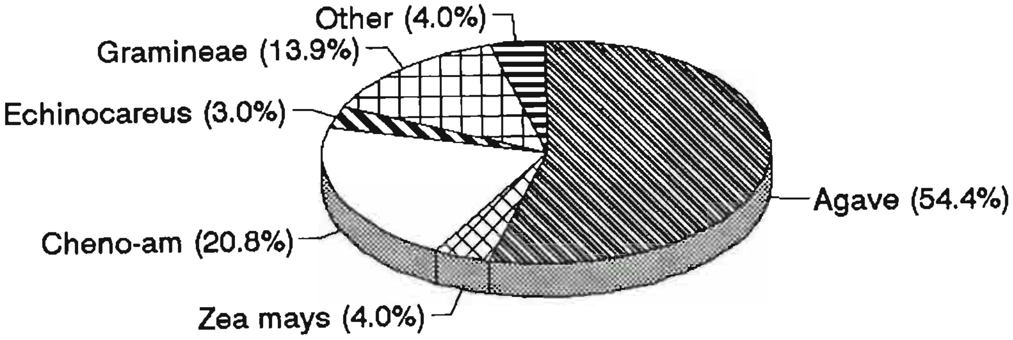

Figure 18.10. Relative parts percentages from the Clover Wash site.

DISCUSSION

Food Plants

Addressing the questions of "Which plants were used for food?" and "How important were different plants in the diet?" is probably best done by considering a number of different variables: systematic biases unique to archaeobotanical data, historic local Native American subsistence practices, comparative regional archaeobotanical information, and an examination of the charred plant assemblage at each project area site.

Inherent Biases

The flotation and macrobotanical results correspond well to a model of systematic biases in charred plant data that lead to the overrepresentation of some taxa and the absence of others (Munson et al. 1971:427). The relatively abundant charred agave fibers and maize cob fragments probably represent dense, inedible waste products from plant processing that could have been burned as fuel. These are precisely the types of plant remains that ought to be preserved with the highest frequency (Munson et al. 1971:427). This is exacerbated in the case of agave because its fibers were probably a major source of cordage used in house construction and because many of the analyzed samples were from burned structural fill where agave ties used to hold a building together may have been charred (Table 18.4). Somewhat dense foods that are subject to fire during processing but are normally ingested in their entirety such as the seeds of Cheno-ams, tansy mustard, purslane, and grass grains ought to be preserved less often (Munson et al. 1971:427), although it might be comparatively easy to lose many of these small seeds and grains during parching. Finally, greens, tubers, and fleshy fruits should rarely, if ever, be preserved (Munson et al. 1971:427). In the Rye Creek area these may have included the fleshy fruits of wild grapes (*Vitis arizonica*) and yuccas (*Yucca* spp.), which were not found in any samples. Because it is likely that the data are skewed it would be unwise to automatically assume that the most common charred plant remains were used most often.

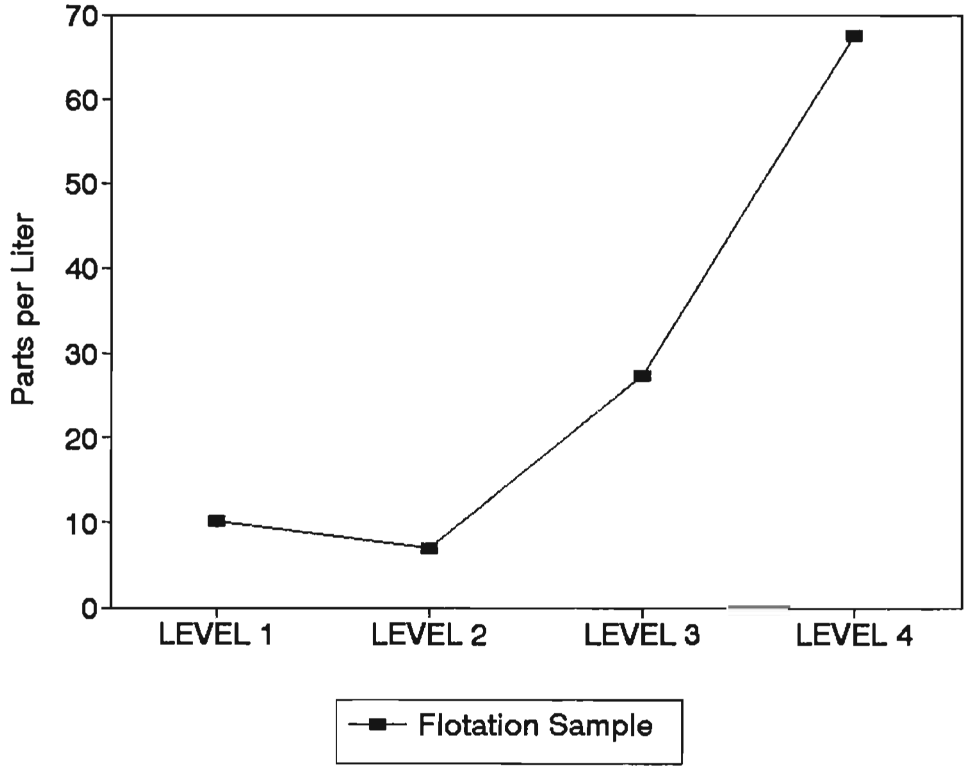

Figure 18.11. Density of charred plant remains by level in trash mound, Feature 2, at the Cobble site.

Table 18.7. Unusually productive flotation samples.

Site	Context and Provenience	Burned	Abundant Remains
Deer Creek	Pithouse hearth F59.01	Y	*Leptochloa* type grains 125.5 ppl[a] (68.2%[b]) and Cheno-am seeds 40.0 ppl (21.7%)
Cobble	D-shaped masonry pitroom hearth F9.01	Y	*Agave* fibers and leaf fragments 66.0 ppl (81.0 %) and *Portulaca* seeds 12.5 ppl (15.3%)
Redstone	Pit F25	Y	*Agave* fibers 75.0 ppl (98.5%)
Cobble	Trash mound F2, level 4	N	*Agave* fibers and leaf fragments 66.5 ppl (98.5%)
Compact	Horno F6	Y	Abundant *Agave* fibers and leaf fragments[c]

[a] ppl = parts per liter

[b] Percentage of the total number of charred plant remains present in the sample.

[c] Abundance measures are not possible because the sample was intensively scanned; it is therefore possible that this sample may not actually be an outlier.

Table 18.8. Summary statistics for uncarbonized plant remains in the detailed analysis flotation samples.

	Mean	s.d.	Range
Taxa per liter	1.07	0.83	0-4.0
"Seeds" per liter (fruits, grains, and seeds)	5.39	10.26	0-61.25
"Other" parts per liter (anthers, leaves, and stem fragments)	1.55	5.23	0-35.5

Note: Fragments are included but "cf.", miscellaneous, and indeterminate identifications were not used.

s.d. = standard deviation

Another problem is that prehistoric natural seed rain may have been accidentally charred and incorporated into the archaeobotanical record (Minnis 1978). Prolific seed or grain producers in the project area that might be expected to become inadvertently burned include the Cheno-ams, tansy mustard, purslane, and a number of different grass grains. Abundant charred Cheno-am seeds, sprangletop-type grains, and purslane seeds occurred in one or another of the two most productive structure hearth flotation samples (Table 18.7); it thus appears that these taxa were at least sometimes intentionally collected and used for food. Further, tansy mustard seeds and dropseed type grains have known historic food value and they occurred in the majority of sites and time periods sampled. It therefore is likely that these historically prolific seed producers were at least sometimes used as food prehistorically.

Table 18.9. Flotation samples with abundant uncarbonized plant remains or introduced taxa.

	Outliers[a]			Introduced Taxa[b]			
Context and Provenience	Taxa per Liter	"Seeds" per Liter	"Other" per Liter	*Bromus rubens* Type	*Cynodon dactylon*	*Erodium cicutarium*	*Schismus* Type
			DEER CREEK				
Pithouse pit F9.08	X	--	--	--	--	--	--
Pithouse trivet F12.01	--	--	--	--	--	X	--
Roasting pit F15	X	--	--	--	--	--	--
Pithouse F18 lower floor fill	--	--	X	--	--	--	--
Roasting pit F15 (detailed analysis)	--	--	--	X	--	--	--
Roasting pit F15 (scan)	X	--	--	X	--	--	--
Pit F45	X	--	X	X	X	X	--
Pithouse hearth F59.01	--	X	--	--	--	--	--
Pit F75	X	--	--	--	--	--	--
Pit F81	--	--	--	--	--	X	--
			COBBLE				
Trash mound F2, level 1	--	--	--	--	--	X	X
Trash mound F2, level2	--	X	--	--	--	X	--
			BOONE MOORE				
Masonry pitroom F1 floor fill	--	--	--	X	--	--	--
Masonry pitroom F18 upper floor	X	X	--	--	--	--	--
Pithouse F19 floor fill	--	--	--	--	--	X	--
			REDSTONE				
Pithouse F5 floor fill	--	X	--	--	--	--	--
Pit F25	--	--	--	--	--	X	--
			ROOTED				
Pithouse hearth F14.08	--	--	--	--	--	X	--
			ARBY'S				
Slab-lined pitroom F3 floor fill	--	--	--	--	--	X	X
Cobble brush structure hearth F5.01	--	--	--	X	--	--	--

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[a] Outliers = more than two standard deviations from the mean

[b] Does not include *Papaver somniferum*.

Table 18.10. Charred macrobotanical identifications.

Context and Provenience	Provenience Number	Identification	Comments
		DEER CREEK	
Pithouse F2 floor fill	392-8	1 *Pinus edulis* type seed (uncarbonized)	The endosperm is moist, so it is probably a contaminant
Pithouse F14 floor fill	172-6	1 *Acacia greggii* seed half	A cotyledon
Pithouse F21 floor fill	291-6	1 *Juglans major* nut	Split in half longitudinally but otherwise well preserved
Pithouse F32 roof/wall fall	274-3	1 *Zea mays* kernel fragment	No discernible difference in endosperm constituency
Pithouse F32 floor contact	287-12	1 *Prosopis velutina* seed	One (beetle?) hole
		REDSTONE	
Pithouse F11 floor fill	136-8	1 cf. *Cercidium microphyllum* seed fragment	
Pithouse F11 floor fill	189-13	27 *Nolina* leaf fragments	Leaf margins are more similar to *Nolina microcarpa* than *Agave*, *Dasylirion*, or *Yucca*
		7 *Populus/Salix* type wood charcoal fragments	
		1 Unknown type wood charcoal fragment	

Several other taxa, however, were represented by only one or two charred plant remains and seem to be more likely candidates for accidental inclusion. These are: *Astragalus nuttallianus* type seeds, Pink family cf. campion seeds, spurge seeds, *Phacelia* seeds (all types), canary grass grains, Indian wheat seeds, and potato family seeds.

Historic Local Subsistence

The Rye Creek Project area lies within the historic territories of two groups of Native Americans, the Kewevkapaya or Southeastern Yavapai (Gifford 1932; Khera and Mariella 1983), and the Southern Tonto group of Western Apaches who are believed to have migrated into the area after about A.D. 1750 (Basso 1983:465) (see Ferg, Chapter 23, this volume). Although there are a substantial number of sources describing Western Apache subsistence practices, there are comparatively few Yavapai references. The next section discusses a few of the more thorough ethnobotanical studies to provide information about local historic subsistence pursuits.

Gifford. Gifford (1932) states that the southeastern Yavapai subsisted wholly upon wild products. He attributed the lack of agriculture to an absence of suitable land, an abundance of wild products, fear of attack, and tradition. The most common cooking methods were boiling and parching. Six important plant foods, listed in their approximate order of their dietary importance, were agave, saguaro (*Carnegiea gigantea*), prickly pear, velvet mesquite, acorns, and pinyon nuts. The latter two foods were not considered staples. Informants described agave as "the essential food" that was available year-round.

Khera and Mariella. Today agriculture has apparently become more important now that the Yavapai have been forced onto a small reservation and denied access to their formerly vast territory (Khera and Mariella 1983). Gifford's informants knew of only one southeastern Yavapai farmer, but Khera and Mariella describe the modern cultivation of maize, beans, squash, and tobacco in washes, streams, and near springs, sometimes using irrigation ditches. Gardens are planted and intermittently returned to in between hunting and gathering expeditions. Maize is the most often planted crop.

Khera and Mariella note that although local Yavapai bands generally move their camps to be near different ripening plant foods, they might congregate for up to four months each year to exploit agave. Food is most plentiful during fall when several types of wild plants have ripened and the agricultural crop is harvested.

Goodwin. Goodwin (1935) stated that plant foods accounted for roughly 60 to 65 percent of the Western Apache diet, with meat comprising the rest. Cultivated plants constituted from nearly 0 to 20 or 25 percent of the diet depending on access to a farm, although most people did some planting. Farm fields were often half an acre or less. Maize was the most important crop, but beans, squash, and wheat also were planted.

The most important wild plant staples were agave and acorns. Other important foods were saguaro fruits, mesquite pod mesocarp, yucca fruits, sunflower achenes, prickly pear fruits, pinyon nuts, and juniper fruits (berries).

Buskirk. Buskirk's (1986) published dissertation on the Western Apache subsistence economy notes that farms usually were located above the floodplain along stream courses, and tended to be long and narrow, often on the order of one-half to three-quarters of an acre. Over half of the fields were left in fallow each year.

Although men usually did the heavy work of building dams, digging ditches, and clearing the fields, women shared in all aspects of the labor and were considered to be the best farmers in pre-reservation days. Fields were cleared by burning off weeds, removing smaller stones, and soil was broken with a digging stick. Crops were planted in one day. Ditch irrigation and diversion dikes were common. Fertilizers were not used.

Maize was the most important agricultural crop; all who farmed planted maize and more maize was grown than any other crop. Although pumpkins (*Cucurbita moschata* or *C. pepo*) were an ancient crop, they apparently were not grown in large numbers. Buskirk noted that the seeds of a species of *Chenopodium* were broadcast near camps for use as a potherb. He believed that domesticated sunflower (*Helianthus annuus*) was first cultivated after 1860.

Agriculture was viewed as of secondary dietary importance compared to either hunting or gathering in pre-reservation days. Buskirk (1986:197-198) summarized the most important wild plant foods:

> In the order of their relative economic importance, wild plant foods used by the White Mountain and Cibecue were mescal [agave], acorns, sunflower seeds; other wild seeds and nuts, including piñon and walnut; yucca fruit, prickly pear fruit, juniper berries, mesquite and saguaro. In addition to these, various roots, greens, and berries were used. Favorite foods, or at least the foods spoken of most often, were mescal and acorns, although sunflower seeds and piñon nuts were close behind in favor.

Summary. Each of the three ethnobotanies that ranked pre-reservation foods listed agave as the principal wild plant food (Buskirk 1986; Gifford 1932; Goodwin 1935). Each of these also listed acorns, saguaro fruits, pinyon nuts, prickly pear fruits, and mesquite pod mesocarp as important foods. Further, maize was consistently mentioned as the most frequently planted crop, although agriculture was considered to be less important than gathering.

Local Comparative Archaeobotanical Data

The author is aware of only two other Upper Tonto Basin flotation studies: the Oxbow Hill-Payson Project (L. Huckell 1978), and the Ord Mine Project (Halbirt and Gasser 1987). The Oxbow Hill-Payson Project may not be the best comparison because it can either be considered as at the north edge of or just out of the Tonto Basin. A limitation is that both of these studies were performed before the time (ca. 1982) when charred agave fibers were recognized (Gasser and Kwiatkowski 1991). The charred plant taxa identified during these two analyses are listed in Table 18.11.

The Oxbow Hill-Payson Project. Lisa Huckell (1978) found 45 charred maize kernel fragments in floor fill, floor contact, and a storage pit in a masonry structure at Casita Escondida, AZ O:15:42 (ASM), and she recovered a charred manzanita nutlet and a carbonized pigweed seed in the bottom interior fill of a metate. Bruce Huckell (1978:87) dated this site to somewhere between A.D. 800 and 1300, and he hypothesized that it represents a "short-term, seasonally occupied habitation camp". Four pollen samples contained maize pollen, and Bruce Huckell concluded that the site was probably occupied from late spring through summer, and may have been associated with small-scale agricultural activities, although he did not rule out the possibility of use of the site area as a base for wild plant exploitation. A single flotation sample from a second masonry structure at another site was analyzed but contained no identifiable charred plant material.

The Ord Mine Project. Over 100 flotation samples were analyzed from 16 sites (Halbirt and Gasser 1987; Table 18.11). Most of the sampled contexts dated to the early Classic period, ca. A.D. 1100-1300, except for four samples from protohistoric Apache mescal processing features. Possible dietary staples identified were maize, legumes, grass grains, and Cheno-ams.

Halbirt and Gasser (1987:316) found that courtyard sites (which were the largest sites, consisting of one or two courtyards, each with associated primary habitation dwellings and storage structures) yielded both cultivated and wild plants indicative of a mixed subsistence strategy. All but one of the homesteads (one- or two-room structures with cooking facilities, well-defined outdoor activity areas, and a larger, more diverse artifact assemblage than fieldhouse sites) also contained evidence of a mixed subsistence economy. The single exception had no cultivars. One of the homesteads with both wild and cultivated plants, Gold Creek House (NA16,926), may have emphasized the exploitation of manzanita and juniper fruits. Field house sites (primarily single-roomed sites with rare cooking facilities and low artifact diversities), in contrast, seemed to be somewhat specialized because each yielded only either maize or wild plant remains.

Architectural assessments of courtyard site room functions were supported by archaeobotanical data because several storage rooms had higher lily family and maize pollen percentages than corresponding habitation rooms. Few economic taxa were found in structure hearths and it was believed that they were not frequently used for cooking. The archaeobotanical contents of rock-filled pits, containing abundant wild plant resources but no domesticates, differed from the slab-lined pits that yielded only maize and Cheno-am remains. It was suggested that slab-lined pits were most likely used for storage.

The Ord Mine Project produced far more unproductive flotation samples, and yielded lower diversities and abundances of charred plant material than the Rye Creek Project. Some of these differences are probably due to alternative sample collection, processing, and analytical techniques, rather than reflections of substantial archaeobotanical differences between the two areas (although the Rye Creek sites are both earlier and generally larger than the Ord Mine sites). Agave identifications doubtlessly account for some of these differences. If agave was not identified, the number of unproductive samples from the Rye Creek Project would more than double, from six to 13. Further, the Ord Mine light fractions were caught in 0.85 mm mesh (Halbirt and Gasser 1987:284). Most of the small grass grains, Cruciferae seeds, and even many Cheno-am seeds would pass through a screen of this relatively coarse size. If all agave, tansy mustard, sprangletop type, and dropseed type remains were eliminated from the Rye Creek data, there would still be only 13 unproductive flotation samples. Finally, the Ord Mine Project used a two liter standard flotation sample size, while the Rye Creek Project samples were generally four liters; Miksicek (1984a) has demonstrated that there is a direct relationship between flotation sample size and the number of taxa recovered.

Table 18.11. Charred plant taxa recovered from the Ord Mine and Oxbow Hill Payson projects.

Site	Site Type[a]	Date[b]	No. Samples Analyzed	No. Productive	No. Liters Analyzed	*Acacia greggii*	*Arctostaphylos*	Cheno-am	*Cycloloma*	*Echinocereus*	*Eriogonum*	*Erodium*	Gramineae	*Juniperus*	Leguminosae	Platyopuntia	*Prosopis* pod	*Sphaeralcea*	*Zea mays*
ORD MINE (HALBIRT AND GASSER 1987)																			
La Piedra	CY	EC1	7	2	14	--	--	--	--	--	--	X	--	--	--	--	--	--	--
Limestone House	CY	EC1	15	3	27	--	--	--	--	--	--	--	--	--	--	--	--	--	X
Mazatzal House	CY	EC1	42	19	76.8	X	--	X	X	X	--	--	--	X	X	X	X	X	X
Gold Creek	HS	EC1	6	4	11	--	X	--	--	--	--	--	--	X	--	--	--	--	X
Junction House	HS	EC1	1	1	2	--	--	--	--	--	--	--	X	--	--	--	--	--	--
Powerline	HS	EC1	6	1	2	--	X	--	--	--	--	--	--	--	--	--	--	--	--
Swimming Hole	HS	EC1	5	2	9.5	--	--	X	--	--	--	--	X	--	--	--	--	--	X
Dump	FH	EC1	2	0	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Exhastion	FH	EC1	3	0	3.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Flesher	FH	EC1	3	0	3.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Killer Bee	FH	EC1	1	1	2	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Marino	FH	EC1	4	1	8	--	--	--	--	--	--	--	--	--	--	--	--	--	X
Pony Express	FH	EC1	4	1	10	--	--	--	--	--	--	--	--	--	--	--	--	--	X
Powerline Annex	FH	EC1	4	1	8	--	--	--	--	--	--	--	--	--	--	--	--	--	X
Trella	FH	EC1	3	0	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Black Hole	PM	APA	1	1	2	--	--	X	--	--	--	--	--	--	--	--	--	--	--
Mazatzal House	PM	APA	3	3	6	--	X	X	--	--	X	--	--	--	--	--	--	--	--
Ord Mine Totals:			110[c]	40[c]	205.7														

Table 18.11. Continued.

Site	Site Type[a]	Date[b]	No. Samples Analyzed	No. Productive	No. Liters Analyzed	*Acacia greggii*	*Arctostaphylos*	Cheno-am	*Cycloloma*	*Echinocereus*	*Eriogonum*	*Erodium*	Gramineae	*Juniperus*	Leguminosae	Platyopuntia	*Prosopis* pod	*Sphaeralcea*	*Zea mays*
OXBOW HILL-PAYSON (L. HUCKELL 1978)																			
Granite Ridge	MS	EC2	1	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Casita Escondida	MS	EC3	26[d]	13	--	X	X	--	--	--	--	--	--	--	--	--	--	--	X

Note: All taxa are charred grains or seeds, except *Arctostaphylos* (which are nutlets), *Prosopis* (pod fragments), and *Zea mays* (cupules and kernel fragments). Carbonized *Juniperus* branchlets from the Ord Mine project are not included.

[a] Site types: CY = courtyard site; FH = fieldhouse site; HS = homestead; MS = seasonally occupied masonry structure; PM = protohistoric mescal processing midden

[b] Date codes: APA = protohistoric Apache; EC1 = ca. A.D. 1100-1300; EC2 = ca. A.D. 1050-1280; EC3 = ca. A.D. 800-1300

[c] There are slight discrepancies in Halbirt and Gasser (1987) between the text and the tables in the number of samples analyzed and their productivity. These totals are from the raw data table.

[d] Includes 13 macrobotanical samples.

Rye Creek Project Food Plants

The taxa probably used for food and represented by charred plant remains from the Rye Creek Project area are listed by site and time period in Table 18.12. These assessments are based on information provided in the preceding sections including ethnographic analogues, local comparative archaeobotanical data, the likelihood that the taxa could be inadvertently carbonized members of the prehistoric natural seed rain, and the distribution of charred plant remains in project area sites.

Nine different plant food taxa are represented at the majority of sites. Six of these are small seeds or grains: Cheno-am, tansy mustard, hedgehog cactus, sprangletop type, purslane, and dropseed type. The fruit of hedgehog cactus also would have been eaten while obtaining its seeds. Another economic taxon, *Hordeum*, is a relatively large grain. The final two most common economic taxa were agave and maize. Agave hearts were undoubtedly used for food, its leaf fibers were probably an important source of cordage, and agave leaves may have served a dual role as both food and fiber (Castetter, et al. 1938:69). It also seems likely, based on historic analogues, that agave flower stalks were eaten.

The use of stickleaf (*Mentzelia albicaulis* type) seeds has not been noted at other sites in the Upper Tonto Basin and has not been reported in the local ethnobotanies; however, 5 ml of stickleaf seeds were found within a ceramic storage vessel in a pithouse at AZ BB:13:50 (ASM) south of Tucson (Bohrer et al. 1969); Bohrer, Cutler and Sauer (1969:7) also note that stickleaf seeds have been recovered from the Point of Pines area in east-central Arizona and at Cordova Cave in southwestern New Mexico.

The presence of *Hordeum* is interesting because the average Rye Creek *Hordeum* presence value of 41.9 percent is perhaps the highest ever recorded. Comparable *Hordeum* presence values from two sites in the lower Salt River valley were 26.5 percent at La Lomita (Kwiatkowski 1990) and 23.7 percent at El Caserío (Kwiatkowski 1989a). That is, *Hordeum* occurred about twice as often in the Rye Creek flotation samples compared to two sites in the lower Salt River valley that are considered to be representative of *Hordeum* cultivation.

Dietary Speculations

The Rye Creek flotation data correspond well in several respects with the historically recorded uses of plants in the area. Agave seems to have been quite important and maize appears to have been a vital agricultural crop, although the probable cultivar *Hordeum* was quite common.

There was, perhaps, more reliance on small seeds and grains than was the case historically. This probably stems from the diminished use of grass grains during historic times in response to their decreased availability, the introduction of Old World foods, and the rather high labor investment required for grass grain collection. Bohrer (1975) has argued that a number of grass types declined in economic importance after 1870 as the result of overgrazing. Minnis (1991) has pointed out that once important plant foods have become present-day famine foods, and the famine foods of yesterday -- including wild grass grains -- are rapidly being forgotten.

The most notable difference between the flotation data and the local ethnobotanies is the absence of three historic plant staples: acorns, pinyon nuts, and saguaro fruits. At least three explanations seem likely. The first is that some of these resources were not locally used. This seems possible in the case of saguaro, a plant that does not currently grow in the area. In this case the under-utilization of these plants may be related to the reduced mobility of the prehistoric population of the Rye Creek Project area compared to their historic counterparts. Support for a more sedentary lifestyle is perhaps found in architectural comparisons. Prehistoric buildings in the project area frequently seem to have been built for durability compared to the relatively diaphanous Western Apache and southeastern Yavapai dwellings (see Gifford 1932:203; Reagan 1929:143-144). It is harder to determine why acorns and pinyon nuts are missing from the assemblage using only this explanation, however, because these taxa commonly are represented by project area wood charcoal (see Chapter 19).

Table 18.12. Summary of the economic analysis.

Site:	Deer Creek		Hilltop		Compact	Redstone	Rooted	Clover Wash	Cobble	Boone Moore	Arby's
Date:[a]	GB	PRE	SAC	CLA	SAC	SAC	SAC	SAC	EC	EC	EC
					PLANT FOODS[b]						
Agave hearts	Y	Y	Y	--	Y	Y	Y	Y	Y	Y	Y
Cheno-am seeds	Y	Y	Y	Y	Y	Y	Y	Y	Y	--	Y
Echinocereus fruits and seeds	Y	Y	Y	--	Y	Y	Y	Y	Y	Y	Y
Zea mays green corn and kernels	Y	Y	--	--	Y	Y	Y	Y	Y	Y	Y
Hordeum grains	Y	Y	Y	--	Y	Y	Y	Y	Y	--	--
Portulaca seeds	Y	Y	--	--	Y	Y	Y	Y	Y	Y	--
Leptochloa type grains	Y	Y	Y	--	--	Y	Y	Y	--	--	--
Sporobolus type grains	Y	--	--	--	Y	Y	Y	Y	Y	--	--
Descurainia seeds	Y	Y	Y	--	--	--	Y	--	Y	--	--
Arctostaphylos fruits	Y	Y	--	--	--	Y	--	--	Y	--	--
Globular unknown seeds	Y	Y	--	--	--	--	--	Y	--	Y	--
Mentzelia seeds	Y	Y	--	--	--	--	--	--	--	--	--
Platyopuntia fruits	Y	--	--	--	--	--	--	Y	--	--	--
Acacia greggii pods	Y	--	--	--	--	--	--	--	--	--	--
Bromus and *Elymus* type grains	Y	--	--	--	--	--	--	--	--	--	--
Cercidium microphyllum seeds	--	--	--	--	--	Y	--	--	--	--	--
Juglans major nut meat	Y	--	--	--	--	--	--	--	--	--	--
Juniperus fruits	Y	--	--	--	--	--	--	--	--	--	--
Prosopis velutina pod mesocarp	Y	--	--	--	--	--	--	--	--	--	--
Salvia seeds	Y	--	--	--	--	--	--	--	--	--	--
Agave flower stalks and leaves	I	I	I	--	I	I	I	I	I	I	I
Boraginaceae like unknown seeds	I	I	--	--	--	I	I	--	I	--	--
Distichlis type grains	I	I	--	--	--	--	--	I	--	--	--
Compositae achenes	I	I	--	--	--	--	--	--	--	--	--
Opuntia seeds	I	--	--	--	--	--	--	I	--	--	--
Phalaris grains	--	--	--	--	--	I	--	I	--	--	--
Platyopuntia seeds	I	--	--	--	--	--	--	I	--	--	--
Sphaeralcea seeds	I	--	--	--	--	--	I	--	--	--	--
Teardrop-shaped unknown seeds	I	I	--	--	--	--	--	--	--	--	--
Acacia greggii seeds	I	--	--	--	--	--	--	--	--	--	--
Prosopis velutina seeds	I	--	--	--	--	--	--	--	--	--	--

Table 18.12. Continued.

Site:	Deer Creek		Hilltop		Compact	Redstone	Rooted	Clover Wash	Cobble	Boone Moore	Arby's
Date:[a]	GB	PRE	SAC	CLA	SAC	SAC	SAC	SAC	EC	EC	EC
PLANT FOODS[b]											
Argemone seeds	N	--	--	--	--	--	--	--	--	--	--
Astragalus Nuttallianus types seeds	N	--	--	--	--	--	--	--	--	--	--
Caryophyllaceae seeds	N	--	--	--	--	--	--	--	--	--	--
Euphorbia seeds	N	--	--	--	--	--	--	--	--	--	--
Phacelia seeds	N	--	--	--	--	--	--	--	--	--	--
Plantago seeds	--	--	--	--	--	N	--	--	--	--	--
Solanaceae seeds	N	--	--	--	--	--	--	--	--	--	--
CORDAGE OR MATTING											
Agave fibers	Y	Y	Y	--	Y	Y	Y	Y	Y	Y	Y
Other Agavaceae fibers	Y	--	--	--	--	Y	--	Y	--	--	--
STRUCTURAL MATERIAL											
Nolina leaves	--	--	--	--	--	Y	--	--	--	--	--
Populus/Salix type wood	--	--	--	--	--	Y	--	--	--	--	--
FUEL											
Zea mays cobs	Y	Y	--	--	Y	Y	Y	Y	Y	Y	Y
Gramineae culms or Monocot stems	I	I	--	--	I	I	--	--	--	--	--

Note: The "Other Agavaceae" category includes samples with abundant charred round fibers without styloid or raphide crystals that are not believed to be *Agave*.

[a] Date codes: CLA = Indeterminate Classic; EC = Early Classic (ca. A.D. 1150-1300); GB = Gila Butte (ca. A.D. 750-850); PRE = Indeterminate Preclassic; SAC = Sacaton (ca. A.D. 950-1150)

[b] Economic codes: I = Indeterminate economic importance; N = Probably an incidentally included component of the prehistoric seed rain; Y = Probably economically important

A second alternative is that some or all of these foods were used locally, but were not exposed to fire during processing or discard, and therefore have left no traces in the archaeobotanical record. This is possible because each of these foods do not *necessarily* require direct heat for processing, although fires are commonly used to release young pinyon nuts from their cones.

It will be recalled that local Native American groups historically moved their camps at certain times of the year to collect ripening wild plant food resources in areas where they were locally plentiful. Therefore a third alternative explanation is that although the inhabitants of the Rye Creek sites exploited plant foods such as saguaro fruits, acorns, and pinyon nuts, they were collected, processed, and perhaps largely consumed off-site. In this scenario, although pinyon nuts and juniper berries were locally available, gathering parties nevertheless traveled to areas where they were especially abundant or palatable. This would reduce and perhaps eliminate the by-products from plant processing that otherwise would be evident at the Rye Creek sites. Of course, any or all of these alternatives, and perhaps others, may have worked in concert to produce the absence of saguaro seeds, acorn nut shells, and pinyon nuts observed at the Rye Creek sites.

Seasonality

Elson (Chapter 26, Volume 3) has assessed the annual occupation spans of the Rye Creek sites through a multivariate analysis where project area sites were compared to other sites of known or suspected levels of permanence. The project area sites are believed to have ranged from permanent (Deer Creek during Gila Butte phase, and possibly the Rooted site and the Cobble site) to short-term permanent (the Redstone, Clover Wash, and Boone Moore sites), to seasonally reused (the Compact and Hilltop sites) and seasonal (the Arby's site).

Because some of the Rye Creek sites seem to have been occupied throughout the year while others were not, the flotation data are next considered for evidence of seasonal site use. First, the historical Western Apache seasonal round is discussed as a historic analogue because comparable information for the southeastern Yavapai are too incomplete. While the prehistoric inhabitants of the project area could have been less mobile than the Apache, a consideration of historic seasonal variability provides an idea of when and where a number of agricultural and gathering activities may have occurred, as well as providing a model for seasonal dietary variation.

A Historic Analogue: The Western Apache

The agricultural cycle began with the return to farm fields in March or April (Buskirk 1986:26). It took about a month to prepare and plant fields (Goodwin 1935:63). If beans (*Phaseolus acutifolius*, *P. vulgaris*, and either *P. lunatus* or *P. coccineus*) were grown they were usually planted together with maize in April or early May (Buskirk 1986:27-28). After good rains and two or three irrigations had assured the success of a crop the farmers would often leave to gather wild foods, returning for the harvest (Buskirk 1986:70; Goodwin 1935:63). Therefore, the only essential time to be at the fields was during the spring planting and fall harvest. This allowed for the collection of ripening wild plant foods such as acorns during much of July and August at locations where they were most abundant. The wild plant food staples grew at different elevations, so that it was necessary to mount expeditions of from ten days to one month to harvest them (Goodwin 1935:62). Maize, beans, and pumpkins were harvested together generally around late August to September (Buskirk 1986:70). The harvest took about a month (Goodwin 1935:63). After the harvest and acorn gathering most people moved south across the Salt River and wintered in agave fields until March or April (Buskirk 1986:162).

Seasonal variation in the Western Apache diet was described by Buskirk (1986:215):

> On the whole, spring was the time when grass and weed seeds, stored acorns, and jerked meat were eaten, although there might be fresh meat to boil.
>
> During summer there were quantities of green corn, green-corn tortillas, beans, pumpkins, watermelons, mesquite, and acorns but not much meat.
>
> In the fall there was an abundance of acorns and other wild food plants in addition to the harvested crops.
>
> During the winter there was more use of mescal and meat. Stored acorns, walnuts, berries, and corn were also eaten. An attempt was made to have some corn with every meal, or at least once a day. Dried summer berries also were made to last through the winter.

Flotation Seasonal Indicators

Using flotation data to assess site seasonality is complicated. Harvest and gathering schedules doubtlessly fluctuated somewhat in response to the demonstrated annual differences in effective moisture (Shaw 1990). Further, in light of Buskirk's (1986:25) observations on seasonal variation in the Western Apache diet it cannot be automatically assumed that seeds or grains normally collected during one season were consumed immediately rather than stored for use during leaner times of the year.

Probably the best seasonal indicators are plant remains that were burned accidentally during their harvest and processing, or burned waste products from plant processing. Although the Pima and Tohono O'odham often parched seeds and grains immediately after their harvest and before storage to prevent mildew and facilitate grinding (Castetter and Bell 1942:181; Castetter and Underhill 1935:24), it is unclear whether this practice was common among the Western Apache and southeastern Yavapai (cf. Buskirk 1986; Gifford 1932; Goodwin 1935; Reagan 1929), or among prehistoric groups.

Waste products. Perhaps the best seasonal indicator in the Rye Creek Project area is the presence of *Hordeum* rachis joint fragments and cf. *Hordeum* spikelet fragments. These waste products from grain processing were almost certainly burned at the *Hordeum* harvest in spring so that grains could be separated from the rest of the papery spike in a process analogous to chaffing. The grains could then either be immediately used or stored with reduced bulk. Sites with and without charred *Hordeum* waste parts are listed in Table 18.13. Based on these data, it is likely that the Deer Creek (Gila Butte phase), Redstone, Hilltop (Sacaton phase), Rooted, and Clover Wash sites were sometimes occupied during the *Hordeum* harvest. This would generally have occurred in March or April (Adams 1987:Table 4).

Table 18.13. Sites with and without charred *Hordeum* waste products.

Permanent Sites	Short-term Permanent Sites	Seasonally Reused Sites	Seasonal Sites
	SITES WITH *HORDEUM* WASTE PRODUCTS		
Deer Creek Gila Butte (rj,sf)	Redstone (sf)	Hilltop Sacaton (sf)	--
Rooted (rj,sf)	Clover Wash (sf)	--	--
	SITES WITHOUT *HORDEUM* WASTE PRODUCTS		
Cobble	Boone Moore	Compact	Arby's

Note: rj = *Hordeum* rachis joints; sf = cf. *Hordeum* spikelet fragments

A somewhat less convincing seasonal indicator is the waste product from maize processing, the cob. Although the consistent occurrence of charred cob fragments in the project area indicates that maize was grown nearby, it is possible that some maize may have been stored on the cob (Buskirk 1986:73) and carried to seasonal sites as prepackaged food bundles. The Western Apache, for example, sometimes tied a dried ear of corn on their belts for food while hunting (Buskirk 1986:130). All of the Rye Creek sites except the Hilltop site yielded charred maize cob fragments, raising the possibility that the latter site may not have been occupied during the maize harvest, around August and September. Other charred waste products from the project area are unreliable seasonal indicators because they either were not identified to a secure level (cf. Cactaceae prickles) or they represent a plant part, (such as agave leaves), that could have been obtained at any time of the year.

Seeds and Grains. Seeds and grains are even less reliable seasonal indicators than maize cobs because of their storage potential. Nevertheless, the presence of seeds and grains normally available during particular seasons is examined as an additional line of evidence for site seasonality since it seems likely that sites abandoned during a particular season ought to contain relatively few plants becoming available during that time of the year. A further problem with this approach is that a number of plants can go to seed at almost any time of the year in response to increased available moisture.

The presence of several charred plant taxa believed to be relatively good seasonal indicators for the Rye Creek sites are listed in Table 18.14. Inspection of this table indicates that while spring and late summer are relatively well represented, few good midsummer and late fall seasonal indicators were present. Only samples from the Gila Butte phase at the Deer Creek site contained both summer and late fall plants. This corresponds well to Elson's (Chapter 26) assessment that this site was occupied permanently during the Gila Butte phase. Besides the Deer Creek site, only the Clover Wash site had evidence for summer plant use in the form of charred Platyopuntia seed fragments. The Hilltop site once again stands out as possibly being occupied primarily during the spring because of the lack of seeds and grains harvested during other times of the year.

Charred Plant Remain Densities. Another way to evaluate the seasonality and intensity of occupation is to determine whether flotation samples at some sites contained significantly more charred plant remains than samples from other sites. Charred plant densities would presumably be lowest at the least intensively occupied sites. In order to examine the Rye Creek data in this way, the number of charred plant parts per liter was used from the detailed analysis flotation samples listed in Table 18.4; multiple samples from the same context were grouped to form a single sample locus, and solitary samples from a site or time period were eliminated. This resulted in 64 sample loci from nine sites or time periods. The charred plant parts-per-liter densities were converted to ranks and a Kruskal-Wallis test (Gibbons 1985:1735-193) was performed (Table 18.15). The results were significant at p=.05 and so a Tukey's multiple comparison test (Ott 1988:446-449) was conducted (Table 18.15). The results indicate that flotation samples from the Arby's site contained significantly fewer charred plant remains than samples from the Deer Creek site (Gila Butte phase), the Redstone site, the Rooted site, and the Cobble site, when the data were converted to ranks. Further, samples from the Cobble site contained more charred plant remains than samples from the Compact and Boone Moore sites. These results reinforce Elson's assessment of the Arby's site as seasonal and the Cobble site as a more permanent occupation.

Taxonomic Diversity. A final way to assess seasonality is to examine whether flotation samples from some sites contained more taxa per liter than others. Seasonally or less intensively occupied sites ought to contain fewer taxa per sample than more permanently occupied ones. The results of this analysis should correspond closely to Elson's multivariate seasonal analysis because this was one of the variables that he used.

The number of charred plant taxa per liter per sample locus was calculated from the raw flotation data listed in Appendix G Tables 1 through 9. Flotation data from both the detailed and the intensive scan analysis were used. Different plant parts from the same taxon (e.g., maize cupules, kernels, and glumes) were grouped as in Table 18.5. These data were then converted to ranks and a Kruskal-Wallis test was performed (Table 18.16). A series of Tukey multiple comparison tests were conducted using a significance level of p=.05 because the Kruskal-Wallis test was significant (Table 18.16). The results of these tests demonstrate that flotation samples from the Boone Moore site yielded less diverse charred plant remains than samples from the Deer Creek site (during both the Gila Butte phase and the indeterminate Preclassic period) and the Rooted site. Boone Moore was particularly unusual in that Cheno-am seeds, which were the second most common taxon in the Rye Creek flotation samples (Table 18.5), were not present despite a relatively large sample size (n=12).

Summary

The results of the seasonality analyses generally correspond well with Elson's multivariate analysis. The Deer Creek site, Gila Butte phase occupation appears to have been relatively permanent because plants collected from spring through late fall were represented. The Cobble site and the Rooted site also had significantly more charred plant remains than several other sites and also seem to have been fairly permanent.

Table 18.14. Some seasonally sensitive plants at the Rye Creek sites.

	Permanent or Probably Permanent			Short-term Permanent			Seasonally Reused			Seasonal
Taxon	Deer Creek Gila Butte	Cobble	AZ O: 15:92	Redstone	Clover Wash	Boone Moore	Deer Creek Indet. Preclassic	Compact	Hilltop	Arby's
				SPRING (March, April, May)						
Descurainia	X	X	X	--	--	--	X	--	X	--
Echinocereus	X	X	X	X	X	X	X	X	X	X
Hordeum	X	X	X	X	X	--	X	X	X	--
				EARLY SUMMER (June, July)						
Platyopuntia	X	--	--	--	X	--	--	--	--	--
Prosopis	X	--	--	--	--	--	--	--	--	--
				LATE SUMMER/EARLY FALL (August, September)						
Zea mays	X	X	X	X	X	X	X	X	--	X
				LATE FALL (October, November, December)						
Juniperus	X	--	--	--	--	--	--	--	--	--

Table 18.15. Results of a Kruskal-Wallis Test on charred plant remains per liter in detailed flotation analysis sample loci.

Site	Actual Mean	Mean Rank[a]	No. Sample Loci
Cobble	40.08	55.0	3
Rooted	17.75	51.3	3
Redstone	26.00	46.5	4
Deer Creek, Indet. Preclassic	37.54	37.4	6
Deer Creek, Gila Butte Phase	12.13	35.9	26
Clover Wash	6.31	32.4	4
Boone Moore	3.03	18.5	9
Compact	2.84	17.8	5
Arby's	0.94	8.3	4

H (corrected for ties): 25.99
SIGNIFICANCE: p=.001 (8 d.f.)

SIGNIFICANT PAIRWISE COMPARISONS USING TUKEY'S W PROCEDURE (p=.05; 36 total comparisons):

Boone Moore vs. Cobble

Arby's vs. Deer Creek, Gila Butte Phase

Arby's vs. Redstone

Arby's vs. AZ O:15:92

Arby's vs. Cobble

Compact vs. Cobble

---

[a] Higher ranks indicate more abundant charred plant remains.

The Hilltop site may have been occupied primarily during the spring because a number of plants normally available during this season were present, including waste products from *Hordeum* processing, but plants from other seasons were not recovered. This is based on so few samples (n=4), however, that it should be viewed as speculative. The Arby's site, that Elson believes was occupied seasonally, contained the lowest density of charred plant parts per sample; perhaps this reflects a relatively slight occupation intensity. If the Arby's site was occupied seasonally, the relative abundance of charred maize remains, including the highest percentage of maize kernel fragments recovered from the project, would suggest that it was occupied during the maize harvest.

The charred plant assemblage at the Boone Moore site exhibited the lowest taxonomic diversity of all sites examined. Perhaps the Boone Moore site was used primarily for a specialized activity such as hunting; Szuter (Chapter 21) found an extraordinarily high number of artiodactyl remains there.

Table 18.16. Results of a Kruskal-Wallis Test on the number of charred plant taxa per liter in sample loci from both the detailed and intensive scan analysis.

Site	Actual Mean	Mean Rank[a]	No. Sample Loci
Rooted	1.67	67.5	3
Deer Creek, Indet. Preclassic	2.68	61.2	7
Deer Creek, Gila Butte Phase	1.48	54.5	37
Clover Wash	1.16	49.6	8
Redstone	1.15	49.3	5
Cobble	0.98	41.0	3
Compact	0.89	37.9	7
Hilltop	0.69	29.1	4
Arby's	0.49	20.4	4
Boone Moore	0.44	18.1	12

H (corrected for ties): 28.84
SIGNIFICANCE: p=.0007 (9 d.f.)

SIGNIFICANT PAIRWISE COMPARISONS USING TUKEY'S W PROCEDURE (p=.05; 45 total comparisons):

Boone Moore vs. Rooted

Boone Moore vs. Deer Creek, Gila Butte Phase

Boone Moore vs. Deer Creek, Indeterminate Preclassic Period

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[a] Higher ranks indicate higher taxonomic diversity.

Finally, surprisingly few good seasonal indicators of midsummer and late fall plants were found even though several plants available during these seasons could have been exploited in the Rye Creek area. Potential midsummer resources include acorns, mesquite pods, and prickly pear seeds, and late fall foods are pinyon nuts and juniper berries. It is presently *not* clear whether this indicates that most of the Rye Creek sites were largely abandoned during these seasons.

Feature Function and Flotation Data Variability

Feature Function

Several other features, in addition to those with an unusual abundance of charred plant material (Table 18.7) seem to contain de facto refuse (Schiffer 1972) related to feature function. These features, along with their inferred economic functions are listed in Table 18.17. Small seeds and grains appear to have been prepared over a number of hearths within structures. Perhaps this occurred most frequently during inclement weather because food could have been processed outdoors during good weather without producing undue heat and smoke. Possibly these seeds were prepared during spring as Buskirk (1986:215) noted. Interestingly, each of the structure hearths with evidence for small seed or grain processing is located at what is believed to be a permanent habitation site (Tables 18.7, 18.17).

Deer Creek Site: Gila Butte Phase/Feature Type Variability

Variability in flotation data among feature types at the best sampled time period and site, the Gila Butte phase at the Deer Creek site, are next examined. Mean relative parts percentages and presence values for each feature type represented by more than one sample locus are summarized in Table 18.18.

Table 18.17. Additional features that may contain de facto refuse related to feature function.

Site	Feature No.	Archaeobotanical Evidence[a]
Pithouse hearths that may have been used to process small seeds or grains:		
Deer Creek	F9.04	11 Cheno-am seeds and 20 seed fragments; 6 *Portulaca* seeds and 5 seed fragments
Deer Creek	F22.01	47 *Mentzelia* seeds and 22 seed fragments; 9 Cheno-am seeds and 17 seed coat fragments, 8 *Salvia* seed fragments
Rooted	F14.05	12 Cheno-am seeds; 8 *Hordeum* grain fragments; 29 *Sporobolus* type grains and 3 grain fragments
Rooted	F14.08	5 Cheno-am seeds and 15 seed fragments; 6 *Echinocereus* seeds and 9 seed fragments
Pit possibly used to burn the papery portions of the *Hordeum* spike away from its grain:		
Deer Creek	F54	10 *Hordeum* grains, 29 grain fragments, ca. 60 rachis joint fragments, and ca. 174 cf. spikelet fragments
Zea mays cobs probably used as fuel in pit:		
Deer Creek	F76	12 *Zea mays* cupules, 51 cupule fragments, and 8 glume fragments

[a] The samples contained other remains in addition to those listed here.

The numbers of charred plant remains per liter from each detailed analysis feature type represented by more than one sample locus were converted to ranks, and a Kruskal-Wallis test was conducted to determine whether certain feature types contained greater abundances of charred plant remains (Table 18.19). A Fisher's Least Significant Difference test (Ott 1988:441-446) was performed on the rank-ordered data because the Kruskal-Wallis test was significant (Table 18.19). These tests reveal that crematoria contained lower abundances of charred plant remains than any other feature type except for roasting pits. Pithouse hearths yielded the highest abundances and had significantly more material than either crematoria or roasting pits. These results underscore the importance of pithouse hearths as loci of food processing and seem to indicate that charred botanical refuse usually was not deposited in crematoria (however, see Chapter 19 for evidence of a possible mortuary offering). The charred plant remains in crematoria and most of the "roasting pits" probably represent sheet trash unrelated to feature function. Four out of the six roasting pits contained no evidence of in situ burning (Table 18.4) and may therefore actually have been trash-filled pits rather than roasting pits.

Table 18.18. Relative parts percentages and presence values from Gila Butte phase feature types at the Deer Creek site.

	Crematoria		Pithouse Floor Fill		Pithouse Hearths		Pits		Roasting Pits	
Taxon	r.p. n=4 16.0 l 11.25[a]	p.v. n=5 20.0 l	r.p. n=9 33.0 l 135.5[a]	p.v. n=15 61.0 l	r.p n=2 8.0 l 50.25[a]	p.v. n=3 12.0 l	r.p. n=5 17.0 l 88.5[a]	p.v. n=7 25.0 l	r.p. n=6 24.0 l 29.75[a]	p.v. n=6 24.0 l
Agave	2.22	40.0	28.23	93.3	14.43	100.0	17.80	57.1	31.09	66.7
Arctostaphylos	2.22	20.0	0.37	13.3	--	--	--	--	--	--
Astragalus	--	--	--	--	--	--	0.28	14.3	--	--
Boraginaceae	--	--	0.74	6.7	--	--	1.69	14.3	1.68	16.7
Caryophyllaceae	--	--	0.18	6.7	--	--	--	--	--	--
Cheno-am	51.11	80.0	25.65	100.0	28.36	100.0	9.04	71.4	22.69	83.3
Compositae	--	--	--	--	--	--	0.28	14.3	--	--
Descurainia	--	--	0.74	20.0	0.50	33.3	1.69	42.9	4.20	50.0
Echinocereus	--	--	28.04	66.7	0.50	66.7	2.54	57.1	7.56	83.3
Euphorbia	--	--	--	--	--	--	--	--	0.84	16.7
Globular Unknown	--	--	--	--	1.00	66.7	1.13	14.3	0.84	16.7
Hordeum	20.00	80.0	3.87	46.7	3.48	100.0	29.10	57.1	2.52	33.3
Juniperus	--	--	0.18	6.7	--	--	--	--	--	--
Gramineae	15.56	60.0	7.75	60.0	6.47	66.7	3.11	42.9	15.13	83.3
Mentzelia	--	--	0.55	26.7	34.83	66.7	1.69	14.3	--	--
Stem fragments	--	--	--	13.3	0.50	33.3	--	--	--	--
Opuntia	--	--	--	6.7	--	33.3	--	--	--	--
Phacelia	--	--	0.18	6.7	--	--	--	--	--	--
Platyopuntia	6.67	20.0	--	6.7	--	--	--	--	--	--
Portulaca	--	--	0.37	13.3	5.47	33.3	0.28	14.3	0.84	16.7
Prosopis	--	--	0.18	6.7	--	--	--	--	--	--
Salvia	--	--	--	--	3.98	33.3	--	--	--	--
Solanaceae	--	--	--	--	--	--	0.28	14.3	--	--
Sphaeralcea	--	--	--	--	--	--	0.28	14.3	1.68	33.3
Teardrop Unknown	--	--	0.37	13.3	--	--	--	--	--	--
Zea mays	2.22	40.0	2.58	33.3	0.50	33.3	30.79	57.1	10.92	66.7
Totals:	100.00		99.98		100.02		99.98		99.99	

Note: r.p. = Parts percentage; p.v. = Presence value

[a] The total number of relative parts upon which the relative part percentages are based.

Table 18.19. Results of a Kruskal-Wallis Test on charred plant part per liter densities from detailed analysis feature types at the Deer Creek site, Gila Butte phase.

Feature Type	Actual Mean	Mean Rank[a]	No. Sample Loci
Pithouse hearths	25.13	22.50	2
Pits	17.70	17.00	5
Pithouse floor fill	15.06	15.61	9
Roasting pits	4.96	9.42	6
Crematoria	2.81	6.00	4

H (corrected for ties): 10.07
SIGNIFICANCE: p=0.039 (4 d.f.)

SIGNIFICANT PAIRWISE COMPARISONS USING
FISHER'S LEAST SIGNIFICANT DIFFERENCE
PROCEDURE (p=.05; 10 total comparisons):

Crematoria vs. pithouse floor fill

Crematoria vs. pits

Crematoria vs. pithouse hearths

Roasting pits vs. pithouse hearths

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[a] Higher ranks indicate more abundant charred plant material.

Differences in the mean rank-order number of taxa per liter in feature types from both the detailed and intensive scan analyses were examined with a Kruskal-Wallis test (Table 18.20) but the results were not significant. That is, no Gila Butte phase feature type at the Deer Creek site contained significantly more charred plant taxa than any other.

A Kendall's Coefficient of Concordance test for complete rankings (Gibbons 1985:301-310) was conducted on mean relative parts percentages to determine if the rank order associations of charred plant taxa were similar in each feature type. This test produces a measure ("W") between 0 (no association) and 1 (perfect association) and a test statistic ("Q") that approximates the chi square distribution and can be used to assess probability. The null hypothesis is that no association exists.

For this analysis the relative parts data from the five taxa common to each feature type (agave, Cheno-am, grass grains, *Hordeum*, and maize) and the remaining relative parts percentages (that were grouped into an "other" category) were compared. The test was not significant (W=.239, Q=5.98, 5 d.f., p=.309) indicating that there was no association among the five taxa in the five feature types. Five additional Kendall's tests were conducted, eliminating one feature type and testing the strength of the associations among the remaining four. Omission of pits produced the only significant result at p=.05 (W=.563, Q=11.26, 5 d.f., p=.047). That is, the associations among charred plant-remain densities was relatively consistent within each feature type when pits were eliminated from consideration. Another Kendall's test was performed to determine the strength of the associations among the mean presence values from the five taxa common to each feature type (presence values could not be grouped into an "other" category). The results were so close to p=.05 (W=.466, Q=9.32, 4 d.f., p=.054) that it was concluded that the presence value associations were relatively consistent.

In short, the five most common plant taxa tended to show up in about the same proportions in flotation samples from each feature type. Further, the relative abundances of charred plant remains in different feature types were also similar except for pits. Pits were different in that they contained relatively high abundances of maize and *Hordeum* but few Cheno-am seeds.

High charred maize abundances occurred in two pits, Features 63 and 76; only the latter was burned. It therefore seems likely that both the use of maize cobs as fuel as well as the deposition of maize cob refuse help account for the unusually good representation of this taxon in pits. Although charred *Hordeum* remains occurred in four out of six pits the unusually high abundance of this taxon is primarily the result of the relatively numerous grains in Feature 54, which was probably used in *Hordeum* processing.

Table 18.20. Results of a Kruskal-Wallis Test on the number of charred plant taxa per liter from detailed and intensive scan analysis feature types at the Deer Creek site, Gila Butte phase.

Feature Type	Actual Mean	Mean Rank[a]	No. Sample Loci
Pithouse hearths	1.92	27.00	3
Roasting pits	1.42	21.42	6
Pithouse floor fill	1.60	19.77	15
Pits	1.25	15.79	7
Crematoria	0.85	9.90	5

H (corrected for ties): 6.56
SIGNIFICANCE: p=.161 (4 d.f.)

[a] Higher ranks indicate higher taxonomic diversity.

Temporal Variability

Assessing changes in the use of plants through time in the project area is complicated because some of the sites (e.g., Arby's and Hilltop) were probably not permanently occupied and so would not be expected to contain all of the plants used throughout the year. Further, other sites (e.g., Boone Moore) may represent specialized activity sites where plant-related subsistence activities were restricted. Finally, except for the Gila Butte phase at the Deer Creek site, few samples were analyzed from sites that appear to be permanently occupied. Caution is therefore in order while assessing diachronic variability.

The mean relative parts percentage and presence value from samples dating to either the Gila Butte, Sacaton phase, or early Classic period are listed on Table 18.21. Data from the 11 taxa present during each time period (and the remaining "other" category in the relative parts comparisons) were converted to ranks and two Kendall's tests were conducted. The first test examined the association among the relative parts percentages and found a strong association (W=.789, Q=26.04, 11 d.f., p=.006). The second test investigated presence values and obtained an even stronger association (W=.871, Q=26.12, 10 d.f., p=.004). Data from the most common plant taxa of the three time periods are therefore quite similar when converted to ranks. The high degree of association among the three time periods is remarkable given that several different site types are represented.

Table 18.21. Relative parts percentages and presence values from three time periods.

Taxon	Gila Butte		Sacaton		Early Classic	
	r.p. n=26 98.0 l 315.25[a]	p.v. n=37 144.0 l	r.p. n=17 67.5 l 199.43[a]	p.v. n=27 105.0 l	r.p n=16 70.5 l 151.25[a]	p.v. n=19 82.5
Agave	22.44	75.7	60.46	74.1	84.81	84.2
Arctostaphylos	0.24	8.1	0.13	3.7	0.17	5.3
Argemone	--	2.7	--	--	--	--
Astragalus	0.08	2.7	--	--	--	--
Boraginaceae unknown	0.95	8.1	0.50	7.4	0.17	5.3
Caryophyllaceae	0.08	2.7	--	--	--	--
Cheno-am	22.05	89.2	17.69	81.5	1.41	15.8
Compositae	0.08	2.7	--	--	--	--
Descurainia	1.27	29.7	0.88	14.8	0.04	5.3
Echinocereus	13.56	59.5	4.46	48.1	0.37	15.8
Euphorbia	0.08	2.7	--	--	--	--
Globular Unknown	0.56	10.8	0.25	14.8	0.33	5.3
Hordeum	11.34	56.8	2.53	37.0	0.25	10.5
Juniperus	0.08	2.7	--	--	--	--
Gramineae	7.22	59.5	8.17	44.4	0.70	10.5
Mentzelia	6.26	18.9	--	--	--	--
Stem fragments	0.08	8.1	0.52	14.8	--	--
Opuntia	--	5.4	0.13	7.4	--	--
Phacelia	0.08	2.7	--	--	--	--
Plantago	--	--	0.13	3.7	--	--
Platyopuntia	0.24	5.4	--	3.7	--	--
Portulaca	1.19	13.5	1.04	38.3	8.76	15.8
Prosopis	0.08	2.7	--	--	--	--
Salvia	0.63	2.7	--	--	--	--
Solanaceae	0.08	2.7	--	--	--	--
Sphaeralcea	0.24	8.1	0.25	3.7	--	--
Teardrop unknown	0.16	5.4	--	--	--	--
Zea mays	10.94	45.9	2.88	33.3	2.99	47.4
Totals:	100.01		100.02		100.00	

Note: r.p. = Parts percentage; p.v. = Presence value

[a] The total number of relative parts upon which the relative part percentages are based.

Nevertheless, there does appear to be at least one temporal trend, the reduced presence of *Hordeum* during the early Classic period. Charred *Hordeum* grain or rachis joint fragments occurred in 21 out of 37 Gila Butte phase sample loci (56.8%), and in 10 out of 27 Sacaton phase samples loci (37.0%), but in only 2 out of 19 early Classic period sample loci (10.5%). The early Classic period *Hordeum* remains consist entirely of one grain fragment in the floor fill of a D-shaped masonry pitroom (Feature 9) and two grains in Level 3 of trash mound (Feature 2) at the Cobble site. None of the early Classic period samples contained *Hordeum* waste products even though all but one of the Sacaton phase sites did (Table 18.13).

Further evidence for the decreased importance of *Hordeum* in the early Classic period in the Rye Creek area, and perhaps the Upper Tonto Basin in general, comes from the Ord Mine Project. As reported earlier (Table 18.11), Halbirt and Gasser (1987) found no *Hordeum* during this analysis. *Hordeum* is such a large grain (ca. 2-3 mm long) that it could not possibly be missed. Interestingly, each of the Ord Mine sites date to ca. A.D. 1100 or later, exactly the time when *Hordeum* becomes rare in the Rye Creek flotation samples.

In summary, comparative flotation data from the most common plant taxa of the three major occupation periods in the study area were quite similar when they were converted to ranks. Nevertheless *Hordeum* seems to have decreased in importance by the early Classic period. Perhaps these results indicate that few major shifts in plant staples occurred; however, it seems most prudent to await the analysis of additional samples from more sites in the Upper Tonto Basin before the complete picture of the temporal dynamics in prehistoric plant use can most reasonably be reconstructed.

Regional Perspective

Intraregional Patterns

After the differences in flotation sample selection, processing, and analysis noted earlier are considered, two taxa that were relatively rare or absent from the Ord Mine Project but were common at the Rye Creek sites, hedgehog cactus and *Hordeum*, seem to constitute real differences between the two project areas. It has already been argued that the lack of *Hordeum* is probably the result of temporal factors. Two charred hedgehog cactus seeds were recovered from the Ord Mine Project compared to 58 whole and 57 fragmentary seeds for the Rye Creek Project (Appendix G.11). Charred hedgehog cactus remains occurred in less than 2 percent of the Ord Mine samples but in over 45 percent of the Rye Creek sample loci (see Tables 18.5, 18.11). Perhaps the difference in hedgehog cactus recovery between the two project areas reflects reliances on differing local vegetative associations. It will be recalled that plant associations characteristically have patchy distributions around the project area (Gasser 1987).

It has already been noted that Halbirt and Gasser (1987:319-321) found few economic plant remains in structure hearths and concluded that food was probably not frequently prepared over them. Data from the Rye Creek sites suggest, however, that several structure hearths at permanent sites probably were used to prepare small seeds and grains. One of these, Feature 9.01 in a D-shaped masonry pitroom at the Cobble site, dates to the same time period as the Ord Mine sites. Further studies must be conducted before it can be determined whether this apparent difference between the two project areas is real or a product of sampling bias.

Regional Perspective

Shoofly and Star Valley. Miller (1990) analyzed 74 flotation and 95 macrobotanical samples from Shoofly village, a large masonry pueblo dating to ca. A.D. 900 to 1300 and located approximately 20 km north of the Rye Creek Project area (Table 18.22). Shoofly yielded five cultivars: squash (*Cucurbita* sp.), cotton, lima beans (*Phaseolus lunatus*), common beans (*P. vulgaris*), and maize. Maize was the most ubiquitous taxon, occurring in 52 (70.3%) of the samples. No *Hordeum* grains, acorn shells, or pinyon nuts were recovered, and only one tansy mustard seed was found. Agave was less well represented at Shoofly compared to the Rye Creek sites; however, relatively more juniper seeds and walnut shells were recovered. Increased juniper levels are expected because Shoofly is at a higher elevation and located in a woodland dominated by Utah juniper (*Juniperus osteosperma*).

Miller (1990:Table 33) also reports the analysis of 48 flotation samples from 12 small sites located in Star Valley, approximately 4 km south of Shoofly (Table 18.22). These sites were primarily fieldhouses or farmsteads except for a pueblo with two roomblocks (AR-03-12-04-620 (TNF)), and a pithouse village (AR-03-12-04-650 (TNF)) (Jo Anne Miller, personal communication, 1990). Maize was by far the most common cultivar recovered from Star Valley and crop diversity was less at these smaller sites compared to Shoofly.

Perhaps the most interesting difference between the Shoofly data and the Rye Creek data is the relative abundance of cultivars. Maize and possibly *Hordeum* were the only Rye Creek cultigens recovered from the flotation analysis while maize and a single grain of *Cucurbita* (squash) pollen (from the Deer Creek site) were recovered in the pollen analysis. Although it is tempting to conclude that crop diversity was greater at Shoofly compared to sites in the Rye Creek area, it should be kept in mind that the major portion of Shoofly, which was probably a permanent habitation, was occupied during the time (ca. A.D. 1100-1300) that many of the Rye Creek sites may have been seasonally occupied. Furthermore, in comparison to Shoofly, all of the Rye Creek sites were less intensively inhabited. Perhaps if flotation samples were analyzed from the nearby Rye Creek Ruin they might contain more cultivars. This would be significant because this approximately 150-room pueblo is located within only 2.5 km of each of the project area sites and probably represents the Classic period permanent occupation associated with some of the seasonal sites. If this were true it would mirror the pattern found in the Star Valley and Shoofly data.

It also is interesting that *Hordeum* was absent from Shoofly. It is tempting to speculate that the use of this plant was largely associated with Hohokam-affiliated cultural groups because Shoofly village was not a Hohokam site (and *Hordeum* occurred in far lower frequencies on the later, perhaps non-Hohokam affiliated, Classic period sites in the project area). Finally, perhaps the lack of acorns and pinyon nuts at Shoofly should serve as a signal that these plant remains should not be expected to regularly occur in flotation samples from central Arizona sites even from areas where they seem likely to have been used.

Lower Tonto Basin and Pine Creek Sites. Comparative flotation and macrobotanical data from the Lower Tonto Basin are uneven (Tables 18.22 and 18.23). Few charred plant remains were recovered from the Reno-Park Creek, Ash Creek, and Pine Creek projects, but Tonto National Monument boasts one of the most thorough Southwestern paleoethnobotanical studies (Bohrer 1962). Although the lack of agave remains in flotation samples from the Reno-Park Creek sites is due to a recognition bias, it is interesting that two studies completed after the time when agave was consistently identified in flotation samples, the Ash Creek and Pine Creek projects, failed to recover them. The Ash Creek, Pine Creek, and Reno-Park Creek projects are interesting in that no saguaro seeds were recovered, even though local historical sources indicate that this was an important plant food resource, and saguaro are present today in all three of these areas.

Bohrer's (1962) study of plant remains from the the cliff dwellings at Tonto National Monument provides perhaps the most thorough glimpse into the prehistoric use of plants for food, medicine, and other purposes by the Salado that we will ever have. This is due to the unusually good preservation of perishable material. The list of economic plants Bohrer recovered is far more substantial than any other site in the Lower Tonto Basin (Table 18.22) and her study should serve as a reminder of what an incomplete picture of subsistence we can obtain with only charred plant remains.

Hordeum and the Hohokam. A decrease in the importance of *Hordeum* comparable to that postulated for the Rye Creek sites has been reported for the lower Salt River Valley Hohokam (Kwiatkowski 1989a; Gasser and Kwiatkowski, 1991). This trend apparently ends around the Gila River area where *Hordeum* has been found in Classic period contexts at Las Fosas (Miksicek 1983a), the Gopherette site (Miksicek 1983b), and the Brady Wash site (Gasser 1988b). This pattern may also not be present within the Lower Tonto Basin because *Hordeum* spikes were common at the Classic period Tonto National Monument (Bohrer 1962) and because Gasser identified one "cf." *Hordeum* grain in a Salado roasting pit at AZ U:3:50 (ASU) on the Ash Creek Project (Fish, Gasser, and Swarthout 1985).

Table 18.22. Plant food taxa identified from Tonto National Monument, Shoofly Village, the Star Valley sites, and the Reno-Park Creek Project.

	Tonto Ruins (Bohrer 1962)	Shoofly Village (Miller 1990)	Star Valley (Miller 1990); Site AR-03-12-04-__ (TNF)												Reno-Park Creek (Gasser 1978)		
Site:			620	637	619	650	647	021	632	624	631	656	640	639	Trick	Reno Creek	Treat
No. samples analyzed:	513MB[a]	74F[a], 95MB	17F	4F	3F	3F	8F	2F	2F	1F	1F	1F	2F	4F	9[b]	7[b]	8[b]
No. liters:	--	132.3+	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Approximate date (A.D.):	1100-1450	900-1200	--	--	--	--	--	--	--	--	--	--	--	--	800-1000	1150-1300	1150-1300
Acacia greggii	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Agave	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Amaranthus hypochondriacus (grain amaranth)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arctostaphylos	--	X	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--
Aster (aster)	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--
Canavalia spp. (jackbeans)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carnegiea gigantea	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Celtis (hackberry)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cercidium microphyllum	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cirsium (thistle)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cheno-am		X	X	--	X	X	--	--	--	--	--	--	--	--	--	--	--
Cucurbita (squash)	X[d]	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cylindropuntia	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Descurainia	--	X[c]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Echinocereus	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gossypium (cotton)	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gramineae grains	X[e]	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 18.22. Continued.

	Tonto Ruins (Bohrer 1962)	Shoofly Village (Miller 1990)	Star Valley (Miller 1990); Site AR-03-12-04-___ (TNF)												Reno-Park Creek (Gasser 1978)		
Site:			620	637	619	650	647	021	632	624	631	656	640	639	Trick	Reno Creek	Treat
No. samples analyzed:	513MB[a]	74F[a], 95MB	17F	4F	3F	3F	8F	2F	2F	1F	1F	1F	2F	4F	9[b]	7[b]	8[b]
Hordeum pusillum	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Juglans	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Juncus (rush)	--	X[c]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Juniperus	X	X	--	--	--	X	--	--	--	--	--	X	--	--	--	--	--
Lagenaria siceraria (bottle gourd)	X[f]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Leguminosae	--	cf.X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mammillaria (pincushion cactus)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phaseolus acutifolius (tepary beans)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phaseolus lunatus (lima beans)	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Phaseolus vulgaris (common beans)	X	X	--	--	--	cf.X	--	--	--	--	--	--	--	--	--	--	cf.X[g]
Pinus (pinyon)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Platyopuntia	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polygonum (knotweed)	--	X[c]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Portulaca	--	X	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Prosopis	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X
Quercus (acorns)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Simmondsia chinensis (jojoba)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sphaeralcea	--	X[c]	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vitis arizonica (wild grape)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Yucca	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 18.22. Continued.

Site:	Tonto Ruins (Bohrer 1962)	Shoofly Village (Miller 1990)	Star Valley (Miller 1990); Site AR-03-12-04-___ (TNF)												Reno-Park Creek (Gasser 1978)		
			620	637	619	650	647	021	632	624	631	656	640	639	Trick	Reno Creek	Treat
No. samples analyzed:	513MB[a]	74F[a], 95MB	17F	4F	3F	3F	8F	2F	2F	1F	1F	1F	2F	4F	9[b]	7[b]	8[b]
Xanthium strumarium (cocklebur)	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zea mays	X	X	X	X	X	X	X	--	--	X	X	--	X	X	--	--	X

---

[a] F = number of flotation samples analyzed; MB = number of macrobotanical samples analyzed. In the case of Tonto, the number refers to the number of "lots" (i.e., "that material of one identification from one archeological provenience") assigned.

[b] Total number of flotation or macrobotanical samples for each site listed on Gasser 1978:Table 13 (these numbers exclude unproductive samples except for surface control samples. Twenty-four flotation and 5 macrobotanical samples were actually analyzed from the project.

[c] Taxa of uncertain economic importance

[d] *Cucurbita foetidissima* (wild buffalogourd) as well as the domesticated types *C. mixta*, *C. moschata*, and *C. pepo*

[e] *Setaria* sp. (bristlegrass) and *Phalaris caroliniana*

[f] Used as a container rather than as a food.

[g] This bean might actually be Cercidium microphyllum.

Table 18.23. Plant food taxa identified at Ash Creek and Pine Creek Project sites.

	Ash Creek (Fish et al. 1985); site AZ U:3:__ (ASU)						Pine Creek (Hutira 1990); site AZ U:3:__ (ASM).						
Site:	44	46	49	50	50	51	83	84	85	86	87	88	89
No. samples analyzed:	1[a]	2[a]	4[a]	2[a]	9[a]	5[a]	16F[b]	8F, 1MB[b]	2F[b]	3F[b]	14F[b]	3F[b]	4F[b]
Date:	Santa Cruz	Sacaton	Gila	Sacaton-Hardt/ Miami	Late Roosevelt-Gila	Late Sacaton-Hardt/ Miami	Sacaton	Sacaton	Sacaton/ Early Soho	Sacaton	Santa Cruz-Late Sacaton	Late Santa Cruz-Early Sacaton	Late Santa Cruz-Sacaton
Site type[c]:	HAB	HAB	HAB	HAB	HAB	HAB	HAB	HAB	PRO	PRO/ HAB?	HAB	HAB	HAB
Astragalus	--	cf.X	--	--	--	--	--	--	--	--	--	--	--
Cheno-am	--	--	--	--	--	X	X	X	--	--	--	--	--
Echinocereus	--	--	--	--	--	X	--	--	--	--	X[d]	--	--
Eschscholtzia (prickly poppy)	--	cf.X	--	--	--	--	--	--	--	--	--	--	--
Gramineae grains	X	--	X	--	X	--	X[e]	--	--	--	X[e]	--	--
Gramineae and *Yucca* quid	--	--	--	--	--	--	--	X	--	--	--	--	--
Hordeum	--	--	--	--	cf.X	--	--	--	--	--	--	--	--
Juniperus	--	--	--	X	--	--	--	--	--	--	--	--	--
Prosopis	--	--	--	--	cf.X	cf.X	--	--	--	--	--	--	--
Zea mays	--	--	X	X	X	X	X	--	--	X	X	--	--

---

[a] These are the number of productive flotation or macrobotanical samples. Forty samples were actually analyzed from the Ash Creek project.

[b] F = Number of flotation samples; MB = number of macrobotanical samples

[c] Site type codes: HAB = habitation site (i.e., farmstead to hamlet-sized); PRO = resource procurement/processing site

[d] Hedgehog cactus type

[e] *Sporobolus*

Trade

A Closing Thought. Although there was no good evidence for trade in food stuffs in the Rye Creek flotation or macrobotanical data, the possibility that foods were traded regularly to neighboring groups should not be discounted. Gallagher (1977:51), for example, has noted that the Apache sometimes made a long journey to Oraibi to trade mescal and pinyon nuts for corn and blankets, and Ford (1983:712) found that "all the Western Apache and Upland Yumans people supplied dried mescal (*Agave* spp.) sheets to the Mohave, Papago, Maricopa, Hopi villages, Zuni, and Navajo."

SUMMARY

The use of nine different plant food taxa appears to have been common at the Rye Creek sites: Agave (hearts, leaves, and flower stalks), Cheno-am (seeds), tansy mustard (seeds), hedgehog cactus (fruits and seeds), *Hordeum* (grains), sprangletop type (grains), purslane (seeds), dropseed type (grains), and maize (kernels). Agave in particular seems to have been an important plant food as was the case historically. Although the number of recovered cultigens, just *Hordeum* and maize, was low, the presence value of *Hordeum* may be the highest ever reported. Small seeds and grains were probably more important in the diet than was the case historically after cattle destroyed the once widespread grasslands. Poorly represented or missing taxa were acorns, pinyon nuts, juniper seeds, and saguaro seeds. Several working hypotheses have been advanced for the absence of these taxa.

Based on the presence of charred waste products from *Hordeum* processing, it is likely that the Deer Creek site (during the Gila Butte phase), the Redstone site, the Hilltop site (during the Sacaton phase), the Clover Wash site, and the Rooted site were occupied at least during the spring. The Hilltop site during the Sacaton phase may have been occupied primarily during the spring because it failed to yield either maize cobs or seeds from plants normally available during other times of the year, but this conclusion is based on only a few samples. The Arby's site may have been occupied seasonally because it contained the lowest density of charred plant remains. Because it possessed relatively abundant maize remains, including kernel fragments, it is possible that this site was primarily occupied during the fall crop harvest. Similarly, Boone Moore may have been a specialized activity site because it contained the least diverse charred plant assemblage. The Deer Creek, Cobble, and Rooted sites stand out as probably permanent because each of these sites either contains relatively abundant charred plant remains per sample or has a relatively diverse charred plant assemblage. Midsummer and late fall seasonal indicators generally were rare in the project area except for the Deer Creek site during the Gila Butte phase. It is unclear what these data indicate about the Sedentary and early Classic period use of the project area during these two seasons.

Several structure hearths at permanent sites appear to have been used to cook small seeds and grains. Pithouse hearths contained the most abundant charred plant remains in Gila Butte phase features at the Deer Creek site, and crematoria and roasting pits yielded the least. No Gila Butte phase feature type contained significantly greater taxonomic diversity. The relative abundances of charred plant remains in each feature type at the Deer Creek site during the Gila Butte phase were similar except for pits.

The best evidence for temporal changes in the use of plants within the Rye Creek Project area is the decline in the ubiquity and abundance of *Hordeum* grains during the early Classic period. Other than that, the charred plant assemblages appear relatively similar. This should not be taken as an indication of continuity in subsistence practices, however, because sites of different seasonality and function were being compared.

Shoofly village and the early Classic period Ord Mine sites did not yield charred *Hordeum* grains and it was speculated that this may have been primarily a Hohokam-induced crop. More cultigens occurred at Shoofly than the smaller, nearby Star Valley sites and it was conjectured that the Rye Creek sites may have similarly contained fewer cultivars than the nearby Rye Creek Ruin. Acorns and pinyon nuts were absent at both the Shoofly and Star Valley sites and so it is assumed that these taxa may be preserved rarely even in areas where they probably were used.

ACKNOWLEDGMENTS

I wish to thank Dr. Leslie Landrum for assistance while at the ASU herbarium, and Dr. Vorsila L. Bohrer, Robert E. Gasser, and Dr. Donald J. Pinkava for examining my unknowns. Kate Aason Rylander first suggested that one of my unknowns might be *Mentzelia*, and Bohrer verified this identification. Rylander also suggested that the Boraginaceae-like unknowns may be *Amsinckia* seed interiors, and Gasser tentatively concurred with this identification. I also thank Jo Anne Miller, Douglas R. Mitchell, David R. Abbott, and Christine K. Robinson for commenting on a draft of this report.

CHAPTER 19

WOOD CHARCOAL FROM THE RYE CREEK SITES

Scott Kwiatkowski and Charles H. Miksicek

Wood charcoal samples were analyzed separately by both authors. Miksicek examined 128 samples and made a total of 550 identifications, not including unknown vesicular material in pithouse Feature 21 at the Deer Creek site and a maize kernel in masonry structure Feature 1 at the Arby's site (Appendix G.16). Specimens were broken to expose a fresh cross section that was examined under 30X with a reflected light binocular microscope. Identifications were made by comparison to a modern reference collection.

Kwiatkowski identified up to twenty wood charcoal fragments per sample retained in the 2.0 mm mesh during both the detailed and intensive scan flotation analyses. Seventy-six of the 97 samples (78.4%) contained identifiable charcoal fragments and produced 700 charcoal identifications (Appendix G.17). Specimens were broken to expose fresh cross sections and were examined at 40X with a reflected light binocular microscope. Identifications were made by comparing the specimens to modern carbonized reference material different than Miksicek's. It should be mentioned that Kwiatkowski did most of his analysis after Miksicek had identified the most common charcoal types in the project area and the senior author used these as a basis for his identifications.

IDENTIFICATION ISSUES

The identification of wood charcoal is less straightforward than identifying charred seeds and grains. Wood structure varies depending upon the age of the tree, edaphic conditions, and the portion of the plant (i.e., branch, heartwood, root) that is represented. In a strict sense, the Rye Creek wood charcoal identifications should be viewed as preliminary for reasons discussed by Bohrer (1986:34):

> Now if specialists who identify modern wood regard the study of a cross section as only an initial step and secure additional information from radial and tangential sections, I fail to see how those among us who do so much less than that with prehistoric charcoal can hope to achieve a comparable level of reliability. We are dealing with an undetermined range of anatomical patterning in wood created by juvenile twigs as well as some shrubs and trees whose anatomy remains undescribed in texts.

The levels of certainty implied by an identification vary taxonomically. For example, the identification of saltbush-type and cf. sycamore charcoal was relatively easy because these taxa are distinctive. On the other hand, the separation of the arboreal legumes (i.e., acacia, palo verde, and mesquite) was more difficult because they share several morphological characteristics. Compounding this problem is that hackberry, which to a certain extent resembles both acacia and mesquite, is within a completely different family.

There is a possibility that some of the wood identified as juniper-type actually represents pine. Wood was classified as juniper-type if resin ducts were not observed. Minnis (1987:122) has pointed out, however, that a specimen 4 mm^2 or less may lack resin ducts, not because the tree never had any, but because the piece identified was too small. The majority of wood identified from flotation samples fall into this size range.

Despite the limitations inherent in the data, wood charcoal is the primary source of information about prehistoric fuel and superstructure construction, and under the right conditions can be used to reconstruct prehistoric vegetation change (Brandt and Ruppé 1990; Miksicek and Gasser 1989; Miksicek 1984; Minnis and Ford 1977).

RESEARCH OBJECTIVES

The charcoal analysis was originally undertaken to determine the suitability of the Rye Creek charcoal for radiocarbon dating. It was then expanded to document the taxa used for fuel and house construction. Intersite variability in wood charcoal also has been examined for insight into diachronic or spatial variability.

RESULTS

Twenty taxa were represented in the 1,250 charcoal identifications (Table 19.1). This total includes 44 specimens of juniper-type wood and one of arboreal legume, cf. mesquite, that exhibit an appearance intermediate between carbonized and uncarbonized. Such "caramelized" pieces are believed to either be incompletely carbonized or uncarbonized prehistoric material because several are remnants from in situ structural posts (see also Chapter 18). The 97 flotation samples contained an average of 8.0 ml wood charcoal per liter (s.d.=22.52). The taxonomic composition of wood charcoal from each site and time period is represented graphically in pie chart Figures 19.1-19.9.

FUEL WOOD

Hearths

The taxa present in structure and extramural hearths are listed in Table 19.2. Juniper-type and cf. creosotebush charcoal were recovered from the majority of Preclassic period structure hearths and it seems likely that these were two important fuel sources for domestic heating and cooking during this time. Although it is based on only three samples, an interesting difference with the Preclassic period is that each of the early Classic period extramural or structural hearths with identifiable charcoal contained only arboreal legume wood charcoal.

Roasting Pits and Hornos

Charcoal recovered from roasting pits and hornos bearing evidence of in situ carbonization are listed in Table 19.3. Although the number of wood taxa recovered per roasting pit varied from one to seven, the majority contained both arboreal legume cf. mesquite and juniper-type wood charcoal. It appears that these were important fuel sources in these features.

Crematoria

Wood charcoal from eight Gila Butte phase crematoriums at the Deer Creek site was analyzed (Table 19.4). Juniper-type charcoal was most common, although the number of taxa identified in each feature ranged from one to five. The charcoal assemblage of Feature 50 was the most unusual in that it was the only crematorium that lacked juniper-type wood and because four agave heart fragments were found in it. This is contrary to the pattern noted in the flotation analysis where these features were found to contain little food refuse (Chapter 18). Perhaps the agave heart was a mortuary offering.

Table 19.1. Wood charcoal taxa recovered from the Rye Creek sites.

Scientific Name	Common Name
Agave flower stalk	Agave, century plant, mescal
Agave heart	Agave, century plant, mescal
Arboreal legume cf. *Acacia*	cf. Acacia
Arboreal legume cf. *Cercidium*	cf. Palo verde
Arboreal legume cf. *Prosopis*	cf. Mesquite
Atriplex/Suaeda type	Saltbush type
cf. *Baccharis*	cf. Desert broom
cf. *Canotia holacantha*	cf. Crucifixion thorn
Cupressus/Juniperus type	Juniper type
Cyperus stems	Sedge stems
cf. *Fouquieria splendens*	cf. Ocotillo
Gramineae culms	Grass stems
Indeterminate bark	Bark
cf. *Larrea tridentata*	cf. Creosotebush
Pinus type	Pine type
cf. *Plantanus Wrightii*	cf. Sycamore
Populus/Salix type	Cottonwood/willow type
cf. *Quercus*	cf. Oak
cf. *Tessaria*	cf. Arrowweed
Unknown	Unknown

STRUCTURAL WOOD

Posts and Roof/Wall Fall

The identification of structural posts is listed in Table 19.5. Although the majority were juniper-type, wood from at least three other plants was used for posts. Interestingly, although both of the structures at the Redstone site were burned -- Feature 11 catastrophically -- the posts were nevertheless "caramelized" or incompletely carbonized.

The charcoal identified in roof or wall contexts generally appears to represent roof or wall beams. The only exception is the single cf. arrowweed fragment found in a pithouse (F11) at the Redstone site that may have been part of the superstructure's thatch.

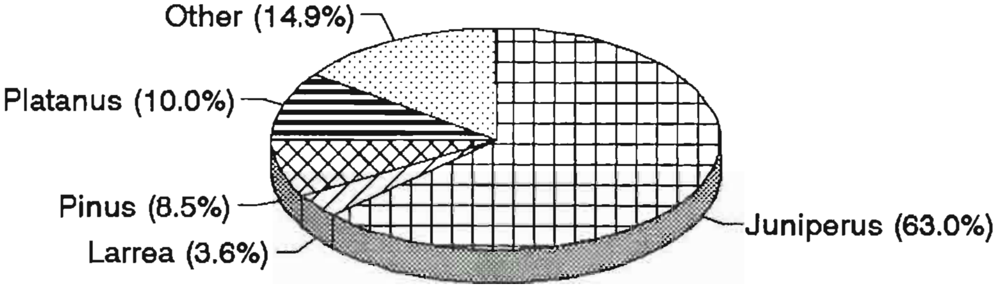

Figure 19.1. Taxonomic composition of wood charcoal from the Deer Creek site, Gila Butte phase.

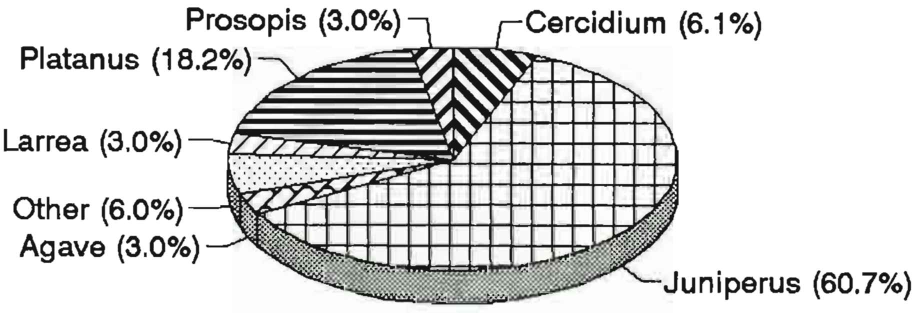

Figure 19.2. Taxonomic composition of wood charcoal from the Deer Creek site, Indeterminate Preclassic period.

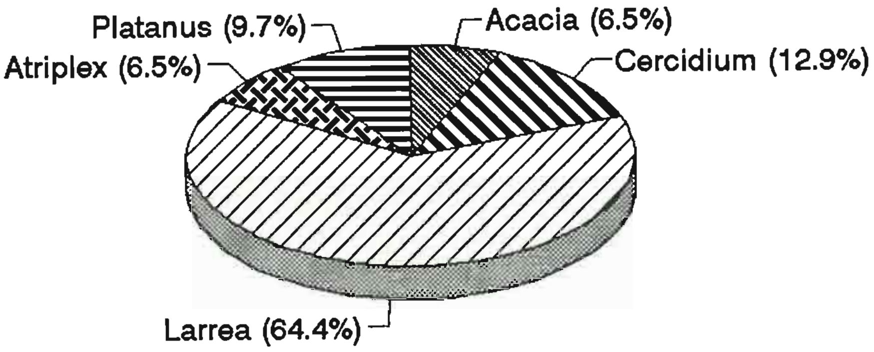

Figure 19.3. Taxonomic composition of wood charcoal from the Deer Creek site, Sacaton phase.

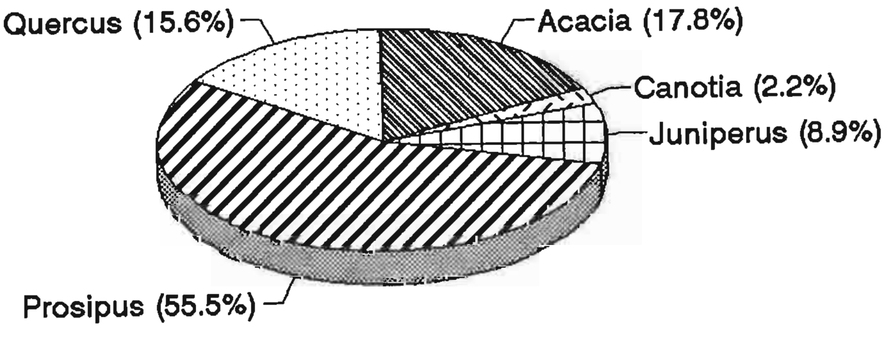

Figure 19.4. Taxonomic composition of wood charcoal from the Boone Moore site.

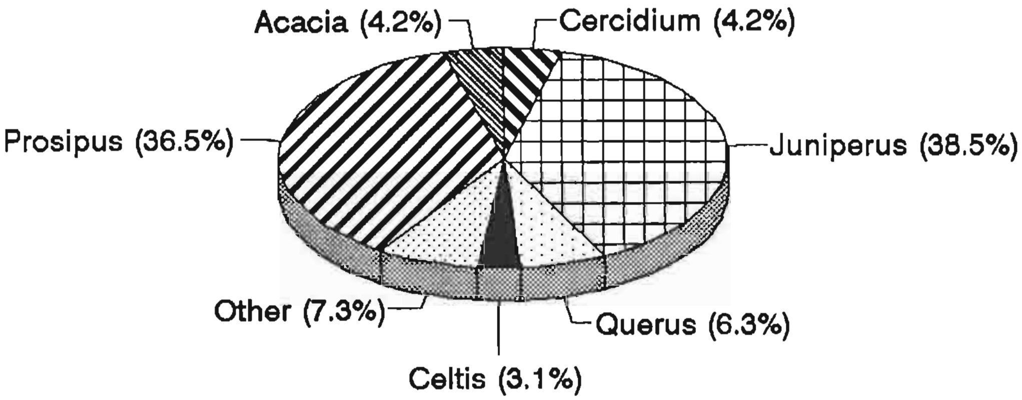

Figure 19.5. Taxonomic composition of wood charcoal from the Compact site.

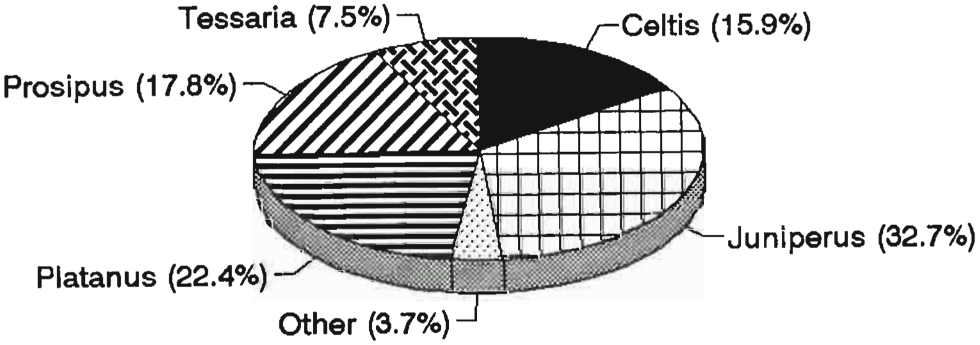

Figure 19.6. Taxonomic composition of wood charcoal from the Redstone site.

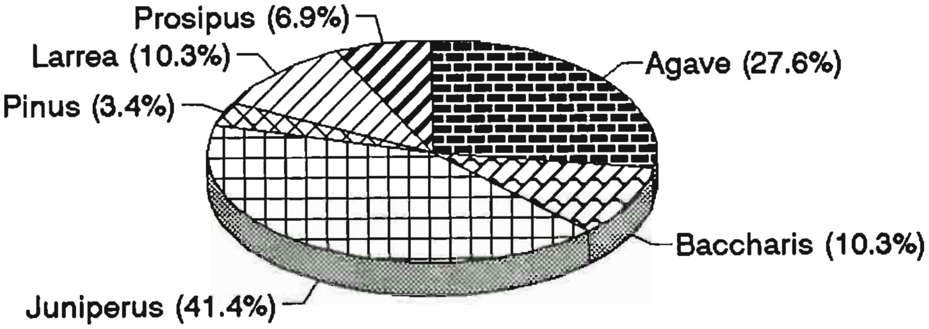

Figure 19.7. Taxonomic composition of wood charcoal from AZ O:15:92 (ASM).

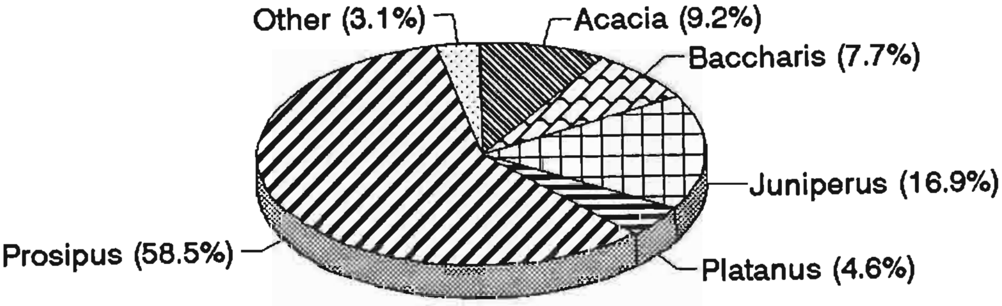

Figure 19.8. Taxonomic composition of wood charcoal from the Arby's site.

Table 19.2. Wood charcoal types recovered from structures and extramural hearths.

Date	Site	Context	*Acacia*	*Atriplex*	*Cercidium*	*Juniperus*	*Larrea*	*Pinus*	*Plantanus*	*Prosopis*
		STRUCTURE HEARTHS								
Gila Butte	Deer Creek	Pithouse F9.04	--	--	--	--	X	--	--	--
	Deer Creek	Pithouse F14.03	--	--	--	X	--	--	--	--
	Deer Creek	Pithouse F14.04	--	--	--	--	--	--	X	--
	Deer Creek	Pithouse F22.01	--	--	--	X	X	--	--	--
Sacaton	Compact	Pithouse F4.01	--	--	X	X	--	--	--	--
	Rooted	Pithouse F14.05	--	--	--	X	X	--	--	--
	Rooted	Pithouse F14.06	--	--	--	--	X	--	--	--
	Rooted	Pithouse F14.08	--	--	--	X	--	X	--	--
Early Classic	Boone Moore	Masonry pitroom F1.01	X	--	--	--	--	--	--	--
	Arby's	Cobble brush structure hearth F5.01	--	--	--	--	--	--	--	X
		EXTRAMURAL HEARTHS								
Gila Butte	Deer Creek	F61	--	X	--	--	--	--	--	--
Early Classic	Arby's	F4	--	--	--	--	--	--	--	X

Note: Wood categories are abbreviations of the taxa listed in Table 19.1.

Table 19.3. Wood charcoal identified in roasting pits and hornos with evidence of burning.

Date[a]	Site[b]	Feature	*Acacia*	*Cercidium*	*Prosopis*	*Atriplex*	Bark	*Canotia*	*Celtis*	*Juniperus*	*Fouquieria*	*Larrea*	*Pinus*	*Plantanus*	*Quercus*
								ROASTING PITS							
GB	52	F28	--	--	--	--	--	--	--	X	--	--	--	--	--
	52	F86	--	--	X	X	--	--	--	X	--	--	X	--	--
	52	F118	X	--	X	--	--	X	--	X	--	X	X	X	--
SAC	90	F8	--	--	X	--	--	--	--	--	--	--	--	--	X
	90	F9	--	X	X	--	--	--	--	--	--	--	--	--	--
	91	F17	--	--	--	--	--	--	X	X	--	--	--	--	--
	91	F20	--	--	X	--	--	X	--	--	--	--	--	--	--
	100	F13	--	--	--	--	X	--	--	X	--	--	X	--	--
	100	F17	--	--	X	--	--	--	--	X	--	--	X	--	X
EC	55	F20	--	--	X	--	--	--	--	--	--	--	--	--	--
								HORNO							
SAC	90	F6	X	--	--	--	--	--	X	X	X	--	--	--	--

Note: Wood categories are abbreviations of taxa listed in Table 19.1.

[a] Date codes: EC = Early Classic; GB = Gila Butte; SAC = Sacaton

[b] Site codes: 52 = Deer Creek; 55 = Boone Moore; 90 = Compact; 91 = Redstone; 100 = Clover Wash

Table 19.4. Charcoal in crematoria at the Deer Creek site, Gila Butte phase.

Feature	*Agave* Heart	*Prosopis*	*Baccharis*	*Celtis*	*Juniperus*	*Larrea*	*Pinus*	*Plantanus*	*Quercus*
F1	--	--	--	--	X	--	--	--	--
F46	--	--	X	X	X	--	X	X	--
F48	--	X	--	--	X	--	--	--	X
F50	X	--	--	X	--	--	--	--	--
F71	--	--	--	X	X	--	--	X	--
F82	--	--	--	--	X	--	X	--	--
F85	--	--	--	--	X	--	X	--	--
F117	--	--	--	--	X	X	--	--	--

Note: Wood categories are abbreviations of taxa listed in Table 19.1.

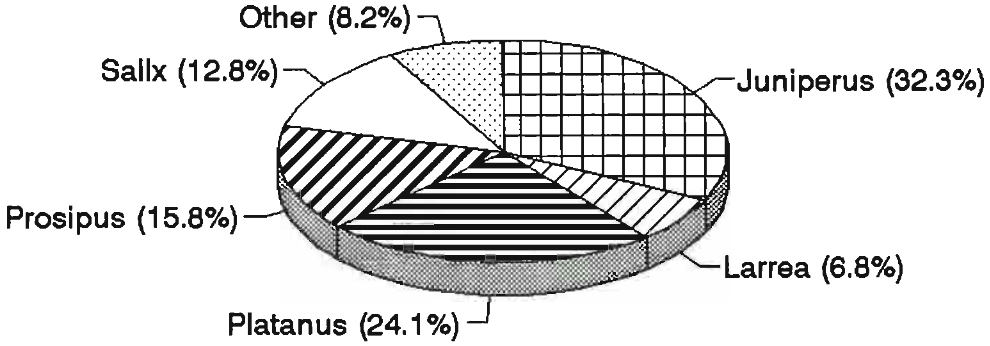

Figure 19.9. Taxonomic composition of wood charcoal from the Clover Wash site.

Table 19.5. Posthole and roof and wall fall charcoal.

Site	Feature	*Juniperus*	*Pinus*	*Plantanus*	*Prosopis*	*Tessaria*
POSTHOLES						
Deer Creek	F14.02	--	--	X	--	--
Deer Creek	F18.02	X	--	--	--	--
Deer Creek	F18.03	X	--	--	--	--
Deer Creek	F21.01	--	X	--	--	--
Compact	F3.02	X	--	--	--	--
Redstone	F5.06	X[a]	--	--	--	--
Redstone	F5.07	X[a]	--	--	--	--
Redstone	F11.01	X[a]	--	--	--	--
Redstone	F11.02	X[a]	--	--	--	--
Redstone	F11.08	X[a]	--	--	--	--
Redstone	F11.09	X[a]	--	--	--	--
Rooted	F15.01	--	--	--	X	--
ROOF/WALL FALL						
Deer Creek	F21	X	--	--	--	--
Deer Creek	F32	X	--	--	--	--
Deer Creek	F65	X	--	--	--	--
Compact	F4	X	--	--	--	--
Redstone	F11	--	--	X	--	X
Clover Wash	F3	X	--	--	--	—
Boone Moore	F5	X[a]	--	--	--	--

Note: All features are pithouses except for extramural surface Feature 15 at AZ U:15:92 (ASM) and cobble-lined adobe pitroom Feature 5 at Boone Moore. Wood categories are abbreviations of taxa listed in Table 19.1.

[a] Caramelized

INTERSITE VARIABILITY

Although based on small sample sizes, a cursory inspection of Figures 19.1 through 19.9 indicates that the early dominance of juniper-type charcoal is replaced by arboreal legumes by the early Classic period. This pattern is illustrated using ratios in Table 19.6. Three alternative explanations, or a combination of them, seem likely to account for these differences. First, it is possible that the inhabitants of the Rye Creek sites selectively used juniper-type wood early in their occupation and used arboreal legume wood more only after they had largely used up the junipers. Or, the juniper tree line moved farther north by the early Classic period and these trees were no longer available in great numbers for fuel. This possibility seems more probable because the project area is today located in an ecozone between the interior chaparral and juniper woodlands and because Shaw (1990) found a 37-year period of low effective moisture at the end of the Preclassic and the beginning of the Classic periods. Finally, it is possible that the sites were located in different vegetation associations and that wood procurement was extremely localized. This cannot be ruled out, because the modern plant associations in the area have been modified to an unknown extent by modern grazing and plowing. This is somewhat suggested, however, by the fact that the three sites showing the highest incidence of *Prosopis* (mesquite), the Boone Moore, compact, and Arby's sites, are situated directly on Rye Creek where a mesquite bosque is present today.

Table 19.6. Ratios of *Juniperus*-type to arboreal legume wood charcoal.

Date	Site	No. *Juniperus*[a]	No. Legumes[a]	Ratio
Gila Butte	Deer Creek	410	60	6.8:1
Indeterminate Preclassic	Deer Creek	20	3	6.7:1
Sacaton	Rooted	12	2	2.0:1
	Clover Wash	43	22	2.0:1
	Redstone	35	22	1.6:1
Early Classic	Arby's	11	45	1:4.1
	Boone Moore	4	33	1:8.3

[a] Total number of charcoal specimens identified.

SUMMARY

A total of 1,250 charcoal specimens from 225 samples was identified. These identifications should be considered preliminary. Juniper-type and cf. creosotebush charcoal was common in Preclassic hearths while wood from arboreal legumes was exclusively present in early Classic period hearths. Arboreal legume wood resembling mesquite and juniper-type wood were apparently primary fuels in roasting pits and hornos. Juniper-type wood was most common in crematoriums. Crematorium Feature 50 at the Deer Creek site was unusual in that it contained no juniper-type charcoal and appears to have held a mortuary offering of a portion of an agave heart. Most of the roof and wall supports examined were juniper-type wood, although cf. arrowweed wood may have been part of the thatch of the superstructure of Feature 11 at the Redstone site.

Juniper-type wood was more commonly represented in the Preclassic period sites and arboreal legume wood was more common at early Classic period sites. It is presently unclear whether this relates to selective wood use, changing plant associations, site locations in different microenvironmental locations, or a combination of these three alternatives.

ACKNOWLEDGMENTS

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CHAPTER 20

RESOURCES AND FUNCTION: RESULTS OF THE RYE CREEK POLLEN ANALYSIS

Suzanne K. Fish

Samples from the modern ground surface, residential proveniences at 12 Rye Creek Project sites, and suspected agricultural alignments at two of these settlements were examined for pollen content. Of 72 samples from archaeological proveniences, pollen sufficient for 200-grain tabulations was recovered in all but seven cases. The Rye Creek Project pollen analysis has documented a variety of plants utilized by study area inhabitants and identified resource associations for particular features. Structure floors were emphasized in the analysis because they are likely to encapsulate a diversity of resources used over time, represent culturally meaningful units for comparison, and provide a standardized depositional context that was sampled at all sites. Differences in palynological distributions among site types suggest functional and environmental implications for prehistoric occupations.

ANALYSIS METHODS

Sixty cubic centimeters of sediment were processed. After addition of *Lacopodium* spores in known quantities to monitor recovery, samples were deflocculated in dilute hydrochloric acid. A single swirl with timed settling rate of the kind described by Mehringer (1967:136-137) accomplished initial reduction of heavy particles in soil matrix. Heavy liquid flotation with zinc bromide of 2.0 density further separated sample material. A cold rinse with concentrated hydrochloric acid removed residual silicates. Rinses with hydrochloric acid, water, and absolute alcohol completed the extraction process. Chemical treatments to remove organic compounds were omitted in view of low organic content of the sediment and in order to limit damage to pollen grains in anticipated delicate condition.

Extract was mounted on slides in glycerol, stained, and viewed at a magnification of 600X. A standard sum of 200 noncultigen grains was tabulated for all samples. This sum has been shown to accurately reflect distributions of common types in Sonoran Desert pollen spectra (Martin 1963:30). Frequencies of types were calculated as percentages of all pollen present, with the exception of cultigens.

Pollen of cultivated plants was excluded from the total for percentage calculations in order to avoid numerical constraint on taxa that more directly reveal environmental conditions. Cultigen pollen is quantitatively expressed as the number of grains encountered in the course of tabulating 200 other types. Although some wild cucurbits cannot be distinguished from domesticates on the basis of pollen grain morphology, the single instance of *Cucurbita* pollen was included in the cultigen category along with the more commonly occurring corn (*Zea*).

After completion of the 200-grain standard sum, an approximately equal amount of sample extract was viewed at lower magnification and without tabulation in order to further record rare economic types. Pollen types observed only in such scanning are indicated in the following tables. The presence of clumped grains or aggregates by a "t" is also noted. Multiple grains in adhering aggregates would be less easily transported by wind than single grains under normal circumstances, and thus suggest plant sources immediate to the sampling locus. Aggregates may also indicate the presence of immature floral parts in which dispersal of individual pollen grains had not yet occurred. In either case, aggregates are potential evidence for the origin of the pollen of useful species on resource materials intentionally transported into site proveniences.

In any comparison of Rye Creek data with studies by other analysts, it should be noted that methodological differences in screening practices may produce somewhat different quantitative results. During extraction procedures, palynologists routinely pass sample sediment through fine screens to remove larger extraneous materials. In order to retain all aggregates of large-sized pollen grains that might be caught in a fine screen, and particularly those of cultigens and other large economic types, screening in the present study was limited to commercial tea strainer sieves rather than a traditionally finer mesh. Thus, those types that occur most frequently in clumped form may be represented in relatively higher numbers. *Boerhaavia*-type is an example of a relatively large pollen type from an insect pollinated plant that tends to occur in aggregates, likely as a mechanism for ensuring insect transport of sufficient numbers of grains. Economic types such as corn or cactus pollen also can occur in multiple instances as aggregates. Elaboration of all aspects of the methodology employed in this analysis can be found in Fish (1984c).

ENVIRONMENTAL PATTERNS

Modern Environment

Three modern surface samples were collected from northern (near AZ O:15:55), middle (near AZ O:15:53), and southern (near AZ O:15:89) portions of the Rye Creek Project study area (Table 20.1). Pollen of the Compositae or sunflower family is prominent in each. These types, divided primarily among morphological categories with short or long spines, encompass many of the common perennial shrubs of the study area and a variety of herbaceous annuals. Sagebrush and related taxa are separately tabulated as *Artemisia*. Grasses (Gramineae) account for approximately 10 percent of the spectra. Cheno-am types, including chenopods and amaranths, are notably low compared to prehistoric levels. This category may include some shrubs such as saltbush (*Altiplex)*, but is also produced by various herbaceous species.

Arboreal pollen consists of abundant juniper and lesser amounts of pine (*Pinus*) and oak (*Quercus)*. Juniper occurs in notably higher frequencies than in the prehistoric pollen spectra, a pattern similarly expressed in analyses from the adjacent Ord Mine Project area (Halbirt and Gasser 1987) to the south. Juniper may be relatively more prominent as a response to modern land use or current climatic conditions. Greater percentage representation of juniper at present may also reflect a decrease in pollen production by grasses, herbs, and shrubs subject to heavy grazing. Likewise, modern values for windblown pine and oak in the upper ranges for archaeological samples are probable correlates of reduced pollen production by forage plants.

Proportions of juniper in the modern samples do not reflect differences among vegetation descriptions for the three immediate sampling locales in a simple manner. Juniper is expectably highest at AZ O:15:53, which has a dense cover of crucifixion thorn, juniper, mesquite, acacia, and grass. AZ O:15:55 and AZ O:15:89 are more open, with very sparse mesquite, acacia, Christmas cholla, and grass at the former location and grass, hedgehog cactus, and scattered mesquite and juniper at the latter. Juniper pollen is more frequent at AZ O:15:55 however, probably due to contributions from trees in a wider surrounding source area. Sunflower family pollen is relatively high at AZ O:15:89 and the Cheno-am category is highest at AZ O:15:53. Densities of shrubs or annuals may be affecting amounts of these pollen classes.

Some common elements of project area vegetation disperse pollen in low amounts and are occasional in samples. Pollen of crucifixion thorn (*Canotia*), Mormon tea (*Ephedra*), mesquite (*Prosopis*), and acacia (*Acacia*) is infrequent. Only single instances of the first two types were encountered. Cactus pollen also was absent for each of the three categories of cholla (*Cylindropuntia*), prickly pear (*Platyopuntia*), and saguaro, hedgehog, and related taxa (*Cereus* type). An instance of willow (*Salix*) is the only type attributable to riparian species along the drainages.

Table 20.1. Percentages of pollen types in modern surface samples from the Rye Creek study area (n=200 grains).

Site/Feature	*Artemisia*	*Ambrosia*-type	High Spine Compositae	Cheno-am	Gramineae	*Boerhaavia*-type	*Sphaeralcea*	*Eriogonum*	*Euphorbia*-type	*Erodium*	cf. Leguminosae	*Ephedra*	*Pinus*	*Quercus*	*Juniperus*	Other	Indeterminate
Near AZ O:15:53	.5	15	20.5	14	7			.5		.5	.5	.5	3.5	3	31.5	.5 *Canotia*	2.5
Near AZ O:15:55	1	17.5	13	3.5	9	.5	.5	.5	2		3.5		6.5	7.5	25	1 *Salix*, .5 Rosaceae, .5 *Prosopis*	3.5
Near AZ O:15:89	+	27.5	21.5	1.5	11.5		+	1			2	+	9.5	5	16	.5 Liguliflorae	4

+Indicates a pollen observed only in scanning of additional sample material after completion of a 200-grain standard sum of all pollen types.

Prehistoric Environment

As a result of analysis of large numbers of archaeological samples, and in some cases artificial concentration through introduction of resource plants, the overall diversity of prehistoric pollen types is greater than in the modern samples (Tables 20.2-20.5). Yucca (*Yucca*), creosote bush (*Larrea*), jojoba (*Simmondsia*), and hackberry (*Celtis*) are among the additional perennial species with naturally low dispersal rates that were observed only in prehistoric samples. Former riparian communities are attested by willow, alder (*Alnus*), cattail (*Typha*), and sedge (*Cyperaceae*).

A major contrast between the prehistoric samples and modern ones is the importance of Cheno-am pollen. With the exception of several small sites, average prehistoric percentages are from two to three times greater than the modern high of 14 percent. Archaeological proportions undoubtedly include increments from weedy annual species responding to culturally disturbed and enriched habitats, and from resource species used for edible seeds and greens. The consistency of elevated frequencies in spectra from the majority of sites suggests that disturbance plants are responsible for much of this pollen.

Although the Upper Tonto Basin is heavily grazed today, the associated vegetation and ground disturbance evidently does not increase weedy chenopods and amaranths at a rate similar to archaeological occupations. These species appear more closely related to residential soil disturbances and garbage disposal. In some cases, agricultural weeds in fields surrounding sites also may be involved. Prehistoric Cheno-am levels likely reflect a combined measure of occupational intensity from weeds in all culturally shaped microhabitats.

Pollen of several weedy plants typically occurs in Hohokam agricultural settings in frequencies greater than in modern natural vegetation (Fish 1984b, 1985). Spiderling (*Boerhaavia*-type), globe mallow (*Sphaeralcea*), and Arizona poppy (*Kallstroemia*) have therefore been combined in the data tables presented below into a distinctively agricultural weed category. Other common weedy taxa that may be agricultural as well as residential at Tonto Basin sites include wild buckwheat (*Eriogonum*), filaree or heron-bill (*Erodium*), and evening primrose family (*Onagraceae*). Evening primrose family pollen was associated most strongly with the environs of Hohokam canals in a previous study (Fish 1984b). Species that favor other kinds of culturally modified habitats are likely for Rye Creek in view of the apparent absence of irrigation.

An Old World and an indigenous species of *Erodium* are found today in the study area (Kearney and Peebles 1964:486). Because the introduced species is so widespread at present, *Erodium* pollen has sometimes been considered an indicator of modern contamination in archaeological samples. The presence of this type in numerous prehistoric proveniences in the present study, however, suggests that within the project area the native species is the source.

SITE RESULTS AND COMPARISON

Intersite comparison necessarily devolves on patterning in nonarboreal pollen types, including those affected by cultural modification of site environs. Table 20.6 presents two sets of summary statistics of selected types for this purpose. In one set of calculations, all analyzed samples from habitation areas of a site are considered (two instances of samples from potentially agricultural rock alignments are not included). A variety of proveniences is the best measure of overall pollen deposition. Emphasis on resource-related activities may be registered strongly in extramural features, particularly when site occupation includes warm seasons. Intersite comparison based on all samples from each site is problematic, however, when classes of features have not been sampled equally due to limitations on excavations extent of available funding for analysis.

A second set of figures in Table 20.6 is limited to samples from the floors of structures. Floor samples standardize pollen assemblages to a context subject to a common range of depositional biases, and floor proveniences were targeted in the selection of samples for analysis. Pollen is homogenized to some degree by sweeping and other activities, and accumulates continuously as soil becomes compacted into earthen floors.

Table 20.2. Values for pollen types in samples from Rye Creek Colonial period (Gila Butte phase) sites. Percentages of noncultigen types are calculated on the basis of a 200-grain standard sum of all noncultigen taxa. Cultigen types are quantified as the number of grains encountered during completion of this standard sum.

Feature	*Artemsia*	*Ambrosia*-type	High Spine Compositae	Cheno-am	Gramineae	*Boerhaavia*-type	*Sphaeralcea*	Onagraceae	*Eriogonum*	*Euphorbia*-type	*Erodium*	cf. Leguminosae	Cylindropuntia	Platyopuntia	*Cereus*-type	*Ephedra*	*Pinus*	*Quercus*	*Juniperus*	*Typha*	Other	Indeterminate	*Zea* (No. of grains)	*Cucurbita* (No. of grains)
Pithouse																								
F.2 floor	+	19.5	8	44*	9.5	5	1		.5			1.5			.5		2.5	+		3	1 Liguliflorae, 1 Cruciferae	3	1*	
F.6 floor	3	20	6.5	42.5	3	4*	5.5		3			.5	+	2			1.5	1.5	2		.5 Liguliflorae,	4.5	2	
F.9 floor	.5	24	9.5	39	5.5*	2.5	2	4*								+	3	2.5	1		.5 *Kallstroemia*	6	1	
F.11 floor		12.5	12	45.5	8	3.5	2.5		1	.5	.5		2		+	1.5	+	2	3.5		.5 Labiatae, .5 Rhamnaceae	4	3	
F.12 floor		20	14	38	2.5	4	4	+	4		1				2		4	.5	.5		.5 *Celtis*, 1 Cyperaceae, .5 Liliaceae	3.5	2*	
F.13 floor	.5	22*	9.5	40	6	2*	2		4.5			.5		1	2.5	.5	.5	3	3			2.5	+*	
F.14 floor		25.5	5.5	42	15*	1.5	1.5		1		.5				1		1	+	.5		3.5 *Prosposis**	1.5		
F.18 floor	2	28	10	34.5*	6.5	1.5	1.5		6					4*	1		2	+	1			2	5	
F.21 floor		18	21.5*	31	5.5	4.5	2		+	.5		2	1		.5	2	2.5	1	2*	+	.5 Caryophyllaceae, .5 *Kallstroemia*	5	2	
F.22 floor		22.5	6	40	9	6*	+		1.5			1	5*				1	2	1		1 Cruciferae	4	+	
F.25 floor		16.5	5	43	5	5*	2.5		8.5			2				.5	2.5	.5	1		2 *Canotia*, .5 *Acacia*, 1 Cruciferae	4.5	4	
F.32 floor	3.5	26	10.5	32*	6.5	4*	.5		3			2.5				1	3.5	2.5	+	1	.5 *Acacia*	3		
F.36 floor	1.5	27.5	9*	30.5	7.5	4.5	1		5.5							1	1.5	1	1.5		.5 Liliaceae, .5 *Alnus*	7		
F.62 floor		17.5	7.5	41.5	10	4	1.5	1	+		+		.5		3	2	1.5	3.5	2		1 Liguliflorae, .5 Ericaceae	3	9	
F.34 floor - (insufficient pollen)																								
F.59 floor	+	23.5	8	46.5*	5	3.5*	1	.5	4	1		1	+				1	.5	.5		.5 *Alnus*	3.5	1	
Extramural Surface																								
F.20 surface		14	13.5	45.5	4.5*	1.5	2.5	+	1.5						2*	1.5	2.5		.5		.1 Cruciferae, 4 *Prosopis*	5.5	+	
F.66 surface		25.5	6	38.5*	13*	4	2.5	1	.5					.5			4	.5				4	15	1
F.72 surface		21	4.5	45*	.5	2	3*		10*		4	1	1				1.5	2.5	2		.5 *Gilia*, 1 Caryophyllacea	.5		
Extramural Pit																								
F.45	2.5	13.5	11.5	20	12.5	1.5	2		3.5							4	10.5	7	1.5	2.5	.5 *Prosopis*, 2 *Alnus*	5		
F.63	1	22	7	39.5*	6	4.5	2	+	2	2.5			1.5	1		.5	3	.5	+		4 Cruciferae*, .5 *Larrea*	2.5	17*	
F.64		18	5	46*	2.5	3	.5		2.5						4.5*	10*	1	1	2		.5 *Prosopis*, .5 Solanaceae	3	6*	
Crematorium																								
F.52 pit bottom	6.5*	28.5	8.5	31.5	4	2	+		1.5	.5		1				1	3.5	3	4		.5 *Acacia*	4	1	
F.1 pit bottom - (insufficient pollen)																								
F.88 under RV		21.5	3.5	41	7.5	1.5	11.5*		1			.5				1	1.5	.5	2			7	+	

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[1] Probable Sacaton phase context

*Indicates a pollen type occurring in aggregates of six or more grains.

+Indicates a pollen type observed only in scanning of additional sample material after completion of a 200-grain standard sum.

Table 20.3. Values for pollen types in samples from Rye Creek Sedentary period (Sacaton phase) sites. Percentages of noncultigen types are calculated on the basis of a 200-grain standard sum of all noncultigen taxa. Cultigen types are quantified as the number of grains encountered during completion of this standard sum.

Site/Feature	*Artemsia*	*Ambrosia*-type	High Spine Compositae	Cheno-am	Gramineae	*Boerhaavia*-type	*Sphaeralcea*	Onagraceae	*Eriogonum*	*Euphorbia*-type	*Erodium*	cf. Leguminosae	Cylindropuntia	Platyopuntia	*Cereus*-type	*Ephedra*	*Pinus*	*Quercus*	*Juniperus*	*Typha*	Other	Indeterminate	*Zea* (No. of grains)
AZ O:15:92																							
Pithouse																							
F.14 floor		27	8.5	31.5	6	8*	1.5		5.5			.5			.5		2	4.5	1		1 *Salix*, .5 Rhamnaceae, .5 *Prosopis*	1.5	12
F.14 floor	.5	19.5	4.5	34	10*	12.5	3		3	.5		.5				1	1.5	2	.5		2 Lilaceae, .5 Liguliflorae	4.5	3
Ramada																							
F.15 floor	+	14.5	6	40*	7.5	10	2		2.5			1	.5	+	3	1	6	3	+		.5 Solanaceae	2.5	2
AZ O:15:100																							
Pithouse																							
F.1 floor	.5	26.5	17	42*	7.5	1.5	.5		1		+					.5	.5	+	+			2.5	+
F.3 floor by hearth	.5	23	24.5	28.5	9.5	3	2					.5					1.5	2		.5	.5 *Alnus*	4	+
F.4 floor	2.5	14	10.5*	23*	30*	4*	1.5	1	1.5		4.5		1		1	+	2	1	.5		1 Cruciferae, .5 Solanaceae	.5	2
F.6 floor		20.5	19.5	26.5*	7*	5	2	1.5	4.5	.5					+		4		2		.5 *Prosopis*	6.5	
F.12 floor		27	16	22	10.5	4.5	1		2	1		1		.5	+	3	2.5	2.5	1.5	3.5	.5 *Canotia*, .5 *Yucca*	.5	2
Exterior Pit																							
F.2 pit bottom	.5	24.5	27	16.5	9*	9	2	1	4	.5						.5	1.5	.5	1		.5 *Kallstroemia*	2	3
F.20 pit fill - (insufficient pollen)																							
F.27 near bottom	1	29.5	14*	24	4	5.5*	+	1	6*		3		1		.5	+	3	1	2.5		.5 *Salix*, .5 Labiatae	3.5	+
F.28 near bottom		21.5	20.5	40*	6	4	3										1	1				3	1
F.22 intrusive ash pit in F.12	2	26	18	21	5.5	3.5	.5		3.5			2					2.5	1.5	7*		.5 *Celtis*, .5 Cruciferae	6	1
Roasting Pit																							
F.13 pit bottom		30	29	21.5	8.5	5	1					.5	2				+	+	.5			4	+
F.17 pit bottom	1.5	13	23.5	34.5*	16*	1.5	.5		.5					1			2.5	1.5					
AZ O:15:91																							
Pithouse																							
F.5 floor		42.5	9*	13*	3	12.5	3.5	1.5	4.5	.5							5	2	1.5		.5 *Prosopis*	1.5	2*
F.11 floor		16	7.5	30	5.5	6.5	2	4*	2			3.5		1.5	1	2.5*	2	4.5	+	4	2 Liguliflorae, .5 Rosaceae	5	5
F.11 min. jar in bench	.5	20	14.5	29.5	10	4.5	4	+	3.5							.5	3	2.5	2		.5 Labiatae, .5 *Alnus*	4.5	+
Extramural Pit																							
F.22 under slab		12.5	10	26.5*	6.5	7.5	2		2		.5	.5			2.5		4.5	3	3		11.5 Cruciferae, 3 *Prosopis*, .5 *Salix*	4	

Table 20.3. Continued.

Site/Feature	*Artemsia*	*Ambrosia*-type	High Spine Compositae	Cheno-am	Gramineae	*Boerhaavia*-type	*Sphaeralcea*	Onagraceae	*Eriogonum*	*Euphorbia*-type	*Erodium*	cf. Leguminosae	Cylindropuntia	Platyopuntia	*Cereus*-type	*Ephedra*	*Pinus*	*Quercus*	*Juniperus*	*Typha*	Other	Indeterminate	*Zea* (No. of grains)
AZ O:15:90																							
Pithouse																							
F.3 floor	+	16	8.5	36.5	20*	1.5	2	+	1		+		+		+		2.5	6	.5	+	.5 Ericaceae, .5 *Acacia*	4.5	2
F.4 floor	.5	14	10	41	7	4*	+		1.5	1.5	.5		.5		3*	1	3	2	2		.5 *Alnus*, .5 Rosaceae, .5 *Celtis*	7	+
F.5 floor		11.5	6	50	8.5	11.5*	.5				3				1.5		.5				3.5 Caryophyllaceae, .5 Liguliflorae	3.5	1
AZ O:15:53																							
Pithouse																							
F.1 floor	1.5	5.5	13.5	44*	11*		4*		2			2	2			1.5	3.5	1.5	.5		.5 Cruciferae, 2 *Yucca*, .5 Malvaceae	4.5	1
F.6 floor	.5	8.5	9	15.5	40*	+			.5							.5	.5	1	1	1	20 Cruciferae*, .5 Caryophyllaceae	1.5	1
F.9 floor	1.5	14	20	31.5	18		1.5		1	.5	.5						2	2			.5 Liliaceae, .5 *Polygonum*	6.5	+

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*Indicates a pollen type occurring in aggregates of six or more grains.

+Indicates a pollen type observed only in scanning of additional sample material after completion of a 200-grain standard sum.

Table 20.4. Values for pollen types in samples from Rye Creek early Classic period (Roosevelt phase) sites. Percentages of noncultigen types are calculated on the basis of a 200-grain standard sum of all noncultigen taxa. Cultigen types are quantified as the number of grains encountered during completion of this standard sum.

Site/Feature	*Artemsia*	*Ambrosia*-type	High Spine Composilae	Cheno-am	Gramineae	*Boerhaavia*-type	*Sphaeralcea*	Onagraceae	*Eriogonum*	*Euphorbia*-type	*Erodium*	cf. Leguminosae	Cylindropuntia	Platyopuntia	*Cereus*-type	*Ephedra*	*Pinus*	*Quercus*	*Juniperus*	*Typha*	Other	Indeterminate	*Zea* (No. of grains)
AZ O:15:99																							
Cobble Room																							
F.1 floor	1	32.5	14.5	33*	1.5	3	1.5					1.5			+		4.5	1.5	+			5.5	1*
F.3 floor		28	20	36.5	3.5	2.5	1		+								2	2	.5		.5 *Simmondsia*	3.5	4
Terrace																							
F.2	1	11	25	28.5	4.5	3.5	2		3.5		1					.5	9.5	1	1		.5 *Salix*, .5 Liguliflorae	7	
AZ O:15:55																							
Cobble Pitroom																							
F.1 floor	+	11	5.5	64*	6	1.5	1.5						2			2.5	1	2.5	.5		.5 *Alnus*	1.5	2
F.5 upper floor	8.5	19	12.5	26*	5.5*	3	5	1.5	.5	2		2	3.5				1.5	1.5	1.5	2	.5 *Yucca*, .5 *Salix*, .5 *Celtis*	3	14
F.5 lower floor	1.5	14.5	15	18.5*	2	10	2.5		3		4		7*		6.5*	.5	4	3	1.5	1.5	1 *Salix*	4	20
F.6 floor		23	11	37	7.5	2.5	1.5		1					.5	1	+	3.5	4	2		.5 Liguliflorae, .5 Cruciferae	4.5	2*
Pithouse																							
F.11 floor		15.5	6.5	44.5*	10	6.5	1.5					2.5				2	2	.5	1		1 *Kallstroemia*, .5 *Yucca*, .5 *Gilia*	5.5	
F.19 floor		22.5	11.5*	38.5	4.5	4	3	1	.5	.5		1	+		.5	1.5	1	2.5	3		.5 Verbenaceae, .5 Cyperaceae	3.5	1*
Trash or Storage Pit																							
F.10 pit bottom	+	17.5	13	39*	8.5	4*	2	+			+				1.5		5	.5	3	+	.5 Labiatae, .5 *Prosopis*	5	4
Inhumation																							
F.17 pit edge - (insufficient pollen)																							
AZ O:15:54																							
Cobble Pitroom																							
F.5 floor	.5	26.5	15.5	45	2.5	1.5	1		2	1						+	+	1.5	1		.5 Umbelliferae	1.5	1*
F.8 floor		19	13	27.5	6*	3.5	3	1.5	4	.5		1	1.5		3*		2	5.5	1.5	2.5	1 Liguliflorae, .5 *Salix*, .5 *Kallstroemia*	3	25*
Slab lined Pitroom																							
F.9 floor		16.5	17	40.5	5	2.5*	4		+								4	3	3			4.5	3
Trash Mound																							
F.2 L1-L4 and bottom	+	18.5	21	29*	1.5*	10.5	2		4.5	.5	1	.5		2	+		2	2	.5	1	1 Cruciferae, .5 *Canotia*	2	2

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*Indicates a pollen type occurring in aggregates of six or more grains.

+Indicates a pollen type observed only in scanning of additional sample material after completion of a 200-grain standard sum.

Table 20.5. Values for pollen types in samples from Rye Creek Indeterminate sites (probably Classic period). Percentages of noncultigen types are calculated on the basis of a 200-grain standard sum of all noncultigen taxa. Cultigen types are quantified as the number of grains encountered during completion of this standard sum.

Site/Feature	*Artemsia*	*Ambrosia*-type	High Spine Compositae	Cheno-am	Gramineae	*Boerhaavia*-type	*Sphaeralcea*	Onagraceae	*Eriogonum*	*Euphorbia*-type	*Erodium*	cf. Leguminosae	Cylindropuntia	Platyopuntia	*Cereus*-type	*Ephedra*	*Pinus*	*Quercus*	*Juniperus*	*Typha*	Other	Indeterminate	*Zea* (No. of grains)
AZ O:15:70																							
Rock-lined Pit F.2 - (insufficient pollen)																							
AZ O:15:71																							
Cobble Room F.1 floor	3	34.5	16	15	6.5	+	2	3.5*								1.5	7	5.5	2			3.5	+
Slab-lined Cist F.4 floor - (insufficient pollen)																							
AZ O:15:89																							
Cobble Room F.1 floor	1.5	35	17	21.5	4.5		.5		1.5			1			+	2	6.5	1	3		.5 Rosaceae	4.5	
Terrace F.2	1	27	26.5	5.5	7		2		7.5		.5	1		.5		1	9.5	4.5	1.5		.5 Solanaceae, .5 *Kallstroemia*	5	
AZ O:15:96																							
Cobble Room F.1 floor		40	12.5	11.5	10	3	2.5	3	5.5*			.5					2	3	3.5		2.5 *Prosopis*	.5	

*Indicates a pollen type occurringin aggregates of 6 or more grains

+Indicates a pollen type observed only in scanning of additional sample material after completion of a 200 grain standard sum.

Table 20.6. Average values for selected pollen types in all habitation features and in structure floors of Rye Creek sites.

			All Habitation Features					House Floors Only				
Site	Site Type	Phase	No. of samples	% Cheno-am	% Ag weeds	No. of grains corn	% Cactus	No. of samples	% Cheno-am	% Ag weeds	No. of grains corn	% Cactus
AZ O:15:52	Hamlet	Gila Butte, Santa Cruz-Sacaton	23	39.0	5.6	3	1.6	15	39.3	5.7	1.9	1.7
AZ O:15:54	Hamlet	Early Classic	4	35.5	7.1	7.8	1.6	3	37.7	5.3	9.7	1.5
AZ O:15:92	Hamlet?	Sacaton	2*	36.4	11.3	4.8	1.9	1*	32.8	12.5	7.5	.3
AZ O:15:91	Farmstead/Homestead	Sacaton	4	24.8	10.6	1.8	1.3	2	21.5	12.3	3.5	1.3
AZ O:15:100	Farmstead	Sacaton	11	27.2	5.5	.8	.6	5	28.4	5	.8	.5
AZ O:15:90	Farmstead	Sacaton	3	42.5	6.5	1	1.7	3	42.5	6.5	1	1.7
AZ O:15:53	Farmstead/Fieldhouse	Sacaton	3	30.3	1.8	.7	.7	3	30.3	1.8	.7	.7
AZ O:15:99	Fieldhouse	Early Classic	2	34.8	4	2.5	0	2	34.8	4	2.5	0
AZ O:15:89	Fieldhouse	Indeterminate Class	1	21.5	.5	0	0	1	21.5	.5	0	0
AZ O:15:71	Fieldhouse	Indeterminate Class	1	15	2	0	0	1	15	2	0	0
AZ O:15:96	Fieldhouse	Indeterminate Class	1	11.5	5.5	0	0	1	11.5	5.5	0	0

*Two floor samples from F.14 at AZ O:15:92 were averaged as a single entry in calculations for this table.

Floor sediments should therefore contain pollen characterizing a broad interval of occupational time and a cross section of resource types from indoor storage, preparation, and consumption. Where possible, composite samples were assembled from multiple floor locations to most thoroughly characterize the breadth of resource use. Because structures are meaningful cultural units, floor samples are further amenable to both intrasite and intersite comparison. Contrasts among Rye Creek sites derived from total site samples are generally paralleled by samples from structure floors (Table 20.7).

Pollen distributions can be evaluated in relation to the Rye Creek site categories of hamlet, farmstead, and fieldhouse along a scale of potentially differential function and occupational magnitude and duration. If Cheno-am levels represent a generalized measure of occupational intensity, elevation of weedy plants producing this type must occur at some threshold regularly attained by both farmsteads and hamlets. A number of factors such as local edaphic differences and seasonal span could enter into the variation within these two categories. For example, the Redstone site (AZ O:15:91), a more substantial farmstead on the basis of other archaeological evidence, has a comparatively low Cheno-am average. Values for the Arby's site (AZ O:15:99), a fieldhouse, overlap with the farmstead and hamlet categories. Why these values do not fit the expected pattern is currently unclear, although AZ O:15:99 appears to be a more substantial settlement than the other fieldhouse sites.

Table 20.7. Summary of economic pollen occurrences in structure floors of Rye Creek sites.

Site/Feature	Low Spine Comp. Sunflower Family	High Spine Comp. Sunflower Family	Cheno-am Chenopod, Amaranth	Gramineae Grass Family	Onagraceae Evening Primrose Fam.	*Eriogonum* Wild buckwheat	% Cylindro puntia Cholla	% Platyopuntia Prickly pear	% *Cereus*-type Hedgehog, saguaro, ect.	% Total Cactaceae Cactus	*Yucca* Yucca	Liliaceae Lily Family	*Typha* Cattail	*Cyperaceae* Sedge	*Prosopis* Mesquite	Mustard Family Cruciferae	*Juniperus* Juniper	*Zea*, corn No. of grains	% Ag. weeds	*Ephedra* Mormon tea	Caryophyllaceae Pink Family
AZ O:15:52																					
F.2 pithouse									.5	.5			x			x		1*	6		
F.6c pithouse							+	2		2								2	9.5		
F.9 pithouse				x	x													1	5		
F.11 pithouse							2		+	2								3	6		
F.12 pithouse									2	2		x		x				2*	8		
F.13 pithouse	x							1	2.5	3.5								+*	4		
F.14c pithouse				x					1	1					x				3		
F.18 pithouse								4*	1	5								5	3		
F.21c pithouse		x					1		.5	1.5			+				x	2	7		
F.22 pithouse							5*			5						x		+	6		
F.25 pithouse																x		4	7.5		
F.32 pithouse													x						4.5		
F.36 pithouse		x										x							5.5		
F.62 pithouse							.5		3	3.5								9	5.5		
F.59 pithouse							+											1	4.5		
Site Avg.										1.7								1.9	5.7		
AZ O:15:54																					
F.5 pitroom																		1*	2.5		
F.8 pitroom				x			1.5		3*	4.5			x					25*	7		
F.9 pitroom																		3	6.5		
Site Avg.										1.5								9.7	5.3		
AZ O:15:92																					
F.14 (avg. of 2 samples) pithouse				x					.3	.3		x						7.5	12.5		
AZ O:15:55																					
F.1c pitroom							2			2								2	3		
F.5 upper c pitroom				x			3.5			3.5	x		x					14	8		
F.5 lower c pitroom							7*		6.5*	13.5			x					20	12.5		
F.6c pitroom								.5	1	1.5						x		2*	4		
F.11c pithouse											x								9		
F.19c pithouse		x					+		.5	.5				x				1*	7		
Site Avg.									3.5									6.5	7.3		
AZ O:15:91																					
F.5c pithouse		x																2*	16		
F.11c pithouse					x			1.5	1	2.5			x					5	8.5	x	
Site Avg.										1.3								3.5	12.3		

Table 20.7. Continued.

Site/Feature	Low Spine Comp. Sunflower Family	High Spine Comp. Sunflower Family	Cheno-am Chenopod, Amaranth	Gramineae Grass Family	Onagraceae Evening Primrose Fam.	*Eriogonum* Wild buckwheat	% Cylindro puntia Cholla	% Platyopuntia Prickly pear	% *Cereus*-type Hedgehog, saguaro, ect.	% Total Cactaceae Cactus	*Yucca* Yucca	Liliaceae Lily Family	*Typha* Cattail	*Cyperaceae* Sedge	*Prosopis* Mesquite	Mustard Family Cruciferae	*Juniperus* Juniper	*Zea*, corn No. of grains	% Ag. weeds	*Ephedra* Mormon tea	Caryophyllaceae Pink Family
AZ O:15:100																					
F.1 pithouse			x															+	2		
F.3c pithouse													x					+	5		
F.4c pithouse		x		x			1		1	2						x		2	5.5		
F.6c pithouse				x					+										7		
F.12 pithouse								.5	+	.5	x		x					2	5.5		
Site Avg.								.5										.8	5		
AZ O:15:90																					
F.3c pithouse				x			+		+				+					2	3.5		
F.4c pithouse							.5		3*	3.5								+	4		
F.5c pithouse									1.5	1.5								1	12		x
Site Avg.										1.7								1	6.5		
AZ O:15:53																					
F.1c pithouse			x	x			2			2	x					x		1	4		
F.6c pithouse				x									x			x		1	+		
F.9c pithouse												x						+	1.5		
Site Avg.										.7								.7	1.8		
AZ O:15:99																					
F.1 masonry structure									+									1*	4.5		
F.3 masonry structure																		4	3.5		
Site Avg.																		2.5	4		
AZ O:15:89																					
F.1 masonry structure									+	+									.5		
AZ O:15:71																					
F.1 masonry structure					x													+	2		
AZ O:15:96																					
F.1 masonry structure						x													5.5		

Corn is quantified as number of grains encountered during completion of a 200-grain standard sum of all noncultigen types.
Percentages are given for cholla, prickly pear, *Cereus*-type cactus, total cactus, corn, and agricultural weeds. Other types are represented as present in tabulation (x) or as observed in scanning (+).
+Indicates a pollen type observed only in scanning of additional sample material after completion of a 200-grain standard sum.
*Indicates a pollen type occurring in aggregates of six or more grains.
cIndicates a composite sample.

The primary contrast in Cheno-am frequencies is between all sites (other than AZ O:15:91) and the three fieldhouses in the southern portion of the project area. AZ O:15:71, AZ O:15:89, and AZ O:15:96 yielded the lower end of the prehistoric range. Although the record for these three sites is confined to a single floor sample from each, results from these fieldhouses further suggest a low intensity and short duration of occupation by the absence of the ubiquitous cultigen pollen, corn, and of the most common wild resource, cactus.

Combined values for the agricultural weeds, spiderling, globe mallow, and Arizona poppy, are notably high at the Redstone (AZ O:15:91) and Rooted (AZ O:15:92) sites, but fall within a range from about 5 to 7 percent at five other hamlets and farmsteads. The most ephemeral farmstead site (farmstead/fieldhouse), the Hilltop site (AZ O:15:53), resembles three of the four fieldhouse sites in lower frequencies. AZ O:15:96 is the exception in the fieldhouse category, with agricultural weed values overlapping hamlets and farmsteads. These patterns counter the expectation that fieldhouse sites, presumably in the immediate vicinity of fields, would be subject to most abundant pollen deposition from agricultural weeds, through transport by air or introduction on feet, clothing, and harvested crops of occupants.

Distributions of cultigen pollen also call into question a primarily agricultural function for Rye Creek sites in the fieldhouse category. Elevated quantities of these types may be related to both the relative abundance of crops in a provenience and to the form of the cultigens that are involved. Corn pollen (*Zea*) is the only cultigen type present with sufficient regularity for quantitative comparison. Freshly harvested ears should disperse the greatest amount of pollen, particularly if outer husks or stalk materials are present. Husked ears, shelled corn, roasted kernels, and ground meal should shed less pollen at each subsequent step in processing. Newly harvested crops, permanently or temporarily stored in fieldhouses and prepared for consumption during the occupational season, would be expected to create strong pollen evidence.

Regardless of whether all habitation samples or only structure floors are considered, hamlets and more substantial farmsteads (farmstead/homesteads) exhibit higher levels of corn pollen as a group than fieldhouses or other farmsteads. In conjunction with the tendency for higher representation of agricultural weed types in hamlets and farmsteads, distributions of corn pollen suggest that the most concentrated agricultural activity may have been associated with the larger and more substantial Rye Creek sites rather than the smaller, more ephemeral ones.

Structures with relatively unusual abundances of corn pollen are likely to have had a pronounced role in storage or preparation of this crop; abundance would be compounded if crops were in early stages of processing. None of the very high values in the Rye Creek analysis occur at less substantial farmsteads or fieldhouses (Table 20.7). Structures with maximally high corn values occur at the Cobble (AZ O:15:54) and Boone Moore (AZ O:15:55) sites, an early Classic hamlet and farmstead, respectively. No structure with equivalent quantities was encountered at the Preclassic hamlet, AZ O:15:52, or the four Preclassic farmsteads, in spite of examination of a large number of structures. More functionally specialized structures with regard to crops, or storage of harvests in less processed forms, may have characterized the Classic occupation. The strong resource association of the two Classic structures marked by unusual corn quantities, Feature 6 at the Cobble site and the upper and lower floors of Feature 5 at the Boone Moore site, are further evidenced by the diversity of economic types in those houses including appreciable cactus pollen.

Cactus pollen, divided into three types, is the most common indicator of wild plant resources in Rye Creek samples, although it has been suggested that cholla may have been transplanted or cultivated by aboriginal groups in the southern Southwest (e.g Fish 1984a; Bohrer 1987). It seems likely that fieldhouse occupants would have readily gathered cactus fruits or buds if they were resident during the season of availability. Access should have been enhanced at small, isolated habitations compared to the environs of larger sites, where competition for resources in a convenient radius would have been greater. Nevertheless, cactus pollen was observed only in scanning after tabulation of samples from the four fieldhouses and the more ephemeral farmstead, the Hilltop site (AZ O:15:53). Lesser pollen evidence for use of wild plants as well as for cultigens distinguishes the smaller and less substantial Rye Creek sites from larger settlements.

A conservative approach has been taken in the economic distinction of commonly occurring pollen types from natural background levels, with the undoubted outcome of underrating palynological evidence for use. Ambiguity in discriminating culturally augmented concentration is pronounced for two resource categories known to have been routinely utilized in the Southwest. Mesquite pollen occurs in small percentages in numerous samples, was likely widespread in the prehistoric natural vegetation, and therefore has been designated as an economic indicator only when aggregates were observed. Although charcoal resembling mesquite occurs in several sites, definitive flotation evidence for food use is more limited (see Chapter 18). Pollen of chenopods and amaranths is always elevated above modern levels in the Rye Creek sites and occurs regularly in aggregates; only aggregates and frequencies anomalous among other site values were designated as economic concentrations because residential weeds around dwellings would tend to create similar patterns. Unlike mesquite residues, identifiable seeds of species in the Cheno-am category were routinely recovered by flotation.

Two agricultural weeds, globe mallow and spiderling, also occur often in aggregates but are not designated as resources. In the case of spiderling, the tendency is so pronounced that it appears to be a characteristic of the manner of pollen dispersal by this insect-pollinated plant. These aggregates may also reflect indirect transferral of pollen among cultigens, direct contact between cultigens and interspersed weeds in the fields, and subsequent introduction into site proveniences on the surfaces of harvested items. Although most instances of aggregates are probable correlates of agricultural weeds, both globe mallow and spiderling were utilized ethnographically. Globe mallow furnished medicinal ingredients to various groups such as the Pimans (Russell 1975:79; Curtin 1984:80-81) and Hopi (Whiting 1939:85), and occasional food use is reported. Spiderling was prepared as a pot herb by the Seri (Felger and Moser 1985:349) in a manner similar to the use of chenopod or amaranth greens.

AZ O:15:96, Fieldhouse

A single sample from the floor of a cobble room was analyzed. Only wild buckwheat (*Eriogonum)* was a probable economic type. In addition to medicinal uses, shoots and seeds of wild buckwheat were eaten by the Cahuilla (Bean and Saubel 1972:72) and seeds by the Navajo (Wyman and Harris 1951). Without species identification, availability could extend from spring through summer.

AZ O:15:71, Fieldhouse

Pollen was not recovered from Feature 4, a slab-lined cist. From the floor of Feature 1, a cobble room, evening primrose family was the sole resource indicator. Species in this family have been consumed in the form of greens (Castetter and Bell 1942:62), roots (Kearney and Peebles 1964:593), and fruits (Castetter 1935:17), and medicinal uses are known. Midspring through late summer are potential seasons of availability. Corn pollen, observed only in scanning, fails to support an interpretation of primary agricultural function.

The Overlook Site: AZ O:15:89, Fieldhouse

A possible terrace (Feature 2) yielded no cultigen pollen and a relatively low percent of globe mallow, a weed associated with Hohokam agriculture. A frequency for wild buckwheat in the upper range for project samples might indicate agricultural disturbance, but feature function cannot be considered conclusive on this basis. Agricultural weeds were even less abundant on the floor of the cobble room (Feature 1). *Cereus*-type pollen, probably from hedgehog cactus, was seen in scanning.

The Arby's Site: AZ O:15:99, Fieldhouse

AZ O:15:99 is located in the vicinity of Rye Creek and farther north in the study area than the three preceding fieldhouses. It is also more substantial, containing a higher artifact density and greater diversity. Location may figure in the stronger evidence for agricultural activity at this site. A cobble terrace (Feature 2) here yielded a moderate level of agricultural weeds but no cultigen pollen. A similar level of the weeds and corn pollen occurred in each of two cobble rooms. Levels at AZ O:15:99 in both these categories are duplicated or superseded in many structures at farmsteads and hamlets. *Cereus*-type cactus seen in scanning of the Feature 1 sample is the only other economic pollen. Charred hedgehog cactus seeds point to the specific resource denoted by this type.

The Hilltop Site: AZ O:15:53, Farmstead/Fieldhouse

Evidence of agricultural activity at AZ O:15:53 is not as strong as at AZ O:15:99, in spite of the fact that small amounts of corn pollen were tabulated for two pithouse floors and this type was observed in scanning of the third. No aggregates were encountered, however, and the absence of corn in flotation results also suggests that large quantities of freshly harvested crops were not present. Spiderling, the most abundant of the agricultural weed categories at other sites, was not tabulated.

Samples from the three structures revealed a diversity of resources in Features 1 and 6, whole Feature 9 contained only lily family pollen of probable economic origin. This type could indicate a variety of species, but a likely candidate is bluedicks (*Dichelostemma pulchella*), a common spring annual of the Tonto Basin and a bulb eaten by Pimans (Kearney and Peebles 1964:182). Mustard family (Cruciferae) pollen in Features 1 and 6 (tansy mustard or *Descurainia* by reference to charred seeds) is an indicator of the spring season. Grass pollen in both these structures confirms the flotation importance of wild barley (*Hordeum*), and further pertains to spring gathering. Cholla buds and cattail pollen also would be available in this season. Although occupation into other seasons cannot be ruled out, resources at AZ O:15:53 embody a strong spring emphasis.

The Compact Site: AZ O:15:90, Farmstead

Two structures, Features 3 and 5, at AZ O:15:90 yielded the lower range of corn pollen values in tabulation, and a scanning presence was recorded in Feature 4. Hedgehog cactus was registered in each structure, with cholla in Features 3 and 5. Cactus products were probably staple resources at the site. Grass and cattail pollen complete the resource inventory of Feature 3. A member of the pink family (Caryophyllaceae) appears to have been utilized in Feature 4. No charred material identified a potential plant source at AZ O:15:90, but a charred seed resembling the genus *Silene* in this family was recovered at AZ O:15:52. An ethnographic use is not known.

The Clover Wash Site: AZ O:15:100, Farmstead

With the exception of AZ O:15:52, the largest number of analyzed samples are from AZ O:15:100 and house floors make up less than half of the total. Nevertheless, the wider range of analyzed proveniences at this site does not account for the relatively lower average value for corn pollen at AZ O:15:100 than at other Rye Creek Project farmsteads and hamlets (Table 20.6). Although house floors are high probability contexts for the deposition of cultigen pollen, floor samples echo the low level in total site samples. Of five pithouse samples, corn pollen was tabulated in only two. Other than for AZ O:15:53, the number of flotation samples in which corn occurred was also lowest among farmsteads and hamlets.

Average frequencies for cactus pollen are again relatively low for AZ O:15:100. Features 4 and 12, the two structures yielding tabulated corn pollen, are also the only structures containing tabulated cactus types. Overall diversity of resource records is greatest for these pithouses as well (Table 20.7). Pollen distributions suggest that Features 4 and 12 were the scene of more substantial occupations in which a great range of resources were utilized. Seasonal habitation in two of the other pithouses may be indicated by reuse of the hearth in Feature 1 and two hearths in Feature 3. Alternatively, activities involving food preparation or storage could have been concentrated in Features 4 and 12 to a greater degree than in the other structures.

A number of extramural pits were sampled. In several cases, economic types were present. Grass and corn were associated with the bottom of Feature 2; a member of the sunflower family, wild buckwheat, cholla, or amaranths and corn with Feature 28. With multiple resources from each of these features, it is possible that primary functions involved several resources or that residues from utilized plants were present as refuse in the sediments ultimately filling these pits. Feature 22, an ash-filled pit intrusive into the Feature 12 pithouse, also contained multiple economic types. Corn, mustard family, and juniper were indicated. Again, it is difficult to distinguish between functional association and inclusions in trash. Food may have been processed or prepared in conjunction with Feature 22. Juniper aggregates could originate on edible berries or on the bark of fuel wood.

Two roasting pits yielded ecomonic indicators. Feature 13 contained cholla as the sole type. It is probable that cholla buds were cooked in this feature. Samples from a modern roasting pit used to prepare cholla buds contained pollen frequencies in a similar range (Greenhouse et al. 1981). Feature 17 contained grass, prickly pear, chenopod or amaranth, and a scanning record of corn. Flotation also yielded the latter three resources, as well as agave. It is likely that all of these items were roasted on different occasions although the grass may have served as a pit liner or steaming agent. Again, however, the multiplicity of resources raises the possibility that some of the economic types originated in unintentional trash inclusions.

The Redstone Site: AZ O:15:91, Farmstead/Homestead

Both structures at AZ O:15:91 contained evidence of corn. Feature 5, with corn aggregates and a relatively high frequency of agricultural weeds may have had the closer association with agricultural activity or storage of crops prior to processing. This pithouse yielded only a member of the sunflower family as an additional resource. Feature 11 had a more diversified economic record suggesting a more substantial occupation or generalized function with evening primrose family, prickly pear, *Cereus*-type cactus, cattail, and Mormon tea (*Ephedra*). Mormon tea had medicinal uses among the Pima (Curtin 1984:76-77) and other aboriginal groups. A miniature jar from within the bench of the remodeled Feature 11 (see Chapter 8, Volume 1) revealed no pollen evidence for contents.

Feature 22, an intrusive pit within Feature 11 of later date than the primary occupation of the pithouse, was sampled beneath a grinding slab. Mustard family pollen was unusually abundant and *Cereus*-type was present. Agricultural weeds occurred in frequencies similar to other samples from the site. Feature 22 might represent a reuse of the structure for a more temporary subsequent occupation or as a protected outdoor work area while later structures were occupied. Spring gathering is probable for the mustard family resource.

The Boone Moore Site: AZ O:15:55, Farmstead/Homestead

AZ O:15:55 is artificially separated from the Compact site (AZ O:15:90) by State Route 87 and produced equivalent average values for Cheno-am and agricultural weed pollen. Although the main occupation at AZ O:15:55 is somewhat later than AZ O:15:90, the general character of the two occupations as reflected by pollen appears similar. Elevated quantities of corn pollen from two sequential floors in a cobble pit room, Feature 5, create a high average for AZ O:15:55. This feature also contained a high average of cactus. Both floors contained evidence of cholla and cattail, with grass and yucca also on the upper floor and *Cereus*-type cactus on the lower. Feature 1 yielded corn and cholla and Feature 6 yielded corn, prickly pear, *Cereus*-type cactus, and mustard family pollen. Multiseason occupation seems to be indicated.

Like the pitrooms, one of two sampled pithouses had a variety of economic types. Corn, cholla, *Cereus*-type cactus, sunflower family, and sedge (Cyperaceae) pollen grains were recovered from pithouse Feature 19. Sedge species provide edible seeds and tubers (Curtin 1984:99) and stems for crafts such as matting. Feature 11 contained only yucca as a potential resource, suggesting some difference in resource association compared to other structures at the site. A mixture of economic types in Feature 10, a pit, includes appreciable corn pollen, cattail in scanning, and *Cereus*-type cactus. Because pit contents suggest trash fill, it is unclear whether pollen contents originated with resource storage and preparation or with debris of utilized plants.

The Rooted Site: AZ O:15:92, Hamlet?/Agricultural Site

Features at AZ O:15:92 were extensively disturbed by previous root-plowing for range improvement. Disturbance and the limited amount of excavation in the present study prevent detailed knowledge of the nature of the occupation, but a substantial settlement is probable. Pollen spectra from a pithouse and a ramada fit the pattern of more permanent Rye Creek habitations. Agricultural weeds were prominent and corn was present in each, with a comparatively high value in one of two floor samples from the pithouse, Feature 14. Grass, *Cereus*-type cactus, and lily family types were recovered in this feature. The ramada contained all three cactus types.

The Cobble Site: AZ O:15:54, Hamlet

Three early Classic pitrooms were marked by levels of corn and agricultural weeds typical of the more substantial sites. Feature 8, a badly disturbed cobble structure, produced the highest value for corn pollen in any sampled provenience of the Rye Creek analysis. Additional economic types in this pitroom included grass, cholla, *Cereus*-type cactus, and cattail. Cultigen abundance and diversity combine to differentiate Feature 8 from the two other structures with regard to cobble pitrooms, contained only corn.

A composite sample includes multiple levels in a trash mound, Feature 2. Agricultural weeds were more plentiful than in the structures. Corn, mustard family, cattail, prickly pear, *Cereus*-type cactus, and grass largely overlap with economic types in Feature 8.

The Deer Creek Site: AZ O:15:52, Hamlet

More samples were analyzed from this Preclassic settlement than from any other Rye Creek site. The site was primarily occupied during the Gila Butte phase, although a reoccupation during Santa Cruz-Sacaton times appears to be centered in the northern part of the site. During the later interval, a farmstead or fieldhouse rather than hamlet designation may be appropriate. Only three analyzed samples are of probable Santa Cruz-Sacaton affiliation, however. These samples from Features 59, 20, and 66 differ in no systematic manner from other site records, and have been included in site averages in Table 20.6.

The floor of Feature 59, a Santa Cruz-Sacaton pithouse contained only a small amount of corn pollen and a scanning observance of cholla. Greater diversity in ecomonic types characterized two later activity surfaces or ephemeral structures overlying the fill of this house. The uppermost, Feature 20, yielded corn in scanning, and possibly mesquite, mustard family, *Cereus*-type cactus, and grass. The lower surface, Feature 66, produced a large quantity of corn pollen, the only cucurbit record in the Rye Creek sites, prickly pear, and grass. Pollen content of these surfaces is compatible with use as brush kitchens. A second possibility is a fieldhouse function during a persisting use of fields about the site. However, frequencies of agricultural weeds were not higher than in earlier Preclassic proveniences.

Of 14 pithouses dating to the earlier Gila Butte phase occupation, three failed to yield corn pollen. These were Features 14, 32, and 36. Feature 14, which had a large ground stone assemblage on the floor, contained grass, *Cereus*-type cactus, and mesquite pollen; Feature 36 contained sunflower family and lily family pollen;

and Feature 32 contained only cattail pollen. Features 32 and 36 are superimposed in an uncertain order. The few resource types recovered from the floors of these two pithouses and the lack of common food types suggests that they may represent rebuildings of a structure with specialized function in the same location.

Feature 62 contained the most corn pollen of the 11 Gila Butte phase structures along with cholla and *Cereus*-type cactus. Corn values in the other pithouses ranged from scanning observances to midrange values among all Rye Creek structures (Table 20.7). *Cereus*-type cactus was ubiquitous, occurring on 8 of the 11 floors in either tabulation or scanning. The wide variety and seasonal variability of additional economic types includes two divisions of the sunflower family, grass, evening primrose family, cholla, prickly pear, lily family, cattail, sedge, mesquite, mustard family, and juniper. Pollen distributions suggest no detectable functional differentiation among these structures, including the small, round Features 11 and 12.

Wild buckwheat and cholla are economic types found in Feature 72, an extramural activity surface. Two ash pits and a hearth originating on this surface might have been used in food preparation. Pollen content is not equivalent with that of the possible brush kitchen floors of Features 20 and 66, suggesting an alternate use.

Three extramural pits were sampled. Feature 45, a small pit probably associated with the Feature 18 pithouse, contained a red argillite phallic censer. Only cattail was identified as an economic type. In addition to edible uses of the plant, cattail pollen is employed as a yellow body paint by Pimans (Curtin 1984:65). Alternatively, a wrapping of cattail basketry or matting might have enclosed the offering.

Plentiful corn pollen and aggregates, mustard family, prickly pear, and cholla occurred in Feature 63, a trash-filled pit. These resources may pertain to the original pit function or to food debris in the fill. In Feature 64, a bell-shaped pit in the same area, corn, Mormon tea, and *Cereus*-type cactus were indicated. The fill of this feature contained few artifacts; these resources may have been associated with a storage function.

The bottom of Feature 52, a crematorium, yielded an instance of corn pollen and aggregates of sagebrush (*Artemisia*). The latter may have been introduced on shrubs used as fuel or possibly for its aromatic qualities. In Feature 88, a second crematorium, a sample beneath a reconstructible vessel contained only a scanning observation of corn pollen, probably an unintentional inclusion. A relatively high frequency of globe mallow (*Sphaeralcea*) and aggregates may indicate an intentional introduction; uses of this plant are mainly medicinal.

RYE CREEK RESOURCE PATTERNS

The 12 Rye Creek sites in the current analysis subsume locational and temporal variability, but can be considered together for general patterns of resource use from Gila Butte times through the early Classic period in this portion of the Upper Tonto Basin. In order to apply a standardized measure that reflects each site in the same manner, only structure floor samples are included (Table 20.7). Corn pollen is the most frequently registered economic type, tabulated in 29 (67 percent) of 43 structures. If scanning results are included, corn is associated with 36 (84 percent) of the structures.

Corn ubiquity among structure floors also provides a comparative assessment of agricultural dependence with other parts of the region. Although the precision of this measure is limited by differences in analytical procedures, sample numbers per structure, and numbers of structures examined, Rye Creek frequencies do not appear to contrast significantly with those of surrounding prehistoric occupations. Corn pollen was present in 9 (82 percent) of 11 structures in the Ord Mine Project just to the south (Halbirt and Gasser 1987), in 7 or 67 percent (73 percent with scanning results), of 11 Pine Creek Project structures to the south and west (Cummings 1990), and in 6, or 60 percent, of 10 structures of the Ash Creek Project in the Lower Tonto Basin (Fish et al. 1985).

Based on both abundance of agricultural weeds and quantities of corn pollen, agricultural activity was most intense at substantial Rye Creek sites rather than at the small, ephemeral settlements classified in the fieldhouse category. Individual structures marked by the most elevated cultigen values occur in early Classic sites; in spite of the larger numbers of sampled Preclassic structures, equivalent records were not encountered. A diversity of economic types in these same Classic structures further supports a specialized function with regard to resources.

Cultigen diversity is low in Rye Creek subsistence remains. Although cotton and cucurbit pollen are always rare types, a single instance of the latter is the sole occurrence of either type in project samples. Flotation analysis likewise failed to record cultigens other than corn. Corn was a staple, but gathered resources apparently played a major role in subsistence.

Cactus pollen was tabulated in 23 cases, or 53 percent of structures. *Cereus*-type is the most common of three cactus types, tabulated in 37 percent of structures as compared to 26 percent for cholla and 14 percent for prickly pear. With scanning results, respective percentages are 67, 35, and 14. *Cereus*-type appears to represent hedgehog cactus in almost all cases, based on identified seeds from flotation samples. Saguaro, which is widespread in the Lower Tonto Basin, also produces this pollen type, but charred saguaro seeds were absent. This is also supported by the fact that hedgehog cactuses are present today in the project area while saguaro are noticeably rare. Cholla pollen tends to dominate in Hohokam sites to the west of the study area. The greater likelihood of cholla buds (containing pollen) than hedgehog fruits to introduce pollen into site sediments underscores the comparative importance of Rye Creek hedgehog use.

Other resources in order of ubiquity in structure samples are grass (23 percent), cattail (21 percent or 26 percent with scanning results), mustard family (16 percent), sunflower family with high spine pollen (12 percent), yucca (9 percent), lily family (9 percent), evening primrose family (7 percent), sedge (5 percent), and one occurrence each (or 2 percent) for Sunflower family with low spine pollen, wild buckwheat, juniper, Mormon tea, and pink family. Grass pollen is present in virtually every sample, and criteria for an economic designation undoubtedly discriminate only a fraction of the occurrences related to resource use. As discussed in an earlier section, the economic significance of chenopods, amaranths, and mesquite cannot be evaluated effectively due to the difficulty of separating natural and culturally augmented pollen occurrences. For all plant resources, pollen quantities and ubiquity among samples reflect the magnitude of prehistoric use indirectly, in accordance with the botanical characteristics of each species and the manner of cultural utilization.

CHAPTER 21

SEASONALITY AND RESOURCE USE: ANALYSIS OF THE RYE CREEK FAUNAL ASSEMBLAGES

Christine R. Szuter

A total of 2,785 animal bones, teeth, and antler fragments were recovered from eleven sites excavated from the Rye Creek project. This total includes 42 worked fragments. These settlements, located along four drainages -- Hardt Creek, Deer Creek, Clover Wash, and Rye Creek -- were occupied from approximately A.D. 750 through A.D. 1450. The site types represented include fieldhouses, farmsteads, hamlets, and villages. Although species diversity, in terms of taxonomic richness, was substantial (24 different taxonomic groups represented), taxonomic abundance was generally minimal. Most taxonomic groups comprised less than one percent of the total number of remains recovered from a site. Unidentified remains accounted for 64.27 percent of the entire assemblage. Identified remains were primarily artiodactyl (specifically mule deer) and lagomorph (primarily jackrabbit).

The Upper Tonto Basin, the location of the Rye Creek Project sites, is a mountainous environment of mixed chaparral and desert grassland (see Elson, Chapter 2, Volume 1) suitable for the exploitation of deer and rabbits. Research questions focused on the seasonality of resource procurement and intensity of occupation among functionally and geographically different settlements.

METHODS FOR ANALYSIS

All of the recovered faunal remains were analyzed. All material was washed in tap water, using a soft-bristle toothbrush when necessary to remove the dirt. The bone was then air-dried. Identifications were made using the National Park Service faunal collection curated at the Arizona State Museum Zooarchaeology Laboratory. The faunal remains were weighed to the hundredth of a gram using a Mettler AC100 balance. The bone was weighed in the Laboratory of Traditional Technology in the Department of Anthropology at the University of Arizona.

The following variables were recorded for all of the faunal remains: feature number, stratum, provenience and bag number, faunal bag and case number, class, taxon, size, side, body part, portion, percent of element, fusion, burning, presence of butchering marks, spiral fracture, rodent and carnivore gnawing, weathering condition, breakage pattern, evidence of being worked, and weight of bone. Additional information on individual fragments of bone was provided by including written comments. Appendixes H.1, H.2A, and H.2B (Volume 3) list the variables and values used in this analysis. This coding format is a slightly altered version of one developed by Bayham (Hatch, et al. 1987) and Szuter (1989) for the La Ciudad and Las Colinas projects, respectively.

A few comments about the values for these variables are necessary. Taxonomic identification consisted of coding the class, size (for mammals), and taxon to the lowest taxonomic level. Unidentified bone was considered to be bone that was not identifiable below the level of order. Although taxonomic identification was not possible for these remains, the mammalian fragments were categorized by class size. Four major and three intermediate size categories were used for this analysis. Rodent-size (size 1), lagomorph-size (size 3), carnivore-size (size 5), and artiodactyl-size (size 7) were the four major size categories. Intermediate categories were between each of these major size groupings. For example, most unidentified fragments could be placed as rodent-size (size 1) or lagomorph-size (size 2), but at times when a size determination could not be made for these two categories, the fragment was placed in size category 3 (rodent- or lagomorph-size). Bones coded as "unknown" were thought to be potentially identifiable because of the presence of distinctive morphological features, but because of the limitations of the comparative collection as well as skill of the analyst no further identification was possible.

Provenience information was recorded from the bag and included the site number, feature number and stratum. As part of the faunal analysis each bag and each bone within the bag was given a sequential number which facilitated pulling out the worked bones and deer mandibles for further analysis.

Descriptions of the body part included coding the skeletal element, the side of the element, the portion represented, and the percent of the element present. These data are used for understanding butchering patterns (particularly of artiodactyls) and taphonomic processes that affect the recovery of particular types of skeletal elements.

Modifications of the bone included burning, spiral fracturing, butchering marks, rodent and carnivore gnawing, weathering patterns, breakage patterns and working of the bone. No further detailed analysis on spiral fracturing, butchering marks, or rodent and carnivore gnawing was done because of the lack of these types of modifications on the many small fragmentary bones.

Three categories of weathering were used: good condition, slightly weathered, or heavily weathered. Bone in good condition had an intact cortical surface, whereas heavily weathered bone had a cracked or flaking cortical surface. Burned bone was grouped by degree of burning based on color. Bone was either not burned, was burned to a brown-blackened color, or calcined to a white-blue-gray color. The classification of bone as burned was fairly conservative. Bone that was brown in color was often not categorized as burned because of the difficulty in making the distinction between slight burning and discoloration from burial in the soil.

Breakage patterns were recorded as old breaks, fresh breaks, or a combination of fresh and old breaks. Freshly broken bone was extremely common at the Rye Creek Project sites. This fresh breakage was primarily the result of damage from the backhoe, although some shovel excavation damage also occurred. The weight of each bone was taken because of the high percentage of freshly broken bone. The faunal remains were not weighed for sites O:15:71, O:15:90, O:15:99, O:15:92, and a small portion of O:15:55, because the decision to weigh the bone was made after the analysis for these sites was completed.

RESULTS: TAXONOMIC ABUNDANCE

A total of 2,785 faunal remains from 11 sites was analyzed, including 42 worked bones. Twenty-four taxonomic groups were represented. Table 21.1 presents the scientific and common names of the animals identified. Animals ranged from the common taxa such as the black-tailed jackrabbit (*L. californicus*), cottontail (*Sylvilagus sp.*), and mule deer (*O. hemionus*) to rarer taxa such as bear (*Urus americanus*), badger (*Taxidea taxus*), and dog or coyote (*Canis sp.*).

Table 21.2 gives the number of identified specimens (NISP) and percent of each taxonomic group for each site. Nearly 70 percent of the bone came from the Boone Moore site (AZ O:15:55). None of the other sites commanded over 8 percent of the entire assemblage. Most bone from all of the sites was unidentifiable (nearly 64.27 percent). Among the identifiable remains, artiodactyl and lagomorph remains were nearly equally represented (15.30 percent and 14.69 percent, respectively). The remaining 5.71 percent came from birds, rodents, carnivores, and nonmammalian taxa. Birds were only recovered from two sites, Rye Creek Ruin (AZ 0:15:1) and the Boone Moore site. Rodent and carnivore remains, although relatively abundant at these same two sites, also were found at several of the other sites.

The taxonomic richness exhibited at Rye Creek Ruin and the Boone Moore site far surpassed any of the other sites. Taxonomic richness, or the number of different taxonomic groups present in an assemblage, is correlated positively with sample size (Grayson 1979, 1981, 1984). The Rye Creek Project sites follow this pattern with one major exception, Rye Creek Ruin. Rye Creek Ruin has an NISP of 208 with 15 different taxonomic groups identified. The only other site with as many identified taxa is the Boone Moore site, with 1,940 specimens. Sites with comparable overall sample size to Rye Creek Ruin have seven or fewer identified taxa. Table 21.3 presents information on the faunal assemblage from each site. While density measures have not been calculated for these sites, information is provided on the number of different contexts or features that contained faunal remains and the number that were excavated or sampled. The taxonomic richness found at Rye Creek Ruin cannot be explained in terms of number of excavation units. Only three contexts, all trash mounds, were sampled and these all had faunal remains. Other sites with far more contexts containing animal remains had far fewer taxonomic groups represented. Rye Creek Ruin differs from the other sites in terms of its size and function and this difference is reflected in its diverse faunal assemblage even when the sample size is small.

As archaeological recovery techniques improve, more faunal assemblages have greater quantities of bone that cannot be identified. These unidentified remains are not useless in terms of understanding prehistoric faunal procurement. They can be used to strengthen or refute patterns observed in the identifiable remains. Large quantities of small fragments of bone, for example, can indicate intensive processing of the animal.

Table 21.1. Scientific and common names of taxa identified from the Rye Creek Project sites.

SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME	COMMON NAME
Testudinata	Turtle/Tortoise	*Spermophilus variegatus*	Rock squirrel
Phrynosoma sp.	Horned lizard	*Thomomys* sp.	Pocket gopher
Serpentes	Snake	*Perognathus* sp.	Pocket mouse
Colubridae	Nonpoisonous snake	*Dipodomys* sp., small	Kangaroo rat
Crotalidae	Poisonous snake	cf. *Sigmodon* sp.	Cotton rat
Buteo sp.	Hawk	*Neotoma* sp.	Wood rat
Phasianidae	Quail	Carnivora	Carnivore
Columbidae	Doves	*Canis latrans/ C. familiaris*	Coyote/Domestic dog
Colaptes sp.	Flicker	*Urocyon cinereoargenteus*	Gray fox
Leporidae	Rabbit and hare	cf. *Taxidea taxus*	Badger
Lepus sp.	Jackrabbit	*Ursus americanus*	Bear
Lepus sp. cf. *L. alleni*	Antelope jackrabbit	Artiodactyla	Artiodactyl
L. californicus	Black-tailed jackrabbit	Cervidae	Elk and deer
Sylvilagus sp.	Cottontail rabbit	*Odocoileus* sp.	Deer
Rodentia	Rodent	*O. hemionus*	Mule deer
Sciuridae, small	Squirrel and allies	*O. hemionus/Ovis canadensis*	Mule deer/bighorn sheep
Sciuridae, large	Squirrel and allies	*Bos/Bison*	Cattle/bison

Table 21.2. Quantity (Qty) and percent (%) of taxonomic groups by site.

	O:15:71		O:15:52		O:15:53		O:15:100		O:15:91		O:15:1		O:15:92		O:15:54		O:15:55		O:15:90		O:15:99		Total	Total
Taxonomic Group	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	Percent
Unid class & size indet	1	50.00%			1	4.17%			1	0.83%	2	0.96%	46	64.79	2	3.77%	17	0.88%	1	1.43%	1	50.00%	72	2.58%
Unid Bird											3	1.44%					2	0.10%					5	0.18%
Unid Mammal size indet			13	9.35%			4	2.55%	3	2.50%	6	2.88%			3	5.66%	73	3.76%	18	25.71%	1	50.00%	121	4.34%
Unid Mammal size 1											2	0.96%					5	0.26%					7	0.25%
Unid Mammal size 2									1	0.83%	1	0.48%			2	3.77%	4	0.21%					8	0.29%
Unid Mammal size 3			33	23.74%			1	0.64%	27	22.50%	29	13.94%	1	1.41%	9	16.98%	128	6.60%	2	2.86%			230	8.26%
Unid Mammal size 4							1	0.64%	1	0.83%	4	1.92%			1	1.89%	18	0.93%					25	0.90%
Unid Mammal size 5							2	1.27%															2	0.07%
Unid Mammal size 6			9	6.47%			52	33.12%	13	10.83%	16	7.69%	1	1.41%	13	24.53%	307	15.82%	21	30.00%			432	15.51%
Unid Mammal size 7			32	23.02%			22	14.01%	31	25.83%	44	21.15%	1	1.41%	2	3.77%	691	35.62%	12	17.14%			835	29.97%
Testudinata															3	5.66%							3	0.11%
Phrynosoma sp.											1	0.48%					1	0.05%					2	0.07%
Serpentes					22	91.67													2	2.86%			24	0.86%
Colubridae											24	11.54%											24	0.86%
Crotalidae																	2	0.10%					2	0.07%
Leporidae							1	0.64%	8	6.67%			1	1.41%	2	3.77%	20	1.03%					32	1.15%
Lepus sp.			5	3.60%			2	1.27%	2	1.67%	12	5.77%			3	5.66%	26	1.34%	1	1.43%			51	1.83%
L. alleni									1	0.83%							2	0.10%					3	0.11%
L. californicus	1	50.00%	11	7.91%			4	2.55%	8	6.67%	12	5.77%	19	26.76	9	16.98%	167	8.61%	3	4.29%			234	8.40%
Sylvilagus sp.			5	3.60%			1	0.64%	5	4.17%	13	6.25%	1	1.41%	1	1.89%	62	3.20%	1	1.43%			89	3.19%
Rodentia									1	0.83%	3	1.44%					9	0.46%	4	5.71%			17	0.61%
Sciuridae, small			1	0.72%							1	0.48%							2	2.86%			4	0.14%
Sciuridae, large																	1	0.05%					1	0.04%
Spermophilus variega variega																	1	0.05%					1	0.04%
Thomomys sp.			1	0.72%							1	0.48%			1	1.89%	3	0.15%	1	1.43%			7	0.25%
Perognathus sp.											1	0.48%											1	0.04%
Dipodomys sp., small											1	0.48%					1	0.05%					2	0.07%
cf. *Sigmodon*																	1	0.05%					1	0.04%
Neotoma sp.											5	2.40%					3	0.15%	1	1.43%			9	0.32%
Carnivora			2	1.44%													1	0.05%					3	0.11%
Canis latrans/C. familiaris			1	0.72%			25	15.92%	1	0.83%	3	1.44%					1	0.05%					31	1.11%
Urocyon cinereoargenteus											1	0.48%											1	0.04%

Table 21.2. Continued.

	O:15:71		O:15:52		O:15:53		O:15:100		O:15:91		O:15:1		O:15:92		O:15:54		O:15:55		O:15:90		O:15:99		Total	Total
Taxonomic Group	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	Percent
cf. *Taxidea taxus*																	1	0.05%					1	0.04%
Ursus americanus							1	0.64%															1	0.04%
Artiodactyla			20	14.39%			37	23.57%	5	4.17%	4	1.92%	1	1.41%	1	1.89%	138	7.11%	1	1.43%			207	7.43%
Cervidae																	65	3.35%					65	2.33%
Odocoileus sp.									3	2.50%	2	0.96%			1	1.89%	107	5.52%					113	4.06%
O. hemionus											2	0.96%					32	1.65%					34	1.22%
O. hemionus/Ovis canadensis																	7	0.36%					7	0.25%
Bos/Bison									1	0.83%													1	0.04%
Buteo sp.											1	0.48%					1	0.05%					2	0.07%
Phasianidae																	19	0.98%					19	0.68%
Columbidae											2	0.96%											2	0.07%
Colaptes sp.											2	0.96%											2	0.07%
Unknown			3	2.16%					8	6.67%	6	2.88%					24	1.24%					41	1.47%
Human/non-human bone			3	2.16%	1	4.17%	4	2.55%			4	1.92%											12	0.43%
TOTAL	2	100.00	100.	100.00	100.	100.00	100.	100.00	100.	100.00	100.	100.00	100.											

Unid = unidentified
Indet = indeterminate

Table 21.3. Quantity of faunal remains, taxonomic groups, worked bones, rodent taxa, and other information on the Rye Creek sites. (Column headings keyed below by number).

Site #	Number of Taxonomic Groups	Number of Worked Bones	Number of Rodent Taxa	Number of Large Mammals[1]	Number of Small Mammals[2]	Number of Contexts[3]	Number of Excavated and Sampled Contexts[4]	Quantity[5]
O:15:1	15	7	5	68	66	3	3	208
O:15:52	6	6	2	61	53	16	71	139
O:15:53	1	0	0	0	0	3	19	24
O:15:54	4	0	1	17	24	3	9	53
O:15:55	15	7	5	1,347	405	14	21	1,940
O:15:71	1	0	0	0	1	1	5	2
O:15:90	7	0	3	34	7	5	7	70
O:15:91	6	16	1	52	51	5	18	120
O:15:92	3	2	0	3	22	1	4	71
O:15:99	1	0	0	0	0	2	6	2
O:15:10 0	5	4	0	111	9	7	21	157

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[1] Includes all identifiable artiodactyls and unidentifiable mammalian bones coded size 6 and size 7.
[2] Includes all lagomorphs and unidentifiable mammalian bones coded size 3.
[3] Contains faunal remains, each feature and nonfeature are counted as one context.
[4] Information from site reports in Volume 1.
[5] Remains recovered from each site.

In the case of sites from the Rye Creek Project the unidentified fragments confirm the importance of artiodactyl- and lagomorph- size animals in the assemblage. Small- and large-size mammalian fragments are not represented in even proportions as they are among the identified lagomorph and artiodactyl remains. Unidentified mammalian remains from size 7 (large artiodactyl-size range) are at least three times as common as size 3 (small lagomorph-size range). When the inhabitants of the Rye Creek settlements hunted, large game commonly was pursued.

Appendix H.3 lists the NISP by feature number, feature type and stratum for each site. This table also includes the weight of fragments and the quantity of worked bone by feature and stratum. The following is a brief description of the faunal remains from each site.

AZ O:15:1 Rye Creek Ruin (Rye Creek Drainage)

AZ O:15:1, Rye Creek Ruin, is the only village site in the project area and was occupied during the Classic period. Excavations from three features yielded 208 faunal remains from 15 different taxonomic groups. As mentioned previously, the taxonomic richness, that is, the number of different taxonomic groups, for this small sample stands in contrast to the other sites. AZ O:15:55 also has as high taxonomic richness, although the sample size is considerably larger.

AZ O:15:52 Deer Creek Site (Deer Creek Drainage)

AZ O:15:52, the Deer Creek site, is a small pithouse village or hamlet primarily occupied during the Gila Butte phase (A.D. 750-850). Although this is the largest site in the project area and 16 features had faunal remains, the total quantity of bones only numbered 139. As with most of the other sites, unidentified remains accounted for the majority of bones in this assemblage; identified fragments were nearly equally represented by lagomorphs and artiodactyls. The 20 artiodactyl skeletal elements were represented by cranial, podial, and fore- and hind-limb fragments. Artiodactyl ribs and vertebrae were not present. Worked-bone fragments were concentrated throughout several strata of a pithouse (Feature 21). One additional worked piece was from another pithouse, Feature 2.

AZ O:15:53 Hilltop Site (Deer Creek Drainage)

AZ O:15:53, the Hilltop site, is a multicomponent fieldhouse or farmstead site primarily occupied between A.D. 1000 and 1150. Twenty-three bone fragments were recovered with the majority (n=22) identified as Serpentes (snake) from a crematorium pit (Feature 4). An unidentified fragment came from a nonfeature context. The lack of faunal remains from this site suggests it was not intensively occupied throughout the entire year.

AZ O:15:54 Cobble Site (Rye Creek Drainage)

AZ O:15:54, the Cobble site, is a Classic period hamlet. Only 55 faunal remains were recovered from two structures and a trash mound. Over half of the remains were unidentified mammalian fragments with the remaining represented by lagomorphs, artiodactyls, rodent, and turtle. No worked bones were recovered.

AZ O:15:55 Boone Moore Site (Rye Creek Drainage)

AZ O:15:55, the Boone Moore site, is a Classic period (A.D. 1150-1300) farmstead or homestead. This site had the majority of faunal remains recovered from the entire project (n = 1940) with 15 taxonomic groups represented. In contrast to the diverse animal assemblage, plant diversity was quite low (see Kwiatkowski, Chapter 18, this volume). This pattern undoubtedly relates to specialized use of this site for hunting. Artiodactyls and unidentified large mammalian fragments dominated the assemblage. The mandibles of mule deer (*O. hemionus*) were recovered in substantial quantities from Feature 5, a cobble-lined adobe pitroom, and from Feature 22, an intrusive pit in Feature 5. These deer ranged in age from only several months to adults over four years. The age of death of these animals suggests that they were killed during the late fall to early winter.

AZ O:15:71 (Hardt Creek Drainage)

AZ O:15:71 is a small fieldhouse site located along the Hardt Creek Drainage and probably occupied during the Classic period (A.D. 1150-1300). Very few artifacts were recovered from this site and the faunal remains were no exception. Two fragments, one unidentified and one *Lepus californicus* innominate fragment, were recovered from the fill (Stratum 10) of a masonry structure (Feature 1). The small quantity of faunal remains from AZ O:15:71 is typical of most fieldhouse sites in the Southwest.

AZ O:15:90 Compact Site (Rye Creek Drainage)

AZ O:15:90, the Compact site, is a farmstead that was occupied during the Sacaton phase (A.D. 1000-1150). Seventy bones were recovered from three pithouses, an horno, and a roasting pit. Unidentified mammalian fragments comprised the bulk of these remains (n=54) followed by rodents (n=8). The only artiodactyl remain was a cheek tooth fragment.

AZ O:15:91 Redstone Site (Clover Wash Drainage)

AZ O:15:91, the Redstone site, is a farmstead or homestead containing two pithouses occupied primarily during the Sacaton phase (A.D. 1000-1150). One-hundred and twenty remains were recovered from four features and one nonfeature area. Large game was common as were lagomorphs. Worked bone was most abundant at this site (16 fragments) and was scattered throughout many of the features containing other faunal remains.

AZ O:15:92 Rooted Site (Rye Creek Drainage)

AZ O:15:92, the Rooted site, is a root-plowed, disturbed agricultural site and possible hamlet occupied between A.D. 920 and 1035. All of the 71 faunal remains were recovered from the fill and floor of a pithouse (Feature 14). The remains represented jackrabbits (*L. californicus*), cottontails (*Sylvilagus*), and artiodactyls. A complete splinter awl and an awl or hairpin fragment also were recovered from Feature 14.

AZ O:15:99 Arby's Site (Rye Creek Drainage)

AZ O:15:99, the Arby's site, is an early Classic period (A.D. 1150-1300) fieldhouse located near the Rye Creek floodplain. Only two unidentified fragments of bone were recovered from the fill of two structures (Feature 3 and Feature 5). As with AZ O:15:71 and AZ O:15:53, the minimal quantity of faunal remains indicates either a very short-lived occupation or the use of these settlements for other activities than animal procurement.

AZ O:15:100 Clover Wash Site (Clover Wash Drainage)

AZ O:15:100, the Clover Wash site, is a farmstead occupied during the Sacaton phase (A.D. 1000-1150). Seven features contained 155 animal remains. Large game dominated the assemblage with one pithouse (Feature 12) also containing canid and lagomorph remains. Artiodactyls were represented by mandibular fragments, cheek teeth and metapodials. The worked bone was the most distinctive from this site. One bear (*Ursus americanus*) terminal phalanx was burned and drilled. A large mammalian element was worked into a hairpin or awl that was drilled and notched on the proximal end. All of the worked bone came from one pithouse (Feature 12).

RESULTS OF THE ANALYSIS

Worked Bone

Forty-two bones from six sites had evidence of being worked. Only two complete artifacts were recovered: a splinter awl from the Rooted site (AZ O:15:92) and a drilled bear phalanx from the Clover Wash site (AZ O:15:100). The Clover Wash site also had an awl or hairpin that was drilled and notched on the proximal end. The majority of the worked bone, however, consisted of relatively small shaft fragments of awls or hairpins. These fragments generally were concentrated in the fill of one feature at a site and in some cases probably represent one artifact that was broken into several pieces. Table 21.4 presents metric data for each artifact along with information on the condition of each piece. Most fragments were less than 5 cm in length and weighed under 3 g. Long bone shafts of large animals, likely artiodactyls, were used to make these tools. The worked bone represent fragments of tools that were discarded. Further analysis of the distribution and quantity of the worked remains is discussed under issues of intensity of occupation.

Modifications of Faunal Remains

Cultural and natural modifications of the faunal remains were recorded. These variables included weathering, burning, carnivore and rodent gnawing, and excavation breakage. Evidence of carnivore and rodent gnawing was minimal. Rodent remains in general occurred in small quantity although rodent taxonomic richness was high at Rye Creek Ruin (AZ O:15:1) and the Boone Moore site (AZ O:15:55). Kwiatowski (Chapter 18, this volume) notes that the flotation samples from the Rye Creek Project were particularly high in rodent fecal pellets. The presence of fecal pellets and therefore confirmation of rodent disturbance at these sites was not mirrored in the faunal remains in terms of rodent-gnawed bone or the presence of rodent bones.

Table 21.5 presents the quantity of burned skeletal elements by taxonomic group for each site. Only 9 percent of the Rye Creek assemblage was burned, which is a fairly low percentage. Burning among worked bone was considerably higher (17 out of 42 specimens). Burned, worked bone is fairly common at Hohokam sites (Haury 1976; Szuter 1991), although the reasons for the differential modification of worked and unworked bone are unknown at this time.

Artiodactyl Exploitation: Skeletal Representation

Bayham (1982) and other researchers (Bayham and Hatch 1985; Szuter and Bayham 1989; James 1990; Szuter 1991) have proposed models for artiodactyl hunting among the Hohokam. Bayham argues that differential hunting patterns may exist between upland and lowland Hohokam sites and that those differences would be reflected in artiodactyl skeletal representation. Major meat-bearing skeletal elements would remain at the place of butchering (presumably an upland site) and only the meat would be transported to lowland sites. Lowland sites would therefore lack the high utility/high meat-bearing elements. James (1990:486) uses Bayham's model and argues for the Pine Creek sites (in the Mazatzal uplands south of the project area) that a high preponderance of lower legs "is what one might expect for butchering sites, since these elements have little meat and would generally be discarded at the place where the animals were butchered." Szuter (1991) argues that cranial and podial elements would be found at nonbutchering as well as butchering sites because these elements would be useful for headdresses and for the manufacture of bone tools. Their utility would extend beyond the quantity of meat they hold.

Table 21.6 presents the distribution of artiodactyl skeletal elements by site. The artiodactyl remains recovered from eight sites primarily represented cranial elements. When post-cranial remains were identified they were often lower limb elements such as metapodials, carpals, tarsals, or phalanges. This uneven distribution of the artiodactyl skeletal elements results from several factors.

First, cranial elements and lower limb (podial) elements are dense and therefore more durable (Lyman 1984). For example, cranial elements such as mandibles and teeth or lower limb (podial) elements such as distal metapodials or astragali, are more likely to survive destruction from natural processes than, for example, the spongy epiphyses of humeri.

Second, these dense, durable fragments often have more easily identifiable morphological characters than the same size shaft fragments of limb bones. A mandibular fragment is often unique enough to be identified as such because it does not resemble other bones in the skeleton. A small long bone shaft fragment, on the other hand, could be from several of the limb bones.

Table 21.4. Metric and nonmetric information on worked bone from the Rye Creek sites.

AZ O:15:1 Rye Creek Ruin

Case	Fea/Str	BN	PL	STR	BK	LTH	WDTH	WT	Comments
475	TM1/50	No	S	Y	O	6.04	0.58	0.87	
497	TM1/50	No	N	N	FO	6.64	1.05	3.12	Splinter awl
496	TM1/50	No	S	Y	F	7.15	1.26	4.85	Tip measures .38 x .37
415	TM1/50	No	N	Y	O	4.14	1.22	2.61	
428	TM1/50	No	S	Y	O	6.01	0.59	1.26	
371	TM1/50	No	S	Y	FO	5.43	1.71	4.97	
370	TM1/50	BL	S	N	O	5.28	1.45	4.69	Shaft and articular end

AZ O:15:52 Deer Creek Site

Case	Fea/Str	BN	PL	STR	BK	LTH	WDTH	WT	Comments
212	21/10	BR	S	Y	FO	1.63	1.12	0.97	
207	21/10	BL	Y	Y	O	2.65	0.83	1.37	
254	21/11	BL	Y	Y	O	2.26	0.75	0.77	
221	21/19	BL	S	Y	O	2.21	0.61	0.82	
253	21/9	BL	S	N	O	2.10	1.14	1.02	
188	2/10,19	No	N	N	F	4.97	2.43	11.75	Artiodactyl humerus bone tube

AZ O:15:55 Boone Moore Site

Case	Fea/Str	BN	PL	STR	BK	LTH	WDTH	WT	Comments
37	11/19	No	Y	Y	O	2.48	1.07	0.77	Medium-large mammal
108	11/19	BL	Y	Y	FO	1.87	0.73	0.75	
1235	5/49	BL	N	N	O	1.84	0.94	1.13	
1455	5/49	No	N	N	O	2.14	0.47	0.18	Tip measures .30 x .17
1441	5/49	No	Y	N	O	3.29	1.24	1.08	Tip measures .57 x .21
990	6/10,11	No	N	N	F	2.55	1.17	1.49	
989	6/10,11	No	N	N	F	5.33	1.43	2.99	Tip measures .67 x .6

AZ O:15:91 Redstone Site

Case	Fea/Str	BN	PL	STR	BK	LTH	WDTH	WT	Comments
757	11/10	BL	S	N	FO	2.80	1.25	1.76	
752	11/11	BL	Y	Y	FO	2.93	0.62	0.59	
751	11/11	BL	Y	Y	FO	1.83	0.77	0.73	Case 751 and 752 probably same element
774	11/40	No	S	N	F	3.06	0.62	0.60	
767	11/40	No	N	N	FO	3.05	1.33	1.27	
771	11/40	No	N	N	F	8.98	0.88	4.60	Case 771 and 772 probably same element; medium-large mammal
773	11/40	No	S	N	F	6.65	1.56	4.82	
764	11/40	No	N	N	O	3.27	1.09	1.11	Tip measures .39 x .33; Case 764 and 767 same element
772	11/40	No	N	N	F	6.24	0.97	2.53	Medium-large mammal
768	11/40	No	Y	Y	FO	2.95	1.25	1.11	Groove on shaft
722	5/19	BL	N	N	O	1.53	1.00	0.42	
707	5/19	C	Y	N	O	3.60	0.60	1.62	

Table 21.4. Continued.

Case	Fea/Str	BN	PL	STR	BK	LTH	WDTH	WT	Comments
727	5/9,10	BL	N	N	O	2.26	0.88	0.78	
798	-/9	No	N	N	FO	5.28	0.98	2.90	
799	-/9	No	S	N	O	1.82	0.88	0.53	
797	-/9	BL	Y	Y	FO	5.16	0.85	2.39	

AZ O:15:92 Rooted Site

Case	Fea/Str	BN	PL	STR	BK	LTH	WDTH	WT	Comments
-	14/10	No	Y	N	FO	1.12	0.64	0.28	
-	14/20	No	S	N	-	12.70	0.66	3.89	Tip measures .22 x .21; Complete splinter awl

AZ O:15:100 Clover Wash Site

Case	Fea/Str	BN	PL	STR	BK	LTH	WDTH	WT	Comments
592	12/19	No	Y	N	O	2.04	0.37	0.26	Tip measures .24 x .24
591	12/10	C	Y	N	FO	2.11	0.57	0.50	
567	12/19	No	N	N	O	17.10	1.90	2.45	Drilled and notched awl/hairpin
571	12/19	BL	N	N	-	-	-	2.08	Drilled *U. americanus* (black bear)

Note: All specimens are large mammalian long bone shaft fragments Phalanx 3 of awls/hairpins unless otherwise noted in "comments."
Case = Faunal case number; Fea/Str = Feature number/Stratum number
BN = Burned; No = Not burned; C = Calcined; BL = Black burned; BR = Brown burned; PL = Polished; Y = Yes; N = No; S = Slightly polished; STR = Striations; BK = Breakage pattern; O = Old breaks; F = Fresh breaks; FO = Fresh and old breaks; LTH = Length measured in centimeters; WDTH = Width measured in centimeters; WT = Weight in grams
Comments = Additional information on specimen

Third, the destruction of bone from the backhoe meant that large or possible complete skeletal elements were reduced to hundreds of fragments. These pieces could only be identified if morphological characters were present or if their bone density and size protected them from the crushing effect of the backhoe. Teeth, by their very nature of not being bone, could be readily identified as such from a very small fragment. The same could not be done for shaft fragments; as a result, these pieces were categorized as unidentified large mammalian fragments. Likewise, dense elements, such as tarsals or carpals, may not have been broken (and therefore potentially unidentifiable) because of their density.

All of these factors, therefore, contribute to the skewed distribution of artiodactyl elements. The question still unanswered, however, is whether cultural factors have helped shaped this pattern as well. While the number of identified specimens and percentages indicate that cranial elements are most abundant (particularly at the Boone Moore site), the calculation of MNI supports this trend as well. Mandibles, the most common element at the Boone Moore site, represent 12 individuals of varying ages. The majority of these mandibles are concentrated within two features (Features 5 and 22). A cultural interpretation of the distribution of artiodactyl skeletal remains at the Boone Moore site suggests a pattern of butchering where cranial elements and lower limb elements (perhaps still attached to the hide) are brought back to the site. Bone that could not easily be cleanly stripped of meat, such as ribs, sterna and vertebrae, would have been brought back as well. Limb bones, such as femora or humeri, would have been stripped of their meat and left at the kill site. Although this pattern holds for five sites (AZ O:15:54; AZ O:15:91; AZ O:15:90; AZ O:15:92; and AZ O:15;100) with small quantities of artiodactyl remains, and generally holds for AZ O:15:55 with the largest quantity of artiodactyl remains, a different pattern emerges at the two largest sites in the project area, Rye Creek Ruin (AZ O:15:1) and the Deer Creek site (AZ O:15:52). Cranial and podial elements are represented in small quantities at these two settlements along with long bone fragments. Basically, considering the small sample size, cranial and podial along with hind and forelimb elements, are present. Differential preservation and/or butchering patterns are not evident.

Table 21.5. Quantity of burned skeletal elements by taxonomic group for each site.

	SITE NUMBER (AZ O:15:_____)									
Taxonomic Group	1	52	53	54	55	91	92	100	Total	Percent
Unidentified mammal, size indeterminate	1				6		9		16	6.15%
Unidentified mammal, size 2				1					1	0.38%
Unidentified mammal, size 3	12	6		3	34	3	3	1	62	23.85%
Unidentified mammal, size 4	1				1			1	3	1.15%
Unidentified mammal, size 5								1	1	0.38%
Unidentified mammal, size 6	3	1	1	3	17	3	1	13	42	16.15%
Unidentified mammal, size 7	8	7			16	11	1	4	47	18.08%
Leporidae				2	2				4	1.54%
Lepus sp.	5	2		2	4	1			14	5.38%
L. alleni					1				1	0.38%
L. californicus	3	4		5	18	1			31	11.92%
Sylvilagus sp.	2	1			7	1			11	4.23%
Spermophilus variegatus		1							1	0.38%
Ursus americanus								1	1	0.38%
Artiodactyla		5			5	1	1	1	13	5.00%
Odocoileus sp.						2			2	0.77%
O. hemionus/O. canadensis					1				1	0.38%
Unknown					4	3			7	2.69%
Nonhuman/Human unidentified		1	1						2	0.77%
Total Burned Remains	35	28	2	16	116	26	15	22	260	100.00%
Percent of Assemblage Burned	17%	20%	67%	30%	5%	22%	21%	14%	9%	

THE QUESTION OF SEASONALITY

A research interest of this project is to determine seasonality of occupation for these settlements. Although seasonality determinations from the faunal remains could not be made for most sites, the Boone Moore site (AZ O:15:55) had numerous deer mandibles. The age of these animals and the season in which they were killed could be determined.

Table 21.6. Artiodactyl skeletal representation by side for each site.

Skeletal Element	Right	Left	Axial	Unknown	Total	Percent
AZ O:15:55 Boone Moore Site						
Antler				65	65	18.62%
Cranium	1	1	1	33	36	10.32%
Mandible	16	18		28	62	17.77%
Tooth indeterminate				6	6	1.72%
Incisor				16	16	4.58%
Premolar				1	1	0.29%
Cheek tooth				112	112	32.09%
Vertebra indeterminate			2		2	0.57%
Cervical			2		2	0.57%
Thoracic			2		2	0.57%
Lumbar			2		2	0.57%
Rib				12	12	3.44%
Sternum			7		7	2.01%
Scapula			1		1	0.29%
Acetabulum	1				1	0.29%
Radius, shaft	1				1	0.29%
Ulna, proximal	1				1	0.29%
Metacarpal, proximal				1	1	0.29%
Femur, distal				2	2	0.57%
Metatarsal, distal				2	2	0.57%
Tarsal	1				1	0.29%
Astragulus	2				2	0.57%
Metapodial, distal				1	1	0.29%
Podial				1	1	0.29%
Phalanx indeterminate				1	1	0.29%
Phalanx 1				3	3	0.86%
Phalanx 2				3	3	0.86%
Phalanx 3				2	2	0.57%
Hyoid				1	1	0.29%
Total Artiodactyl Remains					349	100.00%
AZ O:15:100 Clover Wash Site						
Mandible				3	3	33.33%
Cheek tooth				32	3	33.33%
Metapodial, shaft				2	3	33.33%
Total Artiodactyl Remains					9	99.99%

Table 21.6. Continued.

Skeletal Element	Right	Left	Axial	Unknown	Total	Percent
AZ O:15:51 Rye Creek Ruin						
Cheek tooth				2	2	25.00%
Vertebra, indeterminate			1		1	12.50%
Ulna, shaft	1				1	12.50%
Femur, shaft		1			1	12.50%
Calcaneus		1			1	12.50%
Metapodial, shaft				1	1	12.50%
Total Artiodactyl Remains					8	100.00%
AZ O:15:52 Deer Creek Site						
Cheek tooth				4	4	20.00%
Humerus, shaft	2				2	10.00%
Radius, shaft		1			1	5.00%
Tibia, shaft				4	4	20.00%
Metapodial, shaft				4	4	20.00%
Phalanx 1				1	1	5.00%
Phalanx 2				4	4	20.00%
Total Artiodactyl Remains					20	100.00%
AZ O:15:54 Cobble Site						
Incisor				1	1	50.00%
Tarsal		1			1	50.00%
Total Artiodactyl Remains					2	100.00%
AZ O:15:91 Redstone Site						
Mandible	1				1	12.50%
Cheek tooth				1	1	12.50%
Ribs		1		1	2	25.00%
Carpal				1	1	12.50%
Metapodial, distal				2	2	25.00%
Phalanx 1				1	1	12.50%
Total Artiodactyl Remains					8	100.00%
AZ O:15:90 Compact Site						
Cheek tooth				1	1	100.00%
Total Artiodactyl Remains					1	100.00%
AZ O:15:92 Rooted Site						
Antler				1	1	100.00%
Total Artiodactyl Remains					1	100.00%

Aging of the mandibles was determined by comparing specimens to drawings of wear exhibited on different cheek teeth in Smith (1966) and Harlow and DeFoor (1962) and by examination of tooth eruption and measurements of molar crown height in Hoffmeister (1986:541 Table 5.83). Harlow and DeFoor's work is based on Severinghaus (1949). Hoffmeister's presentation is a modification of Cowan (1936) and Taber and Dasman (1958). Complementing these data on tooth wear, tooth eruption, and crown height are measurements of the mandible. Mandibular measurements were made following von den Driesch (1976:53,56,57). Tables 21.7, 21.8, and 21.9 list these mandibles with information on tooth presence, eruption, wear, molar crown height, and mandibular measurements.

Hoffmeister (1986:542) states that mule deer breed between December 1 and January 15 with the young born from July 1 until September. Gestation lasts 203 days, slightly less than seven months. With these ranges for conception as well as birth, determinations of seasonality remains approximate. Using aging criteria based on occlusal wear these animals range from less than 4 months old to at least 7 1/2 years old. The age of these animals range from less than 4 months to at least 9 1/3 years old using molar crown height measurements. Generally, the aging of the specimens using different techniques is quite comparable. Both techniques resulted in the youngest specimen being less than 4 months old and in 1 1/2 year and 2 1/2 year-old individuals being classified in the same category regardless of the technique used. Dating older individuals was more precisely done using crown height measurements that gave an age of at least 9 1/3 years compared to occlusal wear examination that gave an age of at least 7 1/2 years. The greatest discrepancies in aging occurs for animals between 2 1/2 and 3 1/2 years old. The use of crown heights gives age estimates around 2 1/2 years while the use of occlusal surface wears gives an age of 3 1/2 years. In each case, however, the season of death ranges from fall through the end of winter with a range from November through March at the extremes. This pattern strongly suggests a seasonal and intensive hunting use of this settlement based on the remains from Features 5 and 22.

Table 21.7. Aging criteria used for artiodactyl mandibles based on tooth eruption and tooth wear.

Case No.	Fea/Strat	Teeth Present	Aging Criteria	Age Estimate
1025	19/20	M2, M3 broken	Very worn	-
1089	22/50	Milk PM1-3, M1	M1 in gum, not erupted	less than 4 mo
1090	22/50	PM2-3; M1-3	M3 posterior cusp flat	3 yr 6 mo+
1091	22/50	PM1-3; M1-3	M3 posterior cusp flat; slight wear	3 yr 6 mo+
1092	22/50	M1-3	M1-3 crests very worn	7 yr 6 mo+
1093	22/50	M1 broken; M2-3	M3 not fully erupted	1 yr 7 mo
1098	22/50	PM2,3; M1,2	Somewhat blunt lingual; crest on	2 yr 6 mo to 3 yr 6 mo
1099	22/50	PM1-3; M1-3	Blunt cusp on M1; M3 posterior	3 yr 6 mo
1100	22/50	PM1-3; M1-3	Fully erupted sharp cusps	2 yr 6 mo
1141	5/19	M1, M2, M3	Very slight wear on; M3 posterior	2 yr 6 mo+
1142	5/19	M3	M3 newly erupted?	-
1143	5/19	PM1, PM2, PM3;	Premolars slight/moderately worn	4 yr 6 mo
1145	5/19	PM2	PM2 in gum, not erupted	less than 1 yr 5 mo
1147	5/19	PM1, PM2, PM3	Premolors moderately/heavily	5 yr 6 mo+

Note: All mandibles are from AZ O:15:55 (Boone Moore site).

INTENSITY OF OCCUPATION

The determination of seasonality tells when a site was occupied, but it does not provide information on the intensity of the occupation. Intensity of occupation refers to how long or often a site was occupied and/or how many people may have lived there. Faunal assemblages can provide some information on this issue. Four criteria were used: number of taxonomic groups, the presence of rodents, number of worked bones, and number of unworked bones. Information on these and other variables are presented in Table 21.3. I argue that a more diverse assemblage (in terms of richness), more rodent taxa and quantity of rodent remains, a greater number of worked bones, and a larger faunal assemblage, indicate that a site was either more intensively occupied, or there was a greater specialization in hunting activities.

Based on these variables and other information about the faunal assemblage, the Rye Creek Project sites were grouped into five categories in order to discuss similarities and differences in the intensity of occupation. The first group includes sites with ephemeral occupations or a use of the site not related to hunting activity. The second group includes specialized hunting sites that may or may not have been occupied seasonally. The third group contains sites occupied year-round and intensively. The fourth group represents smaller occupations that may have been used year-round. The fifth group includes smaller occupations where hunting was not specialized and the occupation may have been more temporary.

Table 21.8. Aging criteria and age estimates of deer mandibles based on tooth eruption and molar crown height. Measurements based on those presented by Hoffmeister (1986:541).

Faunal Case Number	Molar 1	Molar 2	Molar 3	Age Estimate
1089	not erupted	-	-	less than 1/4 yr
1090	0.88	1.25	1.40	2 1/2 to less than 3 1/2 yrs[a]
1091	0.94	1.28	1.47	2 1/2 to less than 3 1/2 yrs[a]
1092	0.60	0.82	0.88	9 1/3 yrs
1093	-	1.31	1.20[b]	1 1/2 to 2 yrs
1098	1.06	1.22	-	2 1/2 yrs
1099	1.02	1.24	1.38	2 1/2 yrs
1100	1.05	1.30	1.45	2 1/2 yrs[a]

Note: Measurements are height above gum for M1 and M2 and height of anterior crown for M3. Measurements in centimeters.

[a] aBased on eruption of M3.

[b] Not fully erupted.

Three sites, the Hilltop site (AZ O:15:53), AZ O:15:71, and the Arby's site (AZ O:15:99), fall into the first group and exhibit similar patterns in faunal representation. They have low taxonomic abundance and therefore low taxonomic richness, no recovered rodent remains and no worked bones. This combination of factors suggests an absence of wild animal procurement and an ephemeral occupation of these settlements. All of these sites were classified as fieldhouses. Plant remains at these sites also suggest short-term seasonal use (see Kwiatowski, Chapter 18, and Fish, Chapter 20, this volume). Three other fieldhouse settlements excavated as part of this project did not have any recovered faunal remains: AZ O:15:70; the Overlook site (AZ O:15:89); and AZ O:15:96. From their data, it appears that the inhabitants of fieldhouse settlements probably were not engaged in hunting activities.

Table 21.9. Artiodactyl mandibular measurements (A = Approximate measurement). Measurement numbers refer to measurements in von den Driesch (1976:56-57). Bone weight given in grams.

	Measurement Number (after von den Driesch)											
Faunal Case No.	3	5	6	7	8	9	10L	10B	15A	15B	15C	Weight
466									2.80			18.49
1025												22.95
1089						A4.				1.76	1.20	11.73
1090	5.33	14.4	18.1	9.19	5.58	5.23	2.09	0.94	3.05	2.35	1.99	68.72
1091				10.1	6.15	5.59	2.40		3.39	2.72	2.50	74.03
1092	6.45				5.52		2.27	1.09	3.18	2.46		40.15
1093									3.29			32.52
1098						A3.				2.51		41.60
1099				9.67	5.76	3.75	2.04	A0.		2.29	2.19	44.25
1100				9.28	5.57	3.53	2.07	A0.		A2.	2.04	45.00
1141					5.89		2.39	1.04		2.62		37.50
1142							2.10	A0.	2.95			15.80
1143						3.54				2.16	1.93	14.71
1145											2.01	10.20
1147						3.59						8.45

Measurement descriptions:

3	Length: Gonion caudale-aboral border of the alveolus of MR-Infradentale (+).
5	Length: Gonion caudale-oral border of the alveolus of P2 (+).
6	Length: Gonion caudale-the most aboral indentation of the mental foramen (+).
7	Length of the molar row, measured along the alveoli on the buccal side (-).
8	Length of the molar row, measured along the alveoli on the buccal side (-).
9	Length of the premolar row, measured along the alveoli on the buccal side (-).
10L & 10B	Length (L) and breadth (B) of M3, measured near the biting surface (-).
15A	Height of the mandible behind M3 from the most aboral point of the alveolus on the buccal side (-).
15B	Height of the mandible in front of M1 buccal or lingual side (-).
15C	Height of the mandible in front of P2 buccal or lingual side (-).

Note: A plus (+) after a measurement indicates "dimensions which are precisely measurable and the sign "-" for dimensions which are less precisely measurable" (von den Driesch 1976:11).

Two sites, the Boone Moore site (AZ O:15:55) and the Clover Wash site (AZ O:15:100), represent the second group -- specialized hunting with reuse of the site on at least a seasonal basis. AZ O:15:55 probably was reused or occupied over a longer period of time than AZ O:15:100. This assessment is based on the larger and more diverse faunal assemblage as well as the diversity in rodent taxa recovered from AZ O:15:55. Both sites, however, have artiodactyl remains that outnumber lagomorph remains. These sites also are distinctive in terms of the number and type of worked bones. AZ O:15:55 has seven worked fragments and AZ O:15:100 has four. AZ O:15:100 is further distinctive in the types of worked pieces recovered. The black bear (*Ursus* *americanus*) drilled phalanx and the large mammal drilled and notched awl/hairpin demonstrate hunting expertise and craftsmanship. The hunting of deer was undertaken at both sites. It is at AZ O:15:55, however, that seasonal information was gained from the aging of the abundant number of recovered deer mandibles. The Boone Moore site was occupied minimally at some point during the fall through winter months. Evidence for a seasonal occupation was concentrated in Feature 5 and its intrusive Feature 22; therefore, it is difficult to determine whether the hunting of deer represents intensive reuse of the site or whether the entire occupation of the site was related to hunting. As previously mentioned, the plant assemblage was very limited and nondiverse. This, coupled with the diverse animal assemblage, suggests a long-term pattern of hunting at this location.

The third group is represented by Rye Creek Ruin, which undoubtedly had a year-round permanent occupation. The excavations at this site were limited, consisting of the excavation of 1-m by 2-m test units into three trash mounds, as was the faunal assemblage. This assemblage, however, was quite diverse. Bird and rodent taxa were abundant and seven worked specimens were recovered. Large and small game occurred in nearly equal numbers. Rye Creek Ruin is a large village, containing over 150 masonry rooms and central to activities occurring in other surrounding settlements. The faunal assemblage reflected the settlement's year-round occupation.

The fourth group of sites includes the Deer Creek site (AZ O:15:52) and the Redstone site (AZ O:15:91). These two sites are similar in their equal representation of large and small game, the presence of worked bone in substantial quantities, and the minimal presence of rodents. Artiodactyls are represented by cranial, podial, as well as long bone shafts and rib fragments. While the occupation may have been year-round, it would have been a fairly small group of people based on the recovery of the minimal faunal remains. Specialization in hunting did not seem to occur at these sites; rather, hunting may have been more opportunistic and used for local consumption.

The fifth group of sites includes the Cobble site (AZ O:15:54) and the Rooted site (AZ O:15:92). These two sites had more small than large mammal remains, minimal rodent remains, minimal worked bone, minimal taxonomic abundance, and artiodactyl remains that consisted of cranial and podial elements. Based on these data, neither was intensively occupied or used primarily for hunting. Both sites were extremely disturbed through root-plowing, and only small, unrepresentative samples were recovered. Sites in these last two groups, AZ O:15:52, AZ O:15:91, AZ O:15:54, and AZ O:15:92 were all classified by Elson (Chapter 26, Volume 3) as habitation sites. Even though these settlements may be functionally similar, their use of animals appears to be somewhat different. AZ O:15:52 and AZ O:15:91 focused on larger game more so than the inhabitants of the other two settlements. Those occupations may have been more intense and more permanent than those at AZ O:15:54 and AZ O:15:92 (although again the disturbance at these last two sites needs to be taken into account).

It is difficult to categorize the Compact site (AZ O:15:90). Animal remains are scattered in the fill in five out of seven of the features that were excavated. Although weights of bone were not taken for this assemblage, most of the remains are unidentifiable fragments. Rodent remains from three taxa were recovered but no worked bones were found. The use of this site as a farmstead may explain the minimal quantity of animal remains that were recovered.

COMPARISONS WITH OTHER FAUNAL ASSEMBLAGES

Two projects in the vicinity of the Rye Creek Project, the Pine Creek Project (Green 1990), and the Ord Mine Project (Ciolek-Torrello 1987), both in the Mazatzal Piedmont zone south of the project area, reported the recovery of animal remains. The Ord Mine Project consisted of the mitigation of 24 sites, of which only 6 had faunal remains, and these were limited in number (66 specimens). Nine sites were excavated during the Pine Creek Project; seven sites produced 1,493 faunal specimens. In both projects, as at the Rye Creek sites, unidentified bone fragments from large-sized animals dominated the assemblages. Although prehistoric processing of animals may account for some of the unidentified fragments, freshly broken bone accounts for the majority. James (1990) mentions he attempted refitting the fragments but considered the process to be too time-consuming for the Pine Creek remains. This situation was also true for the Rye Creek faunal remains where most of the bone exhibited fresh breaks as the result from the use of a backhoe. Presenting the weights of the faunal remains was an attempt to provide additional information on the character of the faunal assemblage.

Nonetheless, the hunting of large game was important at both Pine Creek and Rye Creek settlements. The only artiodactyl identified to the species level at Pine Creek and Rye Creek was the mule deer (*O. hemionus*). Artiodactyl and large game bones were used to make bone artifacts, primarily awls, at both project sites but were over twice as abundant and more often represented in their entirety at the Pine Creek Project sites. Although the Rye Creek worked bones were small fragments (less than 10 mm in length), the Pine Creek worked bones were primarily over 10 mm in length.

Differences exist between Pine Creek and Rye Creek projects in terms of lagomorph exploitation. Jackrabbits outnumbered cottontails at the Rye Creek sites while the opposite pattern was observed at the Pine Creek sites. These two projects also differed in the quantity of burned bone. Rye Creek sites had few burned elements (9 percent for the entire assemblage) compared to two-thirds of the Pine Creek assemblage.

Artiodactyl skeletal element representation at Pine Creek sites were dominated by lower limb elements whereas Rye Creek sites had these elements as well as cranial elements dominating the assemblage. Although butchering patterns may have produced this pattern, biases inherent in identification may also contribute to this skewed distribution. Both assemblages had large quantities of unidentified large mammalian remains and other skeletal elements may be hidden within this category.

SUMMARY

The Rye Creek Project faunal assemblages were well represented by deer and rabbits, however, their remains were not equally represented at each site. The fieldhouse sites had minimal or no faunal remains indicating their impermanent occupations. None of the faunal remains contributed any information regarding season of occupation for these settlements.

Specialized hunting was evident at the Boone Moore and Clover Wash sites. The inhabitants of Boone Moore hunted mule deer during the fall and winter months. They hunted newborns to very old individuals. The mandibles of these animals were concentrated in two features at the site. The low diversity of plant remains and high diversity of animal remains further suggest that this settlement may have been used intensively for hunting. The Clover Wash site inhabitants brought back bear and deer remains to the site, which they fashioned into drilled artifacts. Although this site probably was not occupied as intensively as the Boone Moore site, the procurement of animals would also have been important at this settlement.

Rye Creek Ruin represents a permanently occupied large village site. The inhabitants brought back a wide range of different animals ranging from the common deer and rabbit to a variety of birds. Although only a small sample of bone was recovered from the limited test excavations, the diversity present at this site was evident.

The other sites generally appear to be year-round occupations but not necessarily permanent occupations. They were all classified as habitations and the faunal assemblages suggest minimal hunting or the feeding of small numbers of people.

While discussion of intensity of occupation for this study is meant to be suggestive rather than strictly quantifiable the use of multiple lines of evidence can shed some light on the use of these settlements and the ways in which faunal assemblages can be used to address such issues.

CHAPTER 22

THE MINERALOGY AND SOURCING OF ARGILLITE ARTIFACTS: A PRELIMINARY EXAMINATION OF PROCUREMENT, PRODUCTION, AND DISTRIBUTION SYSTEMS

Mark D. Elson and James N. Gundersen

This chapter presents the initial results of a sourcing analysis of argillite artifacts from both the project area and other prehistoric sites in Arizona. Argillite, which comes in a variety of colors and hues, is found worldwide. In general, it contains a mixture of various clay minerals with quartz, feldspar, carbonate, and mica. The argillites examined in this study are soft, red metasediments, varieties of which are generally called pipestones by archaeologists working in the American Plains (Gundersen and Tiffany 1986:46-48). This material, which in the Southwest is often found in bedded form or as small cobbles, is particularly suitable for manufacture into small beads and pendants, although larger items, such as censers and stone bowls can also be manufactured. Prehistoric trade and use of argillite has long been documented, and argillite artifacts are known from many localities in the American Midwest, Southwest, and possibly northern Mesoamerica (Bartlett 1939; Fish 1974; Fish and Fish 1977; Gundersen 1981, 1987; Gundersen and Tiffany 1986; Haas 1971b; Haury 1976; Jernigan 1978; Kamp and Whittaker 1990; McGregor 1941). Argillite artifacts have been most extensively examined and sourced in the American Midwest and Plains regions (Gundersen 1981, 1987, 1991; Gundersen and Tiffany 1986). To our knowledge this is the first major analysis of Southwestern material.

Argillite artifacts and potential raw material source areas were analyzed through X-ray powder diffractometry under the direction of James Gundersen of Wichita State University. In nontechnical terms, X-ray diffractometry is a process by which a flat-surfaced, powdered sample is rotated about a predetermined axis through a fixed narrow X-ray beam. An X-ray detecting system is used to measure the angle of the scatter of the X-rays deflected from the sample. The resulting pattern of scattered X-rays is unique for each constituent mineral within a sample and therefore a unique mineralogical "fingerprint" can be determined. These data were then plotted using correspondence analysis, a multivariate data reduction technique (described below) which displays the data matrix as points in low dimension geometrical space. This allowed for the linkage between an argillite artifact from a given provenience with its raw material source area.

Our analysis included x-ray diffraction data from 714 source area samples and 179 artifact samples. These data suggest that although the dispersion of argillite artifacts is very widespread, argillite distribution points are limited to a very few specific source areas in central and southern Arizona. This has allowed for a preliminary examination of argillite procurement and distribution networks.

THE MINERALOGY OF ARGILLITE

We first became interested in Southwestern argillite during the course of the Rye Creek Project when it was discovered that argillite was being procured and used in relative abundance on almost all project area sites. Once this was recognized a source for the raw material was located within the project area on the terrace south of Deer Creek (see Figure 1.2, Volume 1). This source had been previously identified by Tonto Forest archaeologist J. Scott Wood (1985; personal communication, 1989) and by previous excavators in the general vicinity (Haas 1971b; B. Huckell, personal communication, 1989). Over 300 pieces of worked argillite and argillite debitage were collected from project sites, one of the largest collections recovered to date. These include a wide variety of artifact shapes and forms, including beads, pendants, shell bracelet and copper bell mimics, eccentrics, a phallic-shaped censer, and a large number of ground pieces and polishing stones (Figure

22.1). In addition, the presence of ground argillite on manos and burned house floors raised the possibility that argillite also was used as a red-colored pigment. Our research, although not definitive, suggests that argillite was used as a pigment in prehistoric redware ceramic manufacture.

Prior to discussing the results of our research, a brief introduction to the mineralogy of the argillites studied is presented. More specific and highly detailed discussions can be found in Gundersen (1991) and Gundersen and Tiffany (1986), from which much of the following is taken.

Argillite is a specific petrologic name for a slightly metamorphosed, well indurated, claystone or mudstone that is formed during diagenesis and/or authiagenesis. It is a soft (easily carveable), sound (nonslacking in water), dense (impermeable), red (hematite-colored), fine-grained metasediment that formed during the early Proterozoic Era (ca. 1.5-1.7 billion years ago) (Gundersen and Tiffany 1986:48). Southwestern argillites are generally not internally laminated, and although they show only a poorly developed shaly structure, they typically exhibit parting along bedding surfaces. With more intense pressure and heating argillite might typically be metamorphosed into a fine-grained slate.

Although there are many mineralogical varieties of argillite worldwide, the argillites of our study were found to consist of only five minerals: kaolinite (K), pyrophyllite (P), diaspore (D), muscovite (M), and quartz (Q). These five minerals, which are also found in all argillites analyzed from the Midwest, fit compositionally into a petrogenic system composed of four oxides: silica (SiO_2), alumina (Al_2O_3), water (H_2O), and potash (K_2O) (Figure 22.2a). The SiO_2-Al_2O_3-H_2O-K_2O petrogenic system is a reactive system in which the minerals that can form from these oxide "building blocks" depend not only on the net composition of a given mixture of these components in a given rock, but also upon its geological environment (specifically the thermal, mechanical, and chemical energy available to form various mineral assemblages). Table 22.1 presents the number of specific oxide components necessary to constitute the structural composition indicated for each of these minerals. For example, one each of an H_2O component and one of an Al_2O_3 component are required to constitute one compositional unit of diaspore (which consequently plots halfway between these oxide end-members of that binary system shown in Figure 22.2a).

Table 22.1. Characterizing minerals of argillite.

Mineral	Component Composition SiO_2	 Al_2O_3	 H_2O	 K_2O	Structural Formula
Diaspore (D)		1	1		$HAlO_2$ or α-$AlO(OH)$
Kaolinite (K)	4	2	4		$Al_4(Si_4O_{10})_1(OH)_8$
Pyrophyllite (P)	8	2	2		$Al_4(Si_4O_{10})_2(OH)_4$
Muscovite (M)	6	3	2	1	$K_2Al_4(Si_3Al_1O_{10})_2(OH)_4$
Quartz (Q)	1				α-SiO_2

Although the four oxides in the petrogenic system can combine into about three dozen different minerals, the argillites under study were found to contain only these five minerals (at least in the over 700 Arizona provenance samples analyzed to date), and only four of these occur together in any one specimen. This is due to the "Mineralogical Phase Rule," which states that the maximum number of mutually stable minerals that can coexist in a petrogenic system at any arbitrary temperature and pressure of a given geologic environment cannot exceed the number of components of the system. That is, of the five minerals of this quaternary system commonly found in argillite, only four can occur together in equilibrium at any given provenance. This has

Figure 22.1. Argillite artifacts recovered from the Rye Creek Project.

been confirmed in all the argillite provenances and artifacts studied to date. At first, one might expect to find little mineralogic difference among argillites when only four such characterizing minerals can occur at a given provenance, but four is the maximum number of minerals that can occur. The majority of argillites are composed mainly of only three, two, or rarely, even one, of these common characterizing minerals. Furthermore, the phase rule does not restrict the relative amounts of each mineral that can be present; analyses have shown that the four minerals are rarely present in equal abundance, and in terms of the entire sample set, one is always distinctly least abundant. Consequently, there are many possible combinations that can occur within any argillite mineral assemblage. These combinations can be used to characterize any particular provenance, or even to define a specific argillite type whose provenance is yet to be encountered.

The apparent relative abundance of the five minerals can be plotted on the surface, or within the volume, of the trigonal dipyramid shown in Figure 22.2b, whose end-member corners are the characterizing minerals. The compositions of all argillites can be plotted on or in this figure, but with differing degrees of difficulty. For example, an argillite consisting entirely of kaolinite would plot at the K corner. One with equal amounts of pyrophyllite and quartz would plot halfway on the line between the P and Q corners. Another with equal amounts of pyrophyllite, diaspore, and muscovite, would plot in the middle of the PDM triangular face. Once the mineral assemblages get more diverse, however, the representation of their apparent relative abundances on such a three-dimensional schematic becomes much more difficult to plot and to interpret, especially if a fourth mineral is present. For example, if the argillite in the last example also contained kaolinite it would be plotted within the volume of the PDMK tetrahedron. It is for this reason that we chose not to analyze the argillite solely through the use of these schematics, as is commonly done, but also through a correspondence analysis discussed below.

All argillites also contain subordinate amounts of other minerals whose elemental oxide components do not belong to, and in fact are completely inert in the presence of, the SiO_2-Al_2O_3-H_2O-K_2O system components. One inert component is Fe_2O_3 which occurs as the mineral hematite, the coloring agent in all red argillites. Another inert component is titanium dioxide (TiO_2), which occurs most commonly as trace to minor amounts of anatase, but locally also appears as trace to minor amounts of rutile. As will be discussed more thoroughly below, within the Southwest the distinction between argillites with anatase versus argillites with rutile is an important factor in separating source area provenances.

ANALYTICAL METHODS

X-Ray Powder Diffractometry

The primary method being used to investigate the role of argillite in the prehistoric economy of the Southwest is through the sourcing of argillite artifacts and pigments through X-ray powder diffractometry (or XRD) analysis. We have now analyzed over 700 samples from four known source areas and close to 180 artifacts from 25 archaeological sites.

Essentially any mineral is composed of orderly arrangements of ions (or groups of ions) that are located at regularly repeated, fixed distances from one another in three-dimensional space so as to constitute their own specific internal crystalline structure. Each structure is essentially unique to a given mineral species. The three-dimensional periodic distribution of ions further defines a number of differently oriented, internal sets of regularly spaced, parallel planes that are also specific for a particular mineral; the regular distance of separation of these parallel planes is the "d-spacing." Depending on its internal complexity, a given mineral can have a dozen or two sets of specific "d-spacing" planes of ions. The spatial orientations of the many sets of parallel planes within the crystalline structure are designated by their Miller indexes, h k l; a shorthand method of designating planar directions with respect to the relative intercepts of a given plane with the crystallographic axes of the mineral. As any elementary mineralogy text will explain, the Miller indexes are the reciprocals of these intercepts.

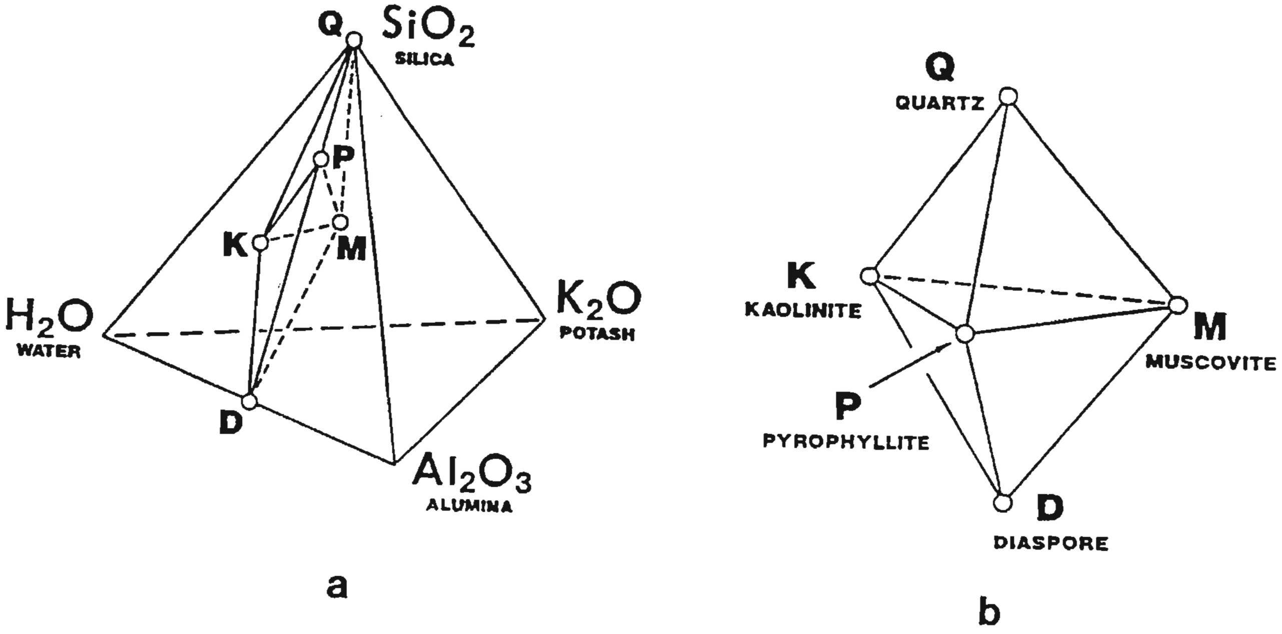

Figure 22.2. (a) The SiO_2-Al_2O_3-H_2O-K_2O petrogenic system; and (b) Mineralogical systematics for characterizing argillites.

Consequently, a specific d_{hkl}-spacing is the distance of separation between each of the parallel planes of ions of that set of parallel planes whose Miller indexes are h k l. Because x-ray photons interact with the electrons of the ions of these internal parallel planes in a very specific manner, x-ray diffraction analysis of minerals is the standard method used to detect the presence of such internal ionic planes in a mineral (i.e., crystalline) sample. There are actually a number of instrumental techniques that are collectively called "x-ray diffraction analysis." They are all directed toward detecting the presence of, and measuring the magnitude of, the numerous sets of internal d-spacings (i.e., d_{hkl}) of these ionic planes for all the minerals of the sample. The essence of any XRD analysis technique is in recognizing when the Bragg equation,

$$n\ \lambda = 2d_{hkl} \sin \theta_n;\ \text{for } n = 1, 2, 3 \ldots,$$

is satisfied for constructive interference of the scattered (i.e., diffracted) x-rays. When satisfied, this equation implies that if a beam of x-ray photons on known wavelength λ strikes, at specific angle θ, an (h k l) oriented set of parallel planes of a given d_{hkl}-spacing in a mineral, a reinforced (by constructive interference) scattered x-ray beam would be diffracted (deviated) at the same specific angle θ from that set of parallel planes. The equivalent geometry of such constructive interference diffraction of an x-ray beam from a given set of d_{hkl}-spaced planes is that of specular reflection in optics, where the angle of reflection is equal to the angle of incidence of the beam to the planar reflecting surface. Such diffracted beams are commonly called "reflections" and the reflecting surface is the given set of hkl planes of ions. Differing values of n in the Bragg equation correspond to differing orders of reflection from the same set of d_{hkl} planes. Physically, the values of $n = 1$, 2, 3, relates to the number of whole wavelength path differences that the diffracted x-rays travel in the reflection direction, θ_n, from each successive plane of the parallel set of internal planes. Consequently, reinforced reflections from a given set of parallel planes in a mineral occur only at specific angles θ_1, θ_2, θ_3, etc., for differing interference path differences of 1λ, 2λ, 3λ, etc. The higher order reflections, for $n = 2, 3$, are indicated by multiplying the Miller indexes of the reflecting plane by the order, n, of the reflection. In typical analyses the x-ray wavelength, λ, is known and the θ_n angles of all reinforced diffracted beams are measured, from which the numerous d_{hkl}-spacings of the mineral are determined.

In order to detect the presence of as many of the reflections as possible from all of the sets of internal d-spacing planes present in a given mineral or assemblage of minerals, a completely random oriented powder sample is placed in the incident x-ray beam. The particular XRD method used in this study is x-ray powder diffractometry. Here a flat-surfaced, powdered sample is placed in the x-ray beam, whose orientation is taken as the $\theta = O^0$ direction in the diffractometer (essentially an x-ray goniometer). The sample is slowly rotated, at a constant angular rate about a horizontal axis in the middle of, and parallel to, the sample surface: rotation in this study is arbitrarily from a low, to increasingly high, incident angle θ of the beam to the sample surface. The essential geometry of the diffractometer is that its x-ray detector (for receiving the reinforced scattered beam) is also continuously revolving about the same sample rotation axis at exactly twice that angular rate. Thus, the detector is continuously positioned at the reflection angle θ, corresponding to the incident angle θ of the x-ray beam on the planar sample surface at any given instant during sample rotation. Consequently, the detector is always at an angle of 2θ to the incident $\theta = 0^0$ x-ray beam. During most of this scan of increasing angle, the scattered x-rays from the powdered sample destructively interfere with one another which only results in a low level of background noise received by the detector. But at specific incident θ angles of the x-ray beam, each set of parallel d-spacing planes parallel to the sample surface will reveal their presence by producing a reinforced diffracted or reflected beam that is received by the detector in the angular reflection position of 2θ, as expected from Bragg's equation. The graphical output from the detector during such an analysis is the x-ray powder diffractogram, wherein diffraction/reflection peaks produced by specific internal d-spacing planes of the contained minerals occur at specific angular positions, in degrees 2θ, of the detector. Several examples of a diffractogram printout are shown in Figure 22.3.

Most significantly, unknown minerals can be identified by comparing the analytical data with that provided by the Mineral Powder Diffraction File (1980) of known mineral standards. Once a mineral is identified, the File provides the h k l indexes of the d-spacing planes that produced the diffracted beam. In addition, the apparent relative abundances of known minerals within a given lithic specimen can be evaluated. Both aspects are relevant to this study.

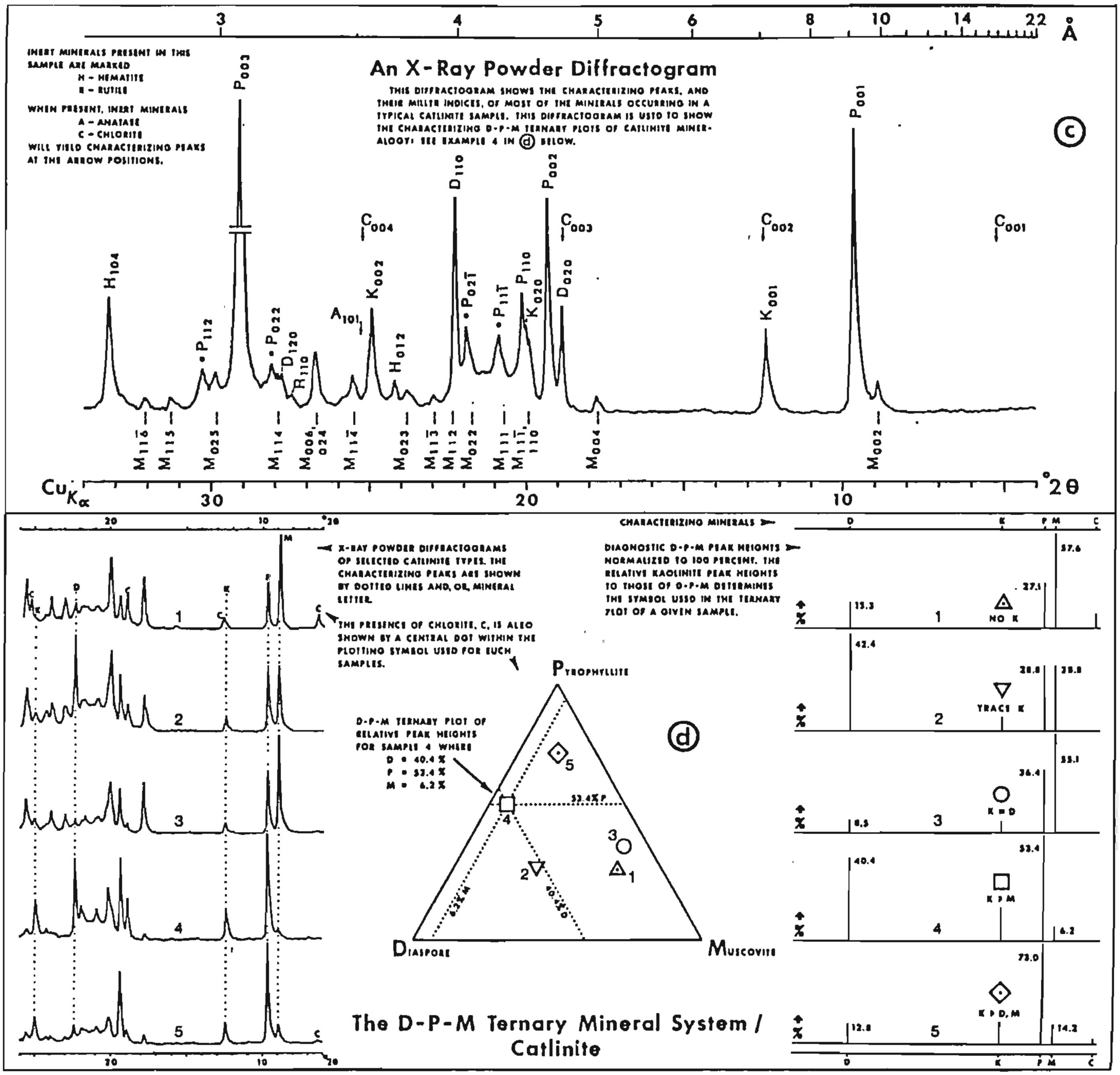

Figure 22.3. Examples of X-ray powder diffractograms.

All XRD analyses were performed with a Philips XRG 3100 constant-potential x-ray generator and vertical diffractometer system located at Wichita State University. The copper-target tube, operated at 30 KV, 20mA, provided a characteristic Cu_{K_α} wavelength of $\lambda = 1.54Å$. ($1Å = 10^{-10}$ meters). The angular scan rate of the vertical diffractometer (goniometer) detector was one degree 2θ per minute. The diffractogram chart was recorded at the rate of 1/2 inch per degree 2θ, with a full-scale peak deflection of 2.5K counts per second; the time-constant, or counting interval, was one second. The system is equipped with automatic θ compensation and a graphite monochrometer.

Preparation and Preferred Orientation of Powder Samples

The intensity of each peak on a diffractogram is a function of the electron density of the ions in the individual planes. These define a given d-spacing set of parallel planes that occur within the mineral being analyzed. Because each different set of d-spacing planes have different distribution densities of ions within them, the set of diffraction peaks of any given mineral have inherently different intensities. The intensity of each diffraction peak is a useful attribute that is tabulated, along with the related h k l indexes and d-spacing, for each mineral listed in the Mineral Powder Diffraction File (1980). In fact, the searching scheme for even finding where to look for the appropriate mineral data in this file depends on knowing these relative intensities, as they would be determined from a randomly oriented powdered sample of the mineral. In a completely random orientation of powder fragments in an XRD sample, there will be an equal number of each of all of the internal sets of d-spacing planes (of all the minerals present) that are oriented parallel to the sample surface. Random orientation can be approached if the powder sample volume is normally about 20 mm long and 15 mm wide and 1 1/2 mm deep in a common size holder. This can be a significantly large volume of powder to remove from a small artifact, particularly since many of the argillite artifacts from the Southwest are recovered in bead or pendant form. Although sample volumes are no problem in analyzing provenance materials, they should be analyzed in the same manner that would be used to evaluate an artifact; that demands the use of a minimum volume of material. This condition can be met by using a shallow sample holder of the same, or even smaller, surface area.

With the exception of quartz, each of the dominant minerals of argillite have internal structures (those sets of parallel d-spacing planes) that produce one perfect cleavage. This attribute causes them to break apart (when powdered) into platy grain shapes and flaky cleavage fragments. Even the loose packing of such a powder in a shallow sample holder will result in having more of these platy/flaky fragments (semi)parallel to the sample surface (a "preferred orientation") to be irradiated with x-rays, and fewer of them will be in random orientation. Consequently, those sets of parallel d-spacing planes that are now parallel to the mineral sample surface will produce more intense peaks than would be expected in random orientation even though the sample volume is appreciably thinner; the scattered x-rays can only escape from a thin upper zone of any sample surface anyway. It turns out that smaller amounts of such platy minerals can be detected with preferred, rather than random, orientation of the sample, a desired effect in this scheme of mineral assemblage analysis. Consequently, every effort is made to enhance the preferred orientation of these samples for XRD analysis. Because all analyses are made under identical conditions, the intensity of a given set of peaks produced by a given mineral will still be a function of the relative abundance of that mineral in the sample.

Optimal sample preparation has been found to be light abrasion (to avoid crushing) with a fine file to produce a fine powder that will be used as is: samples are neither crushed nor ground because some soft crystal structures can be modified by grinding. This powder is pressed flush into a shallow sample holder about 10 mm by 15 mm in area and 0.2 mm deep, with a constant lateral-wiping motion so as to enhance all possible preferred orientation of the flat sample surface.

ARGILLITE RAW MATERIAL SOURCE AREAS IN ARIZONA

Argillite raw material occurs in several different geological source zones within Arizona. This in itself makes sourcing difficult, because the locations of all source areas, or even potential source areas, are not known. Furthermore, it is unknown whether additional argillite deposits are present outside of Arizona, since a few argillite artifacts have been recovered from sites in both New Mexico and Utah. Our data suggest, however, that most prehistoric argillite used at Arizona sites was mined from deposits known geologically as the Mazatzal Quartzite formation. Although several other argillite source areas are known outside of this formation, most notably the Tucson Mountain Redbed source, and several other source areas of unknown provenience are suspected, we believe that the majority of analyzed prehistoric argillite artifacts (94.4 percent) were made out of Mazatzal Quartzite-derived material. This formation is present as relatively thin, widely distributed layers within a few, physiographically discrete areas of central Arizona (Reynolds 1988; Wilson 1922). As shown in Figure 22.4, which portrays all known areas of the Mazatzal Quartzite formation, and hence the most probable potential argillite sources within Arizona, the Mazatzal Quartzite is situated within a small, discontinuous zone running in a relatively northwest by southeast trending band approximately 130 km (80 miles) long by 80 km (50 miles) wide. As this figure also shows, the greatest concentration of this formation is within the vicinity of the Tonto Basin.

In the 1930s an argillite source area within the Mazatzal Quartzite of the Upper Verde Valley (the Del Rio source) was shown to have been used prehistorically (Bartlett 1939; Howell 1940). As mentioned above, a second prehistoric source along Deer Creek in the Upper Tonto Basin has been known for a number of years and was further documented as part of the this project. A third smaller argillite source area also has been documented near the town of Pine, Arizona, along Pine and Oak Spring creeks. A search for Mazatzal Quartzite occurrences on geological maps strongly suggests that only two more possible source areas are present within Arizona (Reynolds 1988; Wilson et al. 1959). One is just south of the Mogollon Rim at the head of Tonto Creek. The other is in the vicinity of Four Peaks in the Mazatzal Mountains. The Four Peaks source may be mineralogically related to the Deer Creek source, which is also in the Mazatzal Mountains although around 50 km (30 miles) further north. The geological maps suggest that these source areas, like the one near Pine, are probably quite small and of less prehistoric significance than the Verde Valley and Deer Creek sources. Field investigations and XRD analyses of these other source areas have not yet been undertaken, although they are planned for the near future.

It is important to note that the argillite samples collected from the source zones for XRD analysis were collected essentially as grab samples, although care was taken to recover as wide a variety of material as possible. The number of recovered samples varies between source zones due primarily to the amount of time spent at each source area and to the distance from the source area to our vehicles (i.e., the distance that we had to carry out hundreds of rock samples). All collected source area samples were analyzed. With the exception of the Tucson Mountain Redbed source (see below), which was included after the primary analysis and from which we have only a few samples, we believe that our sampling is large enough for an initial characterization study. More detailed descriptions of the individual source areas are given below.

The Del Rio Source Area

The Verde Valley source area is located in the Chino Valley about 32 km (20 miles) north of Prescott, Arizona and is called the Del Rio mine. This is the westernmost known outcrop of Mazatzal Quartzite, and it is located approximately 130 km (80 miles) northwest of the Tonto Basin. Katharine Bartlett of the Museum of Northern Arizona visited this area in the late 1930s (assigning it Museum of Northern Arizona site number NA 3640) and published a brief account of her explorations in *Museum Notes*. According to Bartlett (1939:75), interest in a possible argillite source area stemmed from the excavation of Tuzigoot in the early 1930s by E. H. Spicer and Louis Caywood (Caywood and Spicer 1935; Spicer and Caywood 1934), where a cache of 652 argillite bead blanks was recovered. Although Spicer and Caywood searched the neighboring area for the source of these blanks, they were unsuccessful, and the source was not located until the late 1930s when Bartlett and David Howell, a mineralogist specializing in spectrochemical analysis, became interested. Bartlett (1939:76,77) documented four mine holes (one of which she felt was recent), averaging "four by six feet across and two feet deep," along with a "considerable number of picks which were used to 'mine' the argillite." She also documented a moderate-sized pueblo (the Del Rio Ruin: NA 3639) containing close to 30 rooms situated less than half a kilometer east of the outcrop. According to Bartlett (1939:79) the ruin dated primarily to the PIII period (A.D. 1100-1300), although a few earlier PII period (A.D. 900-1100)

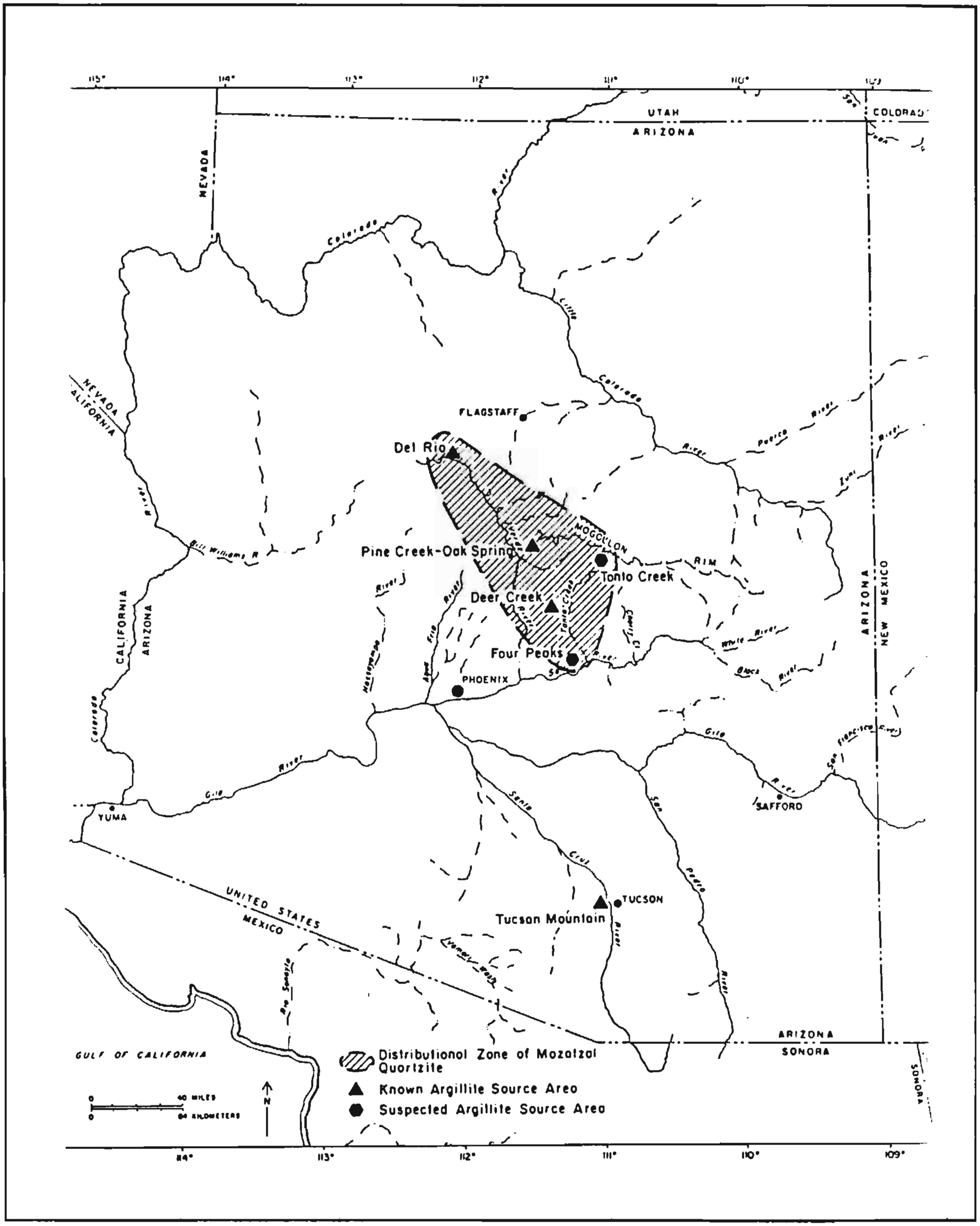

Figure 22.4. Location of the Mazatzal Quartzite formation and potential and known argillite sources in Arizona.

ceramics also were noted. Furthermore, the surface of the site was "strewn . . . with quantities of chips of red argillite from the "mines," and broken fragments of ornaments, etc." (Bartlett 1939:79). Perhaps most significantly, Howell (1940; Bartlett 1939:78), using atomic absorption spectroscopy, was able to source argillite artifacts from several sites in the Flagstaff and Verde Valley areas to the Del Rio mine. These sites, which span the PII (A.D. 900-1100) through PIV (A.D. 1300-1450) periods (although the provenience of the analyzed artifacts within each site is unknown), included Winona Village (NA 2098, 2133, 2134, and 3644), Wupatki (NA 405), Tuzigoot (NA 2733), Montezuma's Castle (NA 1278), King's Ruin (NA 1587), Turkey Tanks Caves (NA 117), Turkey Hill (NA 660), Baker's Bluff (NA 2798), Pittsberg Village (NA 3577), and Elden Pueblo (NA 142). Winona Village contained over 7,000 argillite beads (McGregor 1941) and numerous other argillite artifacts, and is situated approximately 80 km (50 miles) northeast of the Del Rio area. Wupatki, the northernmost site in Howell's sample, is over 110 km (70 miles) from Del Rio. These data indicate significant interaction between the Del Rio area and the general Flagstaff region. Interestingly, there were 12 argillite pieces, (out of a total of 66 analyzed) that Howell could not source, being of a different elemental constituency than the Del Rio material. This led him to speculate on the presence of at least two other argillite source areas (Howell 1940:59).

As part of our research a collecting trip to the Del Rio area was made by the authors and State Lands archaeologist John Madsen of the Arizona State Museum. Our inspections revealed at least nine prehistoric mine holes, some to a depth of 1 to 2 meters, as well as recent indications of argillite mining with heavy machinery. The nine holes are all believed to be prehistoric (and were often surrounded by the "crude" picks described by Bartlett). Although it is not clear why only four of these were previously recorded, the length of Bartlett's stay and the intensity of her explorations are unknown. Three hundred and ninety-five argillite raw material samples were collected and analyzed from this source, and each individual mine hole was mapped and collected separately. A stratigraphic collection from an exposed vertical argillite bed also was obtained. Although the individual mine hole data and the stratigraphic collection have yet to be analyzed separately, it may eventually be possible to pinpoint argillite artifacts to specific mine holes. The Del Rio Ruin also was visited, and the abundance of argillite noted -- in fact, tabular slabs of argillite were found to have been used in wall construction.

The Del Rio argillite differs from the Tonto Basin argillite, being slightly lighter in color, softer, and largely in tabular bedded form. It often contains an abundance of small, circular, yellow bleached spots, not normally found in the Tonto Basin argillite. Although the two are macroscopically different, Del Rio argillite cannot readily be distinguished from Tonto Basin argillite at the small artifact level. As a result of its bedded nature only small artifacts, such as beads and small pendants, were generally manufactured from this material. Several larger artifacts (such as a stone bowl from Homol'ovi IV, for example [E. Charles Adams, personal communication, 1990]) are known, suggesting that additional quarry areas or cobble floats within this general outcrop may be present but unrecorded. This is particularly true given the fact that the geological map of Yavapai County (1959) indicates that the Mazatzal Quartzite formation responsible for the Del Rio argillite encompasses an area approximately 6 km long by 2 km wide, while the area of the Del Rio mine itself, which is the only area that we inspected, is less than a kilometer square. More intensive exploration needs to be made of this area to determine whether other outcrops or float areas are present.

The Deer Creek Source Area

As mentioned, the Deer Creek source area is located along the terrace on the southern side of Deer Creek in the Upper Tonto Basin, about 130 km (80 miles) southeast of the Del Rio source area. This area represents the cobble float from argillite beds located in the Mazatzal Mountains to the west. Haas (1971b), in his excavations at the site of Ushklish, was perhaps the first archaeologist to recognize the significance of this source area, and experimented both with argillite artifact manufacture and pigment production. Two-hundred and nine argillite raw material samples were collected and analyzed from the float within the Deer Creek source area.

Geological maps of Gila and Yavapai counties indicate that the Mazatzal Quartzite formation here encompasses a 17 km-long by 12 km-wide area in the general vicinity of Mazatzal and North peaks (Wilson et al. 1959). These are the two highest peaks in the Mazatzal Mountains, rising close to 8000 feet in elevation. Due to the rugged terrain and relative inaccessibility of the peaks, it is possible that only the cobble float was being intensively utilized, although this still needs to be determined through actual field investigation (this is supported, however, by the recovery of only a few bedded pieces of Deer Creek argillite -- most were in cobular form -- suggesting that the mining of the actual outcrops was relatively limited). Inspection of the float area indicated that argillite was actively procured, tested, and worked within the float, and Phil Weigand (personal communication, 1989) found what he believes to be prehistoric mine holes cut into the surface of the Deer Creek terrace. Within the float itself numerous partially worked objects were noted, as well as a large number of cobbles with deep scratches or several flakes removed. Our own experience with argillite collection suggests that scratching (in our case with a jack-knife) the raw material is the best method for determining its suitability for carving and pigment manufacture, and it appears likely that the prehistoric inhabitants were testing the material in a similar manner. Furthermore, the cobble nature of the Deer Creek argillite makes it more suitable than the Del Rio argillite for the manufacture of large artifacts, such as censers and bowls. Interestingly, in terms of the prehistoric settlement, Rye Creek Ruin (AZ O:15:1), the largest site in the Upper Tonto Basin containing over 150 masonry rooms and two platform mounds (see Craig, Chapter 27, Volume 3), is located directly north of the argillite float, on the north side of Deer Creek. Argillite artifacts were recovered from test excavations within three of the trash mounds there.

Pine Creek-Oak Spring Source Area

The third analyzed source is located in the Mazatzal Quartzite formations north of Payson along Pine and Oak Spring creeks about 40 km (25 miles) north of the Deer Creek source. This area, in the general vicinity of the Tonto Natural Bridge, is approximately 8 km long and ranges between 0.5 and 3 km wide (Wilson 1922; Wilson et al. 1959). One-hundred and seven samples were collected and analyzed from several areas within this source, primarily from the two stream beds that run its length. The Pine Creek-Oak Spring material was found in both bedded and cobble form, and is macroscopically and mineralogically similar to the Deer Creek material. To date there are no indications that this source was actively mined or used in anything but a casual or fortuitous manner; no artifacts could be conclusively identified as stemming from this area, although increased areal coverage and additional sampling are needed to verify this.

Tucson Mountain Redbed Source Area

The Tucson Mountain Redbed source area is a little known source situated within Saguaro National Monument in the Tucson Mountains just west of the city of Tucson. Only three source area samples have been analyzed to date, although the mineralogical signature they give (being almost entirely composed of quartz with a little muscovite) is very clear. This source is not within the Mazatzal Quartzite formation, but in what is called the Tucson Mountain Recreation Redbed formation. It was located by State Lands archaeologist John Madsen who had noticed artifacts made out of this material on sites in the Northern Tucson Basin study area (Fish, Fish, and Madsen 1985). According to Madsen (personal communication, 1991) the source is located in siltstone formations that grade between sandstones and conglomerates, and is relatively common in small pockets throughout southern Arizona. As of now, the homogeneity and extent of the distribution of this argillite are unknown, although the majority of the sampled artifacts from the Tucson Basin appear to be from this material. Additional sampling of this material is currently underway and more is planned for the future.

Other Potential Source Areas: Tonto Creek, Four Peaks, and Unknown Sources

Investigation of the geological map for the state of Arizona (Reynolds 1988) initially indicated that there were eight general areas potentially containing the Mazatzal Quartzite formation (including the three discussed above), and therefore possible argillite source areas. On the state-wide map these areas, all in Gila and Yavapai counties, were keyed as "Xq: Quartzite (Early Proterozoic; 1700 Ma) -- Mazatzal Group and similar rocks." Due to the small scale of this map it was necessary to examine the larger scale individual Gila County (Wilson et al. 1959) and Yavapai County (1958) geological maps, which are more detailed and specifically key the Mazatzal Quartzite formation as "mq: Mazatzal Quartzite, includes Deadman quartzite and Maverick shale." These maps readily eliminated three areas from further consideration, since they contained the "similar rocks" (e.g., Dripping Spring Quartzite) keyed on the state-wide scale and not Mazatzal Quartzite. This left two areas in need of further investigation: one at the head of Tonto Creek just south of the Mogollon Rim, which Wilson originally identified (but did not investigate) in his 1922 master's thesis on the Mazatzal Quartzite, and the other on Four Peaks in the Mazatzal Mountains (Figure 22.4).

The potential source area at the head of Tonto Creek is situated near the village of Christopher Creek, and contains five small, discrete locales spread out over an area approximately 15 km square. The largest source is approximately 4.5 km long by 1.5 km wide, while the smallest is approximately 1.5 km long by 0.5 km wide. The Four Peaks area, at the virtual top of Four Peaks above 7,000 feet in elevation, is approximately 3 km in diameter. Like the sources atop Mazatzal and North peaks, the inaccessibility of this area makes it unlikely that it was ever actively mined, although it is unknown whether a more accessible float area is present like the Deer Creek source area. As mentioned, neither of these areas have been investigated for argillite outcrops. Given the results of our research, as well as their locations away from any known large prehistoric sites, these two source areas may not have been actively mined, although this awaits actual verification and analysis of their material.

Finally, it is important to note that other source areas likely exist, both within and outside of Arizona, that we are unaware of at the present time. This is particularly true given our data, which suggest the presence of at least several additional source areas. As is common in any raw material sourcing analysis, we cannot currently determine whether unplaced artifacts within our sample are from unanalyzed areas within an identified outcrop (such as within noninvestigated areas of the Del Rio or Deer Creek outcrops, for example) or whether they are from undiscovered and unsampled sources. This is particularly true for the Tucson Mountain Redbed sources, which may be abundant throughout southern Arizona (although the extent and use of these sources are unknown). Even with this uncertainty, however, it appears from our data that the sources we have investigated were used for the majority of argillite manufacture in Arizona, and we are relatively confident that we have provenienced close to 90 percent of the analyzed artifacts. Of course, the possibility also exists that unknown source areas are present that have the identical mineralogical signatures of those we have investigated. At the present time there is no way to determine this, except to emphasize that this is a preliminary investigation. More exploratory work needs to be undertaken, and this is planned for the future.

RESULTS OF THE ANALYSIS

The analysis includes x-ray (XRD) diffraction data from 714 source area samples and 179 artifact samples. Our goal was first to mineralogically characterize each source area as completely as possible, and then use the source area data as a baseline for comparison with the mineralogical signatures of the individual artifacts. Two steps were undertaken in this process: the first was the analysis of the raw material source areas and the artifact data through correspondence analysis. This was used as a general guide for assigning artifacts to specific source area proveniences. Since the correspondence analysis was sometimes not definitive, due to overlap in the source area characterizations (see below), a second step involved a case-by-case examination of each artifact using a set of definitive criteria, such as the presence or absence of particular minerals or mineral suites. Both of these methods are discussed more completely below. The combination of these methods is believed to have resulted in the characterization and sourcing of approximately 90 percent of the 179 artifacts.

The source area samples, collected by the authors and John Madsen, were from the Del Rio source (n=395), the Deer Creek source (n=209), the Pine Creek-Oak Spring source (n=107), and the Tucson Mountain Redbed source (n=3). As mentioned, care was taken to procure as wide a variety of source material as possible, although our areal coverage within each source area was limited, particularly when their overall size is taken into consideration. The artifacts were from 25 different sites throughout Arizona, including 12 of the 13 project area sites and Rye Creek Ruin. Artifacts from sites outside of the Rye Creek Project area were obtained from the collections of various institutions and individuals (see acknowledgments). This discussion begins with an examination of the different raw material source areas and then turns to an examination of the artifact data.

XRD Analysis of Argillite Raw Material Source Areas

The XRD diffractograms were converted into percentage data containing the relative amounts of each of the five (i.e., kaolinite, pyrophyllite, diaspore, muscovite, and quartz) mineral constituents within each argillite sample. These data were then analyzed as a matrix with the rows being made up of the 893 individual artifact or source area samples and the columns being made up of the percentages of the five mineral constituents within each sample. A full discussion of the interpretive difficulties created by a data matrix of this sort is beyond the scope of this chapter (Greenacre 1984), but it is important to note several problem areas that are of special archaeological concern. First, the matrix is sufficiently large to necessitate the use of multivariate data reduction techniques in order to interpret it. The problem is in choosing an appropriate technique, because due to the "Mineralogical Phase Rule" discussed earlier, only four of the five mineral constituents can occur together in equilibrium, and three, two, or even one constituent is common; thus, the data matrix has a large number of zero entries. Given this, in no sense can the frequency distribution be considered "normal" and data reduction methods that rely on assumptions of normality are of limited utility.

Correspondence analysis is a technique that is specifically designed to deal with this situation and one that can also accommodate unbalanced multivariate data sets. In correspondence analysis the column and row profiles are related to each other in multidimensional space in a geometric (as opposed to algebraic) form. The chi square statistic is used to measure the distance between data points. The ultimate goal is to create a joint graphic display of the data points in various two-dimensional subspaces. In this way it is possible to simultaneously examine relationships of the row variables and column attributes in a concise graphic display. Although these displays do not inform on the statistical significance of the association, it is possible to easily compute the relative contribution of each axis to the total variation observed. A discussion of the technique is presented in a monograph by Greenacre (1984), and archaeological applications include papers by Hill (1974) and Bolviken et al. (1982).

The data matrix was analyzed using the detrended correspondence analysis program (DECORANA) of Hill (1979) on an IBM-PC compatible microcomputer. Although Greenacre (1984:8, 11) contends that Hill's approach is not "true" correspondence analysis because it is based on algebraic rather than geometric relationships, leading to numeric as opposed to graphic results, we were able to surmount this problem in part simply by converting the numeric scores to graphic displays.

Figure 22.5 shows the correspondence plots of the five mineral constituents of argillite. It is important to note that this figure, and most of the following plots, show only the first two factors since these account for most of the variation in the data; the first two factors, which are loading on the differences between diaspore, kaolinite, and quartz, account for 69.6 percent of the variation in the data, the third factor accounts for 20 percent, and the fourth factor for 10.4 percent. Therefore, the first two factors, while explaining much of the variability, are not always definitive and sometimes the third and fourth factor plots must also be examined. As can be seen from this figure, the differences between muscovite and quartz are not distinguishable through the first two factors, although they are readily separated on the third factor plot shown in Figure 22.6. The remainder of the minerals are extremely distinct, however, meaning that source areas based on the varying ratios of the mineral constituents are discernible from the plots.

Figure 22.7 is a two-factor plot of the 395 raw material samples collected from the Del Rio source area in the Verde Valley. As this shows, this source is composed primarily of a binary system of pyrophyllite-kaolinite, although a second smaller binary system of pyrophyllite-quartz is also present. The oval line shows the limits

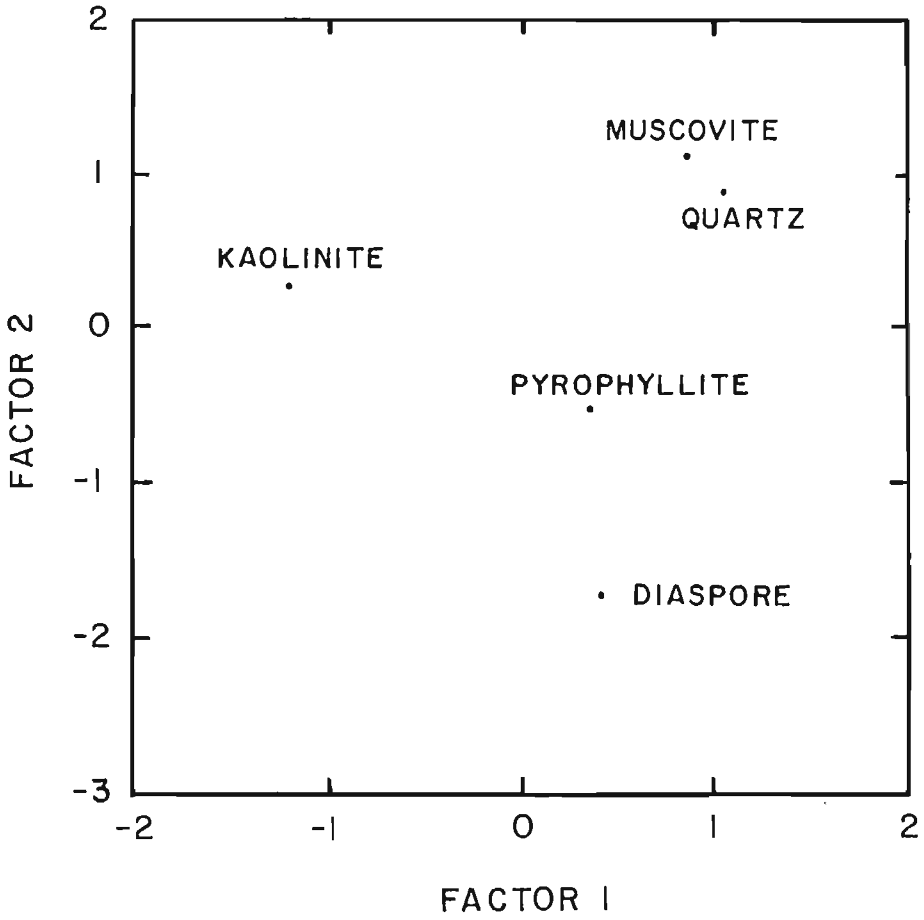

Figure 22.5. Correspondence plot of mineral constituents of argillite -- Factor 2 by Factor 1.

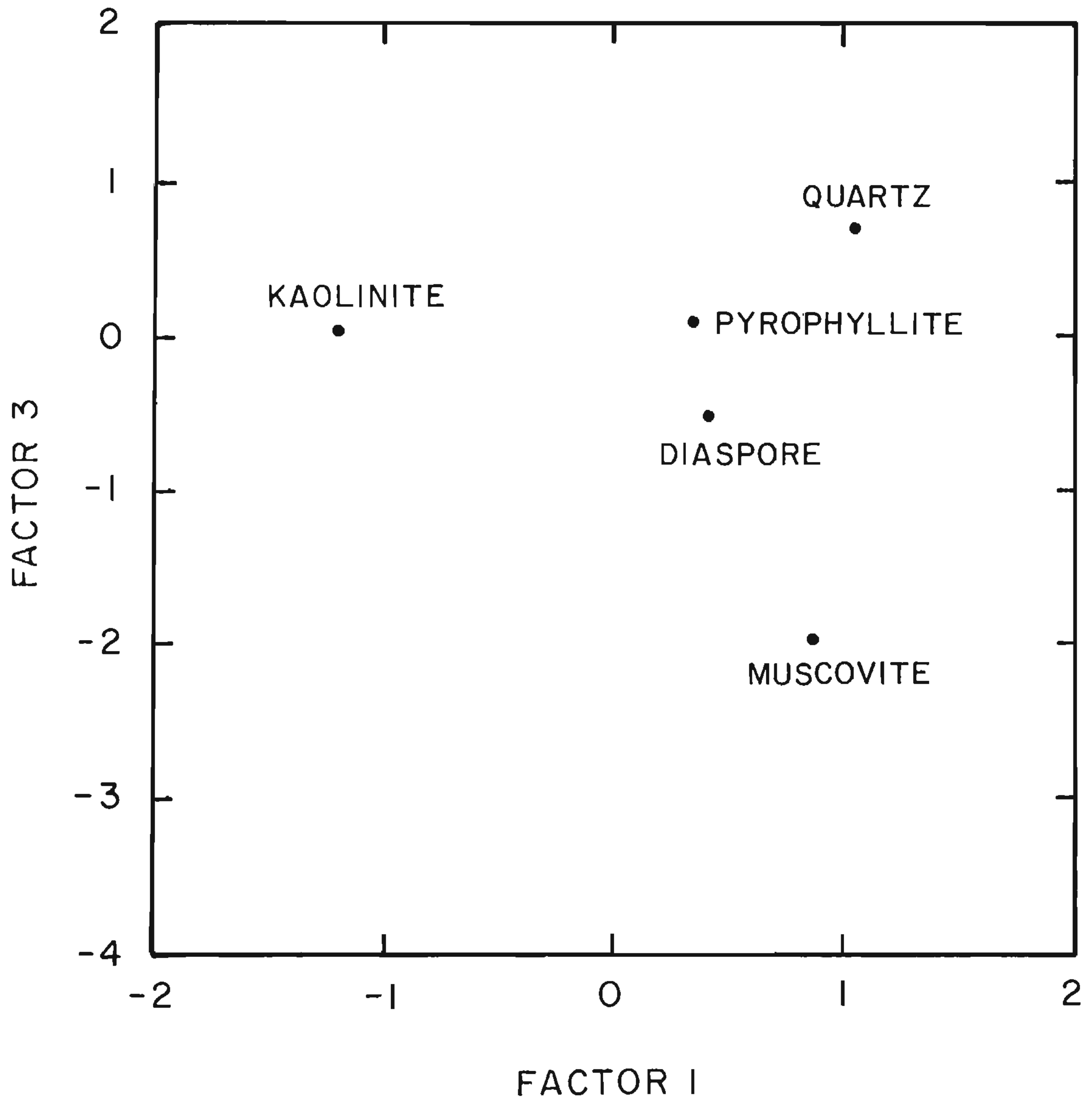

Figure 22.6. Correspondence plot of mineral constituents of argillite -- Factor 3 by Factor 1.

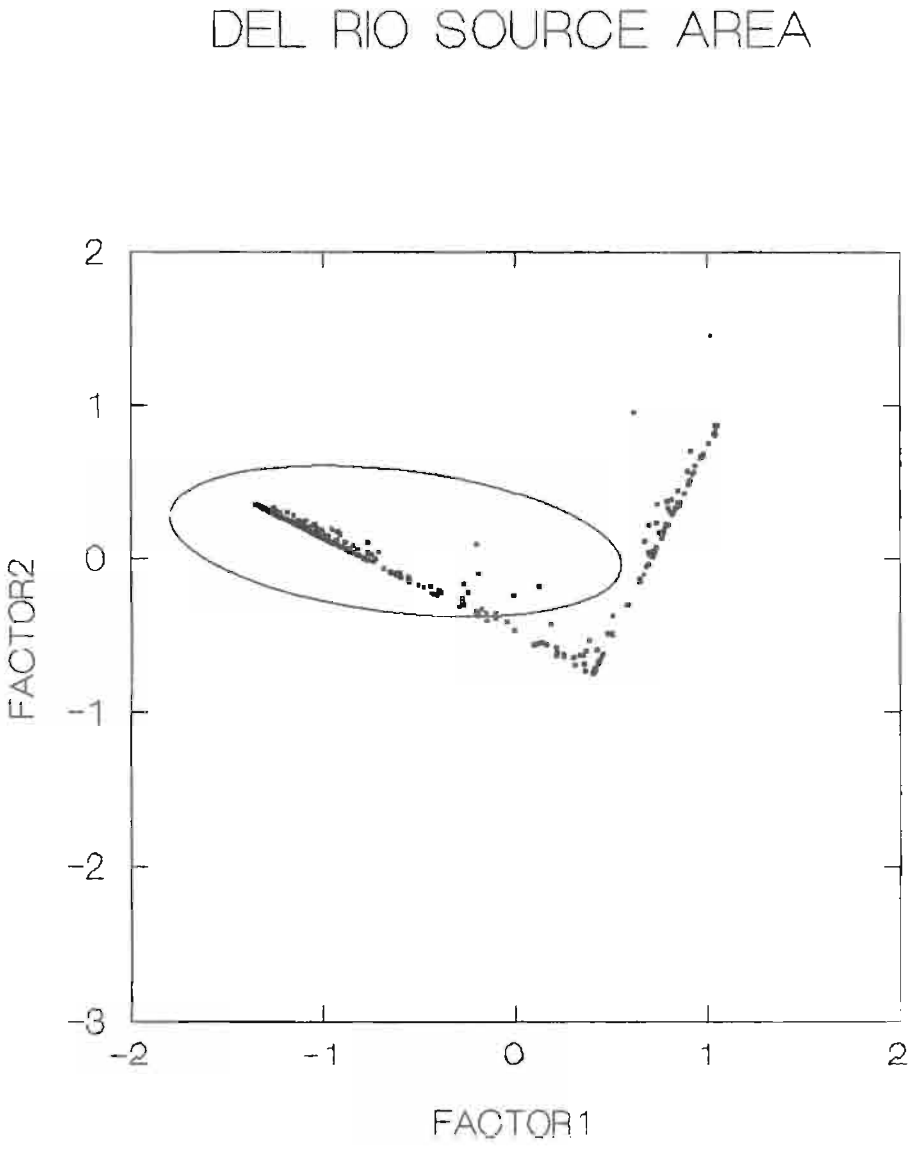

Figure 22.7. Correspondence plot of the Del Rio source area.

of the 66 percent level of confidence (Gausian ELL=0.66), meaning that within this area there is a 66 percent probability that the material has the same mineralogical characteristics as material from the Del Rio source area. A 95 percent confidence level (two standard deviation) plot was also generated but is not reproduced here since the boundaries were too large to be of much utility. Note, however, that some of the Del Rio material on the pyrophyllite-quartz axis falls outside of the 66 percent range. It is for this reason, and because the confidence levels from the different source areas are large and overlap, that the confidence plots were used more as a general guide than a determining factor.

Figure 22.8 shows the Deer Creek source area from the Rye Creek Project. This includes 209 samples. Two types of argillite are present in this system: a pyrophyllite-quartz, which overlaps with the pyrophyllite-quartz axis of the Del Rio source, and a pyrophyllite-diaspore, which is readily distinguishable. Also note that several of these samples plot outside of the range of the 66 percent confidence level on the pyrophyllite-kaolinite axis, which is similar to much of the Del Rio material. As with the Del Rio argillite the 66 percent confidence level is relatively large, indicating a fair amount of variability in the Deer Creek material.

Finally, the 107 samples from the Pine Creek-Oak Spring source area near Pine, Arizona are shown in Figure 22.9. These show a pyrophyllite-quartz-muscovite constituency that plots similar to the Deer Creek and Del Rio pyrophyllite-quartz argillites although within a much tighter confidence level. The Pine Creek-Oak Spring argillites, however, can be readily separated from the others through the third factor since they also contain kaolinite and greater amounts of muscovite, although it is not apparent on this plot. No artifacts could be definitively assigned to this source area.

All 711 argillite samples collected from the three primary source areas are shown in Figure 22.10, along with the three samples collected from the Tucson Mountain Redbed source area. The most readily discrete area where artifacts can be sourced with little problem is to the bottom of the figure on the pyrophyllite-diaspore axis, which represents the Deer Creek argillites. Out of the 714 source area samples analyzed, the Deer Creek source was the only one to contain diaspore; 48.3 percent (101) of the Deer Creek samples contained this mineral. The area on the left side of the figure along the pyrophyllite-kaolinite axis is also relatively clear, although slightly more problematic than the Deer Creek diaspore argillites. This area is primarily composed of Del Rio material. Some of the Deer Creek material also plots within this area, however, and other data must be used in distinguishing these two. The most confusing area is within the configuration that extends towards the top of the figure along the pyrophyllite-quartz axis, which contains potential overlap between all three source areas and the Tucson Mountain Redbed source. As mentioned, some, although not all, of these data can be distinguished by analysis of the third factor which separates muscovite from quartz, and through the analysis of the other factors discussed below.

Several additional and more definitive means can be used to distinguish between the four source areas. These are presented by source area in Table 22.2. One of the most important of these has already been mentioned, and that is the fact that only the Deer Creek argillites contain diaspore. This is important in distinguishing Deer Creek material from either Del Rio or Pine Creek-Oak Spring material, particularly in the areas that overlap on the correspondence plots. Another equally significant measure is the distinction between two titanium dioxide (TiO_2) polymorphs -- rutile and anatase -- which are sometimes found in argillites and were recorded as part of the XRD data. Rutile, which is a crystallized anatase, is only found in the Deer Creek and Pine Creek-Oak Springs material, showing up in some form in 70.9 percent of the Deer Creek argillite and 90.7 percent of the Pine Creek-Oak Spring argillite (Table 22.2). Rutile is not present in any of the Del Rio samples. On the other hand, anatase is overwhelmingly abundant in the Del Rio material, where it is found in 97.5 percent of the samples. Anatase was not found in any of the Pine Creek-Oak Spring samples and was found in only 13.4 percent of the Deer Creek samples. Furthermore, only the Deer Creek argillites contained samples showing both rutile and anatase. Finally, a last potentially important distinction is the presence of feldspar in one of the three Tucson Mountain Redbed argillites. This was the only argillite source area to exhibit feldspar, although it was found in several artifacts all of which plotted in the same area (quartz-muscovite) in the correspondence analysis as the Tucson Basin Redbed source. In fact, the Tucson Mountain Redbed samples were the only analyzed samples to just contain quartz and muscovite without pyrophyllite, diaspore, or kaolinite. This suggests that the combination of feldspar, quartz, and muscovite may be a key

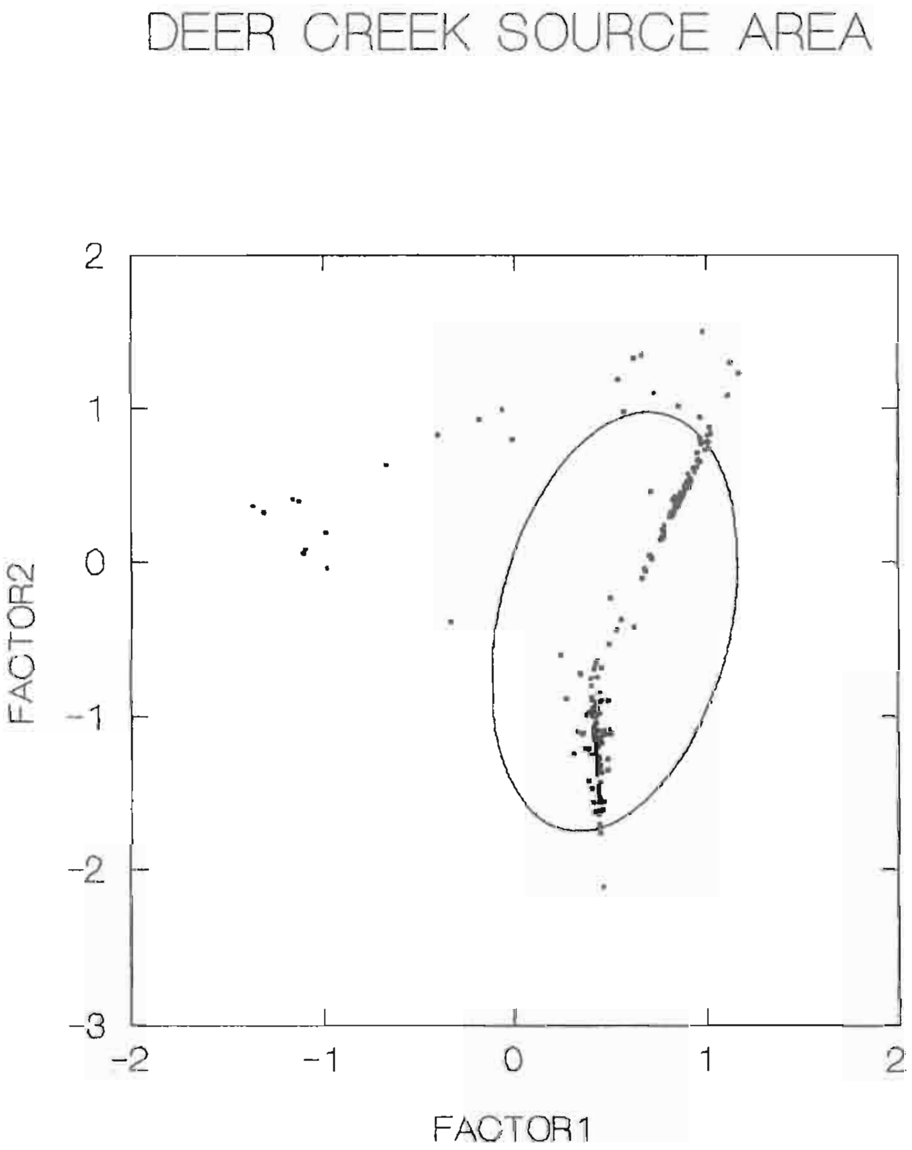

Figure 22.8. Correspondence plot of the Deer Creek source area.

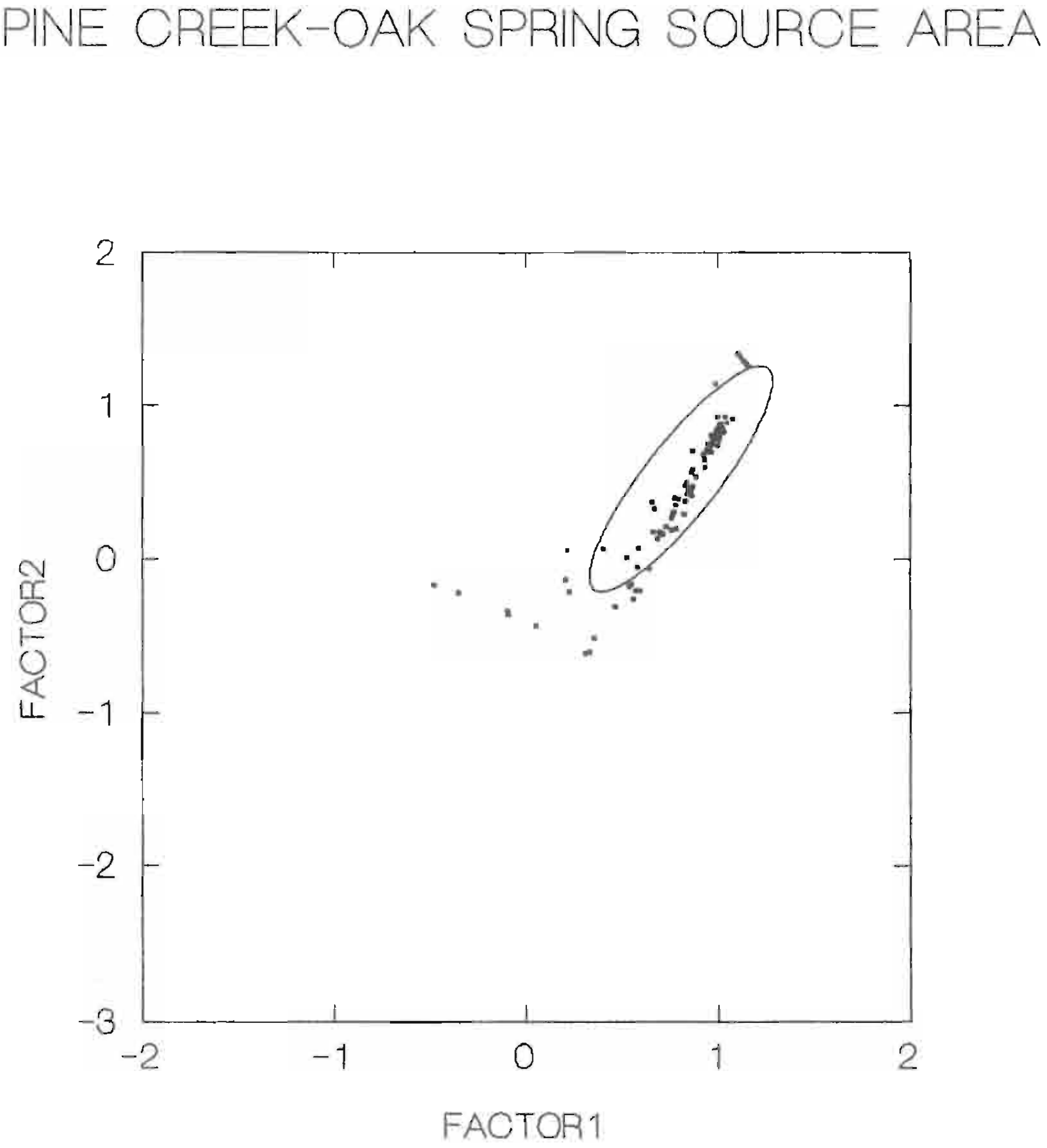

Figure 22.9. Correspondence plot of the Pine Creek-Oak Spring source area.

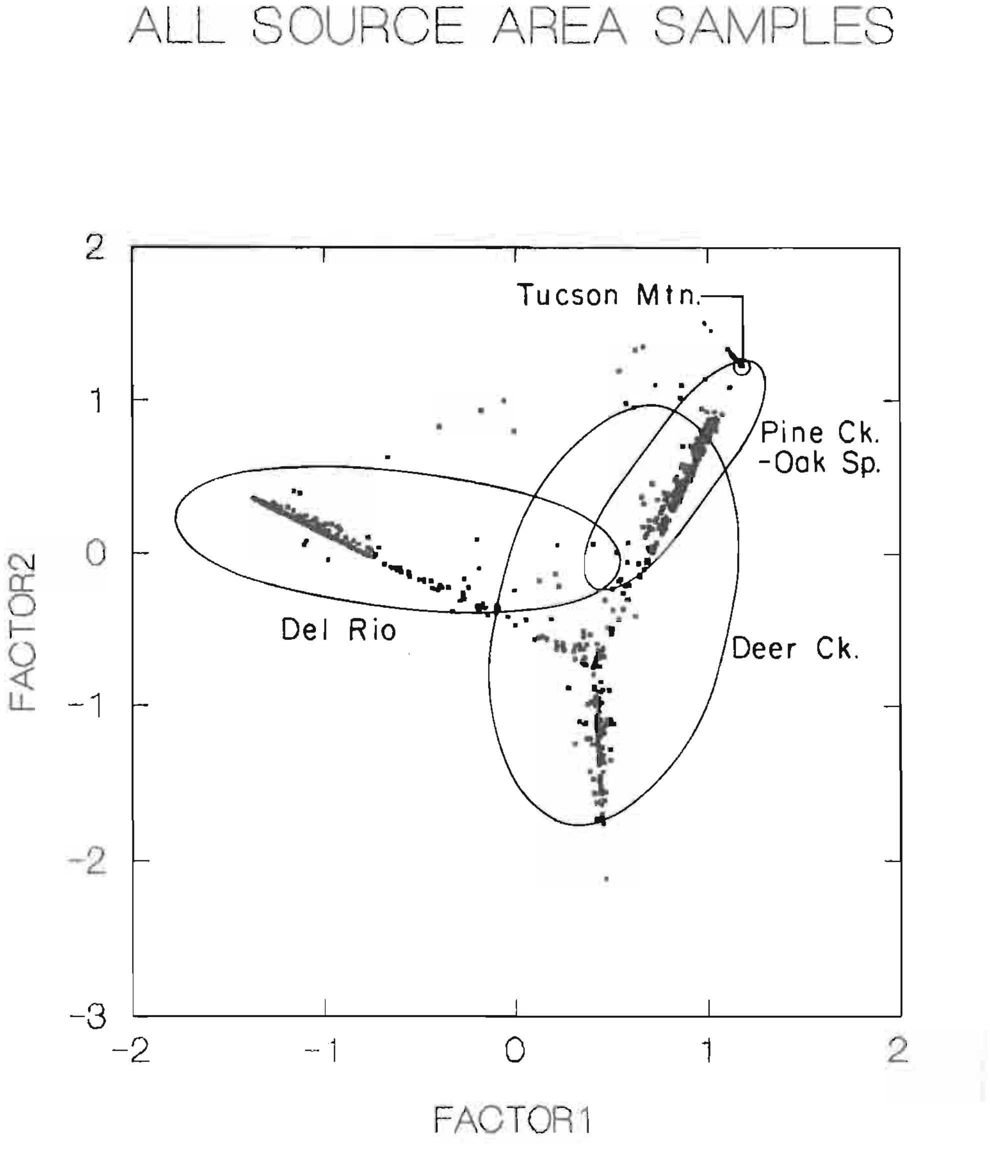

Figure 22.10. Correspondence plot of the Del Rio, Deer Creek, Pine Creek-Oak Spring, and Tucson Mountain Redbed source areas combined.

factor in distinguishing Tucson Basin Redbed argillites, although given the small size of the analyzed sample more extensive analysis needs to be undertaken.

XRD Analysis of Artifacts

The artifact sourcing was undertaken in two different ways. First the artifacts were sourced by Mark Elson through comparing the artifact correspondence data with the individual source area correspondence plots as described above. This included analyzing the artifact data for the key characteristics presented in Table 22.2, which were considered to be in many ways more definitive than the correspondence plots. Each artifact was then assigned a likely source area provenance, although given the overlap in plots (or lack of key characteristics) a few of the artifacts could only be sourced as stemming from one of two likely areas. These data were then compared to sourcing data compiled independently by James Gundersen, who used a more traditional approach consisting of visually lumping mineralogically alike artifacts into categories and assigning these categories to one of the four sources or to several unknown categories. There was an 88 percent agreement between the two independent analyses. The 22 cases where there was disagreement were reanalyzed and a consensus was reached. Most of these cases (20 of the 22) had been sourced to Deer Creek by Elson but placed into several homogeneous unknown categories by Gundersen based on the presence of an unidentified mineral peak (Unknown E), unusual forms of kaolinite (Unknown B and C), or lack of a clear mineralogical source area match (Unknown A and D). In all, these 20 artifacts comprise 11.2 percent of the analyzed artifact sample. Although these artifacts may stem from unsampled areas of Deer Creek, they may also represent new source areas, and their true provenances are currently unknown. Therefore, it is important to note that even though an artifact may fall well within the 66 percent confidence levels for a source area as determined through the correspondence plot, this does not necessarily mean that the artifact originated there. This is due to the problems with statistical analyses, which are only as good as the entered data. In this case, only the relative percentages of the five mineral constituents (K, P, D, M, and Q) were entered -- the presence of anatase, rutile, feldspar, or an unusual kaolinite form or unknown mineral peak, for example, were not considered in the statistical plots. Although the analyzed data were sufficient for most artifact characterization, given the relatively wide dispersion of the individual source areas (which in all cases extended outside of the confidence levels), errors could easily be made if this was the sole data relied upon. Instead, a combination of the visual method, as done by Gundersen, and the correspondence plots (which can easily handle large quantities of data), are thought to be the most reliable means for artifact sourcing. For future analyses the presence of these other mineral signatures could be added to the correspondence analysis, which would reduce the variability in the clustering and make it a more powerful analytical technique.

Table 22.2. Key distinguishing characteristics of argillite source areas (numbers are in percentages).

	MINERALS		TiO_2POLYMORPHS			
Source Area	Diaspore	Feldspar	Rutile	Anatase	Rut/Anat	Neither
Del Rio (n=395)	0	0	0	97.5	0	2.5
Deer Creek (n=209)	48.3	0	58.9	13.4	12.0	15.8
Pine Creek-Oak Spring (n=107)	0	0	90.7	0	0	9.3
Tucson Redbed (n=3)	0	33.3	0	66.6 (?)	0	0

Figure 22.11 shows the distribution of the 179 analyzed artifacts from 25 sites throughout Arizona. Thirteen of these sites were from the Rye Creek Project; the remainder were spread throughout Arizona, from the Tucson Basin in the south to the Flagstaff area in the north (Figure 22.12). These sites, which were all roughly of the same time period, spanning the range between A.D.1000-1350, were selected primarily because collections were accessible for analysis. They include Los Morteros (AZ AA:12:57) and the Marana Platform Mound (AZ AA:12:251) in the Tucson Basin vicinity, Pueblo Grande (AZ U:9:7) in the Phoenix Basin, Grasshopper (AZ P:14:1) in the White Mountains of Central Arizona, Shoofly Ruin (AZ O:11:6 [ASU]) and two nearby small sites (AZ O:11:44 [ASU] and AZ O:15:12 [ASU]) in the Payson Basin, Tuzigoot Pueblo (NA 2733) along the Upper Verde River, and Lizard Man (NA 17957) and Winona-Ridge Ruin (NA 2133, 2134, 2798, 4266, 10792, and 10937) in the Flagstaff area. As can be seen from Figure 22.11, the artifact distribution closely approximates the combined source area distribution shown in Figure 22.10, strongly suggesting that the majority of the artifacts in our sample were manufactured at these source areas.

Table 22.3 presents the sourcing data for artifacts recovered from the Rye Creek Project area. Table 22.4 presents the same data for the 12 sites located outside of the project area. These data are presented here in condensed form; a more detailed record of the sampled artifacts is presented in Appendix I and additional information on argillite artifacts from the project area are described by Craig and Eppley in Chapter 15 and by Eppley in Chapter 16 (see in particular Table 16.12) of this volume. It is important to note that the analyzed samples, particularly from the sites outside of the Rye Creek Project area, were by no means randomly selected and therefore may not be overly representative of the overall population. Material from sites outside the project area were procured via our request to various institutions and individuals and were selected primarily for their availability for XRD analysis, which is a slightly destructive analytical procedure. Although many more sites with argillite artifacts are present in Arizona and the greater Southwest, for this preliminary study we focused on sites that had easily accessible collections. In some cases these artifacts represent the entire collection of argillite recovered from a site, in other cases the analyzed sample is a fraction of the total curated collection. These artifacts were sourced to gain an initial understanding of the movement of argillite across the Southwest, and not to precisely quantify these data.

Argillite artifacts analyzed from the Rye Creek Project sites constitute a better and more representative sample. As can be seen in Table 22.3, our sample ranged from 21.4 percent of the total argillite recovered from the Clover Wash site (AZ O:15:100) to 100 percent at a number of the small sites. In all, we sampled 43.1 percent (131 of 304 pieces) of the recovered argillite artifacts. This is believed to be a large enough sample to be generally representative of the overall assemblage. The Rye Creek sample consists of 92 pieces of chipped stone (mostly debitage) and 212 pieces of ground stone (primarily polishing/polished stones and stone jewelry). Note that these figures differ somewhat from those used in the lithic (Chapter 14) and ground stone (Chapter 15) chapters, because those analyses focused almost exclusively on control units for sampling the respective assemblages. The argillite totals given here represent the entire assemblage, regardless of context, since we are interested in patterning at the site assemblage level and not at the intrasite feature level. Given the discrete, and generally limited, nature of the occupation of the Rye Creek sites, it is relatively safe to assume that an artifact recovered from a site, regardless of its specific context, is related to the general occupation of that site.

Even at this preliminary stage, because this is an initial look at argillite distribution and we are limited to a sample of 25 sites (only 12 of which are outside of the Tonto Basin), the sourcing study shows some interesting and suggestive patterns. For one, argillite from the Del Rio source area in the Upper Verde Valley appears to be much more widely distributed than the Deer Creek argillite from the Tonto Basin or the Tucson Mountain Redbed argillite from the Tucson Basin. Del Rio argillite, although it is concentrated in the Verde Valley and Flagstaff areas, is found throughout the Southwest in small quantities, and with the exception of Los Morteros in the Tucson Basin, every large site that was analyzed contained at least a few pieces of what appears to be Del Rio material. Analyzed sites with Del Rio material include the Marana Platform Mound in the Tucson Basin, Pueblo Grande in the Phoenix Basin, Grasshopper in the White Mountains, Rye Creek Ruin and other smaller sites in the Tonto Basin, Shoofly Ruin in the Payson Basin, and as would be expected, Tuzigoot, Winona-Ridge Ruin, and Lizard Man in the Upper Verde and Flagstaff areas (Table 22.4). As mentioned earlier in this chapter, an additional eight sites in the Flagstaff area also could be added to this list

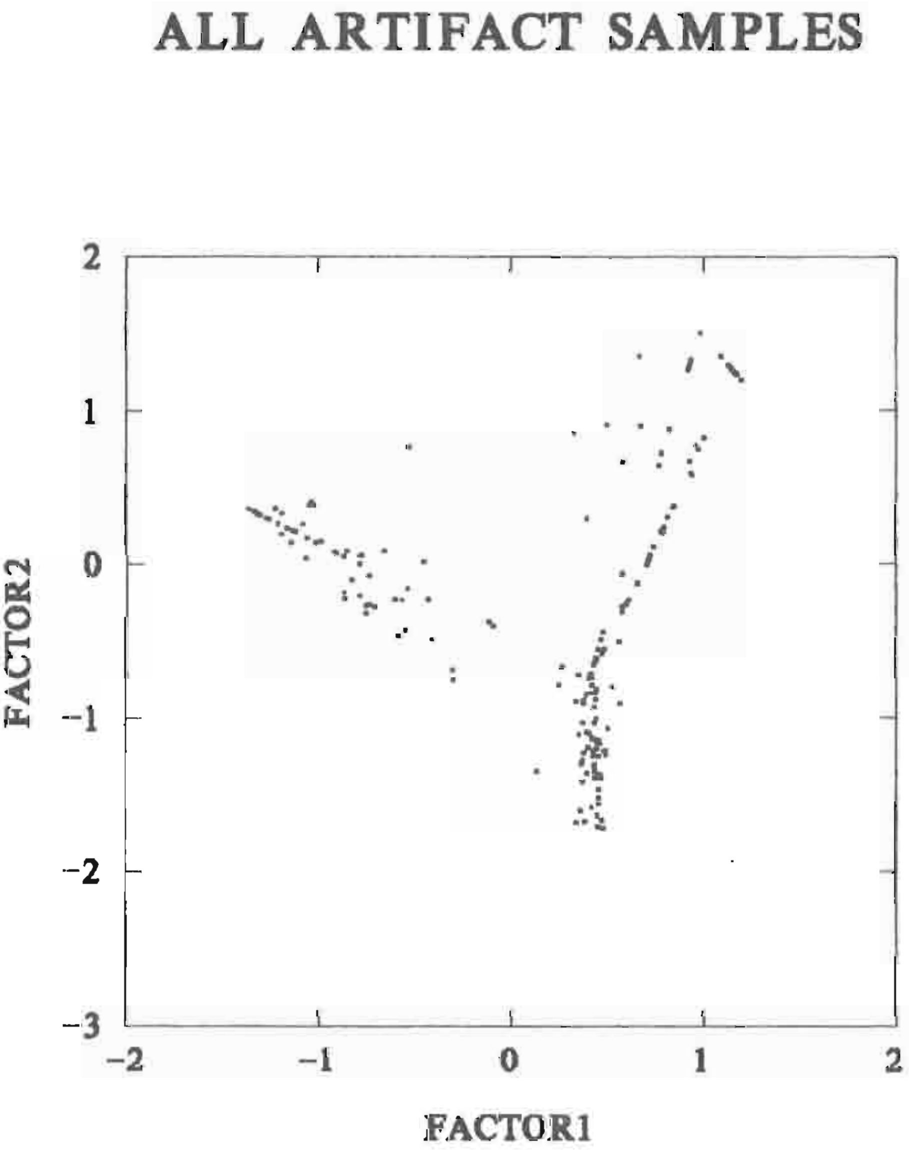

Figure 22.11. Correspondence plot of the analyzed artifacts.

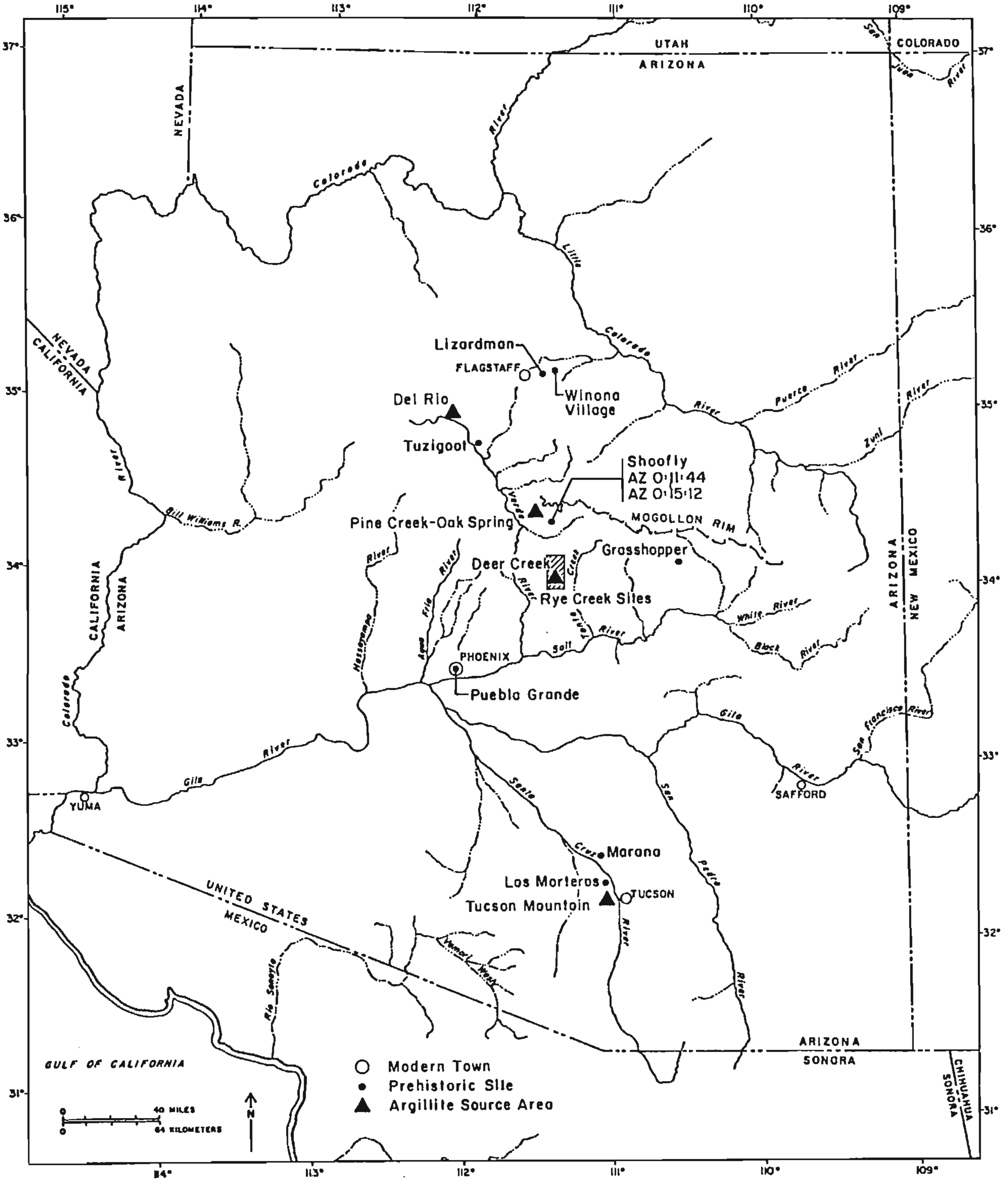

Figure 22.12. Map of locations of analyzed sites and known source areas.

Table 22.3. X-ray diffraction (XRD) sourcing of argillite artifacts from Rye Creek Project sites.

Site	Del Rio	Deer Ck.	Pine Ck./ Oak Sp.	Tucson Mtns.	Unknown	Total XRD	Site Total	% XRD
Rye Ck. Ruin AZ O:15:1	2	17	-	-	1 Unknown E	20	31	64.5%
Deer Creek AZ O:15:52	1	28	-	-	3 Unknown E 1 Unknown D	33	91	36.3%
Hilltop AZ O:15:53	1	2	-	-	1 Unknown C	4	9	44.4%
Cobble AZ O:15:54	-	3	-	1?	1 Unknown E	5	6	83.3%
Boone Moore AZ O:15:55	1	10	-	-	2 Unknown E	13	23	56.5%
AZ O:15:70	-	1	-	-	-	1	1	100.0%
AZ O:15:71	-	2	-	-	-	2	2	100.0%
Overlook AZ O:15:89	1	6	-	-	-	7	7	100.0%
Compact AZ O:15:90	2	2	-	-	-	4	8	50.0%
Redstone AZ O:15:91	6	20	-	-	2 Unknown D	28	73	38.4%
Rooted AZ O:15:92	-	2	-	-	1 Unknown D	3	8	37.5%
Arbys AZ O:15:99	-	-	-	-	1 Unknown C 1 Unknown E	2	3	66.7%
Clover Wash AZ O:15:100	2	6	-	-	1 Unknown E	9	42	21.4%
Project Total:	16	99	-	1?	15	131	304	43.1%

through the work of Howell (1940) with atomic absorption spectroscopy. Although the methods Howell used are very different than those used here, since atomic absorption spectroscopy analyzes material at an elemental level, his results appear to be sound. The distance from the Del Rio source to the Marana Platform Mound in the Tucson Basin is approximately 290 km (180 miles); the distance to Grasshopper, the easternmost known point, is around 185 km (115 miles). Perhaps most interestingly, 8 of the 13 sites with argillite in the Rye Creek Project area also contained Del Rio material, including several small sites, such as the single room fieldhouse Overlook site (AZ O:15:89) or the Hilltop (AZ O:15:53) and Clover Wash (AZ O:15:100) sites, which probably never had more than one or two pithouses present at any one time. Del Rio material comprised 12.2 percent of the Rye Creek argillite assemblage; of the sites that contained this material the range was from 3 percent at the Deer Creek (AZ O:15:52) site to over 20 percent at the Compact (AZ O:15:90), Redstone (AZ O:15:91), and Clover Wash (AZ O:15:100) sites. This suggests the importance of Del Rio argillite, and indicates that it was a desirable commodity even with a local source in the immediate vicinity. As discussed more completely in Chapter 28 (Volume 3), the Del Rio argillite is most prevalent in the project area during the time (approximately A.D. 900-1050) when Tusayan whiteware ceramics are also the most prevalent, suggesting that both ceramics and argillite may be moving through the same interaction network, perhaps centered in the Flagstaff region. Del Rio argillite is relatively scarce during the preceding Gila Butte and Santa Cruz phases (A.D. 750-950), and becomes scarce again during the following Classic period (A.D. 1150-1450). Even with these data, however, the intensity of the interaction may never have been overly significant; within the analyzed Rye Creek argillite assemblage there was a total of 16 pieces of Del Rio argillite (or 37 total pieces when projected to the entire argillite assemblage).

The Del Rio material was most commonly recovered in the form of small carved or ground artifacts -- beads, pendants, nose plugs, lip plugs, etc. (Figure 22.13). Del Rio argillite debitage was recovered from Tuzigoot in the Verde Valley and Lizard Man in the Flagstaff area suggesting that raw argillite was being brought in for manufacture at those sites. An unworked piece of a bedded outcrop fragment also was recovered from the Redstone site (AZ O:15:91) in the Rye Creek Project area. As mentioned, only a single large Del Rio artifact, a bowl recovered from Homol'ovi IV with the characteristic yellow bleach spots, has been noted to date; additional examples of large artifacts will probably be uncovered with more intensive investigation. Although not all analyzed artifacts were weighed, a sample (n=15) of the Del Rio material ranged from 0.5g to 11.4g.

In contrast, outside of the Tonto Basin, Deer Creek argillite appears to be found only at Shoofly (and the two smaller associated sites, AZ O:15:12 and AZ O:11:44), Grasshopper, Pueblo Grande, and Winona-Ridge Ruin, suggesting a much smaller and more localized distributional system than the Del Rio system (Table 22.4). Significantly, while Del Rio argillite was found in minor quantities in the Tonto Basin, no Deer Creek argillite was found at Tuzigoot in the Verde Valley, and only two pieces were found in the Flagstaff region. Deer Creek argillite was also not recovered from either of the two sites in the Tucson Basin. Pueblo Grande and Grasshopper are both around 80 km (50 miles) to the south and east, while Winona-Ridge Ruin is around 130 km (80 miles) to the northwest. This is a significantly smaller area by almost half than the Del Rio distribution zone.

Table 22.4. X-ray diffraction (XRD) sourcing of argillite artifacts from selected sites in Arizona.

Site	Del Rio	Deer Creek	Pine Ck./ Oak Sp.	Tucson Mtns.	Unknown	Total XRD
Los Morteros AZ AA:12:57	-	-	-	3	1 Unknown B	4
Marana AZ AA:12:251	1	-	-	4	-	5
Pueblo Grande AZ U:9:7	2	2	-	1?	-	5
Grasshopper AZ P:14:1	2	2	-	-	-	4
Shoofly AZ O:11:6 (ASU)	1	3	-	-	2 Unknown E	6
AZ O:11:1144 (ASU)	-	2	-	-	-	2
AZ O:15:12 (ASU)	-	1	-	-	-	1
Tuzigoot	5	-	-	-	-	5
Lizard Man NA 17957	5	-	-	1?	-	6
Winona-Ridge Ruin	7	2	-	-	1 Unknown A	10
Totals	23	12	-	9	4	48

On the Rye Creek sites, Deer Creek argillite was primarily recovered in the form of polishing or polished stones, making up 44.1 percent (n=134) of the argillite assemblage. The distinction between the two is that polishing stones have ground facets, whereas polished stones are highly polished but generally unmodified cobbles (see Craig and Eppley, Chapter 15, this volume). The large number of faceted polishing stones (n=63) is believed to be possibly related to pigment production, the significance of which is discussed in greater detail below. Stone jewelry (and indeterminate ground pieces) made up 18.8 percent of the Rye Creek assemblage, while debitage accounted for another 32.2 percent. This contrasts with the 12 pieces of Deer Creek material

Figure 22.13. Examples of argillite artifacts from the Del Rio source area recovered at the site of Winona-Ridge Ruin near Flagstaff.

recovered from sites outside the project area, where 91.7 percent of the assemblage consisted of jewelry or indeterminate ground pieces. The only polishing stone recovered outside the project area was from AZ O:15:12 (ASU), a small site in the Payson Basin approximately 50 km (30 miles) north of the Deer Creek source area. As noted earlier, Deer Creek argillite, due to its cobular form, is frequently made into larger ground artifacts, such as stone bowls or phallic censers. Artifacts weighing over 100g are not uncommon, and one of the largest artifacts weighed close to a kilogram. However, like the Del Rio material, most of the carved or ground artifacts are small, weighing under 5g and averaging close to 2g.

Data on the Tucson Mountain Redbed source in the Tucson Basin is extremely limited, although intriguing. The majority of this material appears to be concentrated in southern Arizona -- 70 percent of the sourced artifacts were from Los Morteros and the Marana Platform Mound, the two Tucson Basin sites. Single pieces also were recovered from Pueblo Grande in the Phoenix Basin, the Cobble site (AZ O:15:54) in the Rye Creek Project area, and Lizard Man in the Flagstaff region. These data are provisional because we cannot yet be certain that we are accurately characterizing these artifacts. However, the very distinctive quartz, muscovite, and feldspar mineralogy of both the artifacts and the three source rock samples suggests that we are correctly assigning them to the same category. Of the three pieces found outside of the Tucson Basin, one was a polished pebble, and the other two were beads.

In addition, five potentially unknown and unsampled source areas were identified (Tables 22.3 and 22.4). These were labeled "Unknown A, B, C, D, and E." Unknown E, which was labeled as such due to the presence of an unknown mineral that did not correlate with any source area sample, contains 12 artifacts, the largest number of any unknown provenience. Unknown D contains four artifacts, Unknown C contains two artifacts, and Unknown A and B contain one apiece. C and B contain an unusual form of kaolinite, the other two simply did not match well with a known source area. As mentioned, it is possible that these represent artifacts from unsampled areas of known sources, which is supported by the fact that Unknown C, D, and E are only found on Tonto Basin sites or at the nearby Shoofly Ruin. Obviously, additional sampling is required to determine this.

DISCUSSION

Modeling the argillite distributional systems is somewhat premature and difficult at this preliminary stage; we simply do not have a lot of data to go on. General patterns are apparent, however, and several ideas can be put forth. First of all, at this point there appears to be little difference in the physical properties of any of the argillite source areas to make one a preferred source over another, except in terms of pigment manufacture and the possibility that the Deer Creek argillite may be more suitable for the manufacture of larger artifacts (which are, however, relatively rare in the assemblage). That is, all three source areas contain red-colored argillites that are soft and easily worked, although the Tucson Mountain Redbed material may be slightly harder (due to the large quartzite constituent). Furthermore, the data suggest that similar artifact types, primarily small beads, rings, bracelets, lip/nose plugs, and pendants, were manufactured from all three sources--no one source appears to have been used exclusively for the manufacture of a particular artifact type. Finally, although more analysis along these lines needs to be undertaken, the contexts where the various argillites were recovered also appear to be similar; they are found in almost every context, from trash deposits, to house floors, to caches, to mortuary offerings. Given that the different source areas appear to be relatively equal in quality and that access to the different argillites does not appear to be restricted, one would expect argillite distribution to follow a least-effort distance model where argillite is procured from the nearest suitable source. As our data show, however, this is far from the case; argillite distribution does not appear to be a result of simple distance or nearest neighbor factors. Although gravity fall-off models (Hodder and Orton 1976) appear to be in operation, because all three source areas have a primary central focus where the material is found in highest density, distribution outside of these central zones varies. Deer Creek argillite is found within a maximum of 130 km (80 miles) from the Tonto Basin. Del Rio argillite, on the other hand, can be found in the Tucson Basin some 290 km (180) miles from its source, more than twice the distance of the Deer Creek material. And Tucson Mountain Redbed material, if we are correct in our sourcing approximation, may have been moved even further, some 340 km (210 miles) to the Flagstaff region.

What we appear to have are three localized systems showing different degrees of interaction with neighboring areas. The Tucson Mountain Redbed system may be the most localized, focusing on the Tucson Basin Hohokam occupation. Only three pieces of this material, out of the 179 examined, have been identified outside of this area, and one of these was from Pueblo Grande approximately 170 km (100 miles) to the north. The single pieces found in the Rye Creek Project area and the Flagstaff region may not be overly significant in terms of long distance interregional trade, although this awaits testing through further analysis. Conversely, very little other argillite material is moving into the Tucson Basin source zone, consisting of a single piece of Del Rio argillite recovered at the Marana Platform Mound. This piece was from a beautifully carved pipe, the only example of this type of artifact encountered in the analysis.

The Del Rio system is localized in the Upper Verde Valley; major sites within this area, such as Tuzigoot, contain an abundance of Del Rio argillite including both worked pieces and manufacturing debris. For all practical purposes, the Flagstaff area, approximately 80 km (50 miles) to the northeast, may also be considered to be part of the Del Rio argillite core area. Although two pieces of Deer Creek argillite and a single piece of Tucson Mountain Redbed material were found in this area, our work and the earlier work by Howell (1940) suggest that the overwhelming majority of material is Del Rio. Argillite debitage has been recovered at several sites in this area, suggesting that the raw material was being brought in for subsequent artifact manufacture. This may have involved actual procurement of the raw material at the Del Rio source area by parties from Flagstaff, or it may have involved some trade in the unworked raw material itself; in all probability both processes were likely occurring. The intrusive Deer Creek and Tucson Mountain Redbed material were all finished pieces, two beads and a ground tablet fragment, suggesting that the finished artifact form was the impetus behind the trade rather than the specific source of the raw material. The Del Rio argillite was widely distributed outside of its local zone, again probably in finished format. Trade may have stemmed from the Flagstaff area or it may have originated from sites in the Upper Verde Valley close to the source.

The Deer Creek system is localized in the Tonto Basin, and specifically the Upper Tonto Basin. Recent work now underway 50 km (30 miles) to the south in the Lower Tonto Basin by Arizona State University (Rice 1990) and Desert Archaeology (Doelle et al. 1991) on the Roosevelt Lake Project have recovered very few pieces of argillite (Norma Ajeman and Arleyn Simon, personal communication, 1991), suggesting that the system may be extremely localized. This accords with the sourcing analysis, which suggests that the Deer Creek argillite is much more areally confined than the Del Rio material, being found no more than 130 km (80 miles) from its source area, and generally in limited quantities. Worked and unworked pieces of argillite were recovered from almost every site in the Rye Creek Project area, from the small single-room fieldhouses to the large pueblo at Rye Creek Ruin, and most every site in the general vicinity has argillite debris on its surface. This suggests that the manufacture of argillite artifacts, at least for internal use, was not an individual specialist's domain, although some sites evidently were more involved in argillite artifact manufacture than others. This is particularly true if the argillite-to-chipped stone ratios are examined for sites containing over 100 recovered pieces of chipped stone (the two sites excluded contained 13 pieces of chipped stone and are considered to be potentially skewed) (Table 22.5). As this table shows, several sites, most notably the Redstone site (named, incidentally for the abundance of argillite), Clover Wash site, and Overlook site, have argillite-to-chipped stone ratios below 1:20, which is significantly higher than the project area average of 1:45. Although the Overlook site, a single-room masonry fieldhouse, is directly within the argillite float, which probably accounts for the high ratio, the other two sites are around 2 km to the north. The Redstone site also contained several areas of ground argillite on the floor of one of the pithouses (Feature 11), and argillite-stained manos. Both the Clover Wash and Redstone sites contained the highest frequencies of intrusive Del Rio argillite (22.2 and 21.4 percent) of any of the project area sites (average 12.2 percent), including an unworked bedded Del Rio quarry fragment at the Redstone site. These data suggest that these two sites may have been actively focusing on argillite procurement and manufacture, although whether this was an impetus behind the settlement of these sites is difficult to say. Furthermore, it may not be solely a coincidence that Rye Creek Ruin (AZ O:15:1), the largest site in the Upper Tonto Basin and one of the largest sites in the Tonto Basin, is situated directly north of the argillite float. Although the argillite-to-debitage ratio at this site of 1:40 is slightly higher than the project average, our excavations here consisted of the testing of only three trash mounds with 1-m by 2-m units. Therefore, our sample is somewhat biased and may not be representative of the actual intensity of use because trash deposits tend to overrepresent more common items, such as lithics,

Table 22.5. Recovered argillite-to-chipped stone ratios for Rye Creek Project sites with over 100 recovered pieces of chipped stone.

Site	Argillite	Lithics	Ratio
Rye Creek Ruin (O:15:1)	31	1304	1:42
Deer Creek (O:15:52)	91	6999	1:77
Hilltop (O:15:53)	9	726	1:81
Cobble (O:15:54)	6	429	1:72
Boone Moore (O:15:55)	23	1583	1:69
Overlook (O:15:89)	7	126	1:18
Compact (O:15:90)	8	253	1:32
Redstone (O:15:91)	73	899	1:12
Rooted (O:15:92)	8	317	1:40
Arbys (O:15:99)	3	269	1:90
Clover Wash (O:15:100)	42	610	1:15
TOTAL	301	13515	1:45

and underrepresent less common material, such as argillite. Collections in the Arizona State Museum recovered from the Gila Pueblo burial excavations in the 1930s contain a relatively large amount of argillite.

Argillite as a Ceramic Pigment

Until now we have focused entirely on the role and distribution of argillite as an easily ground or carveable artifact. Another aspect of argillite trade, and one that is potentially as important, is its role as a red pigment. We became interested in the possibilities of argillite as a pigment after observing ground argillite on the floors of structures at several sites and finding argillite-stained ground stone. Although our analysis at this point is very preliminary, several intriguing possibilities have arisen, which we plan to focus upon in the near future. Most significantly, we have provisionally demonstrated through XRD analysis that Deer Creek argillite was being used as a pigment for redware ceramic manufacture. In this respect, even though it appears that the Del Rio argillite network is far larger and more significant than the Deer Creek network, this may not actually be the case if the use of Deer Creek argillite as a ceramic pigment is widespread. This may be particularly important given the apparent correlation between the Classic period growth of the Tonto Basin platform mound system, particularly Rye Creek Ruin, with the advent of Salado polychromes and increase in redwares throughout the central and southern Southwest. For example, in the Rye Creek Project area the percentage of redware ceramics increases dramatically during the Classic period, going from around 5 percent of the total ceramic assemblage in the Preclassic period to more than 40 percent by the early Classic period (see Stark and Heidke, Chapter 13, this volume). Similar trends occurred throughout central and southern Arizona. The increasing production of these redware-based ceramics during the Classic period, then, may have made redware pigment an extremely valuable commodity.

To demonstrate that argillite could have been used as a ceramic slip, we scraped the red pigment from 12 sherds and submitted them for XRD analysis. Nine of these were redware sherds from the Rye Creek Project area, one was a Gila Polychrome sherd from Grasshopper, one was a Tortolita Red sherd from the Tucson Basin (submitted as a "ringer"), and one was an experimental sherd made by potters Paul and Laurel Thornburg from native Tucson Basin clay and slipped with argillite. Although most of the readings were ambiguous (they could be argillites, or they could be something else), one of the redware sherds from the Rye Creek Project matched almost exactly with the slip from the experimental sherd produced by the Thornburgs. This suggests that at least some of the redware sherds from the Rye Creek Project may have been slipped with argillite. The use of XRD analysis to investigate ceramic slips is problematic, however, because the clay body is often scraped off with the pigment in sample preparation. As a result, quartz and feldspars from the clay body contaminated the samples and masked several of the XRD peaks, thereby making most of our results uncertain. This problem can be surmounted through X-ray fluorescence analysis, which can be used on whole sherds and only penetrates the outermost layer of atoms.

The theoretical potential for ceramic slip production and exchange of pigments is strongly supported by ethnographic and ethnoarchaeological research which suggest that ceramic slips and pigments are obtained at much greater distances from the parent villages than clays and tempers, and that they are often exchanged interregionally (e.g., Arnold 1981, 1985; DeBoer and Lathrap 1979; Nicklin 1979; Shepard 1936). Data compiled by Arnold (1981, 1985) and by DeBoer and Lathrap (1979) indicate that ethnographic groups obtain their pigments from an area between 1 and 880 km distance; the high ranges are due to canoe travel along rivers and most groups obtain their slips and pigments within a distance of 60 km. As stated by Arnold (1981:36), "In contrast to the distance to clay and temper resources, potters do not always travel to their slip and paint resources themselves, but rather *often acquire them through trade*" [emphasis added]. Furthermore, Anna Shepard (1936:451) indicates that in the pueblos of the American Southwest there are only a few recorded instances of trade in clays, but there is abundant trade in clay slips.

We also suggest that there is a possible economic advantage to exporting ground pigment as compared to unprocessed raw materials or even carved artifacts. That is, unlike carved artifacts, the skilled labor requirements for pigment processing are minimal -- it can be handled by a small child or elderly adult and not detract from the subsistence labor pool. In addition, it is likely that ground pigment is more easily and efficiently transported than whole or partial argillite cobbles (if cobbles were being procured or exchanged for pigment grinding), although differences in transport costs between pigments and small carved artifacts are probably negligible. Although exchange in carved artifacts has been demonstrated by this analysis, and was undoubtedly one of the primary reasons for argillite procurement and manufacture, the production of pigment could also have been a focus of argillite utilization. Given the ease of preparation and transport, pigment production, in contrast to artifact manufacture, would have resulted in a relatively high profit margin. This furthermore could have been more efficiently undertaken at the household or group level rather than at the level of the individual specialist.

Finally, the possibility of pigment exchange is partially supported by the presence within the Rye Creek Project area sites and Rye Creek Ruin of ground argillite cobbles, faceted polishing stones, and argillite pigment. As mentioned, a large number of tools that have been traditionally called faceted polishing stones were recovered from the project area. These have commonly been used to infer ceramic production through their inferred use in the polishing and smoothing of green vessels. Although vessel polishing may have been one of their functions, particularly at the Preclassic period sites where redware production was limited, it is also possible that the facets are the result of grinding for pigment production. Although further research is needed here, this is partially supported by the experimental work done by the Thornburgs who in the course of processing argillite pigment, produced striations on the argillite identical to striations found on the faceted stones.

Experimental work by Haas (1971b), and most recently by the Thornburgs, has demonstrated that argillite is a very suitable red pigment for ceramic manufacture. Furthermore, due to differences in their constituencies, argillite may be a more stable pigment than hematite because it is composed partly of the silicate clay minerals kaolinite and pyrophyllite. Although hematite is more common throughout the American Southwest, and has usually been assumed to be responsible for red pigment on ceramics, the clay-like nature of argillite suggests that it should be a better pigment. That is, an argillite-based pigment may not fade as quickly as hematite, should bond to the underlying clay more easily, may be more stable during the firing process, and may produce a more consistent coloring when fired. Experimental ceramics slipped with argillite and fired by the Thornburgs are virtually identical in color to Tonto Basin redwares found on project area sites; the red-coloring also closely approximates the red found on some Salado polychromes. The Thornburgs additionally feel that argillite is one of the best slips they have worked with (Laurel Thornburg, personal communication, 1990), and they have experimented with many different slips and pigments over the years (DeWald and Jacka 1989).

Perhaps most significantly, the Thornburgs have found that only the argillite from the Deer Creek source area in the Tonto Basin is suitable as a red pigment. The Del Rio argillite is not overly soluble and produces only a light brown-to-light red wash when fired. This is due to the differences in the amounts of hematite (which is responsible for the red-coloring in argillite) within the argillites of the two source areas. Redware ceramics recovered from sites in the Del Rio area are extremely different in color than experimental sherds slipped with the Del Rio argillite, and it appears likely that this material was not being used as a pigment for ceramic manufacture. Future experimental work is needed, however, to rule out differences in firing temperature, atmosphere, and clay type, for example, as contributing to the color distinctions.

CONCLUSIONS

In conclusion, the widespread distribution of argillite artifacts, combined with the limited distribution of raw material sources, means that the sourcing of argillite artifacts and pigments has a strong potential to provide significant new information about prehistoric Southwest trade and interaction networks. Our data, although preliminary, suggest that socio-cultural variables, rather than simple "least effort" principles or distance factors, are playing a major role in structuring the argillite exchange networks. These factors are not yet overly clear, but may have to do with the difference between the internal organization and alliances of the Upper Verde-Flagstaff area versus the Upper Tonto Basin and Tucson Basin.

Given the fact that we have sampled but a few of the many Arizona and Southwest sites that contain argillite, we propose the following: 1) Del Rio material, which most often appears in the form of small, easily transportable, red beads, appears to be at least partially focused toward large-scale, long-distance distribution on an interregional level. This is probably related to its connection with the Flagstaff area, although sites in the Upper Verde Valley may also be active in structuring this trade; 2) Deer Creek argillite appears to have been procured primarily for localized consumption with a relatively minor regional trade component. A more widespread component in pigment production and distribution may be present; and 3) Tucson Mountain Redbed argillite appears to be extremely localized, to the extent that it may possibly be monopolizing the southern Arizona argillite trade.

As a closing, and admittedly highly speculative thought, the use of argillite as a red ceramic pigment may be particularly significant if, as suspected, Salado polychromes are being made in many different localities in the Southwest (Crown and Bishop 1987). Salado polychromes are known to have an incredibly diverse array of design styles (Whittlesey 1991), and yet one of the most consistent attributes is the relative uniformity of the red coloring, either on the exterior of the vessels, as in Pinto and Gila polychromes, or integrated within the design style itself, as in Tonto Polychrome. In this respect, if it is perhaps not the design style, but the color and the color integration scheme that is containing the encoded symbolic information (Wobst 1977; Hodder 1982), then the source of the red-coloring pigment may be extremely significant. As an ethnographic example of the potential importance of argillite in a tribal culture, the Lakota Sioux believe that the red in Plains argillite (pipestone) symbolizes the blood of their ancestors, being deposited in quarry areas as a lake by the Great Spirit so that new life could begin again after the great flood (Curtis 1908). An origin myth commemorates this event, and pipestone quarries were considered to be sacred places; rituals were (and still are) associated with the mining of this material (La Batte 1991).

If argillite pigment contains ritual significance, or is simply highly desirable, then it may partially explain the growth and importance of Rye Creek Ruin (AZ O:15:1) during the early Classic period when redware ceramics become increasingly prevalent throughout the Southwest. Rye Creek Ruin is one of the largest sites in the entire Tonto Basin, and one of the few to contain two platform mounds. Furthermore, it is situated in an extremely strategic location at the confluence of Rye and Deer creeks, in a position to serve as a "gateway" (Hirth 1978) exchange community to the Tonto Basin from points north and possibly east. The Tonto Basin has long been known to be on the receiving end of a large number of trade goods, particularly decorated ceramics (see Clark, Chapter 12, this volume), but the local medium being exchanged for these goods is largely unknown, although argillite has been one suggestion (Wood 1985). Given the relative paucity of carved or ground Deer Creek argillite artifacts on sites outside of the Tonto Basin and nearby areas, it appears possible that argillite pigments (as well as argillite artifacts) were a component of this exchange. As mentioned, at Rye Creek Ruin the recovery of a relatively large number of argillite artifacts, faceted polishing stones, and ground argillite cobbles, from the limited testing of this site suggests that argillite procurement and pigment and artifact manufacture may have been important aspects of the occupation.

Obviously, the above speculations are in need of further testing and evaluation. Although we have demonstrated that argillite may have been used as a pigment for (at least some) redwares manufactured in the Upper Tonto Basin, we do not know the extent of use of this material. We also do not know whether argillite was being used as a pigment for any of the Salado polychromes, and particularly for Salado polychromes made outside of the Tonto Basin. Finally, although ethnographic and ethnoarchaeological data strongly suggest that trade in pigments is widespread, we have little evidence that argillite or other pigments were being exchanged to any great degree in the prehistoric Southwest. Testing of ceramic slips and pigments through X-ray fluorescence, as well as additional X-ray diffraction work sourcing argillite artifacts, are planned for the future.

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