SECTION 11.0 FEATURE FORMATION: THERMALLY ALTERED STONE FEATURES

INTRODUCTION

Concentrations and scatters of thermally altered stone (TAS), which may include pieces that are fractured and broken (i.e., fire-cracked rock), discolored or crazed from heating, often occur on archaeological sites. Archaeologists have tended to examine these features functionally, which led to interpretations such as hearths for cooking, processing, drying, or boiling (e.g., Kinsey 1972; Gardner 1977; Cavallo 1987; LeeDecker and Holt 1991; Eisert 1993; Tull 1993). Despite the ubiquity of TAS on sites, it remains unsystematically observed and often reported only as gross counts and weights. This approach tends to obscure the variability often present within the TAS concentrations. More rigorous archaeological analyses are needed to highlight the full range of variation present within TAS assemblages. Understanding the range of variation will allow comparisons to be made to assess the different processes that contribute to the formation of TAS and the clusters and scatters of these artifacts. Features can be interpreted in various ways depending upon the spatial arrangement of the stone, the nature of the heating or burning evidence, and other material associations.

TAS is increasingly being recognized as an important source of information, in that the physical characteristics of the stone may provide information about certain cultural activities. Recent investigations (Pagoulatas 1992; SAA Symposium 1997) have begun to demonstrate ways to quantify and systematically characterize the different types of TAS found on prehistoric sites. This more inclusive term considers all variations of heated stone including fractured fire-cracked rock, reddened or discolored pebbles and cobbles, and stones that have crazed surfaces but have not fractured from heat. Examination of all these variants will provide a more comprehensive view of the actual range of thermal processes that may affect stones.

Experiments undertaken to replicate the processes that produce TAS have suggested that diagnostic criteria can be developed to distinguish between heated rocks used in various activities – lining earth ovens or stone boiling, for example. In addition, when rocks are repeatedly re-used in hearth and boiling operations, they may become increasingly smaller and angular (Thoms 1989 in Latas 1992). There also is some indication that heat retention is reduced by repeated cycles of heating and cooling (Witkind 1977). However, variation in attribute values should be anticipated since many factors may affect the properties of TAS, including raw material types and the intensity and duration of firing.

The re-assembly of material remains, including TAS, has led to a more refined understanding of prehistoric technology and site formation (Cziesla et al. 1990; Hoffman and Enloe 1992; Petraglia et al. 1998a, 1998b). TAS refits can be used to characterize the intensity of use of a feature and to assess whether observed patterning was the result of cultural or natural agents. Refitting may highlight spatial clustering within features that would not otherwise be obvious in the raw data and provide a way to more fully characterize stone attributes not available by only analyzing individual fragments, such as percent completeness.

A total of 26,651 TAS (fire-cracked rock, potlids, heat-altered pebbles and cobbles) was recovered from excavations at Hickory Bluff. These were recovered from 39 evident TAS features and throughout the archaeological levels (additional latent TAS features may become apparent in computer plotting). The TAS concentrations varied in size and arrangement, as did the stones that comprised the features. Moreover, the stones exhibited variable degrees of discoloration and fracturing, within and between feature contexts. As a result of the complexity and prevalence of TAS, a systematic effort was undertaken to examine and characterize the range of variability exhibited by the TAS assemblage.

ECONOMIC, SOCIAL, AND CEREMONIAL RESIDUES

The importance of fires within traditional societies has been noted worldwide and across environmental settings. The range of fire related activities reported in ethnographic literature have included: economic functions, such as cooking fires, smudge fires, hunting fires, land-clearing fires, and fires for ceramic production and tool making; social functions, such as fires for warmth, light, and communication; and ceremonial functions, such as in ritual behavior or sweat lodges (Guernsey 1984a, 1984b). Many of these functions overlapped and commingled, for example, community food preparation can be as much social as strictly economic. However, some "hearths" had specific functions and meanings, which may be reflected in attributes contained within their remains.

The presence of TAS clusters of various morphologies and content have long been recognized on many archaeological sites. Previous interpretative strategies relied on mainly morphological studies of feature types and functional discussions of these differences. This has resulted in an overrepresentation of economic related functional interpretations for TAS features, and a subsequent under-representation of social and ceremonial interpretations for feature function. These different behaviors should be reflected in the attributes of features, and expectations for functional signatures may be derived from a review of ethnographic sources and controlled experimentation.

Use of stone in fire hearths appears to have been a common practice in the Mid-Atlantic region for much of prehistory (McLearen 1991a; Cavallo 1987). In general, stones within a hearth location can be seen as having enhanced airflow to the fire and also functioned as a thermal reservoir, increasing efficiency of the hearth and regularizing heat output.

General Use Hearths

Ethnographic Information

The term hearth has been used both widely and variably throughout the ethnographic and archaeological literature. In most cases, the term refers to clusters of TAS, of variable size and morphologies, thought to represent a range of general purpose activities. In the following discussions, the term hearth will be used in reference to aggregations of TAS used for general purposes that may include the generation of heat, light, or for open air food preparation.

One of the main roles and most important functions of fire within traditional societies was to provide both heat and light. Heat from a fireplace can be transferred both directly and indirectly. Direct heat from a fire may be maximized by its arrangement or placement within a structure. The use of small hearths within the interior of structures has been noted in many societies regularly exposed to colder temperatures. In other instances, the ethnographic record showed fires being constructed near the entrances of structures, just inside or outside, to receive airflow and transfer heat into the structure. Warming fires have also been noted outside of structures; for example, hunting parties that arrange themselves to sleep between fires for warmth at night without needing to construct shelter (Guernsey 1984a, 1984b). In all of these instances, the fire itself provided the heat directly to the recipient.

Indirect heating was also a fairly common example noted within the ethnographic record. In these cases, the fire is used to warm other objects, mainly stones or sometimes sand. The warmed stones were then transferred into structures or around bedding areas to radiate heat and provide warmth. Larger stones retain heat for extended periods and, thus, would provide enough warmth to last overnight (Guernsey 1984a, 1984b). The descriptions of this practice did not mention the types and sizes of stone most preferred for this activity, how the stones were disposed of or if they were reused for other purposes.

The maintenance of fires to provide light for the group was also an important function of fire, which had social implications. Fires for light can be used not only to light the surroundings for a group, but also to keep animals and/or spirits away. Such fires are noted in many cultural contexts, including those located in temperate and even tropical locations; this underlies the importance of this role, as the heat generated from the fire would not be a necessary function in these settings. Fires used for light may be distinguished by their size and location (Guernsey 1984a, 1984b). They would be generally found outside of shelters and would be relatively large, especially if serving a group. An extreme example of this type of fire would be a large bonfire, which would likely also serve further social or ceremonial roles.

Fires that related to cooking activities are the most obvious and widespread economic use of fire within the ethnographic literature. A variety of different cooking activities are performed in many traditional societies, each serving a specific purpose. A common practice was the roasting of meat over an open fire, with or without the assistance of a spit or rack. Fires of this type would range in size, largely dependent upon the size or amount of meat to be prepared. Open-flame cooking was a relatively quicker process than other types of cooking, but required more constant monitoring to ensure even cooking and the prevention of burning.

Use of smoke to cure meat was also a common practice noted in the ethnographic literature (Guernsey 1984a, 1984b). This was a more specialized function of food preparation that was utilized to dry meat products for later use. Smoking requires a lower intensity fire and different types of fuel material than generalized open flame cooking. The process takes a more extended period of time to complete, dependent on the type and amount of meat to be cured. The low intensity fires associated with the smoking process are often referred to as smudge fires or pits, and have a different configuration than other generalized cooking fires. However, both of these food preparation activities utilize direct heat and are conducted in the open air.

Archaeological Interpretation

Archaeologically, the term hearth has been used to describe a number of different types of TAS clusters that likely represented a variety of functions. Small rings of TAS have been found within the outlines of presumed structures and interpreted as interior warming hearths.

Open cooking hearths and smudge pits have been used as functional interpretations for varying other clusters of TAS associated with small basins outside of structures. Smudge pits were often delineated by the inclusion of less fire-cracked rock, indicative of lower heat intensity, and relatively smaller size (Binford 1972; Petraglia et al. 1998a). Common use hearths were distinguished by higher frequencies of fire-cracked rock, charcoal, evidence of in-situ burning, and larger fragment size. A use of the term hearth was also associated with small, shallow basins containing the fire-cracked rock, which suggested a more formal construction.

Large, single and multi-tiered rock hearths are linked to the Late Archaic and Early Woodland periods (McLearen 1991a:110-111). In the upper Delaware River Valley, large fire-cracked rock hearths were the most prominent type of feature associated with Late Archaic and Early Woodland sites in riverine settings (Cavallo 1987: 168). Such large fire-cracked rock features have been interpreted as being related to the processing of anadromous fish (Kinsey 1972, 1975; Kraft 1970). Although this interpretation is reasonable in some instances, it would be simplistic to assume this was their only or even primary function. In Virginia, large fire cracked rock features, although most common in Late Archaic and Early Woodland contexts, are known for a long range of time preceding the Late Woodland (McLearen 1991a:110-111). In the coastal plain of Virginia, large rock hearths, radiocarbon dated to the Middle Woodland, have been recorded on numerous small-camp sites located along minor interior streams (McLearen 1987:166).

Roasting Pits

Ethnographic Information

The utilization of heated stones for indirect cooking was also well documented throughout the ethnographic record. This was usually accomplished with the use of earth ovens, which bake food with the indirect heat from their walls (Guernsey 1984a, 1984b). There are two basic types of earth ovens: the heap oven and the pit oven. Heap ovens are constructed by placing food items within a pile of hot stones stacked on the surface, which are then covered over with a lining to trap the heat. Pit ovens are constructed by digging a small hole in the ground, then lining it with previously heated stones, placing the food within it, then covering it with more heated stones and finally soil to trap the heat. Accounts of pit ovens found in the ethnographic literature for North America suggest that they were primarily used for cooking vegetable matter, such as roots and tubers, and only rarely for cooking meat, which would have been small game (Guernsey 1984a, 1984b).

Descriptions of the types of stones utilized, including material type and size, were not often included with the descriptions of earth ovens. The sizes of the excavated pits associated with these facilities showed a wide range of sizes, mostly related to the type and amount of food to be included. From the North American literature, these sizes ranged from 0.61 m to over 3 m in diameter and 0.20 m to 1.2 m in depth (Guernsey 1984a, 1984b). Fires built above or adjacent to the excavated earth ovens, used to provide continued heat to the stones and contents of the oven, were also noted in several instances.

Archaeological Interpretation

Rock-lined pits were reported by Chapman (1985) along the Little Tennessee River in eastern Tennessee. These features were interpreted as cooking facilities in which food items were placed on heated stones, then covered over to create an oven-like effect (Chapman 1985, pl. 5.13). Generally, fire-cracked rocks found in small basins with evident charcoal, ash, or burned soils have been interpreted as roasting pits or pit hearths (Petraglia and Knepper 1996). The fire-cracked rock associated with these features tends to be larger, more angular pieces. In addition, experiments in stone heating have shown that rocks embedded in soil, when heated, failed to crack (Topping 1998).

Stone Boiling

Ethnographic Information

The use of heated stones to boil foods and liquids was a common practice among many traditional societies. It was a multi-staged process that used indirect heating methods to prepare food. Stones were heated in or near a fire until suitably hot, and then transferred and placed into water-tight containers that held the liquid and food being prepared. Stones would need to be added so that the liquid remained boiling for the necessary time to cook the food. This would vary according to the amount and type of food prepared. The duration of the stone boiling process could be extended further for specialized needs, such as the preparation of bone grease, which could last from one to three days (Guernsey 1984a, 1984b).

Using fire-heated stones for boiling liquids was also widely practiced during prehistory. Prior to the introduction of durable vessel technology, stone boiling would have provided the only practical means of heating liquids. Containers constructed with organic materials, either woven fibers or animal skins, could not withstand direct heating from an open flame and were therefore inadequate for this type of food preparation. However, pottery, which could be used for, and withstand, direct heating from an open flame, did not fully replace stone boiling in food preparation, even when ceramic technology was in place (Sassaman 1993). As a cooking method, stone boiling retained a wide geographic distribution and was favored by the Plains groups up to the time of European contact (Guernsey 1984a, 1984b).

The process of stone boiling would require a significant number of rocks, first to get the liquid boiling, and then to keep it boiling for the necessary time. Most ethnographic descriptions of the stone boiling process failed to describe the type of stones most preferred, as to size and material, but careful selective choices were made. An ethnographic description of the sorting of boiling stones was given for the Nunamiut hunters of Alaska, who examined boiling stones following use and discarded ones that showed signs of fracturing. Binford (1978) describes this process:

> If a stone boiling strategy has been employed, there are large quantities of fired rock, generally separated into at least two piles. One pile is composed of cracked and broken pieces culled during processing, and the other consists of unbroken stones placed close to the hearth where they were drying [for reuse] at the end of the operation (Binford 1978:159).

Archaeological Interpretation

Cavallo (1987) has argued that large fire-cracked rock features of the Late Archaic and Early Woodland periods, encountered on the Abbott Farm Site along the upper Delaware River near Trenton New Jersey, represented boiling stones dumps. In particular, Cavallo (1987:231) saw the large fire cracked rock aggregations on the Area B Site as being associated with large scale processing activities, possibly the rendering of anadromous fish or nuts for their oil content. Smaller fire-cracked rock clusters on this site were interpreted as the boiling stone contents of single containers dumped on the ground (Cavallo 1987:183).

Previous experimental programs have examined the behavior of different lithic materials when exposed to heat and cooled in open air, or submersed in water to replicate stone boiling. The results of these studies indicated that different materials react differently to heat variables. Quartz and quartzite cobbles tended to be more durable, and did not display signs of alteration as quickly as other materials, such as jasper (Custer and Silber 1995; Guernsey 1984a, 1984b). Quartz and quartzite cobbles also tended to fracture into blocky fragments and remained in place without shattering over distance. Other studies have shown that siltstone and sandstone cobbles were more susceptible to breakage and disintegration from heat, which often occurred with initial heating (Cavallo 1987; Guernsey 1984a, 1984b). Jasper and limonite samples radically changed in color a short time after exposure to heat. These samples often cracked and shattered after the color changed, and the fragments were displaced over a greater distance when this fracturing occurred (Custer and Silber 1995). Limestone cobbles were unsuitable for use in heated contexts, as they burned in the fire and reacted chemically when submersed in water (Guernsey 1984a, 1984b).

Although dependent on variables such as duration of heating, amount of liquid and food being heated, and size of the stones, several experiments in stone heating have demonstrated that between 8-10 cobbles were necessary to bring water to a boil (Guernsey 1984a; Custer and Silber 1995). The addition of more stones was needed to maintain the boiling. Experimental studies have also demonstrated that stones that are heated more than once tend to fracture more easily (Custer and Silber 1995). In addition, greater frequencies of fracture and smaller sized fragments were often the result of submersing heated stones in cold water as opposed to open air cooling (Cavallo 1987; Custer and Silber 1995). These results suggested that significant accumulations of stone debris could be generated during relatively short occupations by groups of people, if stone boiling was used as a primary means of food preparation. Each round of stone boiling would require the removal of spent stone, and the procurement of new stone. Increases in the number of individuals practicing stone boiling and/or lengthening duration of occupation at a single site would result in larger piles of spent and fractured stone, which may require specific site maintenance strategies.

The types of observations made from ethnographic sources and experimental replication have led archaeologists to interpret many TAS clusters as refuse from stone boiling operations (Cavallo 1987; Petraglia et al. 1998). Typically, highly fractured and smaller fragment sizes are used as indicators of a stone boiling association. In addition, a lack of charcoal and evidence of in situ burning are also commonly used as likely indicators of stone boiling refuse, which as indirect heat sources would not be associated with these residues.

Ceremonial Contexts

Ethnographic Information

Hearths in ceremonial contexts are not well known as ethnographers and European observers may not have been welcome to participate or share in private and spiritual rituals. Observations have been made of certain ceremonies however, such as communal feasts, dances, and cremations (Guernsey 1984). In certain cases, large platform hearths and “bonfires” may be constructed for processing, cooking, or giving off light. Feasting is a known ceremonial and social phenomenon, where foods may be prepared together rather than individually.

One well-documented ceremony was the sweat lodge purification, which was a widespread custom among native peoples of North America (Bruchac 1997). Sweat lodges and associated ceremonies are reported among culturally and geographically diverse tribes (e.g., Lowie 1954; Drucker 1955; Oswalt 1978). “Sweats” could be informally taken for reasons of medicinal value, personal hygiene, personal stamina, sleeping or they could constitute elaborate ritual affairs with social and spiritual implications. The sweat lodge was also utilized by some East Coast Algonquian groups such as the Powhatan of southeastern Virginia, where each village contained at least one “sweat house” (Rountree 1989:62).

Archaeological Interpretation

Ceremonial behaviors and their archaeological interpretation are not as well known and documented in archaeological context compared to economic interpretations. Archaeologists have had difficulty in interpreting rituals, due to problems with the lack of information on how these may be manifest archaeologically or with the belief that many of these behaviors do not have material manifestations. While ceremonial functions are often not given, archaeologists commonly find hearths which are sometimes given labels such as “communal hearth” or “platform hearth” (e.g., Kinsey 1972; Cavallo 1987), often times implying a larger social unit, possibly for “processing” of foodstuffs. Archaeologists also have identified concentrations of TAS in archaeological contexts, which they have interpreted as sweat lodges (e.g., Barfield and Hodder 1987). Few hearths in the Mid-Atlantic have been recognized to have any precise ceremonial function. One exception is at the Snapp Site, where a number of TAS concentrations were found and interpreted as communal processing features and potential sweat lodge remnants (Custer and Silber 1995).

OBSERVATIONS OF THE HICKORY BLUFF SWEAT LODGE CEREMONY

Ceremonies conducted on the Hickory Bluff site provided an opportunity to examine ritual behavior, the resulting material residues, and the commingling of these ceremonies with economic and social processes. The Nanticoke Indian Tribe wished to conduct a sweat lodge ceremony at Hickory Bluff for purification purposes prior to road construction. The ceremonial activities were undertaken by eight participants over the course of 14 hours, beginning at about noon on October 25, 1998 and ending at 2 AM on October 26. The sweat was followed by a feast by the participants, and a public ceremony the following day.

The Sweat Lodge Ritual

The sweat lodge layout was of a deliberate design (Figure 11.1). A shallow lodge basin (Feature S1) was excavated in the center of the planned lodge structure location and the rim of this basin was lined with 12 locally procured river cobbles. Fill removed from the lodge basin was used to form a low ceremonial mound (Feature S4). The ceremonial fire basin (Feature S3) for heating the lodge stones was constructed at a distance of 5.6 m east of the lodge basin. Local stone was gathered (Feature S7), and together with non-local stone, was added to the ceremonial fire basin. While the stones were being heated, material for constructing the sweat lodge structure (Feature S2) was collected.

At the start of the ceremony, blessings and offerings were made at the site. The participants were then seated in the sweat lodge and the fire tender brought in glowing red stones from the ceremonial fire basin. The facilitator then ladled water onto the rocks, at which point the lodge filled with hot steam. This process was repeated for four hours. At the completion of the sweat, the participants exited the lodge, where a pipe ceremony and a feast followed. A separate cooking hearth (Feature S6) was built and care was taken to keep the lodge area free of any cooking debris or other refuse. At the public ceremony the following day, several TAS from the sweat lodge basin were selected and buried in an excavated basin some distance from the sacred area.

The Structure of the Sweat Lodge Site

A number of stone features resulted from the sweat lodge ceremony and the feast, varying in their structure and content. Four stone features, which contained thermally altered and unaltered stone, would be the most likely to be encountered archaeologically.

Feature S1 Lodge Basin

The lodge basin measured 80 centimeters (cm) in diameter and was situated in the center of the sweat lodge. The purpose of the cobble-lined basin was to hold the heated stones that would be introduced into the sweat lodge from the ceremonial fire (Feature S3) (Figure 11.2). The heated stones from the ceremonial fire were mostly whole or slightly fractured, when they were brought into the lodge. During the course of the sweat lodge ceremony, water was poured on the glowing stones to produce steam. By the conclusion of the ceremony, Feature S1 consisted of highly angular and fractured stones, many of which were broken in place (Figure

11.3). The cobbles that had been carefully placed around the rim of the basin were not fractured, and they were mostly displaced inside the basin, overlaying the fractured stones.

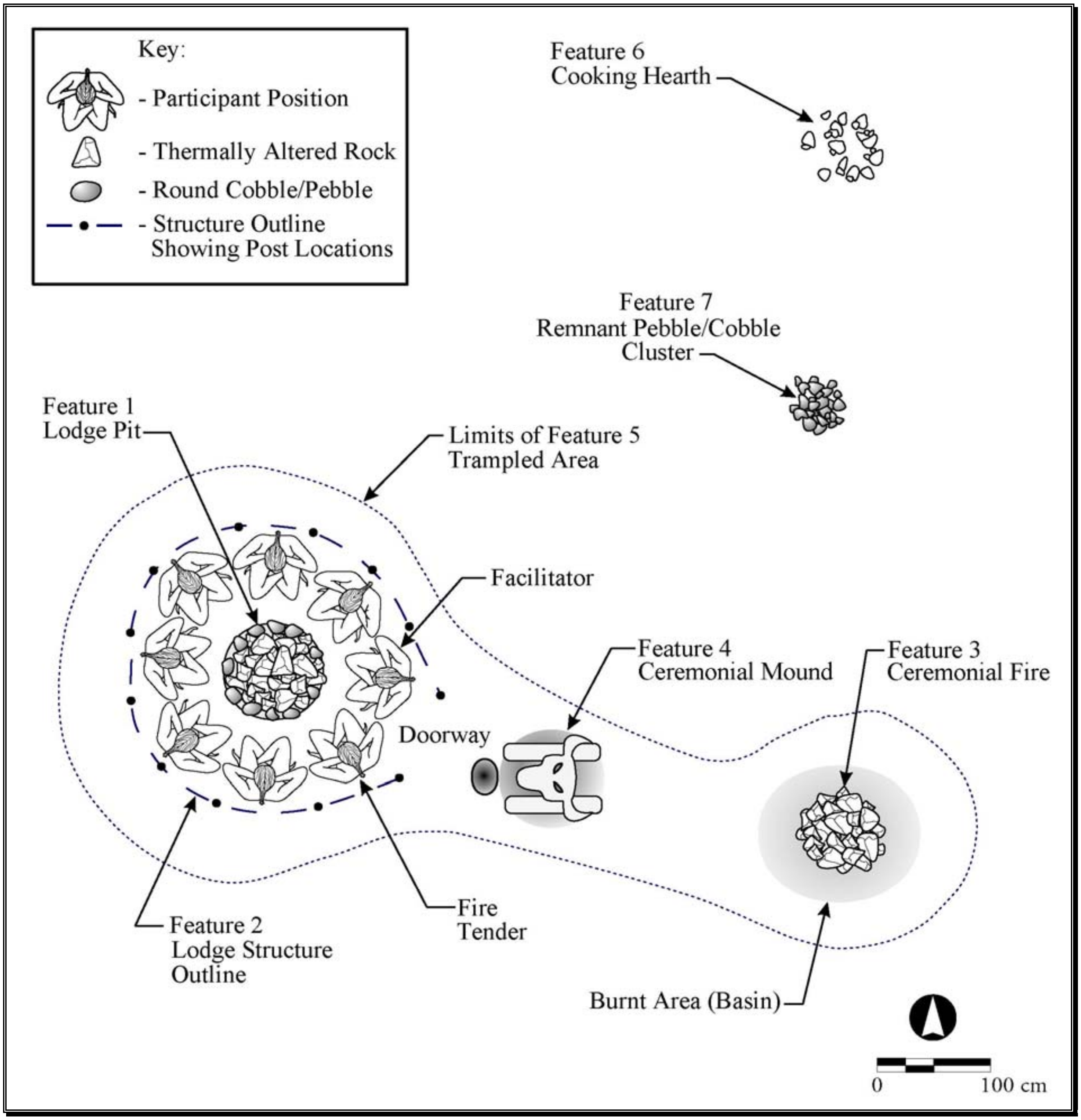

Figure 11.1 Sweat Lodge Layout, October 25, 1998

Feature S3 Ceremonial Fire

The ceremonial fire was used to bring stones to a maximum temperature for use in the sweat lodge. Prior to the fire being lit, non-local and local cobbles (local cobbles were procured from Feature S7) were stacked in multiple tiers between layers of fuel wood. During the course of the lodge ceremony, the fire was repeatedly stoked and raked, and stones were selectively removed for use in the lodge. After the fire had burned down and cooled eight hours after it was started, it was put out with water. The cluster consisted of highly fractured stones lying in a loosely aggregated basin (Figure 11.4 and Figure 11.5).

Figure 11.2 Sweat Lodge Basin, Feature S1, Lined with Mostly Whole Local Cobbles

Figure 11.3 The Sweat Lodge Framework and Sweat Lodge Basin, Feature S1

Figure 11.4 Sweat Lodge Ceremonial Fire Basin, Feature S3, after Extinguishment Showing Fractured Stone, Charcoal and Dense Ash Residue

Figure 11.5 Sweat Lodge Ceremonial Fire Basin, Feature S3, Showing Fractured Stone and Sediment Staining

Feature S6 Cooking Hearth

A cooking hearth was constructed for use after the ceremony, just north of the lodge complex. This hearth was constructed outside the sacred area. A dozen or so fist-sized cobbles, taken from the rock cluster (Feature S7), comprised the hearth stones. One heating event for cooking after the lodge ceremony lasted approximately two hours. Turkey and chicken bones were tossed into the hearth upon completion of the meal and other organic materials from the feast were tossed into the fire. The fire was extinguished with cold water. The next day, the hearth was again used for cooking, which lasted for approximately two hours. Meal residues were again tossed into this fire, and it was extinguished with cold water. After the two cooking episodes, all of the hearth cobbles exhibited a strong degree of reddening (Munsell® Rock-Color Chart [1995] 5YR 6/6 to 10YR 7/4) though only one specimen was fractured (Figure 11.6).

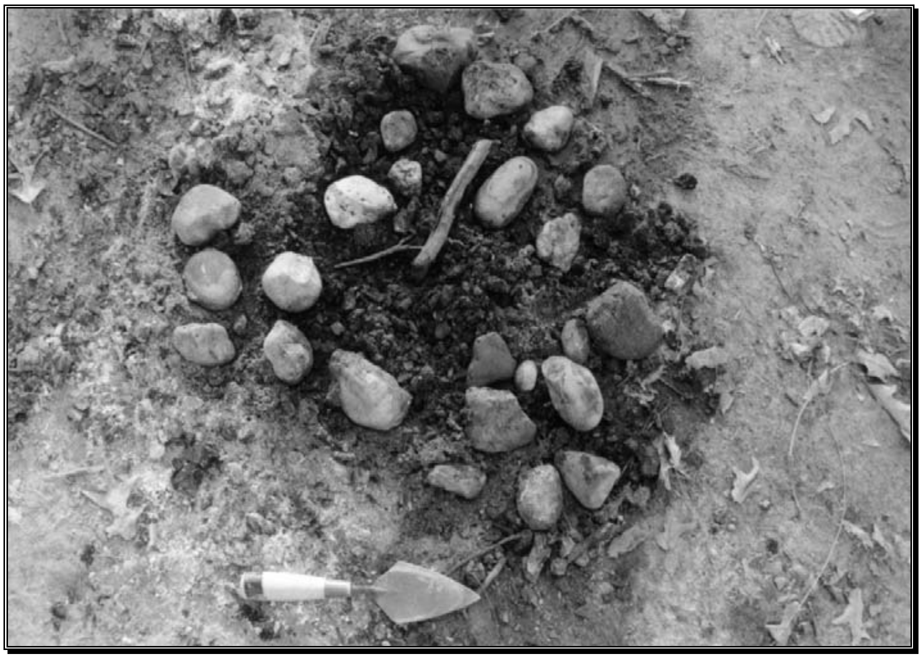

Figure 11.6 Sweat Lodge Cooking Hearth, Feature S6, Showing TAS, Charcoal and Remnant Meal Debris

Feature S7 Remnant Rock Cluster

A remnant pile of unused stones, procured from the downslope river gravel deposit, remained at the conclusion of the ceremony (Figure 11.7). Pebbles and cobbles were collected and placed in a pile just outside of the sacred area. The largest of the cobbles were selected and placed in the Feature S3 ceremonial fire. At the conclusion of the lodge ceremony, cobbles from the pile were selected for the Feature S6 cooking hearth. The remnant, unused stones, mostly all pebbles, resulted in the Feature S7 rock cluster.

Discussion

The participation, observation, and recordation of the sweat lodge allowed for insights concerning the development of a ceremonial site and features. Particularly informative were observations about the stone features, which are also commonly found in archaeological context.

Figure 11.7 Sweat Lodge Remnant Cobble Cluster, Feature S7, After Ceremony

TAS Features

Three of the four features had TAS and each of these would potentially be preserved archaeologically. These features are simulated in archaeological context in plan and profile (Figure 11.8 and Figure 11.9). As the lodge basin (Feature S1) and the ceremonial fire (Feature S3) are set in basins and have dense rock concentrations, these would likely be well preserved archaeologically. The lodge basin would be among the most durable since a dense concentration of heated and unheated stones was contained inside a shallow excavated basin. The stones placed in the sweat lodge basin were in an intentionally excavated basin, thereby assisting in preservation and retention of concentrated stones. Similarly, the intense fire associated with the ceremonial fire burned a void in the humic surface soils and the repeated turning of the stones during heating, created a shallow depression. In an archaeological context, the intentional and unintentional nature of feature construction would be difficult to discern, since they resulted in similarly-shaped basin diameters and depths (though their contents and signs of firing vary). Whether or not a less intense, though repeatedly fired hearth would account for a similar phenomenon is a question worthy of consideration. As a surface manifestation, the cooking hearth (Feature S6) feature would presumably be vulnerable to some horizontal scattering by post-depositional processes. Upon burial, the cluster would be preserved with some of the stones dispersed at some distance away. The heavy charcoal component of the cooking hearth would likely be preserved to some degree as remnant charred pieces, and the chance of the material occurring as a discrete charcoal-rich layer, would be minimal.

Heated Rock Characteristics

In examining the fired rock derived from the ceremonial fire and the lodge basin, the local river cobbles exhibited a wide range of thermal alteration characteristics. Local quartz was the least resistant to fracturing. Quartz cobbles essentially exploded in the heating fire, creating a large number of small fragments. The local quartzite specimens, on the other hand, were generally resistant to fracturing, exhibiting only reddening or incomplete, hairline fissures. Sandstone was the most durable, showing no alteration except for minor reddening. A wide range of thermal alteration characteristics were seen in the jasper specimens. Some cobbles shattered along multiple planes, while others showed little alteration, even in color. The imported granite generally broke along simple fracture planes. The burned specimens showed no evidence of reddening, though the surface was notably friable. Most of the fracturing, both of the local and non-local stones, appeared to have occurred during the heating process and not as the result of cooling, despite the application of cold water. In contrast, the local rocks in Feature S6, the cooking hearth, were not fractured, despite the fact that the fire was used twice (2 hours each episode), and cooled both times with cold water. These heated stones were only discolored red from the heating episodes.

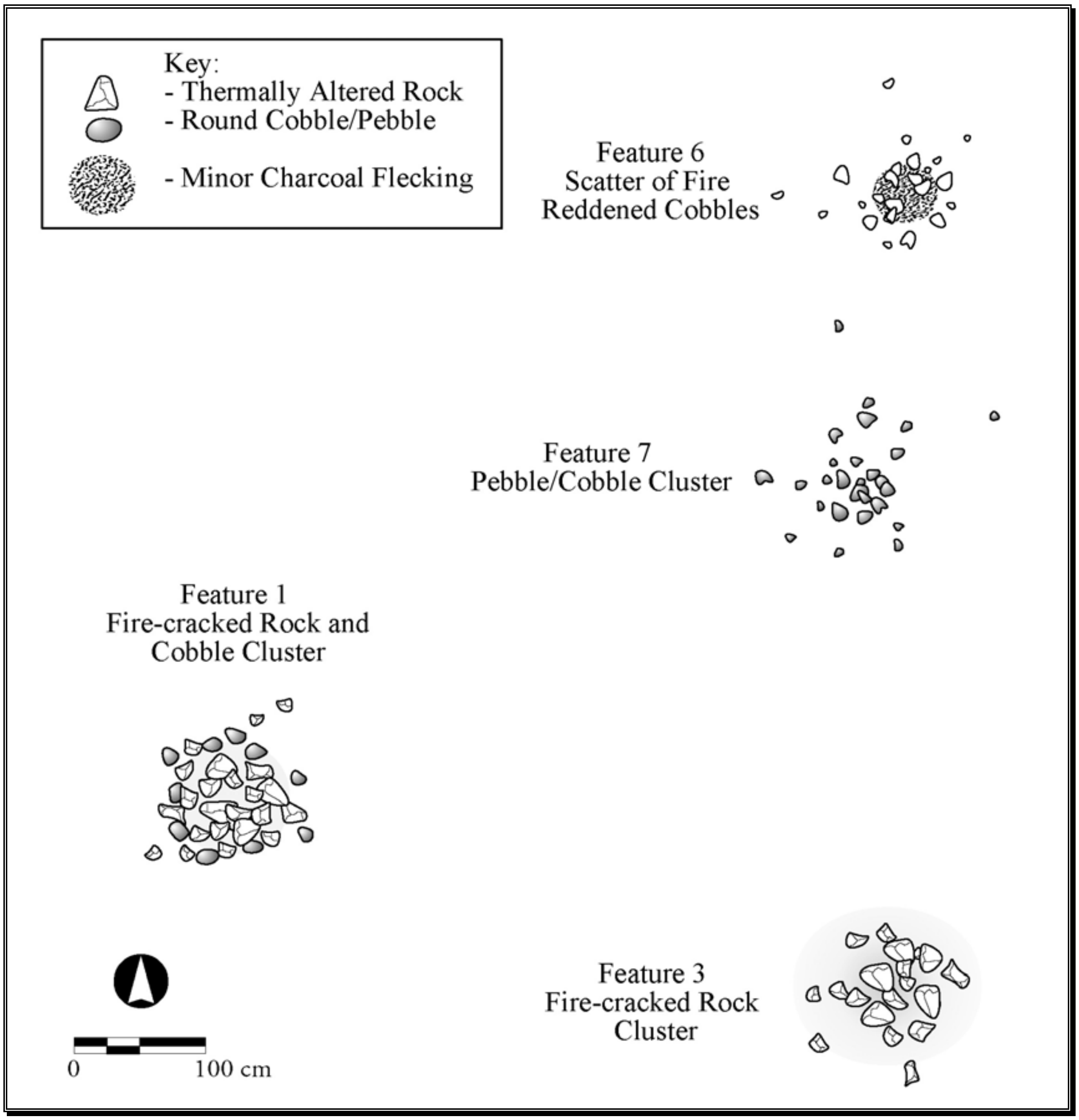

Figure 11.8 Planview of Sweat Lodge Layout after One-Time Ceremony Use

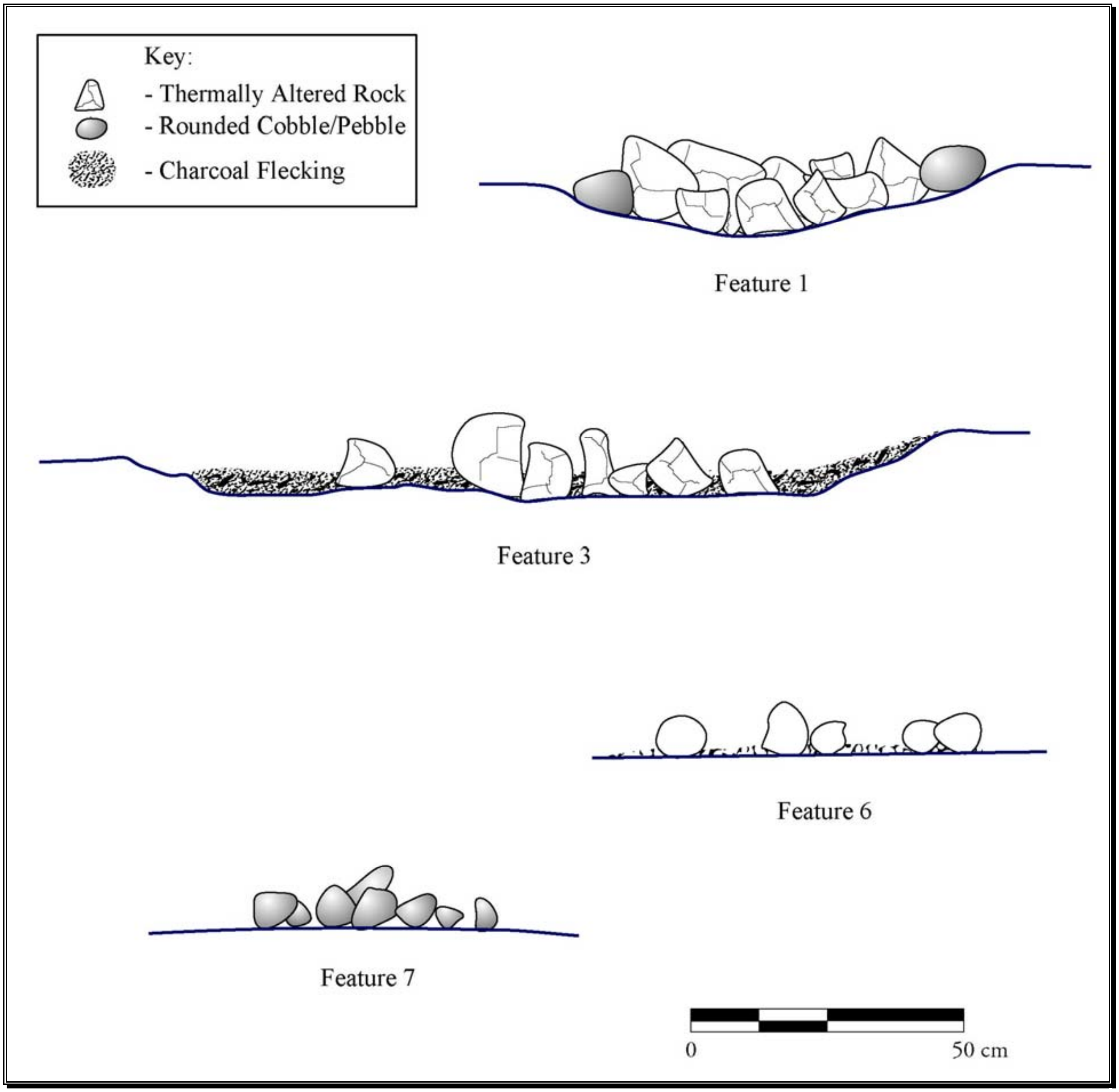

Figure 11.9 Profile of Sweat Lodge Features after One-Time Ceremony Use

Ritual Behaviors and Site Structure and Formation

The ceremonial site that was produced during the two-day event had structural parameters that were visible and easily discernible. The site components consisted of a discrete trampled area, an earthen mound, a ceremonial fire, a sweat lodge basin, a cooking hearth, and a pile of unused stones. The spatial relations between features and the high level of feature integrity was clearly manifested since the site resulted from a single event conducted on a clean surface only two days before. Absolute behavioral relations among the ceremonial fire and the sweat lodge basin could be positively inferred since the fractured rock would refit among the two features.

The sacred area preserves material evidence which is indicative of ritual behaviors. The spacing of and distances between the features themselves, in an hour-glass form, may be detected as an unusual placement. The space and the features are very clean of artifacts or organic remains, clearly contrasting with residues of subsistence or residential activity. The nature of the variation in the features provide for some dramatic contrasts in contents and form, ranging from highly fractured stones with dense charcoal in a basin, to fractured and unfractured stone in a basin without charcoal, to a cluster of unaltered cobbles and pebbles.

The spatial distinction between the features in the sacred circle (e.g., Features S1 and S3) and those outside of the space (Features S6 and S7) is of importance. The accumulation of the gravels for use in the ceremonial fire was deliberate and peripheral to the ceremonial fire although the stones were meant to be placed there. The peripheral placement of the cooking hearth is noteworthy, as this "secular" feature was intentionally segregated a distance away from the sacred circle behaviors. In contrast with other ritual features, the cooking hearth was the only feature that had organic, subsistence-related refuse materials associated with it.

MODEL FOR TAS USAGE

Introduction

The range of behaviors outlined from ethnographic and archaeological observations indicates that the formation of TAS clusters was functionally and depositionally wide ranging and complex. The multitude of factors that affect these clusters post-depositionally was equally, if not more, complex. As a result, the encountered archaeological residues may be intact or maintain only slight resemblance to how the feature looked and functioned during its use-life. With the recognition of this situation, some previous functional interpretations from feature morphology may often be simplistic. Thermal features functioned within many realms of the cultures that created them; separating these into single, absolute functions is difficult and requires more sophisticated analyses of the features and models to create various expectations to evaluate the features.

Despite the various and often interrelated forces working on sites and specific features after their abandonment, signatures related to feature function and use remain. Feature assessment is a complicated process that may not provide exact one-to-one relationships, but examination of several levels of the evidence present will aid in providing plausible interpretations. With clear recognition of this complexity, more refined interpretations can be made that may more clearly reflect behavioral processes and related feature functions.

Feature Formation Processes

It is recognized that a variety of natural and cultural processes work towards material patterning and feature formation. A review of the processes most relevant to TAS features is an essential first step from which to derive analytical expectations. Understanding of formation processes and how they affect features will allow the results to be incorporated into the models for a more inclusive set of testable expectations.

From ethnographic observations, economic, social, and ceremonial realms are sometimes commingled behaviors in traditional societies. Pure economic behaviors may represent one extreme of the spectrum while ceremonial behaviors are at the other end. However, between these extremes is an overlapping area: social/economic, social/ceremonial, and perhaps even social/ceremonial/economic behaviors. Overlapping behaviors such as these are especially important in relation to TAS features, as seen in ethnographic accounts of the ubiquity and importance of fire-related activities (Binford 1978; Guernsey 1984a, 1984b). Archaeologically discovered TAS features may lack evidence of the organic material used in a specific feature, which could be a distinguishing variable. Types of fuel wood, or arrangements of this wood, might be more significant signals related to different functions than the arrangement of the stones found archaeologically.

Behaviors that occur after the use-life of the feature must also be considered while assessing archaeological interpretations. Reuse behaviors should be expected to be common and have several different possible effects upon TAS features. For example, stones from a feature may be removed for use in a separate feature. The same feature could be reused in place for an entirely different function, which may or may not introduce new stones into the feature. These types of behaviors have the effect of masking the original function of a specific feature, which relates to the concept of single-state or multi-state features (Petraglia and Knepper 1998). Single-state features would be those that are not subjected to high levels of reuse behavior, such that they remain close to their originally constructed form. Conversely, multi-state features are those that have been subject to a variety of reuse behaviors, including robbing/scavenging, reuse in place, or reuse for entirely new function (e.g., discard area). Assessing the degree of possible reuse behaviors that may have acted on a particular feature is an important step for the interpretative process. These behaviors are especially important to remember on large sites that represent multiple occupations over an extended period of time.

These various situations relate to the problem of equifinality, whereby the end result and found archaeological residues may look nearly identical for several different functional processes: for example, small night-time warming fires may appear the same as small, open flame cooking fires. Realization of these factors allows interpretations to be more inclusive and account for the range of possible behaviors.

Natural agents will also act on abandoned features. These may include the biotic activities of animals and trees as well as different erosional forces such as groundwater fluctuations, surface run-off, or soil development. These actions may have a variety of different effects upon features that may introduce new objects into a feature or remove elements from the spatial boundaries of the feature.

TAS Model Scenarios

In an effort to examine the multiple processes that potentially operated on the TAS features found at Hickory Bluff, some expectations were modeled. The models incorporated certain variables and potential situations. It is recognized that the models are oversimplifications of multiple site formation processes, but the isolation of several key variables for assessment will provide a baseline from which to envision the myriad of possibilities.

A total of six models (Scenarios #1-6) have been constructed. Each examined how a variety of basic cultural and natural post-depositional actions could be expected to affect a feature and how single-state and multi-state residues would differ. The first three model scenarios isolated specific variables of feature content. Scenario #1 was concerned with selection preference based on size sorting; Scenario #2, with the selection preference based on material type; and Scenario #3, with examination of a mixed situation, without specific selection preferences. After examining the forces that work on specific variables, another level of complexity was added, by considering how different spatial arrangements would be affected by and/or influence postdepositional processes. Scenario #4 considered a large, dense, tiered cluster of stones; Scenario #5 considered stones placed within a small, shallow basin; and Scenario #6 considered a low-density surface manifestation. After understanding how these basic processes work, any of the chosen parameters could be mixed, matched, and simulated to examine even more complex scenarios (e.g., specific surface arrangement of both size and material type sorted stones).

The following models will help to establish expectations against which the TAS features of Hickory Bluff can be assessed and, thus, to derive interpretations of their possible functions at the time of their use.

Scenario #1 – Size Sorted TAS Features

Initial State: Stones were selected primarily on the basis of size. As an example, medium to large stones could comprise the majority of the feature, which also could include random smaller pebbles. A variety of material types could be incorporated into the feature (Figure 11.10).

Natural Interactions: Natural processes would act on the abandoned feature. Natural forces tend to affect smaller objects more readily; small objects would tend to be either pulled down vertically or displaced horizontally by mechanical agents. The result could be that larger objects remain in relatively close proximity to their place of discard, while the smaller fragments disperse from the core of the feature.

Cultural Interactions: After abandonment, a feature area is prone to several different dispersion actions undertaken by people that could impact size sorting (Stevenson 1991).

1) *Trampling* - Foot traffic through the site could begin to displace artifacts from stone features. Larger stones are more apt to be scuffed or kicked, and removed over greater horizontal distances. Smaller pieces are more prone to trampling and would begin to be pushed deeper vertically into the sediment. The result could be a horizontal dispersal ring with larger pieces pushed to the outside, and smaller pieces found variably below the initial feature plane.

2) *Reuse/scavenging* - Larger fragments will more likely be sought for reuse in other features. Their removal from the feature boundaries will create a different size sort than found in the initial feature. The result may now appear more heterogeneous in fragment size or, depending upon intensity of reuse, may appear to be selected for smaller fragment size -- opposite, in fact, of the initial state of the feature.

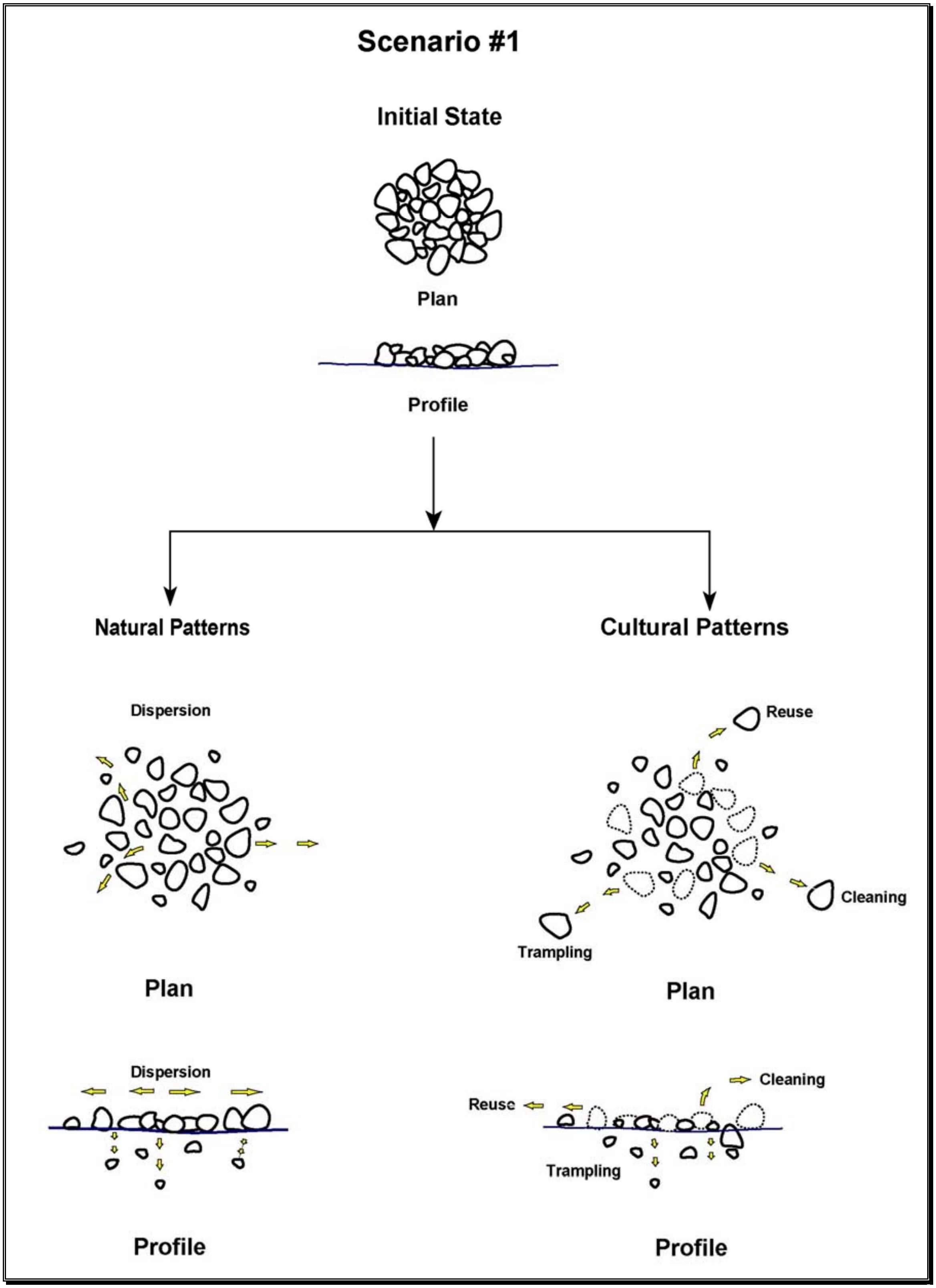

Figure 11.10 TAS Feature Formation Scenario #1, Size Sorted TAS Features

3) *Cleaning* - Cleaning activities are modeled on a theory of "conspicuous-ness." Larger fragments are more prone to be noticed and obstructive and will be tossed further from areas of use. Smaller objects are more likely to go unnoticed and therefore remain close to their point of deposition. This situation would operate for both intensive and expedient cleaning strategies. The result for the feature area would be an opposite size sort from the initial state. A secondary refuse area of selected larger fragments from the feature may also be present. These would tend to be towards the periphery of the site, or deposited into other extent features, such as emptied storage basins.

Scenario #2 – Material Type Selected TAS Features

Initial State: Stones are selected primarily for a specific material type, related to their physical parameters, such as durability and resistance to thermal altering. The feature would also likely include a lesser frequency of other materials, as it is rare to find single material type stone features (Figure 11.11).

Natural Interactions: The natural dispersal factors that act upon stone features would not specifically act on material type. The density of the stone or its resistance to weathering in general would play a role. More resistant materials (e.g., metamorphic) would be favored, especially larger fragments and those that retained cortex. Less resistant stones (e.g., sedimentary) are more apt to weather or possibly to be affected by mechanical dispersion from water and/or gravity. Preservation conditions at the feature area could favor harder, more resistant materials resulting in a greater relative frequency of such items than the initial state.

Cultural Interactions: The feature area would be subject to several different cultural processes upon abandonment, which may or may not affect the initial state of material selection.

1) *Trampling* - Trampling would not affect TAS of specific material type differentially. However, if there were a correlation between size and material then trampling would act to disperse the stones in the manner described in Scenario #1, although the results would still be dependent on the size of the fragments.

2) *Reuse/scavenging* - The same materials initially selected could be preferred for use in another stone feature. As a result, larger fragments of this material would be removed for use in other features. The initial feature area would now appear less homogenous by material type, and may show negative size sorting for the material selected out. Although not as likely a scenario, other material types could also be selected out of the feature for another function, based on different physical parameters. The result would be an even higher frequency of the first material type than found in the initial state. A feature comprised of selected materials could also be prone to reuse in place, for either the same or different activities. This type of reuse could either introduce more highly selected materials, or conversely more heterogeneous materials, based upon the new intended feature function.

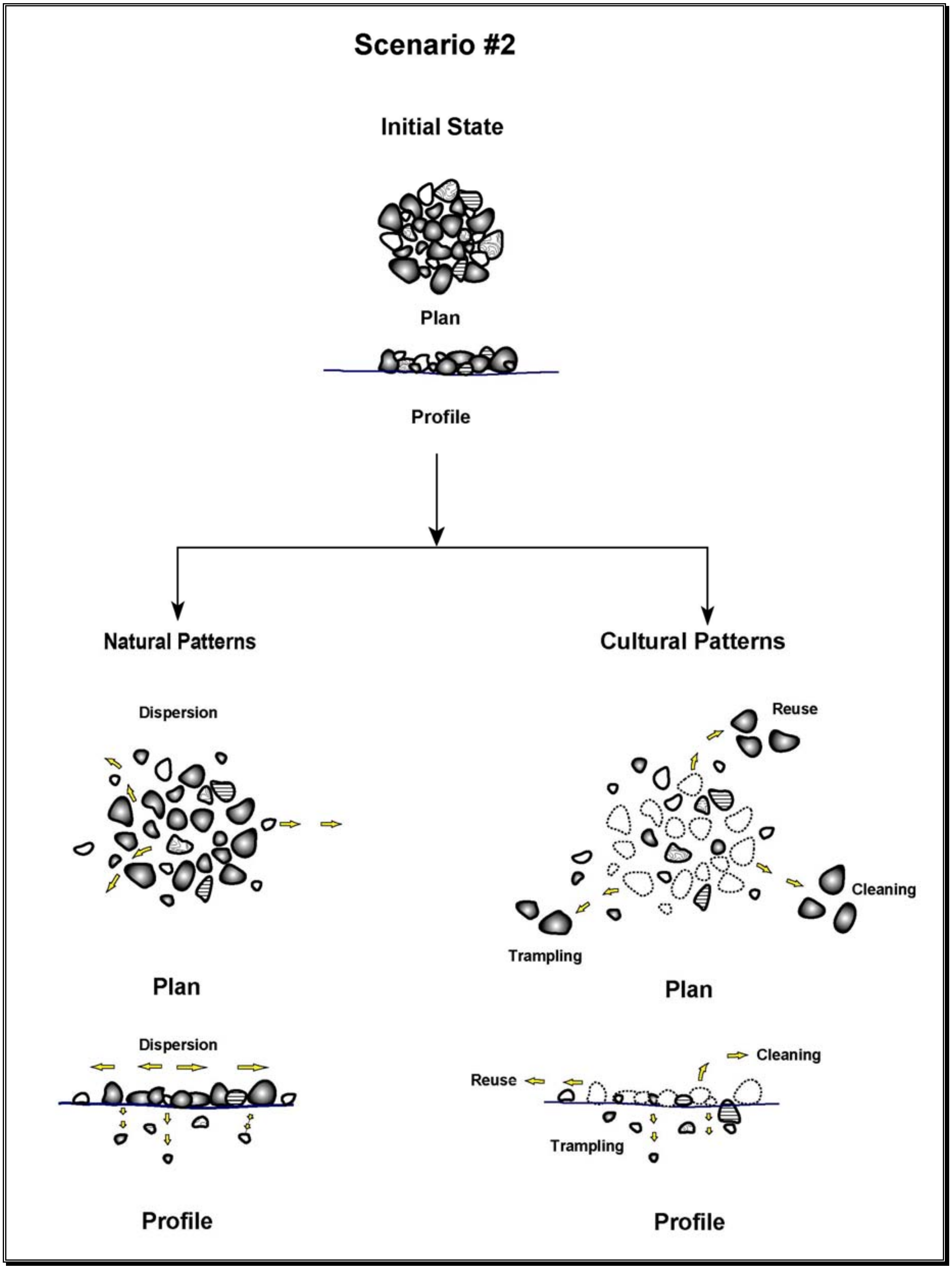

Figure 11.11 TAS Feature Formation Scenario #2, Material Type Selected TAS Features

3) *Cleaning* - Site maintenance activities could also affect material type frequencies in different ways. In addition to large fragments being selected for during cleaning processes (size sorting), certain materials may be more readily apparent and differentially removed. For example, heat-treated jaspers turned bright red would be more visible in a context of dark, ashy soils and removed. Likewise, more pure white/transparent quartzes or materials with phenocrysts would reflect light better, be more visible and, thus, apt to be cleaned away. The result could be a situation where material frequencies in the hearth are changed.

Scenario #3 – Non-specific Size or Material Type Sorting

Initial State: Feature comprised of mixed materials and sizes, with no highly specific selection preferences for size or material type. Although not purely random, the stones included would not be indicative of strict selection preferences and exhibit a range of sizes and types (Figure 11.12).

Natural Interactions: Natural dispersion factors will act primarily on size and not necessarily on material. With the mix of material types and sizes present, it is presumed that material type will not correlate to size. Large fragments tend to be less prone to movement by natural agents, and will remain close to the point they were used. The smaller fragments within the feature will display downward vertical movement and some horizontal displacement. The final residue may appear dispersed, with a variable zone of smaller sized fragments found around the main cluster of artifacts, which will likely retain much of its initial structure and arrangement.

Cultural Interactions: With the combination of different sizes and material types, differential selection from cultural sorting of the feature is expected.

1) *Trampling* - Will operate based upon fragment size. Larger fragments will be dispersed horizontally away from the feature through scuffage, potentially forming a secondary ring or an area of scattered stones. Smaller fragments will be subject to trampling and pushed down vertically in the soil below the feature plane, resulting in the creation of a variable zone with an increased frequency of smaller sized TAS below the delineated spatial boundaries of the feature. The inclusion of a wider range of sizes in the initial state could illustrate these processes more clearly than features already sorted for size in the initial state. A horizontal and vertical size sorting of fragments radiating from the initial feature boundaries would be expected.

2) *Reuse/scavenging* - This behavior will act simultaneously on both fragment size and material type. The result could be that larger fragments of the most desired material type would be first selected and removed from the feature. A higher frequency of smaller fragments and lower relative frequency of the specific material would result. This change in relative frequencies could be misinterpreted as a presumed negative selection for that material and selection for smaller sizes. A larger feature could also be more prone to reuse in place, as removing desired materials may be more labor intensive than just reuse in place, with or without changing the function. Such reuse may introduce new materials and sizes into the initial feature area, but this would be difficult to distinguish from the already mixed initial state.

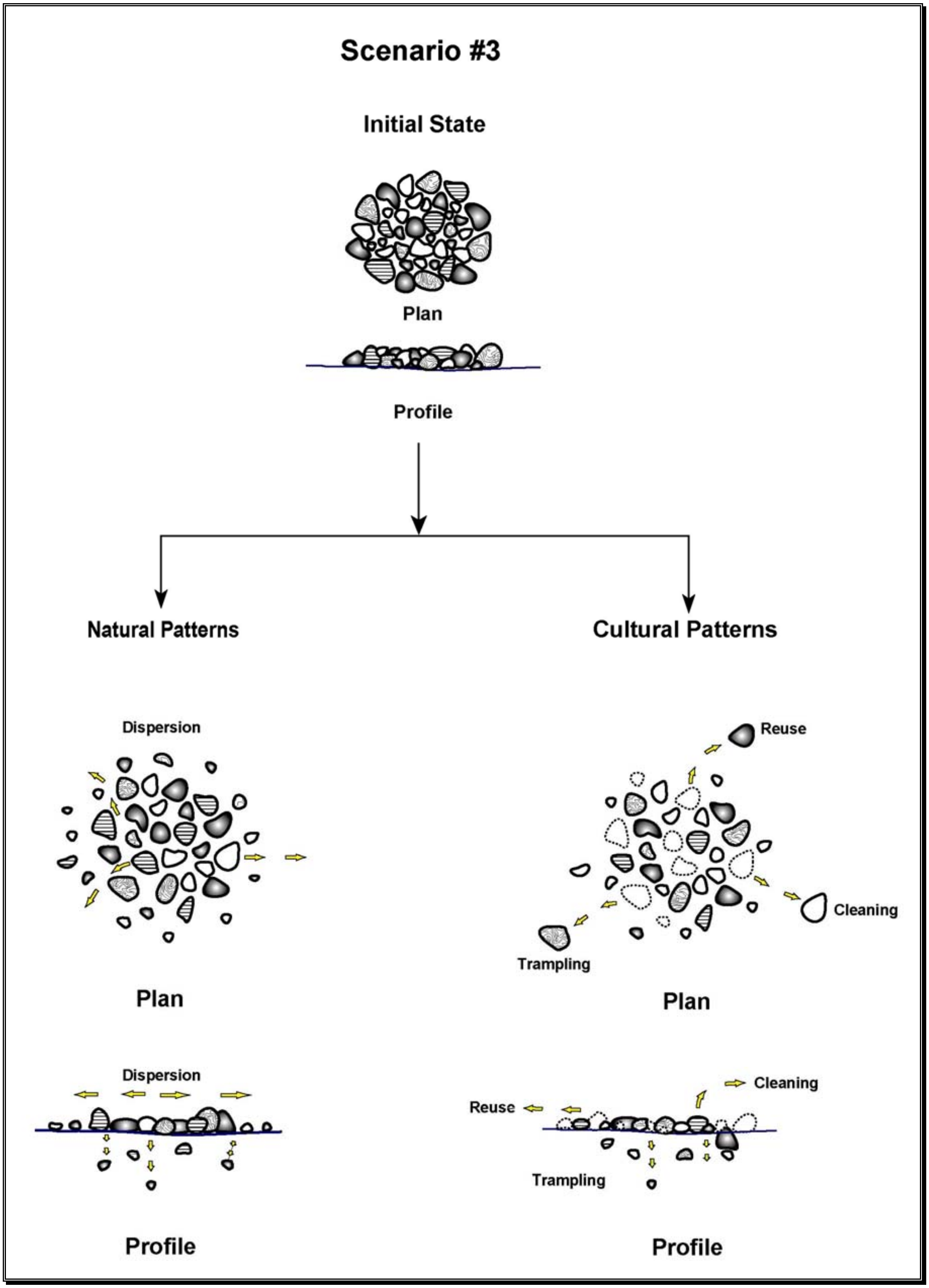

Figure 11.12 TAS Feature Formation Scenario #3, Non-Specific Size or Material Sorting TAS Features

3) *Cleaning* - Cleaning activities would be based on visibility and/or obstruction. Larger fragments would be most conspicuous and removed first. Certain more visible material types would follow, leaving behind a selection of smaller fragments of less visible materials. A secondary refuse pile of larger fragments and the more visible materials could result from an intensive cleaning strategy and appear as a separate selection-based feature. A larger mixed feature may also be avoided as an expedient form of site maintenance, as cleaning it would be more labor intensive than practical, especially if the duration of occupation is short. This would result in the feature maintaining much of its initial state.

Scenario #4 – Multi-Tiered TAS Feature

Initial state: The feature is arranged as a dense, multi-tiered stone concentration with two or three levels of stones piled on a surface. Sorting would occur initially for size, even before abandonment, as larger fragments would tend to cluster toward the middle and not be prone to dispersing when the stones are piled. The smaller fragments would likely fall through voids left within the cluster of larger stones, and/or also roll off towards the edges of the cluster (Figure 11.13).

Natural Interactions: The natural post- depositional agents would act on fragment size. It could be expected that the smaller fragments already on the periphery of the feature would be moved further horizontally beyond the feature boundaries; or migrate deeper in profile. The smaller fragments that filled-in the voids between the larger stones would more likely maintain their position being buffered by the larger stones that are resistant to movement from natural factors. The result would be a more concentrated cluster of larger sized stones, with spaces filled by smaller stones that appears denser and highly selected. A variable zone comprised of smaller fragments could be present around the cluster limits.

Cultural Interactions: The arrangement of stones into a tiered-cluster will have different affects on dispersion behaviors.

1) *Trampling* - A more dense and tiered cluster of stones may be less susceptible to trampling than smaller, more ephemeral features. A large cluster of stones would be more noticeable and likely avoided as a place to walk through or over. Deliberate avoidance could be expected, at least for the densest center portion. Smaller fragments at the peripheral sides of the feature would be subject to downward movement through trampling, especially if people begin to re-visit the location for reuse and robbing. The edges in general would be more prone to scuffage, resulting in greater dispersion at the edge of the feature than in the center.

2) *Reuse/scavenging* - Reuse would act on larger fragments and on desired material types. As previously noted, the larger fragments would tend to be clustered in the center of the feature. If these pieces were removed, it would cause a subsequent downward movement of the smaller sized fragments previously trapped between larger stones. Also, heavy reuse may create large voids or open spaces within the arrangement of stones, especially within the center. The result may then appear as a less dense cluster composed

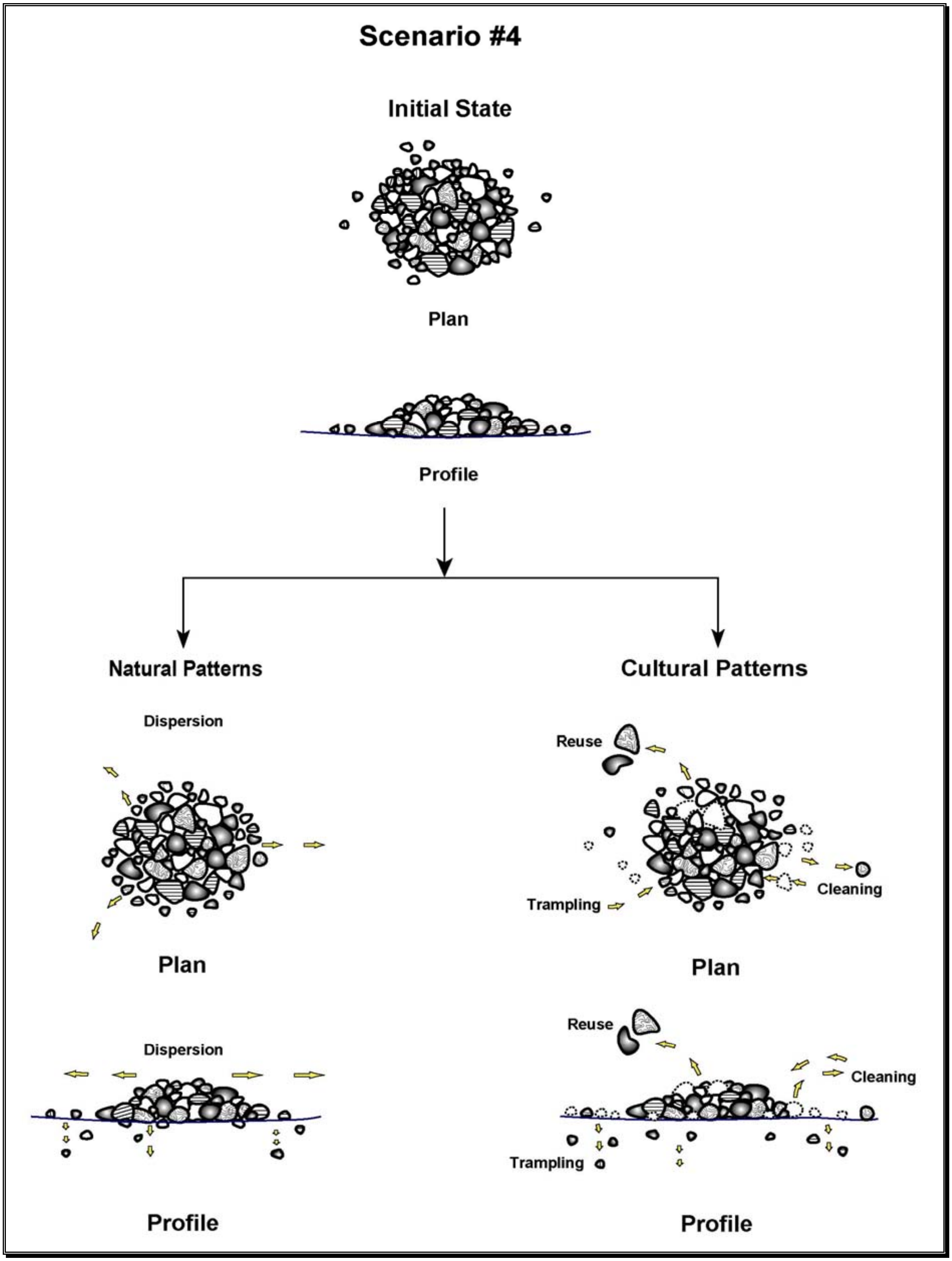

Figure 11.13 TAS Features Formation Scenario #4, Multi-Tiered TAS Features

of medium and smaller fragments. An increase of smaller fragments located in the center void, just below the surface, could also be present. Reuse geared toward specific material types would change the material type frequencies of the original feature and would appear to be selecting against the material removed.

3) *Cleaning* - A larger cluster of stones would be avoided, rather than gathered and/or raked for disposal. Site maintenance activities such as cleaning have an inverse relationship to duration of occupation; a shorter stay is more likely to practice avoidance; longer occupations may eventually initiate intensive cleaning. Another equally likely result would be that the location of a larger, dense cluster of stones would become an attractive location for further discarded materials. The effort to disperse it after serving its initial function might be more labor intensive then just adding to it other discarded stone. This would leave much of the initial arrangement intact, but as more stones are added they may further diffuse the edges, and/or fill voids with smaller stones. The addition of more material could also result in changes to any size or material sorting that was present initially, thus making the secondary refuse pile more diverse in its contents.

Scenario #5 – Stones set in Small, Shallow Basin Feature

Initial state: The feature is constructed as a small basin filled with stones of no specific selection preference. A scatter of stones could be expected around the edges and top of the basin, while the stones that lined the basin would remain in place along the bottom and sides (Figure 11.14).

Natural Interactions: The presence of an excavated basin containing the stones could affect the natural dispersal factors differently than noted for surface hearths. Larger stones would remain at the bottom of the basin and effectively block the downward movement of smaller fragments. The result could appear as size sorting within the basin. The stones found outside of the basin would initially have been less clustered and therefore, more prone to movement from natural processes. Smaller fragments could be moved farther horizontally from the basin opening, or be pulled down vertically outside of the basin limits. The recessed basin would be prone to infilling, and the stones would eventually be covered over with forest litter and soil development. The stones within the basin would then reside at a different horizontal plane than the stones dispersed at the edges and outside of the basin.

Cultural Interactions: The presence of stones both inside and outside of the excavated basin would be subject to different dispersion behaviors.

1) *Trampling* - Stones residing outside of the basin would be more prone to trampling, which would continue to act based on fragment size (i.e., Scenario #1). Initially, larger fragments could be reincorporated into the basin through scuffage, as these fragments would be prone to being kicked, possibly into the still open basin. Smaller fragments may become reincorporated into the basin through trampling after the basin is covered over and filled in, or be found deeper vertically but still outside of the basin limits.

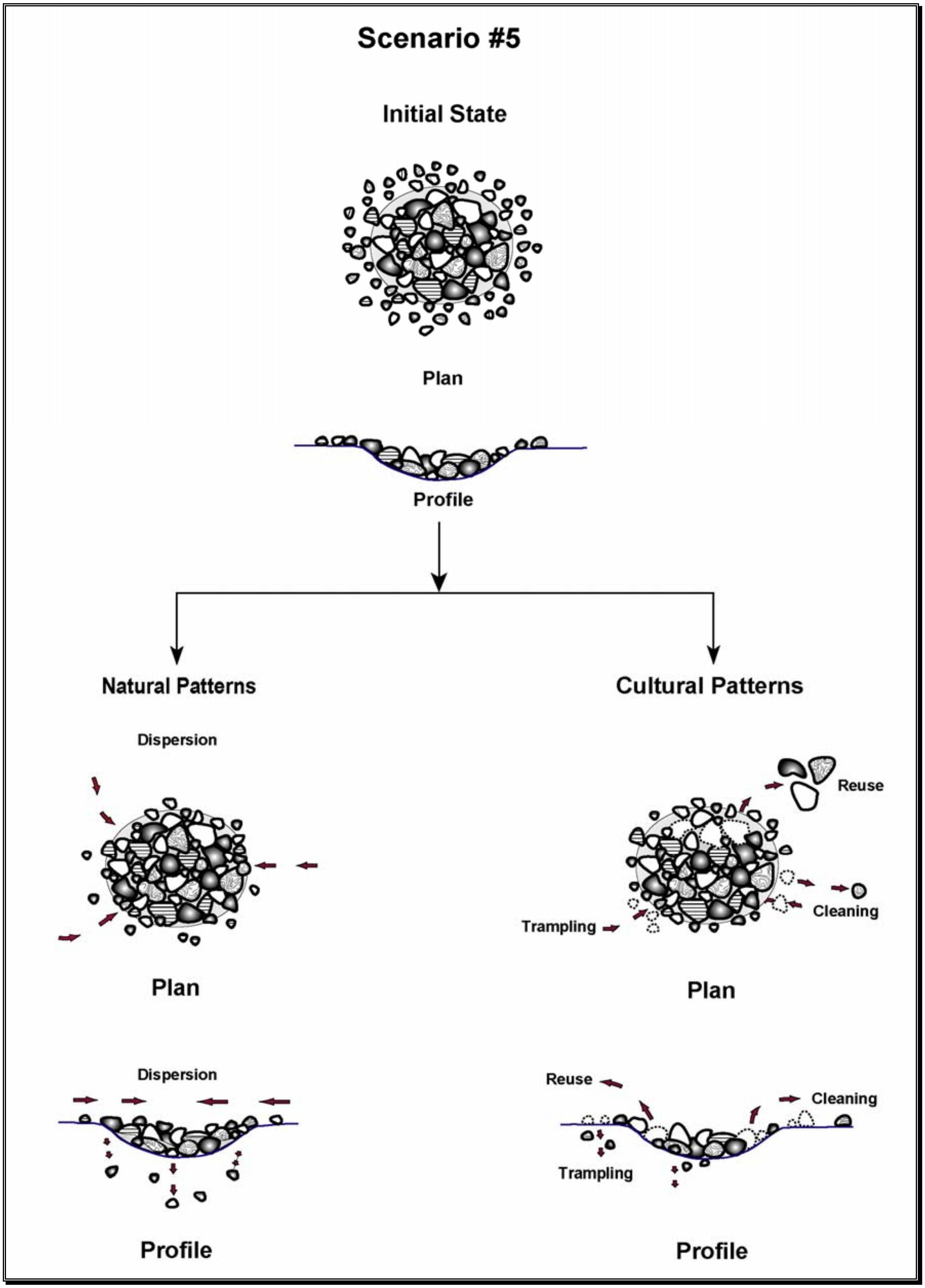

Figure 11.14 TAS Feature Formation Scenario #5, Stones set in a Small Shallow Basin TAS Feature

2) *Reuse/scavenging* - Larger fragments found outside of the basin would be most prone to reuse and be removed from the area, resulting in a ring of smaller sized fragments left around the basin opening. Larger fragments within the basin might also be attractive for reuse initially, which could lower the density of stone within the basin and allow more downward movement of smaller sized fragments within the basin. Removal of larger stone fragments may also result in voided areas within the basin. As the basin is covered over and infilled with forest litter and soil, it would be less conspicuous and therefore not likely subject to reuse. Removal of specific material types from the feature area would have the same general results as reuse for size (i.e., lower density allowing more downward movement). This type of reuse would also alter material type frequencies of the feature.

3) *Cleaning* - For more expedient cleaning and site maintenance, stones outside of the basin would be prone to cleaning first, as they would be exposed and potentially obstructive. This behavior would primarily remove large fragments and visually more evident material types. Expedient cleaning strategies would likely not affect the arrangement of stones that remained within the basin. More intensive cleaning strategies could result in the secondary use of the basin as a refuse location for the stones that littered the surface around it. Therefore, the stones could, through different behavior, become reincorporated into the basin. The open basin could also serve as a disposal for more general swept refuse. With the inclusion of debitage and broken ceramics, for example, into the open basin, its original function could be masked, as any material or size selection preferences in the initial state would be less evident. In either event, the outer upper stones could be removed from the area or reincorporated into the basin, leaving less surface trace of the basin containing the stones, especially as litter/soil covered the basin.

Scenario #6 – Low Density Surface Manifestation of TAS

Initial State: The feature is comprised of a low-density aggregation of non-specifically selected TAS, without tiers and restricted to a single surface (Figure 11.15).

Natural Interactions: The low density surface arrangement of the stone, lacking both dense clustering and tiers, could allow natural dispersal forces to act more freely. These forces tend to act more on size selection with smaller fragments being more prone to movement, while larger fragments are less susceptible to movement. The smaller fragments could disperse farther horizontally from the rest of the stones, or be pulled vertically down and away from the other stones. The result would be an even more dispersed cluster of stone that may appear to be size selecting for larger fragments, with more dispersed small fragments found variably around the main cluster.

Cultural Interactions: A low-density cluster of TAS could be susceptible to substantial changes as a result of cultural dispersion behaviors.

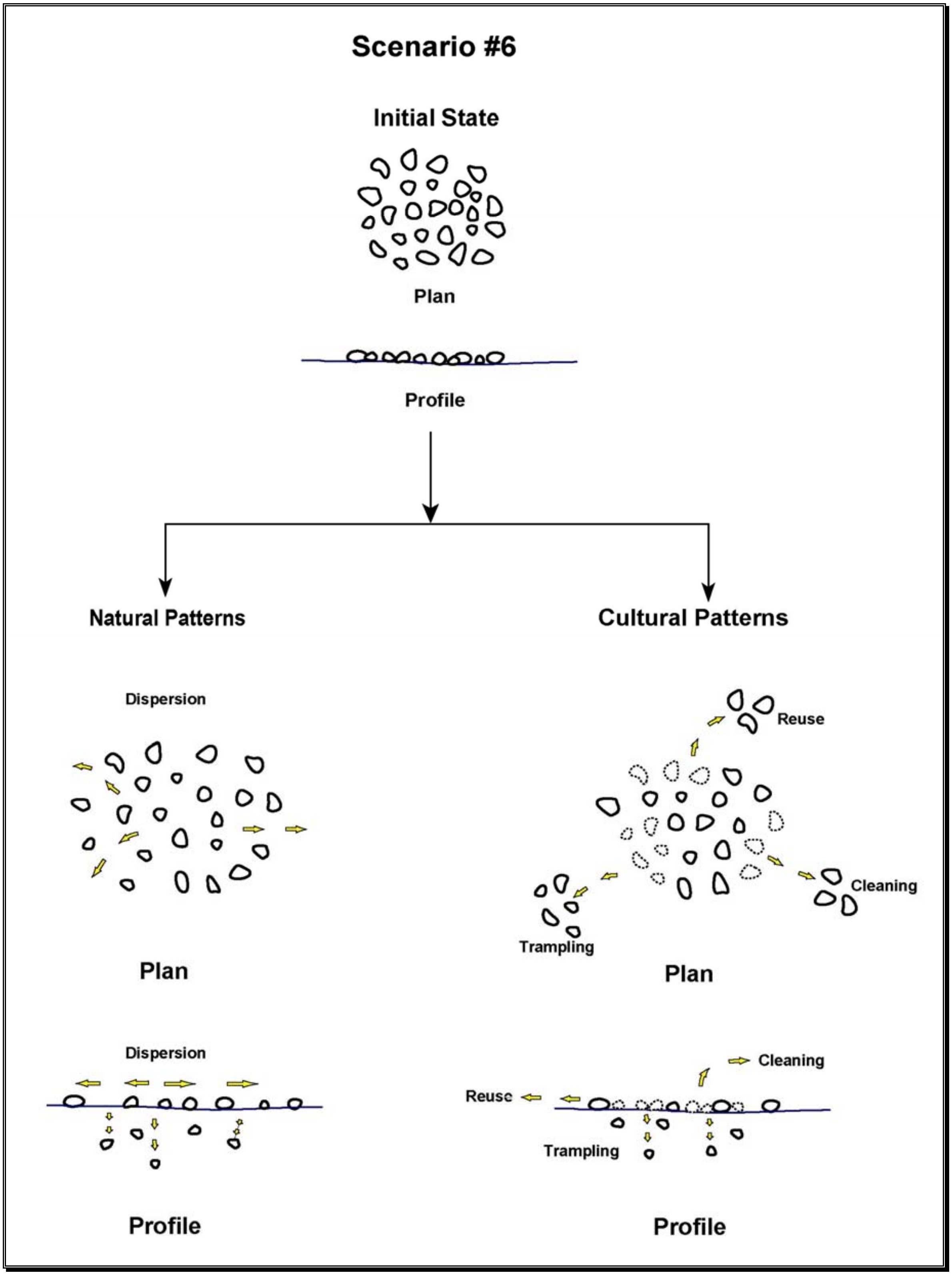

Figure 11.15 TAS Feature Formation Scenario #6, Low Density Surface Manifestation of TAS Features

1) *Trampling* - A cluster without significant density and tiers could be prone to scuffage and trampling behaviors as it would not provide enough of an obstruction to be deliberately avoided. Large fragments could experience more horizontal movement away from the initial location; such movement might occur until the fragments were moved to the edge of a trail or the periphery of the site. Smaller fragments could be expected to experience downward vertical displacement through trampling. In either or both cases, the result would be an even more dispersed appearance, lower density of stone and the loss of clear spatially defined boundaries.

2) *Reuse/scavenging* - Larger fragments contained within the feature, or those of a desired material type, could be the first items reused and removed from the feature. This action would result in a lower density of large fragments for the feature area, and may appear to reflect selection for smaller fragments and specific materials. Reuse could also result in the complete blurring of clear spatial boundaries, such that the feature area could appear as an incidental scatter of TAS and not a formal feature. Reuse in place could also occur and may introduce more stones into the feature area, increasing its density and altering any initial size or material type selections.

3) *Cleaning* - Both expedient and intensive cleaning strategies could have significant affects upon a low-density surface cluster. Expedient cleaning strategies act on larger fragments as they are potentially more obstructive to site activities and more visible. Therefore, the larger pieces of the feature could be more efficiently removed, resulting in a lower density in the feature area and negative size sorting. More conspicuous material types may also be removed in expedient cleaning and change the material type frequencies from the initial state. More intensive cleaning behaviors could result in the dispersal of the entire feature, depending primarily on the size of the fragments, and effectively remove clear signs of spatial boundaries. The stones that comprised the feature may end up as secondary residues incorporated into disposal areas or along the site periphery. Only the very smallest fragments, such as spalls and pot lids, would remain in the initial feature area and likely go unnoticed.

Expectations for TAS Analyses

Based upon the lines of available evidence, including ethnographic accounts, previous archaeological interpretations, previous experimental results of stone heating and theoretical model building, a set of reasonable expectations may be formulated to guide the analyses of the Hickory Bluff feature assemblage.

Morphology

The spatial boundaries and morphology of a feature may be readily recognizable in the field and often used as a basis for functional interpretations. The spatial size, density of stone, and arrangement of stone are all considered potential indicators of function. A careful assessment of the spatial boundaries and arrangement of stones should be made to determine the possible amount of post-depositional alteration and whether the feature represented a single-state or multi-state situation. A more inclusive examination will allow for better interpretations than the often simplistic conclusions based upon size and morphology; for example, large feature size, equates with use for communal activities. This is not to say that such an interpretation is invalid, but analysis should incorporate more variables of evidence than just size.

Spatial Integrity

To aid interpretations of the spatial integrity of features, computer plotting may be used to assess the amount of TAS located outside of the visibly delineated feature boundaries, but still within close spatial proximity. Features experiencing natural dispersion should evidence different concentrations of TAS both vertically below the feature plane and horizontally outside the spatial limits. Recognition of associated but dispersed feature components will allow better assessment of the actual amount and types of material that could have been initially incorporated into the feature, and how they may have affected the arrangement of the feature.

Burning Patterns

Evidence of in situ burning in the form of reddened and burned soils, ashy deposits, and increased charcoal content may be used for functional interpretations. Their presence may be indicative of the primary use of the feature in that location. Conversely, a lack of these indicators may relate to the secondary accumulation of the stone as either discard or indirect heat sources. Although this evidence is important, it is not necessarily available or as indicative as theorized. Site maintenance activities or natural forces can alter this evidence relative to the stones themselves, so that the lack of evidence for in situ burning should not necessarily be used as a negative indicator for use in situ.

Material Type

The range of material types included in a feature may relate to behavioral and functional processes. If a baseline of the locally available raw materials is known, then specific feature contents may be compared to it to indicate selection preferences. Features may also be compared and contrasted to each other to indicate relative selection preferences. Material type is an important variable in assessing possible function, as the behavior of material types in relation to heat may help to assess feature function (i.e., some materials may be better suited for specific roles). Therefore, highly selected homogenous materials may be indicative of a specific intended function, while features containing a greater range of material may serve less specific functions or indicate serial reuse.

Heat Alteration

Differences in the types of heat alteration including reddening, crazing, and pot-lidding, are also relevant to differential use. The variations in visible heat alteration may be related to heat intensity and/or duration of use, and could be used as a relative indicator of functional differences between features. In addition, differences in visible heat alterations identified on fragments of the same stone may be evidence of reuse after breakage or position relative to the heat source.

Stone Size

Assessments of stone and fragment size can be made by utilizing both mean and total feature weights for the feature. High mean weights are suggestive of larger fragment size, which can be compared between features to identify differences that could be related to size selection preferences for intended functions based on size. Total feature weight may also be used to compare and contrast feature size and to assess the relative fragment size between features, as expectations can be constructed for the correlation between total fragments and total weight. Indicators of size are important for assessment of both feature morphology and possible functional differences.

Fracturing

The degree of fracturing among the stones (i.e., those that are cracked and broken from thermal alteration) can be used as an indicator of function or intensity of use. Highly fractured stones have likely been exposed to either intense heat or were used for extended time. Although fracture results may be partly related to material type, the differences in degree of fracture between features serves as a good summary indicator of possible functional differences.

Refit Percentage

Artifact refitting may be used for a variety of feature assessments. Conjoining fragments allow a more exact view of spatial integrity by noting the linkage within or across horizontal and/or vertical proveniences. This type of refitting allows an assessment of the spatial proximity of artifacts, as high refit percentages could indicate that fragments have remained spatially close. Refitting also allows determinations to be made about the actual number of stones present in a feature, as opposed to the number of fragments. This distinction is important for assessments of the actual size of the feature, more accurate frequencies of material type, potential intensity of use, and for allowing recordation of other variables on the stones (e.g., heat alteration, percent completeness).

Percent Complete

Percent completeness of stones comprising a feature is another variable that may be used to compare features and assess their differences. Percent completeness refers to the amount of the refit stone artifact present, providing a finer assessment of spatial proximity and reuse. A greater frequency of stones that are more nearly complete may be indicative of lower reuse of the feature and better spatial integrity. High refit percentages may be obtained for a highly fragmented, large stone that may still be far from a complete stone, for example. In this way, percent completeness allows an indication of how much material may have been removed from the feature boundaries.

Synopsis

These nine variables can be used to analyze TAS features as they encompass much of the range of variability apparent between these types of features. It is recognized that no single variable can provide enough information to determine feature function. However, more plausible and informed assessments of function may be made when examining all of these variables and understanding how they may interrelate. Once the full set of results is assessed and understood, the possible processes that could have acted to form the feature can be formulated. Once these processes and outcomes are determined, plausible behavioral and functional interpretations may be discussed for the feature.

TAS SAMPLE STUDY

Methodology

As a result of the high numbers of TAS artifacts and evident features at Hickory Bluff, it was necessary to sample the large assemblage. A total of 15 features were chosen from among the 39 evident stone features (Type A-1) for systematic examination. They were selected to examine variations in spatial dimension, number of stones, visible fracturing, and material type observed during the excavations to provide a reflective cross-section of the larger assemblage. The selected features had spatial boundaries, ensuring that they were fully exposed and excavated. Of the 15 features selected for detailed analysis, 10 represented the A1-a subtype, covering <1 m in horizontal dimensions; four represented the A1-b subtype, 1<x<2 m in horizontal dimension; and one represented the A1-c subtype, >2 m in horizontal dimension (Table 11.1).

Table 11.1 TAS Features Selected by Type

A-1A Features	A-1B Features	A-1C Features
62, 98, 136, 173, 174, 175, 194, 227, 230, 296	46, 87, 158, 176	55

All of the stone fragments that comprised these features were individually examined in the lab by the same technical specialist to provide consistency. The fragments included fire-cracked rock and heat altered pebbles as well as visibly unaltered pebbles and cobbles, and lithic tool types, such as hammerstones and cores, that were collected within the spatial boundaries delineated for the feature. These tool types were included to examine the possible reuse of these stones within thermal features. The fragments were then categorized according to raw material type, weight, type of heat alteration (reddened, crazed, or potlidded) and percent of completeness. Material type was determined visually based upon mineralogic comparisons. Weight measurements were taken in grams and rounded to the nearest tenth of a gram for each individual fragment using an electronic scale. The type of heat alteration was recorded solely for presence or absence under visual examination. Reddening covered minor pinkish hue changes to very deep red alterations. The presence of crazing was denoted by fine cracks and fissures on the stone surfaces that had not yet broken off from the rest of the stone. Pot-lidding referred to the presence of voids left when small, round fragments of the stone, mainly from the cortex, spalled off due to extreme changes in temperature.

After the stones were examined and fully described within each feature, they were sorted by material type and subjected to refitting. Refitting was conducted only within the delineated boundaries of a specific feature, as the vast size of the assemblage precluded an all inclusive TAS refitting program. The artifacts were labeled with their bag numbers, in order to maintain their provenience information. Several refits were noted during this labeling process, marked in red along the mended portion and bagged separately. Artifact bags were then arranged in provenience order to maintain spatial proximity and to view juxtapositions of conjoined pieces. This system proved successful in locating refit groups. It was evident at times that refit groups were portions of the same cobble, but were missing key portions to be able to directly conjoin these groups. Therefore, once primary refits (directly conjoining fragments of stone) were determined, an effort was made to identify secondary refit groups (fragments from the same stone that do not directly conjoin). Primary and secondary groups were then put together, when appropriate, and assigned “Lot” numbers, which represented an individual, unique stone. The remaining single fragments of stone that were not part of refit groups, were also given lot numbers for identification as unique stones (excluding Feature 46, which was too large for this process). The refitting was undertaken to gain a better sense of the “actual” number of stones present, as compared to total number of fragments.

Estimation of percent completeness was made for each of the stone lots. It was estimated by the nearest 10 percent of a stone, and only on stones greater than 50 percent complete. When fragments were less than 50 percent complete, not enough remained of the stone for a reasonable estimation. The combinations of percent complete and gross weight of a lot provided an indication of stone size as well. The process provided a more summary determination of the actual numbers of stone used in a particular feature.

The descriptive analysis was undertaken by a single technician (excluding Feature 46, which required several technicians) and accomplished at an average rate of one feature per day. Larger features required more time, while several of the smaller features could be completed in a few hours. The specific results and observations recorded for each of the fragments from the analysis were then entered into the comprehensive site database so that they could be assessed.

Feature and Lot Descriptions

The following section provides summary information for each of the features analyzed in this study. It includes the spatial dimensions, morphological form, total weight, and breakdown of the artifacts. A summary of the refitting program is also included to indicate the total number of refit groups and resultant stone lots.

Feature 46

Of all the TAS features, Feature 46 had the highest number of total fragments. It was composed of three tiers of stone located on a flat surface in a semi-ovoid form that measured 1.90 x 1.50 m (Figure 7.5; Appendix C, Locus F). It consisted of 727 fragments of stone that weighed 55,843.8 g: 700 thermally altered rock, 23 pebbles and cobbles, 2 cores, and 2 hammerstones. Of these, 208 fragments conjoined and represented 74 refit groups (due to the number of stones, secondary refitting was not conducted). The remaining 519 fragments that could not be directly conjoined are listed as single stones, with the caveat that the number may be slightly inflated. In total, Feature 46 contained 593 stone lots (Figure 11.16).

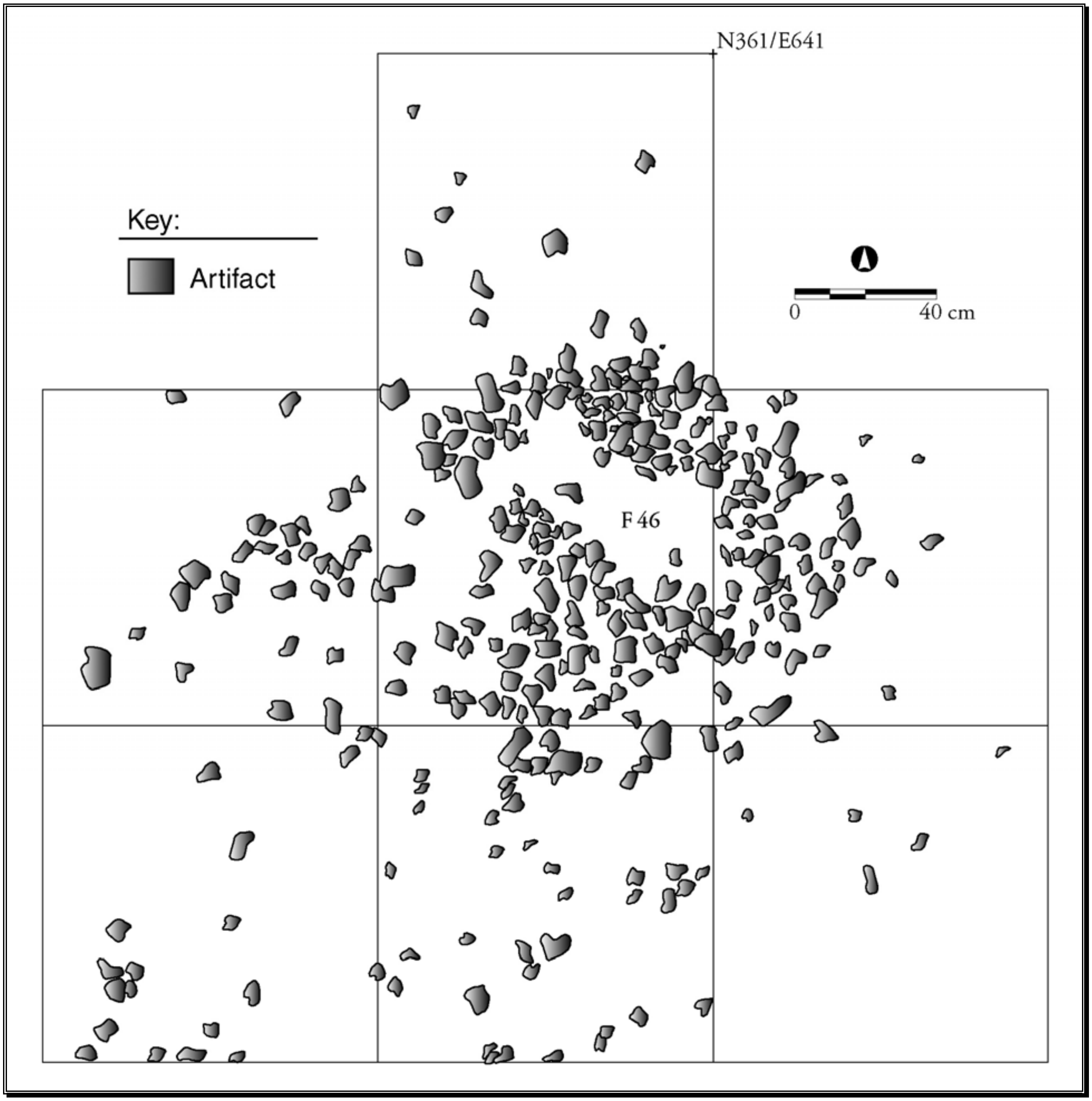

Figure 11.16 Opening Planview of Feature 46

Feature 55

Feature 55 was a diffuse surface scatter of TAS that spanned an area of 2.25 x 1.40 m and lacked a discernable shape, dense clustering or tiers (Figure 7.8; Appendix C, Locus G). It consisted of 67 fragments and weighed 2462.2 g. Of these fragments, 57 were thermally altered and 10 were pebbles. A total of 16 primary refits and 25 secondary refits were identified and represented 10 refit groups. The remaining 26 fragments represented individual lots. A total of 36 stone lots were present in Feature 55 (Figure 11.17).

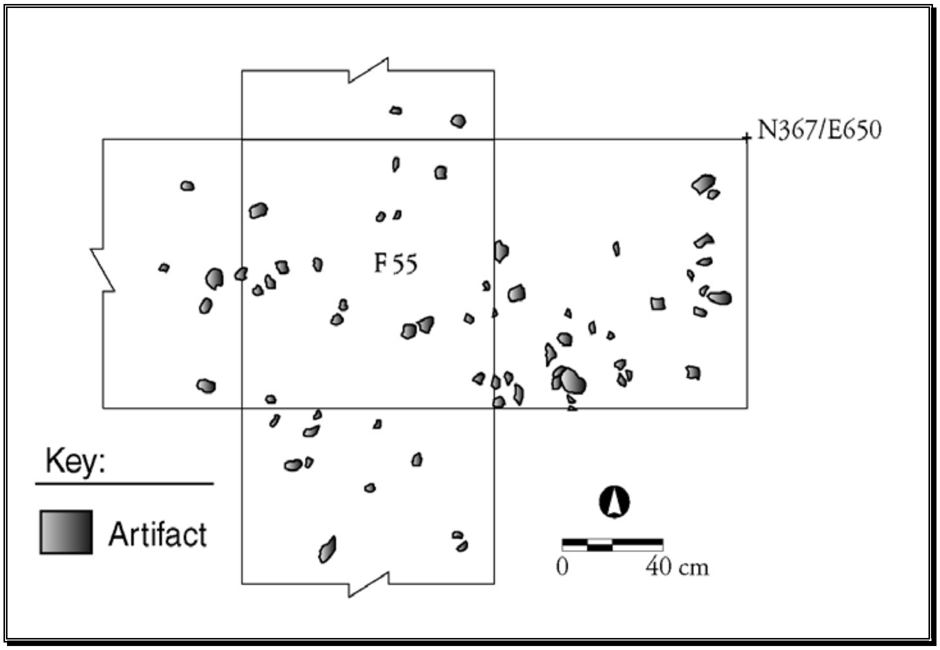

Figure 11.17 Planview of Feature 55

Feature 62

Feature 62 was a small, semi-round concentration of TAS that measured 0.30 x 0.32 m and was contained on a single horizontal plane. The feature comprised 11 total fragments; 10 thermally altered and one cobble. The inclusive weight of the feature was 917.7 g. Six primary refits and two secondary refits were identified and comprised four refit groups. The three remaining fragments were assigned to individual lots. The sum of the refit groups and individual lots was equal to seven stone lots (Figure 11.18).

Feature 87

The feature was a diffuse, sub-ovoid shaped cluster that measured 1.10 x 1.05 m and was contained on a single horizontal plane (Figure 7.6; Appendix C, Locus G). A total of 173 fragments comprised Feature 87: 170 thermally altered, 2 pebbles, and 1 cobble. The total weight of the stones was 5221.1 g. Thirty-three refit groups were identified from 64 primary refits and 51 secondary refits. The remaining 58 fragments were considered individual lots. In total, Feature 87 consisted of 91 stone lots (Figure 11.19).

Feature 98

Feature 98 consisted of a small, tightly stacked cluster of TAS contained within a small, circular basin that measured 0.53 x 0.52 m and had a maximum depth of 0.14 m (Figure 7.2). The feature was comprised of 52 fragments: 41 thermally altered and 11 pebbles, and weighed 8133.6 g. Ten refit groups were identified from 18 primary refits and seven secondary refits. With the remaining 27 fragments, a total of 37 stone lots comprised Feature 98 (Figure 11.20).

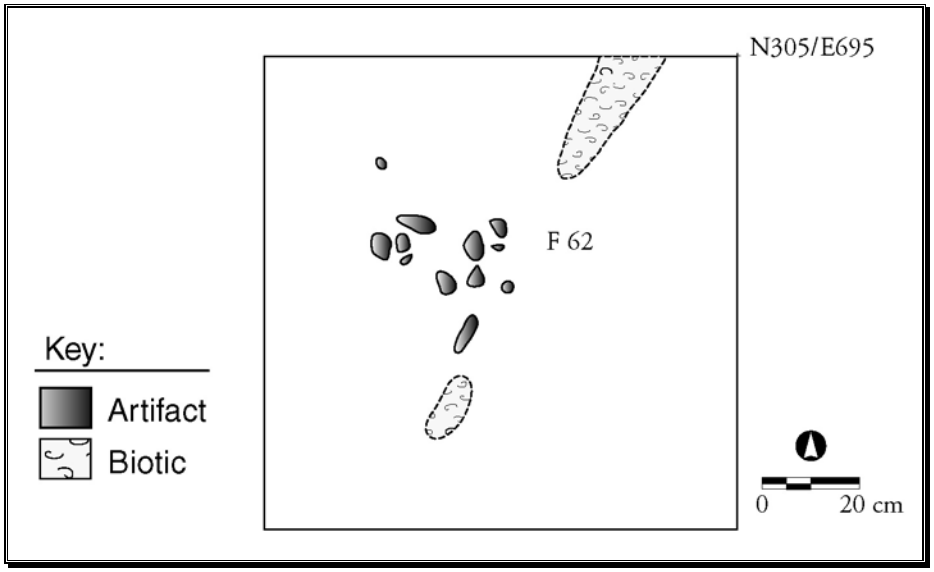

Figure 11.18 Planview of Feature 62

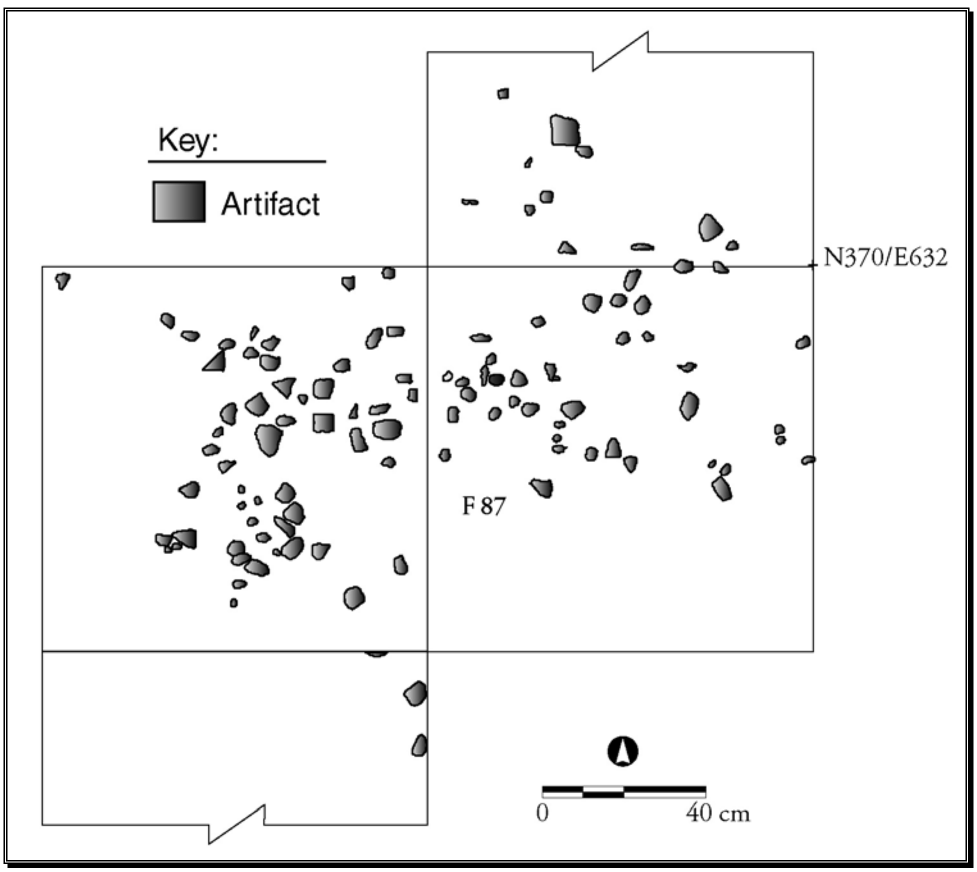

Figure 11.19 Planview of Feature 87

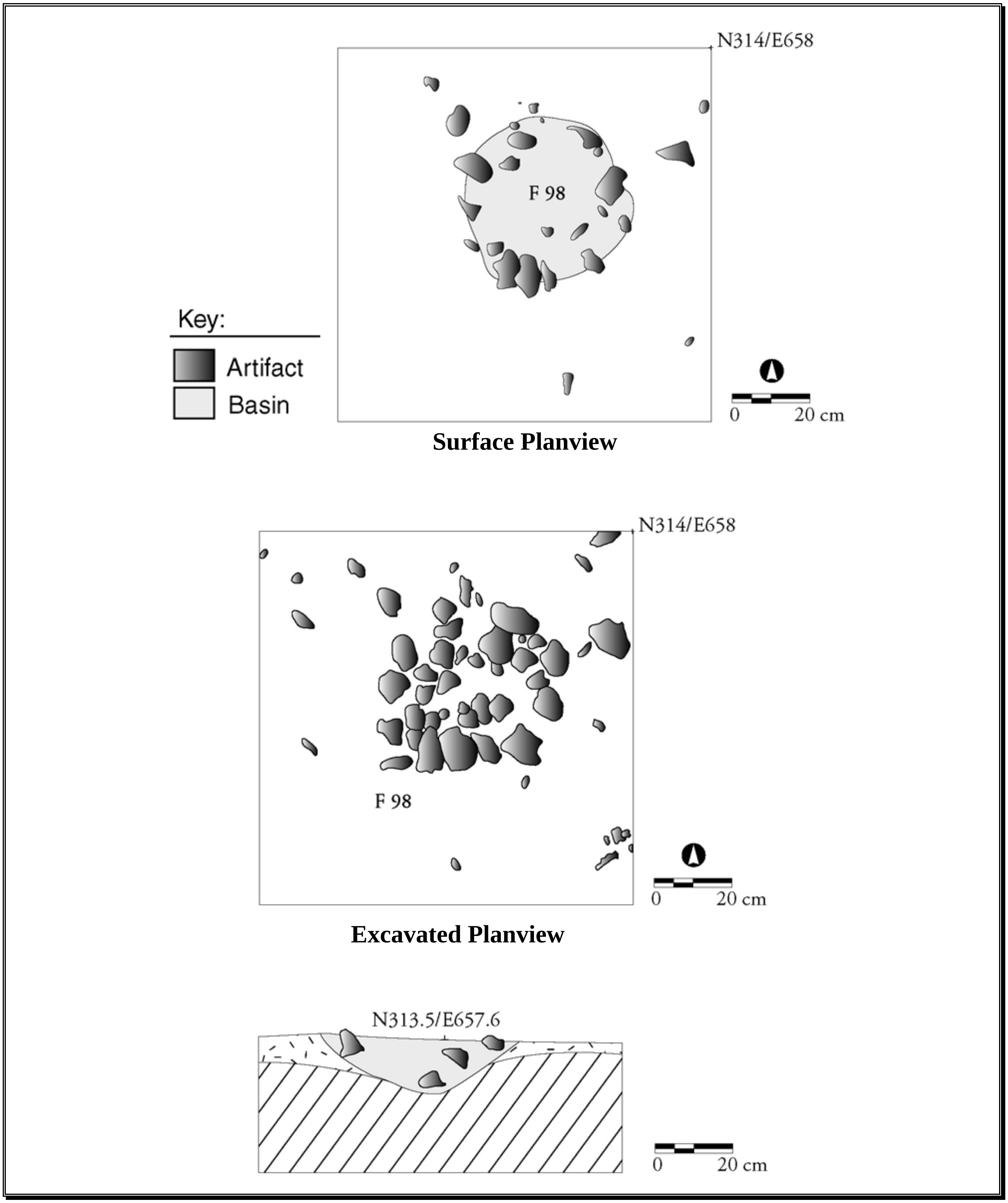

Figure 11.20 Planviews and Profile of Feature 98

Feature 136

Feature 136 consisted of a small irregular linear cluster of TAS that became more linearly dispersed along its northern boundaries. It measured 0.60 x 0.31 m and was contained on a single horizontal plane (Appendix C, Locus A). The feature contained 26 fragments, all of which were thermally altered. Six refit groups were identified from 11 primary refits and six secondary refits. The remaining nine fragments were assigned individual lot numbers, resulting in a total of 15 stone lots for Feature 136 (Figure 11.21).

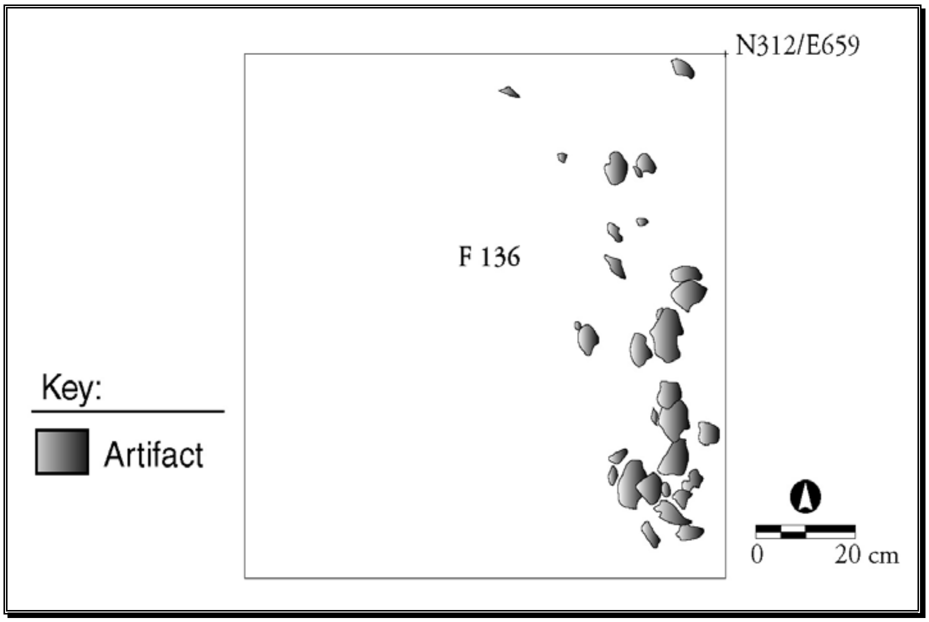

Figure 11.21 Planview of Feature 136

Feature 158

This feature was an irregularly shaped concentration of TAS that measured 142 x 137 cm (Appendix C, Locus F). It contained two distinct tiers of stacked stones. The second tier was more densely concentrated, without the diffuse scatter at the boundaries noted in Tier 1. A total of 225 fragments, weighing 17,524.8 g, were contained in Feature 158: 201 thermally altered, 2 cobbles, 20 pebbles, 1 core, and 1 hammerstone. Thirty-nine refit groups were identified from 62 primary refits and 41 secondary refits, while the remaining 122 fragments were assigned as individual lots. The sum comprised 161 stone lots for Feature 158 (Figure 11.22).

Feature 173

Feature 173 consisted of a large, quartzite boulder fractured into 8 large pieces and contained in an area of 0.44 x 0.40 m (Appendix C, Locus I). An additional 23 fragments of the same boulder and 2 other fragments were also contained within the same spatial proximity. Another large fragment of the same boulder was located 3-4 m outside the feature boundary. In total, Feature 173 weighed 9375.6 g. A single refit group was identified and contained 15 primary refits and 16 secondary refits. The additional 2 fragments represented individual lots, for a total of three stone lots for the feature (Figure 11.23).

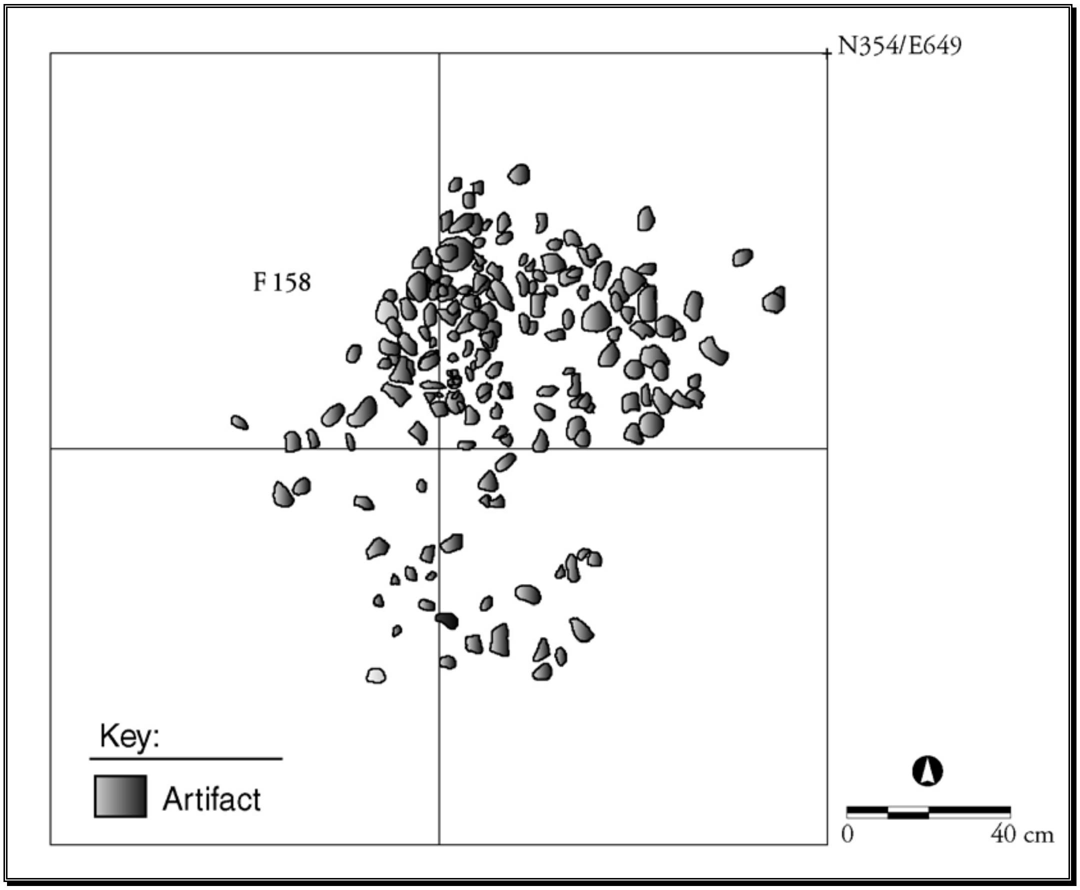

Figure 11.22 Opening Planview of Feature 158

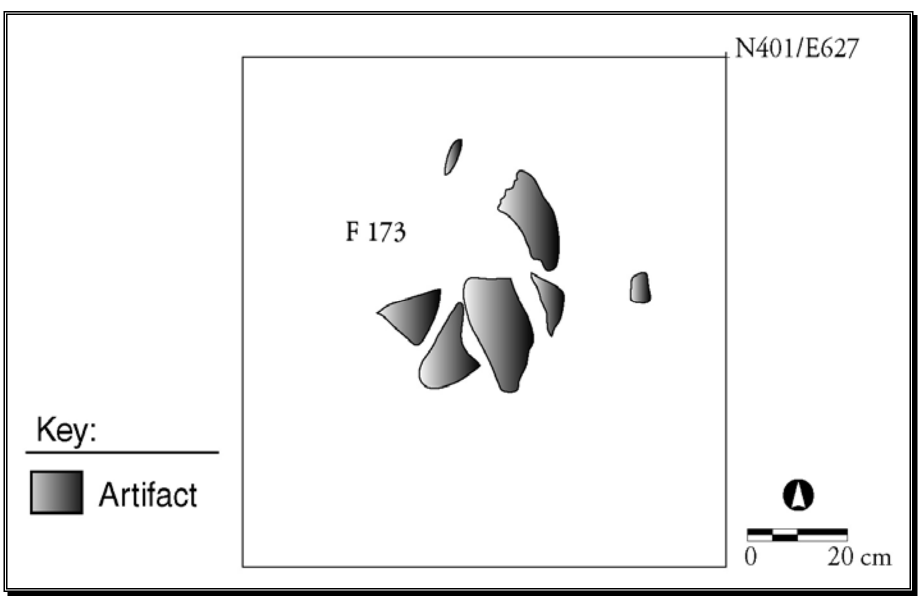

Figure 11.23 Planview of Feature 173

Feature 174

Feature 174 was a scatter of TAS that measured 0.65 x 0.50 m, was situated on a single horizontal plane, and had no discernable shape (Appendix C, Locus H). A total of 23 fragments that weighed 853 g comprised the feature. Two refit groups were identified with 18 primary refits and one secondary refit, with the remaining four fragments assigned as individual lots. This equaled six stone lots for Feature 174. An additional 16 fragments that had three refit groups were identified and conjoined with the larger of the refit groups of Feature 174. These fragments were recovered from within the same excavation unit, but outside of the horizontal boundaries delineated for the feature (Figure 11.24).

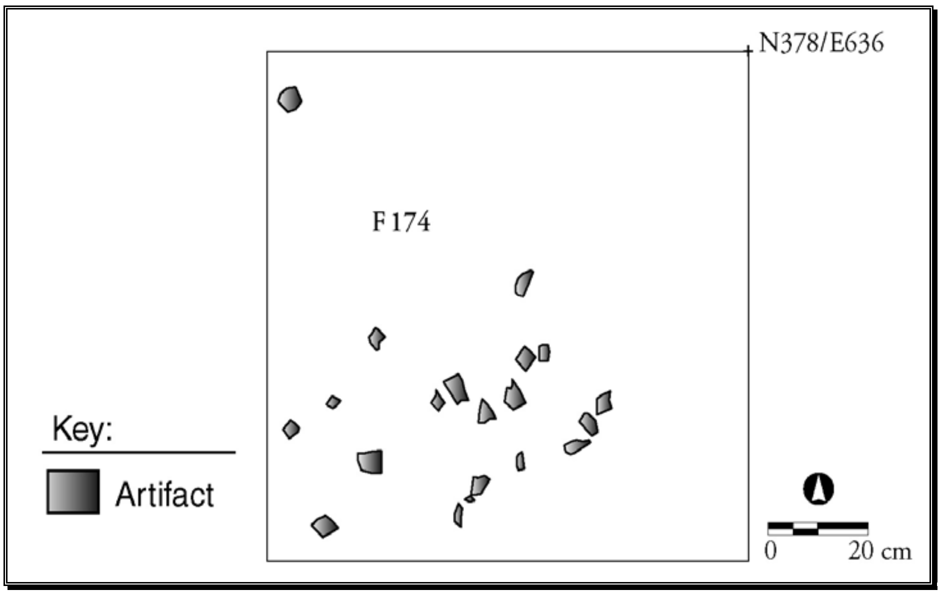

Figure 11.24 Planview of Feature 174

Feature 175

Feature 175 was an irregularly shaped scatter of TAS that measured 0.48 x 0.40 m and was contained on a single horizontal plane. It consisted of 22 fragments: 21 thermally altered and one core. The feature weighed 1756.3 g. Four refit groups were identified from seven primary refits and six secondary refits. The nine remaining fragments were assigned as individual lots. In total, 13 stone lots comprised Feature 175 (Figure 11.25).

Feature 176

The feature consisted of a discrete, tightly clustered, sub-ovoid shaped concentration of TAS, situated in four distinct tiers (Figure 7.7; Appendix C, Locus F). The feature area measured 1.50 x 1.20 m for Tier 1, and decreased to 0.50 m for Tier 4. Feature 176 contained 264 fragments of stone that weighed 16011.3 g. Of these, 109 were thermally altered, 154 were pebbles, and 1 was a core. Fifty primary refits and one secondary refit were identified and accounted for 17 refit groups. The remaining 213 fragments were assigned individual lot numbers. As a result, 230 stone lots were contained within Feature 176 (Figure 11.26).

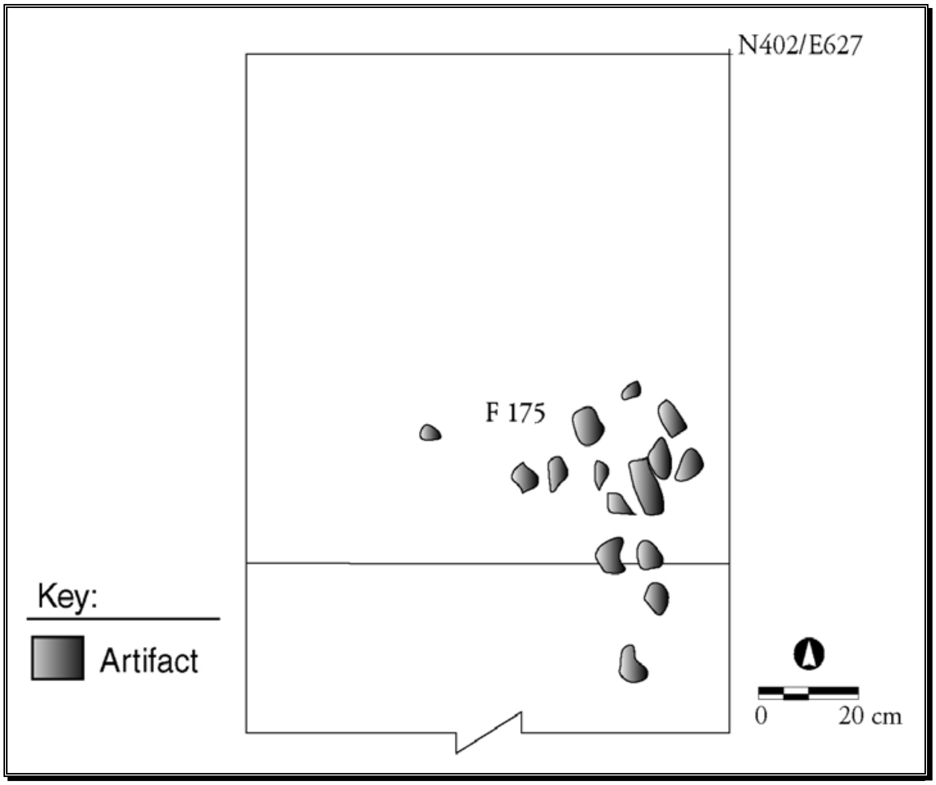

Figure 11.25 Planview of Feature 175

Feature 194

Feature 194 consisted of a small ovoid shaped cluster of TAS that measured 0.42 x 0.26 m and were contained on a single horizontal plane (Appendix C, Backhoe Strip). The feature was composed of five fragments, all thermally altered, that weighed 2196 g. One refit group was identified from two primary refits and one secondary refit. The remaining two fragments were assigned individual lot numbers, for a total of three stone lots for Feature 194 (Figure 11.27).

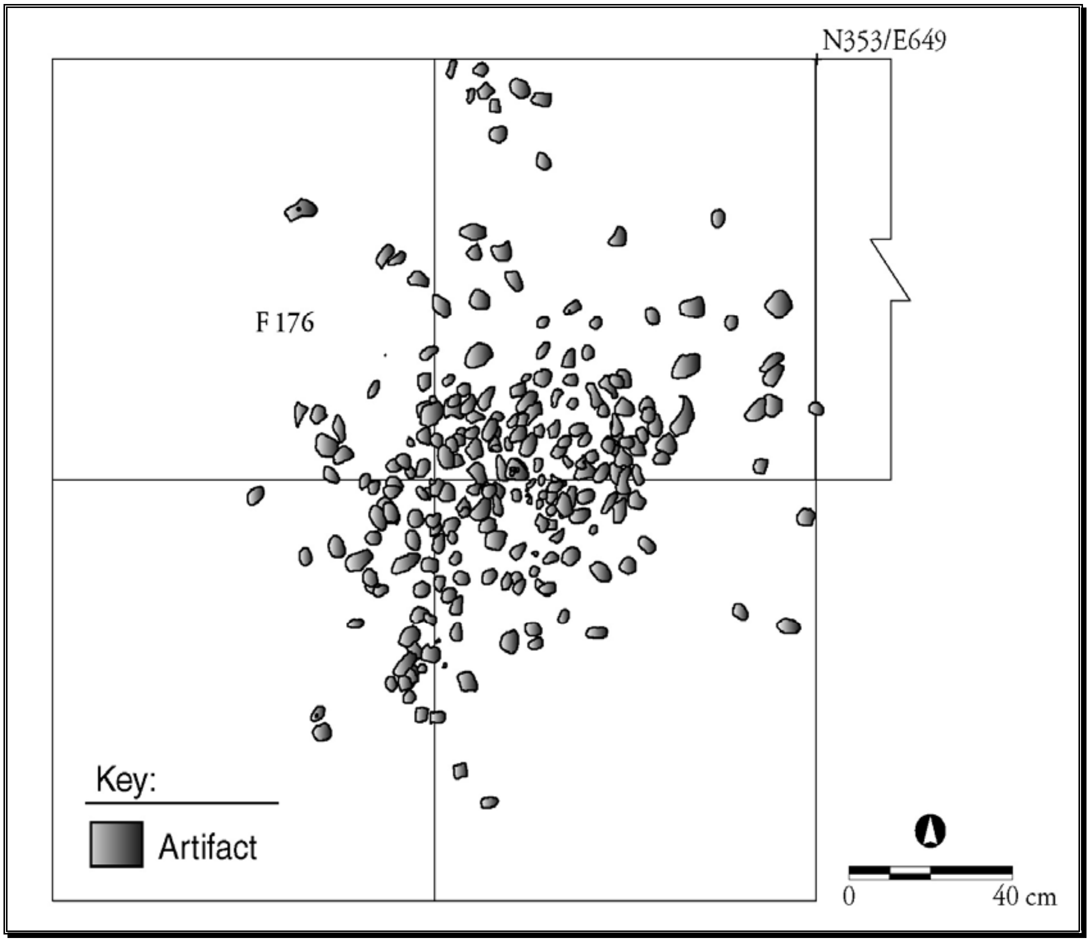

Figure 11.26 Opening Planview of Feature 176

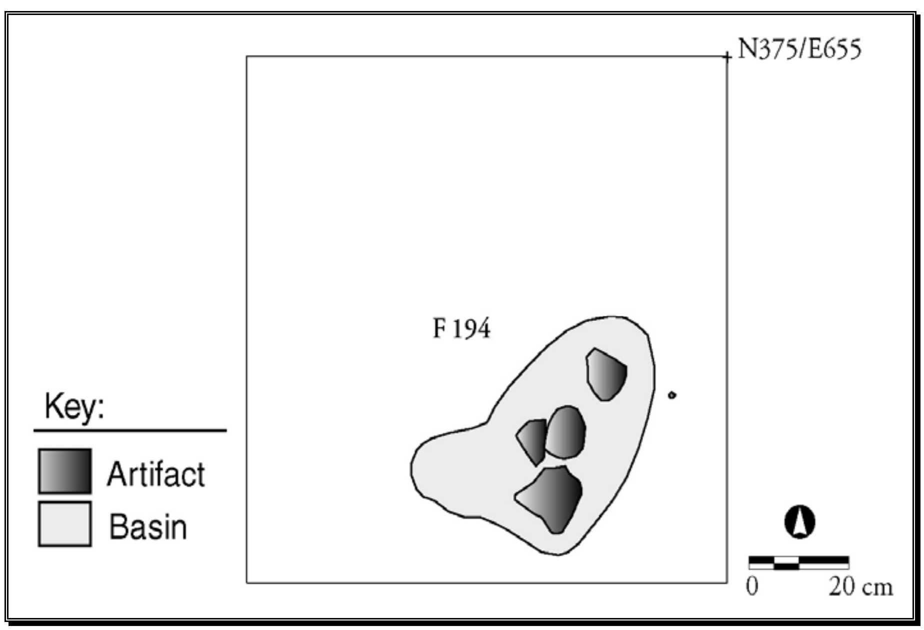

Figure 11.27 Planview of Feature 194

Feature 227

Feature 227 consisted of a cluster of TAS contained on a single horizontal plane and arranged in an incomplete semi-circle that measured 0.52 x 0.50 m (Appendix C, Locus H). Ten fragments were within the feature and weighed 2460 g. Nine of these were thermally altered and the other one was a cobble. Two primary refits and two secondary refits were identified and accounted for two refit groups. The remaining six fragments were assigned individual lot numbers, which accounted for eight stone lots for Feature 227 (Figure 11.28).

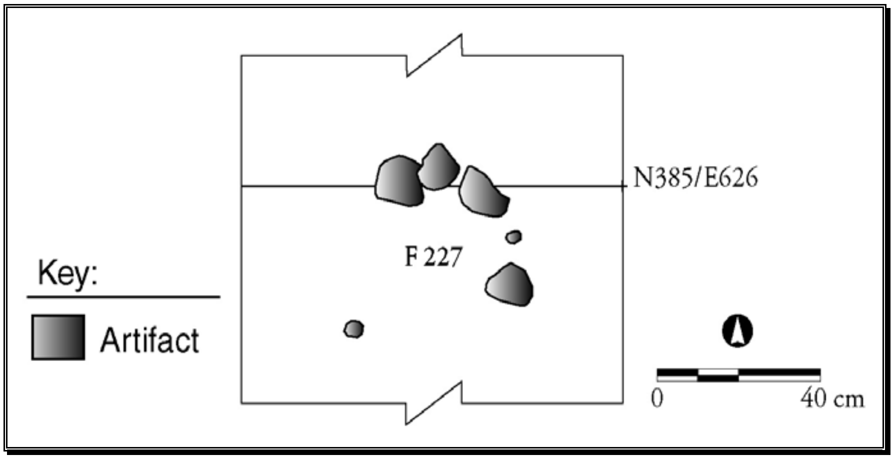

Figure 11.28 Planview of Feature 227

Feature 230

Feature 230 was a two-tiered cluster of TAS, which became more densely concentrated in Tier 2, located in the center of the feature. It covered an area of 0.80 x 0.60 m and was contained within an irregularly shaped soil discoloration (Appendix C, Locus G). A total of 43 fragments (39 thermally altered, 2 cobbles and 2 pebbles) comprised the feature. The stones weighed 2869.1 g. Ten refit groups were defined from 17 primary refits and 18 secondary refits. The remaining eight fragments were assigned individual lot numbers, for a total of 18 stone lots for Feature 230 (Figure 11.29).

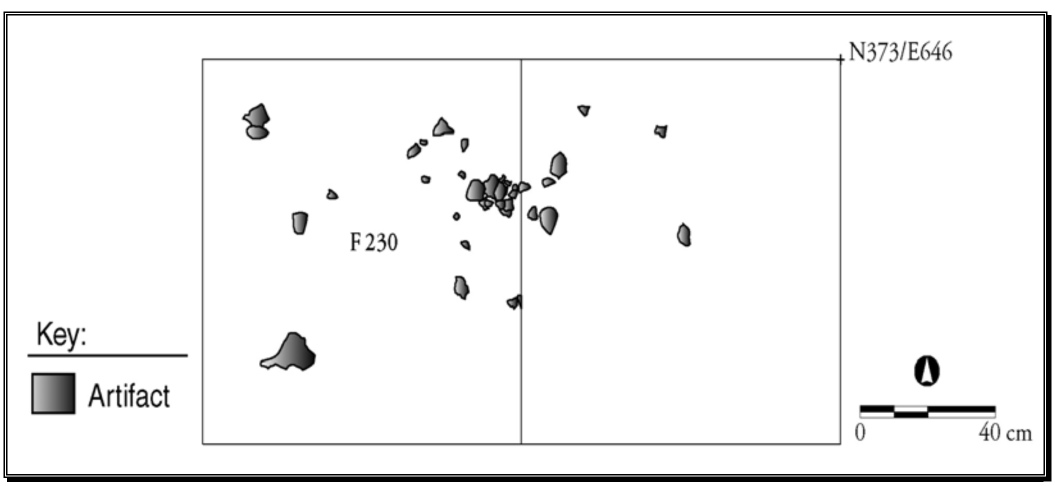

Figure 11.29 Opening Planview of Feature 230

Feature 296

Feature 296 was a dense, sub-ovoid shaped cluster of TAS that measured 0.44 x 0.42 m and was found on roughly the same horizontal plane (Figure 7.4; Appendix C, Locus G). The stones were associated with an area of thermally altered soils and increased charcoal flecks. Feature 296 contained 107 fragments of stone: 96 thermally altered, 9 pebbles, and 2 cores. The cumulative weight of the feature stones was 3224.1 g. Eleven refit groups were identified from 23 primary refits and 45 secondary refits. The remaining 39 fragments were assigned individual lots, for a total of 50 stone lots in Feature 296 (Figure 11.30).

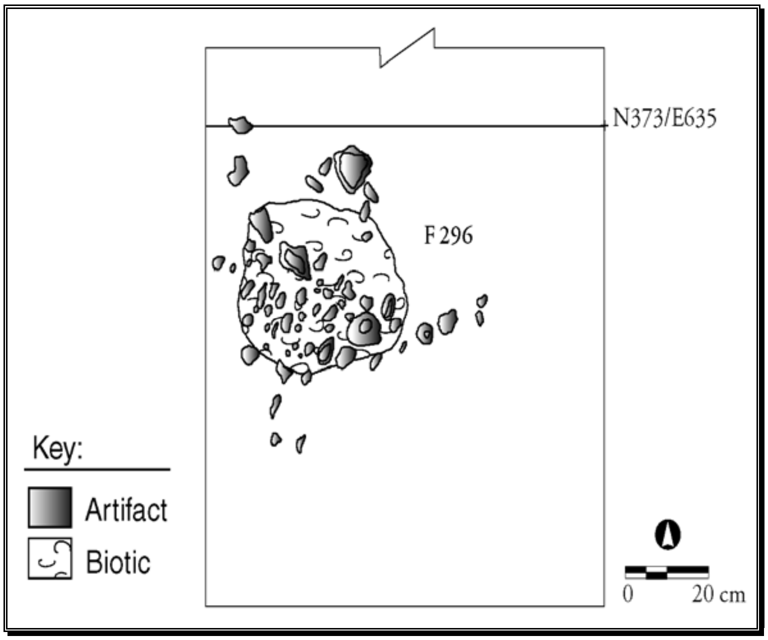

Figure 11.30 Planview of Feature 296

The 15 features selected in this analysis consisted of 1,788 fragments of stone. Of these, 519 primary refits and 222 secondary refits were identified and combined for a total of 224 refit groups (Table 11.2). An additional 1,047 individual fragments remained that could not be placed into refit groups. In total, the features consisted of 1,271 individual stone lots. The range in material, size, and degree of alteration within and between these lots suggested differential formation processes for the features.

Analyses

Analysis of multiple attributes was conducted to understand feature variety. Variables that pertained to lithic material selection and use, heat alteration, and fracture patterning were examined for evaluation of the TAS assemblage.

Table 11.2 Summary of Hickory Bluff TAS Refit Program

Feature	Total Count	Primary Refits	Secondary Refits	Total Refit Groups	Single Fragments not included in refit groups	Total Stone Lots**
46	727	208	0*	74	519	593
55	67	16	25	10	26	36
62	11	6	2	4	3	7
87	173	64	51	33	58	91
98	52	18	7	10	27	37
136	26	11	6	6	9	15
158	225	62	41	39	122	161
173	33	15	16	1	2	3
174	23	18	1	2	4	6
175	22	7	6	4	9	13
176	264	50	1	17	213	230
194	5	2	1	1	2	3
227	10	2	2	2	6	8
230	43	17	18	10	8	18
296	107	23	45	11	39	50
TOTALS	1788	519	222	224	1047	1271

* secondary refits not conducted for this feature
**Stone lots = Refit groups + single fragments

Raw Material Selection

Frequencies of material type were calculated for each feature and for the entire assemblage, based upon the total number of fragments within a feature. Nine different material types were found within the TAS features and are summarized in Figure 11.31 by number of stone lots. Quartz and quartzite accounted for 79 percent of the TAS feature assemblage. The natural gravel sample (Section 13.0) consisted of 64 percent quartz and quartzite. Other material types were found within TAS features with less frequency: sandstone 6 percent, siltstone 7 percent, jasper 5 percent, chert 2 percent, ironstone 1 percent, conglomerate less than 1 percent, and hornblende less than 1 percent. Within the natural gravel sample, sandstone accounted for 18 percent and jasper accounted for 14 percent of the material, both higher frequencies than found within the feature assemblage. These results suggested the intentional selection of specific materials for use within TAS features.

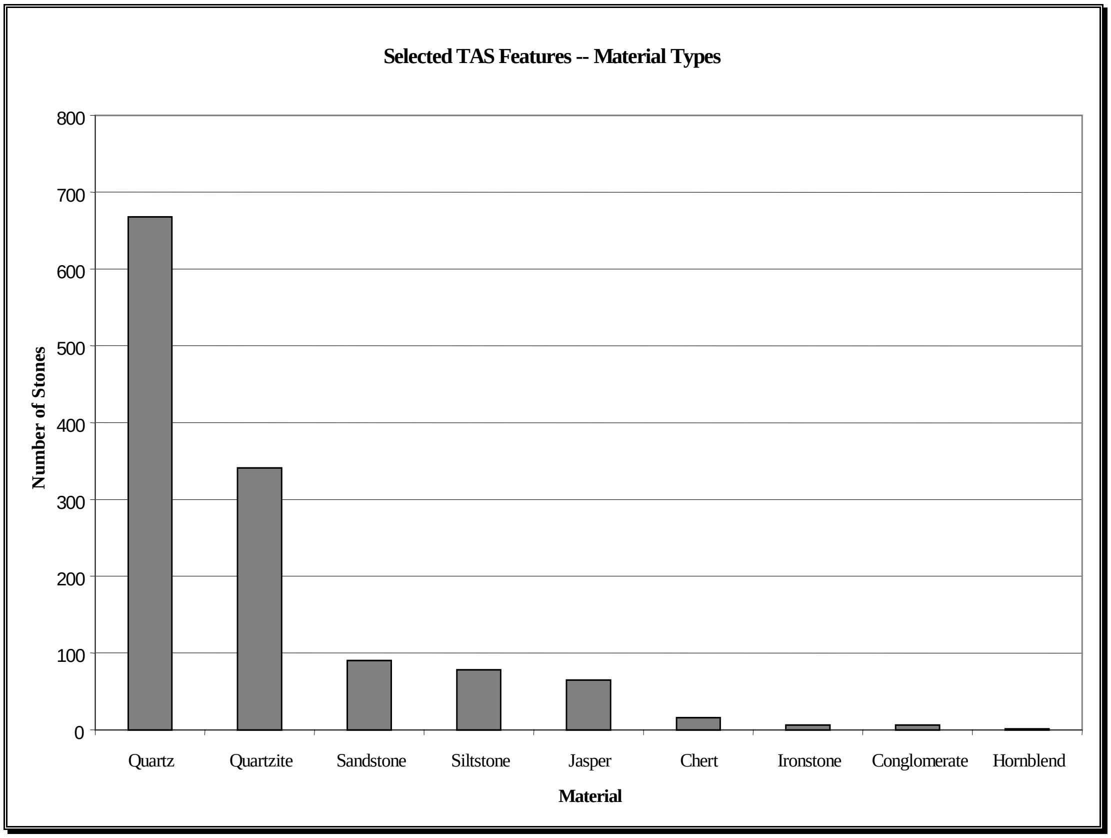

Figure 11.31 Selected TAS Features - Material Types

Frequencies of material types were then compared between features by stone lots and material type (Figure 11.32). The first two categories consisted of quartz and quartzite, as these two materials are similar in mineralogy. The next group consisted of sandstone and siltstone, which are similar substances and often overlap. The final category was the smallest in terms of total numbers of fragments, and was therefore combined for comparison in relation to the other materials. This group consisted of jasper, chert, ironstone, conglomerate, and hornblende.

Quartz and/or quartzite accounted for the majority of stones in 14 features. The exception was Feature 174 that contained only 50 percent quartz and quartzite (Figure 11.33). Features 62 and 87 had the next lowest frequencies of quartz and quartzite with 57 percent and 62 percent respectively. Whereas Feature 62 consisted of seven stone lots, Feature 87 comprised 91 stone lots and represented a substantial decrease in quartz and quartzite material in relation to the rest of the assemblage. As a result, no positive correlation existed between quartz and quartzite presence and total number of stones (i.e., higher total numbers did not necessarily result in higher percentages of quartz and quartzite).

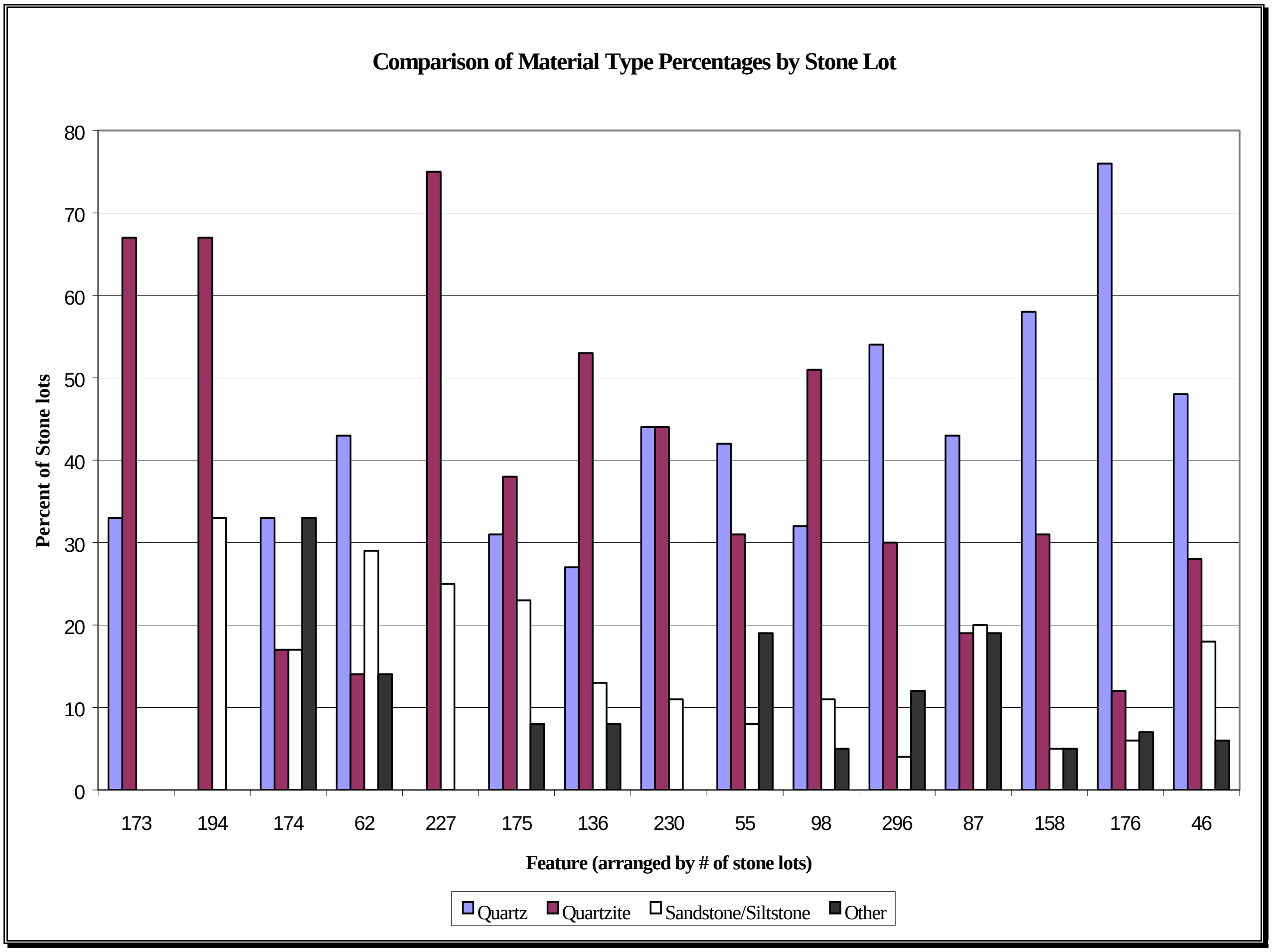

Figure 11.32 Comparison of Material Type Percentage by Stone Lot

Sandstone and siltstone were the next most abundant material types found within the features studied, together accounting for 13 percent of the total number of stone lots. Between features, the percentage of sandstone/siltstone ranged from 0-33 percent of the stones comprising a particular feature. However, the features that contained the highest percentage of sandstone/siltstone, Features 194 (33 percent), 62 (29 percent), 227 (25 percent), and 175 (23 percent), consisted of fewer total stones, which tended to exaggerate the percentages. For example, Feature 194 contained 3 stones, one of which was sandstone, or 33 percent. On the other hand, Feature 87 consisted of 91 stones, 18 of which were sandstone/siltstone; this represents about 20 percent of the feature and thus a higher incidence than the natural sample. Feature 46, which was comprised of the greatest number of stone lots, had the same percentage of sandstone/siltstone as the natural sample, about 18 percent. The other large features, 158 and 176, had some of the lowest frequencies of sandstone/siltstone presence, only 5-6 percent, which was significantly lower than the natural sample.

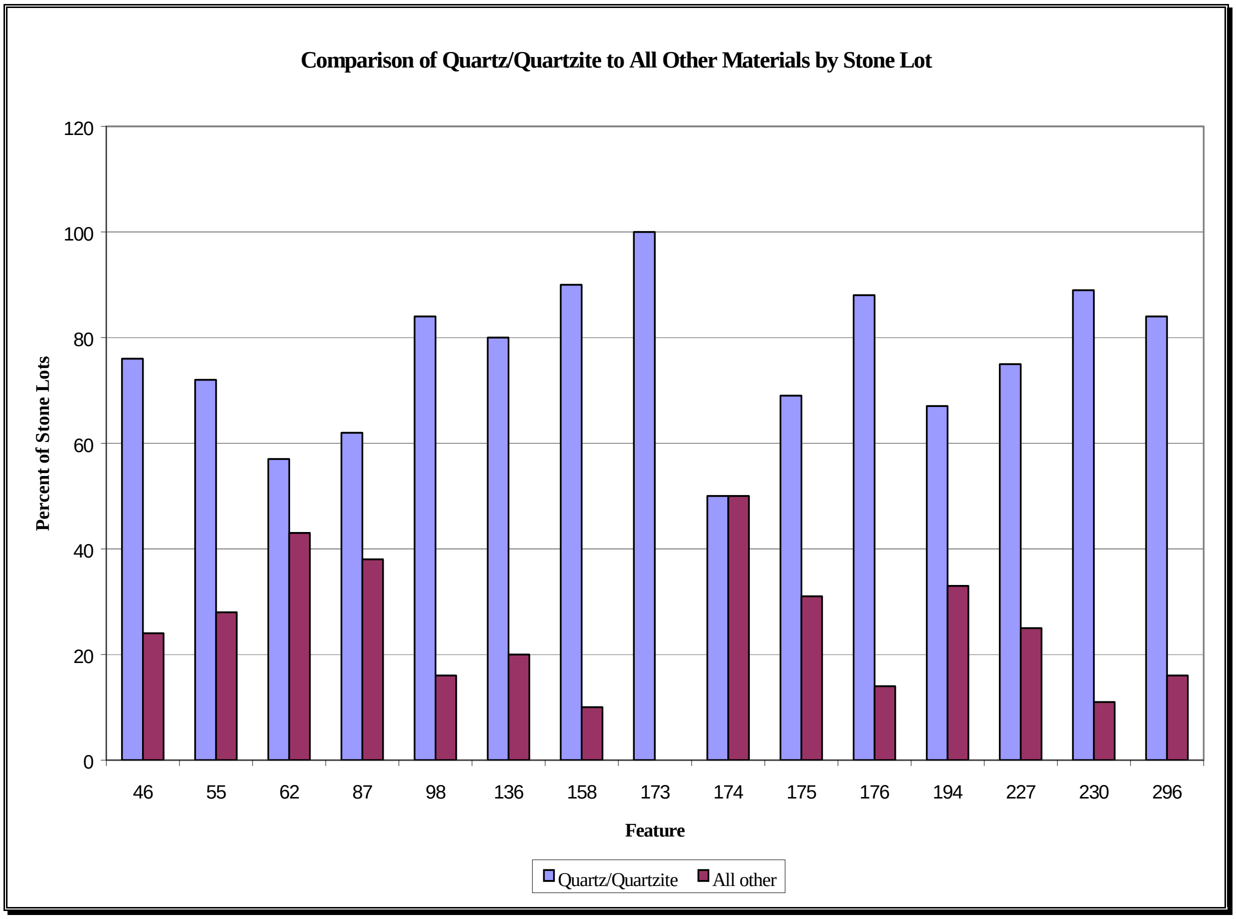

Figure 11.33 Comparison of Quartz/Quartzite to All Other Materials by Stone Lot

The other materials included jasper, chert, ironstone, conglomerate, and hornblende. These were presented as a combined group because the individual frequencies of these materials were too small in comparison to the rest of the assemblage. Within this subset, jasper was the most common material, and accounted for 69 percent of the category. Feature 174 had the highest percentage of "other" material at 33 percent. Features 87 and 55 both contained 19 percent "other" material and were sufficiently large in total number of stone lots to be deemed anomalies when compared to the rest of the assemblage. Features 46, 176, and 158, which represented the largest features in terms of total number of stones, contained only 5-7 percent of "other" materials, suggesting that their inclusion was not just a function of the size of the feature.

The variations of material types within the features of the study supported the notion of differential selection strategies for material types. As noted, quartz and quartzite dominated the assemblage in terms of numbers and percentages in most cases. The variability of the inclusion of sandstone/siltstone and 'other' materials may be indicative of varying functions or intended purposes for these features, as selection preferences were evident. Feature 87 displayed the greatest diversity of material type, by percentage of total stones, while Features 158 and 176 showed little diversity, suggesting careful selection. The smaller features, in terms of total stone lots, exhibited variety in the material types included, but no patterns could be established due to their smaller sample size. It could be that the smaller features functioned in such a way that strict material type choices were not necessary.

Heat Alteration Variables

Examination of heat alteration variables was conducted to assess questions about the intensity of the fire, differential heating properties of raw materials, and reuse or depositional patterns based on differential heat signatures on conjoined fragments. Variables directly related to heat alteration were specifically recorded for each individual fragment and included reddening, crazing, and pot-lidding of the stone. Further evidence of heating was examined by comparing the percentage of fire-cracked stone to visibly unaltered stone within a feature. Analyses of heat alteration variability, both within and between features, considered all individual fragments within a feature, as opposed to analysis focused on the stone lots (in order to quantify the full range of variation present). Fragments of the same stone could display differential heat alteration patterns as a result of their placement within a feature relative to the heat source, their reuse, or from similar effects after initial breakage had occurred.

The sample study features were quantified generally, by the amount of heat alteration compared to unaltered stones contained within the feature (Figure 11.34). As would be expected, the majority of the features displayed high percentages of heat alteration among the stones that comprised the feature. All but Features 176 and 227 contained greater than 80 percent heat altered stones. Feature 227 contained 10 fragments of stone, with only three displaying no signs of visible heat alteration. Feature 176 contained 264 fragments, 164 of which displayed no visible signs of heat alteration. This wide margin of difference clearly sets Feature 176 apart from the rest at this first level of examination.

The degree of variation of visible heat alteration between the different material types that comprised the features was the next variable considered. This examination was conducted before specific heat alteration within the features was examined, to provide an indication of how much variation between features may be attributable to material type and not necessarily to feature function. Variation in the type of heat alteration displayed by material type was noted (Table 11.3 and Figure 11.35).

The most common form of alteration displayed was reddening of the stone (69 percent), ranging from minor changes in hue to a deep reddening. In general, the material types displayed a similar percentage of reddening, with anomalies evident in conglomerate, chert and quartz. The conglomerate material was 100 percent reddened; however, these results can be dismissed as sampling bias, as only six fragments of this material representing a single stone lot were recovered from one feature. As a material type, chert displayed the lowest frequency of reddening (only 7 percent). Quartz also displayed differences in reddening percentage and was, aside from chert, the only material to show a lesser percentage of reddening than crazing. This result was likely a reflection of the quartz material containing less iron to oxidize than the other material types.

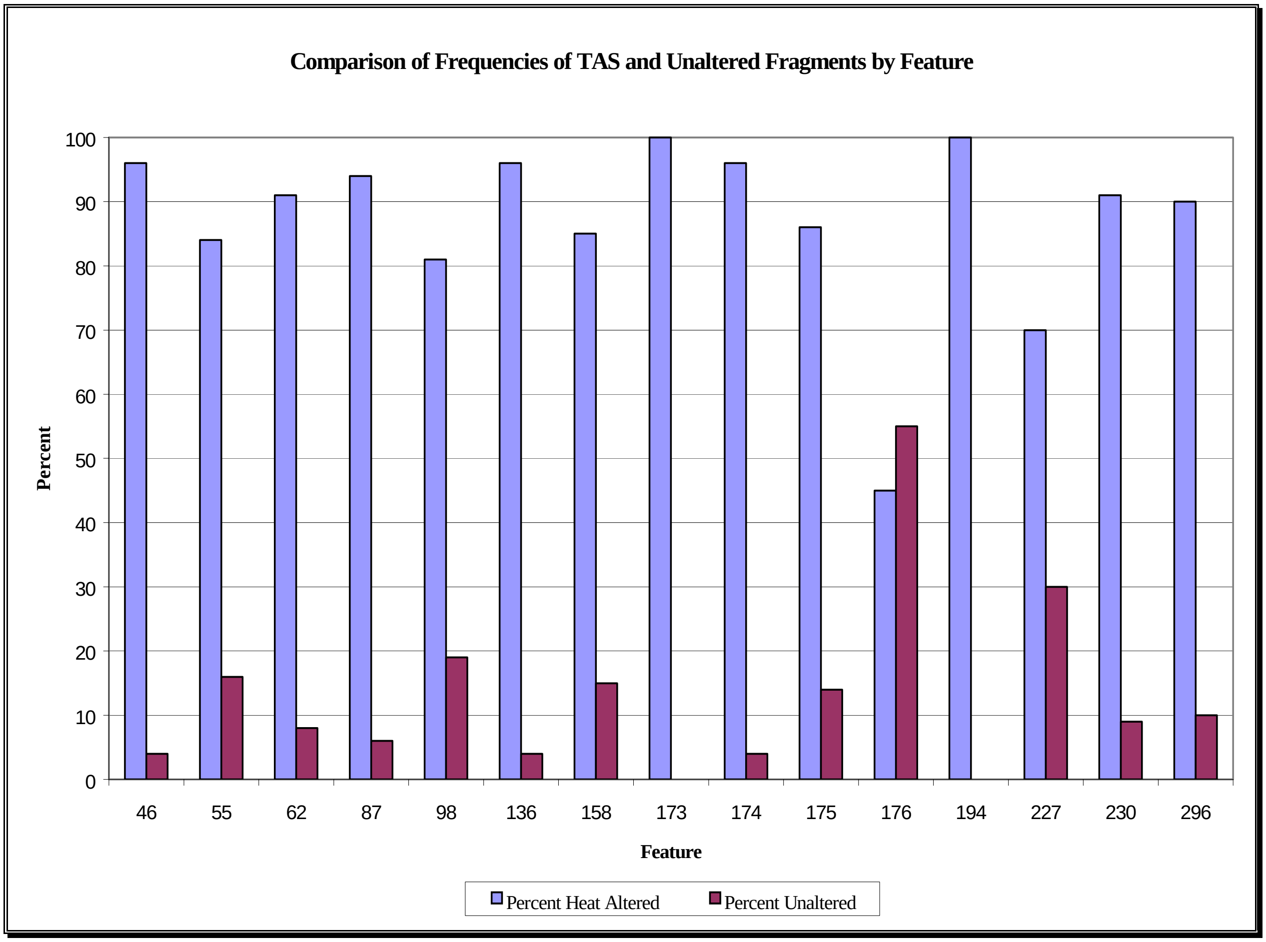

Figure 11.34 Comparison of TAS and Unaltered Fragments By Feature (Based on Frequencies)

The presence of crazing was noted on 59 percent of the fragments in the study, and showed a degree of clustering by material type. Jasper and siltstone were at the low end of the range, with less than 40 percent of fragments displayed crazing. In the middle range, with about 50 percent crazing, were chert, conglomerate, and quartzite. As before, the conglomerate sample size is too restricted to allow for an adequate generalization to be made. A high percentage of crazing was evidenced by sandstone (60 percent) and quartz (73 percent). These clusters are probably indicative of the durability of the material, which was recovered from a variety of different features. Examining crazed rocks in relation to their size might provide an interesting relationship (i.e., if smaller fragments evidence less crazing on their surfaces because they have already fragmented and broken down along the crazed lines).

Table 11.3 Detailed Analysis of TAS Features (Material Type and Heat Type)

Material Type compared to Heat-Type Breakdown

Material Type	**Chert**	**Conglomerate**	**Hornblende**	**Ironstone**	**Jasper**	**Quartz**	**Quartzite**	**Sandstone**	**Siltstone**	**Totals**
Totals	30	6	1	9	98	904	506	106	128	1788
Percentage (of assemblage)	2%	<1%	<1%	1%	5%	51%	28%	6%	7%	
Reddened	2	6	0	5	83	537	413	76	112	1234
Percentage (of material)	7%	100%	0	56%	85%	59%	82%	72%	88%	
Percentage (of heat type)	<1%	<1%	0	<1%	7%	44%	33%	6%	9%	69%
Cracked	16	3	0	0	32	659	238	64	49	1061
Percentage (of material)	53%	50%	0	0	33%	73%	47%	60%	38%	
Percentage (of heat type)	2%	<1%	0	0	3%	62%	22%	6%	5%	59%
Pot-lidded	8	0	0	0	27	27	28	0	11	101
Percentage (of material)	27%	0	0	0	28%	3%	6%	0	9%	
Percentage (of heat type)	8%	0	0	0	27%	27%	28%	0	11%	6%
No Visible	9	0	1	4	15	167	51	11	8	266
Percentage (of material)	30%	0	100%	44%	15%	19%	10%	10%	6%	
Percentage (of heat type)	3%	0	<1%	2%	6%	63%	19%	4%	3%	15%

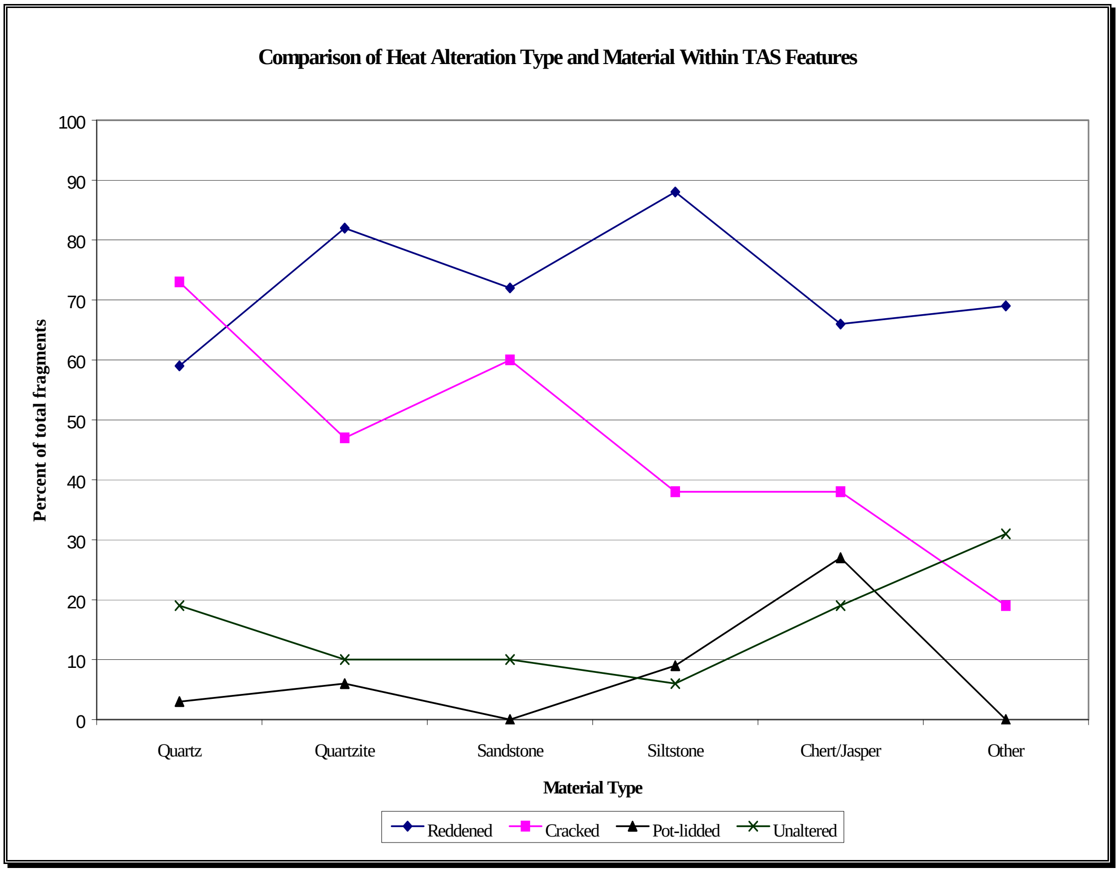

Figure 11.35 Comparison of Heat Alteration Type and Material within TAS Features

Pot-lidding was by far the least common type of heat alteration found within the assemblage, as only 6 percent of the fragments had pot-lidded surfaces. The chert and jasper fragments had nearly identical frequencies of pot-lidding, most likely related to their cryptocrystalline nature. Pot-lidding was present on quartz, quartzite, and siltstone fragments but in all cases amounted to less than 10 percent of the frequencies. The low overall frequency of pot-lidding is more likely reflective of the materials contained within the features and not indicative of a less intense use of those features.

After determining the heat alteration trends that occurred within the material types, the features were compared and contrasted for patterns of heat alteration (Table 11.4, Figure 11.36). As with material type, reddening was the dominant form of heat alteration among the features; however, variation did occur in the percentage of reddening between features (Figure 11.37). Feature 176 had the lowest frequency of reddening (only 37 percent), which separated it from the rest of the assemblage. The next cluster of features ranged in their percentage of reddening from 55-60 percent, and included Features 62, 98, and 194. The next cluster of features was the largest, and had percentages of reddening that ranged from 70-81 percent. Although this is a wider interval, the net changes of frequency between these features remains less than 5, which suggested their correlation. This cluster included Features 227, 87, 46, 296, 175, 158, and 55. The final cluster ranged in percentages from 91-100 percent of the fragments reddened. It included Features 230, 136, 174, and 173.

Table 11.4 Detailed Analysis of TAS Features (Heat Type)

Breakdown of Feature by Heat-Type									
Feature	**Total**	**Reddened**	**Percent Reddened**	**Cracked**	**Percent Cracked**	**Pot-lidded**	**Percent Pot-lidded**	**No Visible**	**Percent No Visible**
46	727	529	73%	544	75%	12	2%	31	4%
55	67	54	81%	33	49%	2	3%	11	16%
62	11	6	55%	10	91%	1	9%	1	9%
87	173	121	70%	96	55%	27	16%	10	6%
98	52	30	58%	33	63%	8	15%	10	19%
136	26	24	92%	18	69%	4	15%	1	4%
158	225	173	77%	109	48%	18	8%	34	15%
173	33	33	100%	0	0	0	0	0	0
174	23	22	96%	3	13%	0	0	1	4%
175	22	17	77%	13	59%	1	5%	3	14%
176	264	97	37%	92	35%	11	4%	146	55%
194	5	3	60%	5	100%	0	0	0	0
227	10	7	70%	1	10%	2	20%	3	30%
230	43	39	91%	31	72%	1	2%	4	9%
296	107	79	74%	73	68%	13	12%	11	10%

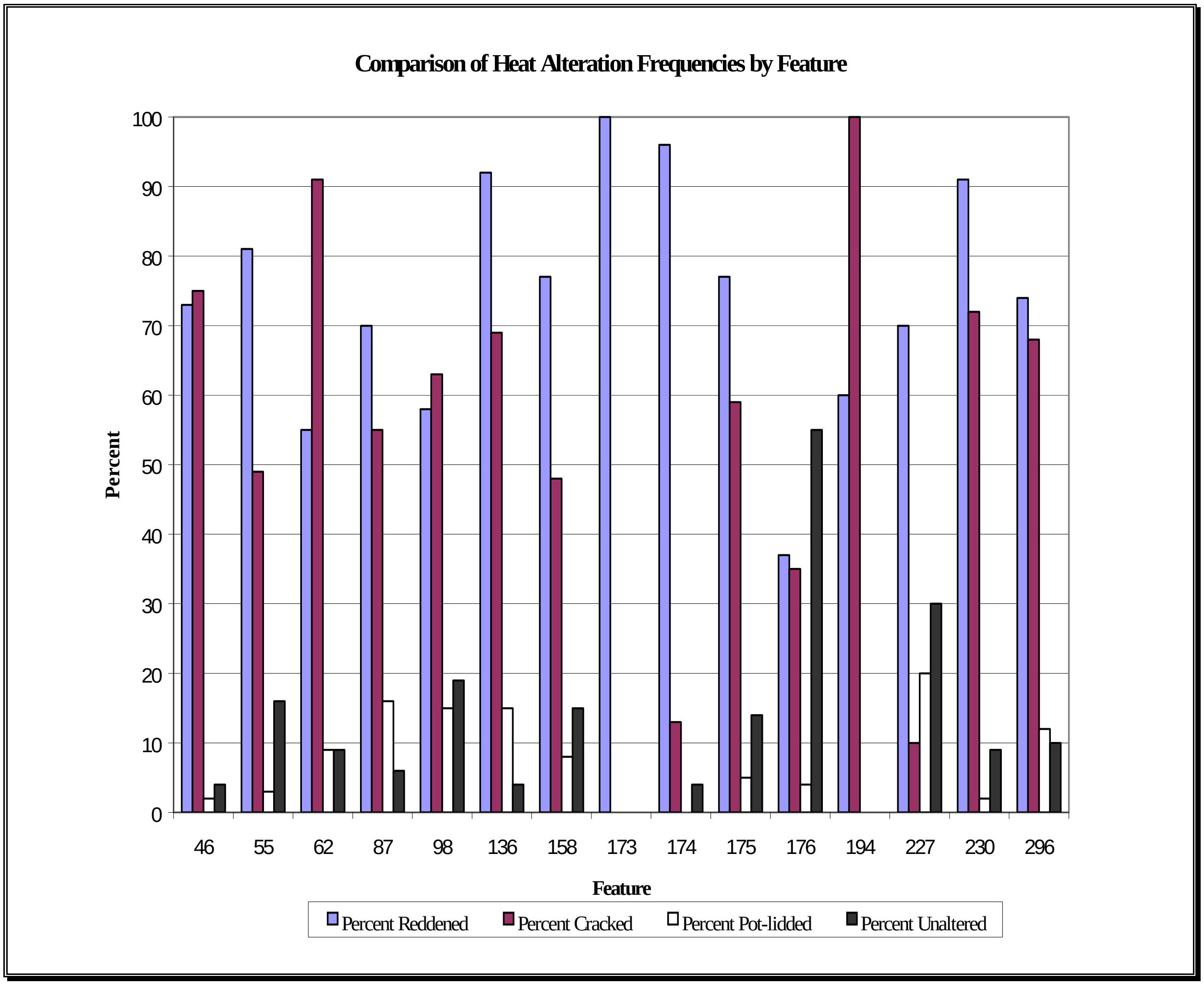

Figure 11.36 Comparison of Heat Alteration by Feature (Based on Frequencies)

The percentage of crazing between features displayed considerably more variation (Figure 11.38). Feature 173 was the only feature to show no crazing on any of its fragments, and was therefore unique. Features 227 and 174 had a similar degree of crazing of their fragments (10-13 percent). The fragments that comprised Feature 176 displayed a 35 percent frequency of crazing, and separated this feature from the rest of the assemblage. The next cluster was large and tended to show a steady increase of crazing rather than large changes and therefore could not be easily sub-divided. This cluster exhibited between 48 and 75 percent frequency of crazing, and included Features 158, 55, 87, 175, 98, 296, 136, 230, and 46. Despite the fact that the cumulative net change from the beginning to the end of this cluster was large, the interior changes were small implying less variation among the features. The final cluster was also not very tight and showed a degree of variation between its constituent features. This cluster ranged in percent crazed from 91-100 percent, and included Features 62 and 194.

The frequency of pot-lidding for all features was comparatively low and did not display a large degree of variation between features (Figure 11.39). The variations that existed may relate more to the material within the feature than to attributes of the feature. Features 194, 173, and

174 displayed no pot-lidding on any fragments. Features 227, 230, 46, 55, 176, and 175 had frequencies of pot-lidding that ranged from 2-5 percent. The next range was from 8-12 percent and contained Features 158, 62, and 296. The final grouping consisted of Features 136, 98, and 87, which had pot-lidding frequencies of 15-16 percent. Overall, the change in frequency from 0-16 percent was substantial, but showed no drastic changes between the features and was characterized by a slow, steady increase. The highest net change between any feature was 3, which when compared to other variables was not great. Therefore, pot-lidding as a variable does not seem to be a clear indicator of difference between TAS features and may likely be related more to material type.

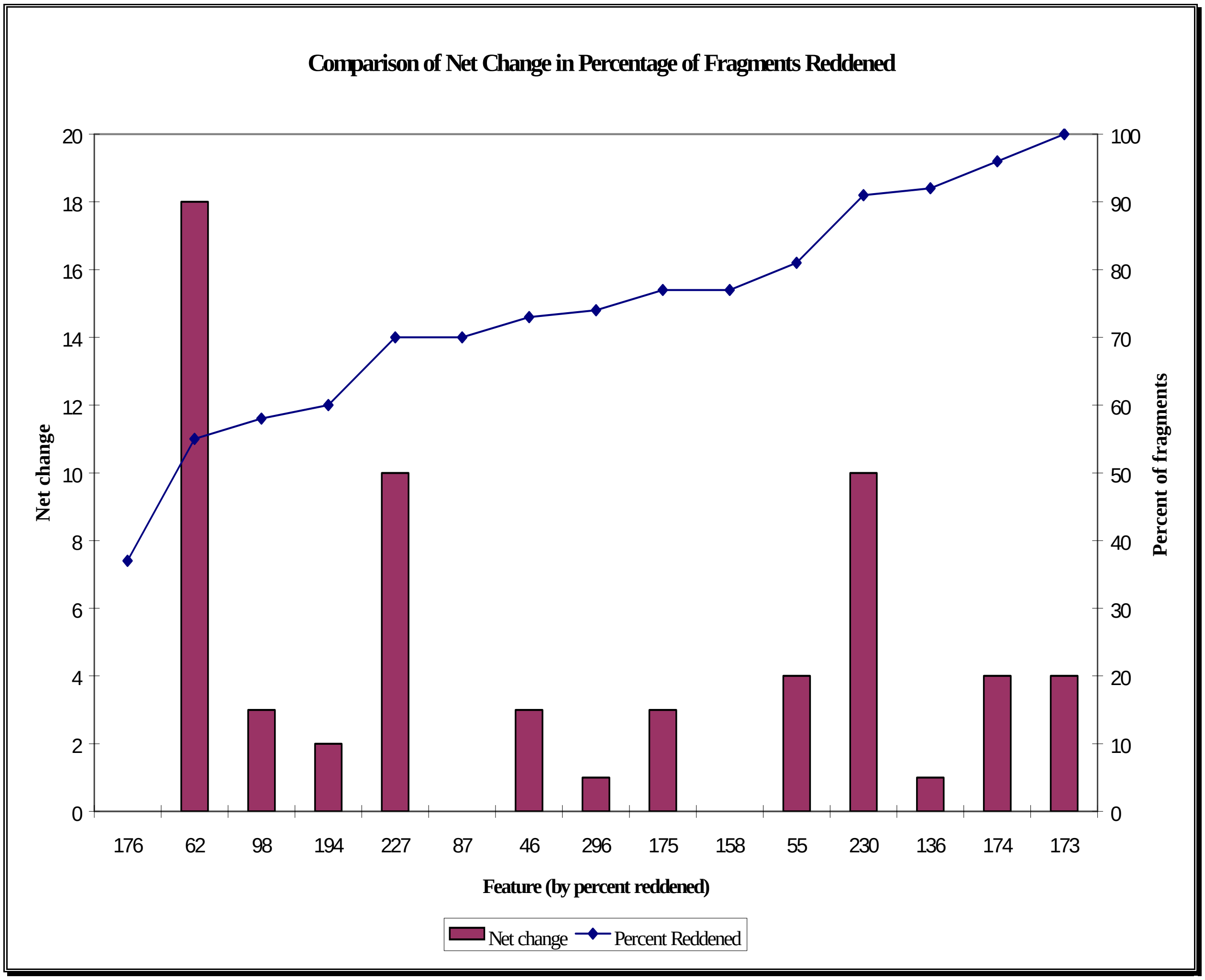

Figure 11.37 Comparison of Net Change in Percentage of Fragments Reddened

An interesting trend that became apparent from the comparison of types of alteration was the almost inverse relationship between reddening and crazing. When examining both material type and individual features for types of heat alteration, the degree of reddening and crazing seemed to have an inverse relationship: those with high reddening exhibited less crazing; those with lower reddening had higher crazing. This relationship did not hold in all cases, but was evident in 11 of 15 features and in most material types except for sandstone (the “other” category was too small a sample to include within this generalization). This type of relationship could be an indicator of a different causal factor, however, previous stone boiling and heating experiments have indicated that reddening, crazing, and fracturing can be obtained from either open air cooling or submersion in water (Custer and Silber 1995; Cavallo 1987). Therefore, another variable for attribute analysis was necessary for a fuller understanding of feature variation -- fracture patterning.

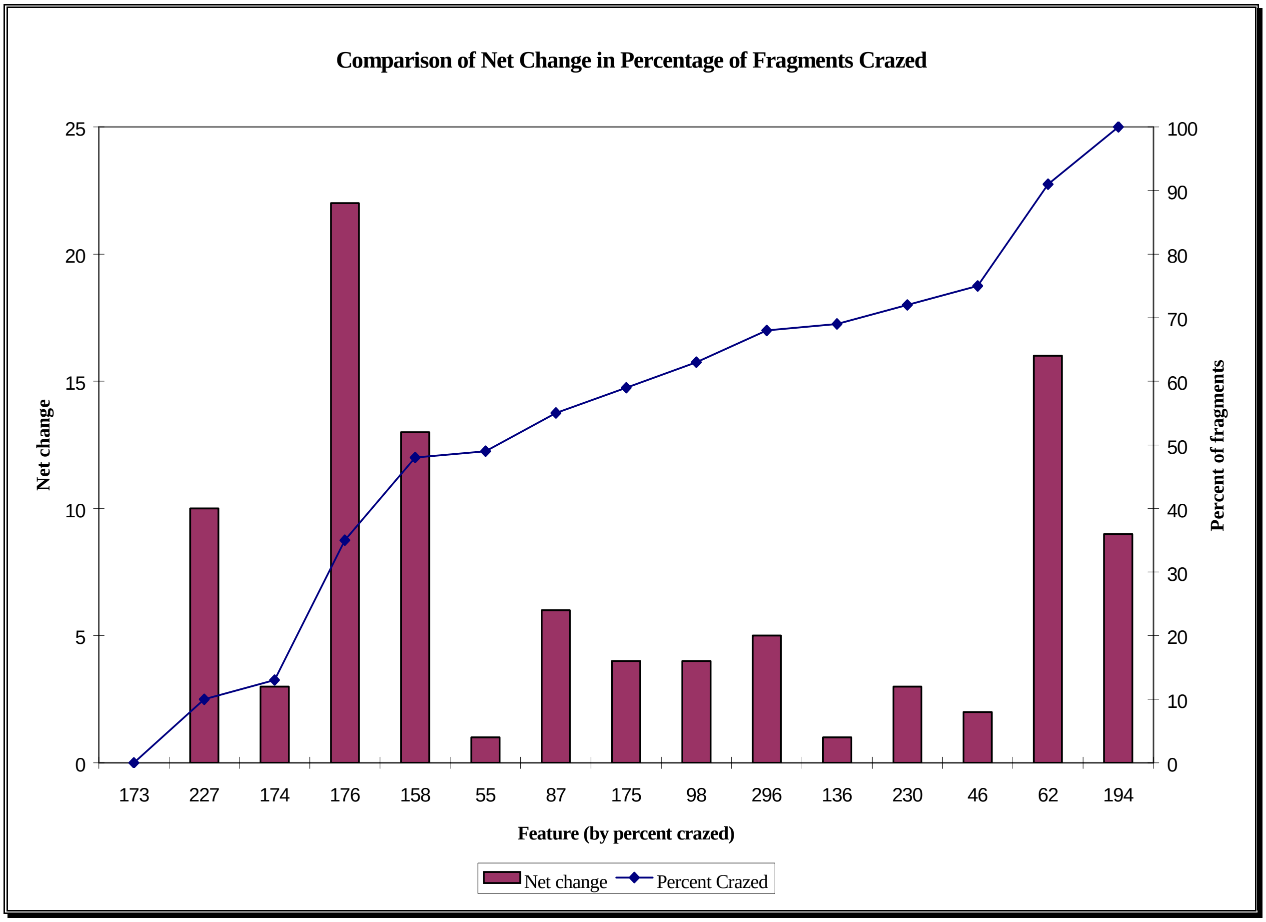

Figure 11.38 Comparison of Net Change in Percentage of Fragments Crazed

Fracture Patterning

A variety of stone attributes fall under the general theme of fracture patterning, including total weight, mean weight, fracture percentage, refit percentage, and percent completeness. A wide variation occurred in the frequency of fractured fragments contained in TAS features and their weights. These categories help quantify the differences in breakage among and between the features, and allow comparisons and contrasts.

Total weights for each feature were calculated by summing the weights of each fragment of stone contained within the designated feature boundaries. Fragments included in this calculation were thermally altered stone, pebbles, cobbles, cores, and hammerstones; debitage, ceramics, or more formal chipped stone tools, if present within the same spatial delineation, were not considered. Total weight comparisons are considered a way to assess the relative size range of fragments within the features (i.e., if weight increased proportionally with the total count [high count = high weight], it would suggest a relative uniformity of size among the pieces) (Petraglia et. al. 1998a, 1998b). When the total weights of the sample TAS features were arranged by total count and their total weights compared, a general proportional relationship was evident (Figure 11.40). Features with more pieces of TAS were heavier, albeit with some slight variance in features at the lower end of the range. However, three features exhibited total weights counter to this proportional trend: Features 173, 98, and 176. Both Features 173 and 98 fit the overall trend in that their weight increased with an increase in total count, but the proportion of this increase was greater than expected from the increase in count. This implied that the fragments that comprised these features were generally larger in size than those that comprised the other TAS features. Although Features 230 and 55 decreased in weight with an increase in count compared to Features 173 and 98, respectively, they more closely conformed to the expected trend and were therefore not considered anomalies in the curve. Feature 176 experienced a decrease in total weight as its total count increased compared to Feature 158, suggesting that the fragments that comprised Feature 176 were of smaller size than those within the rest of the sample assemblage.

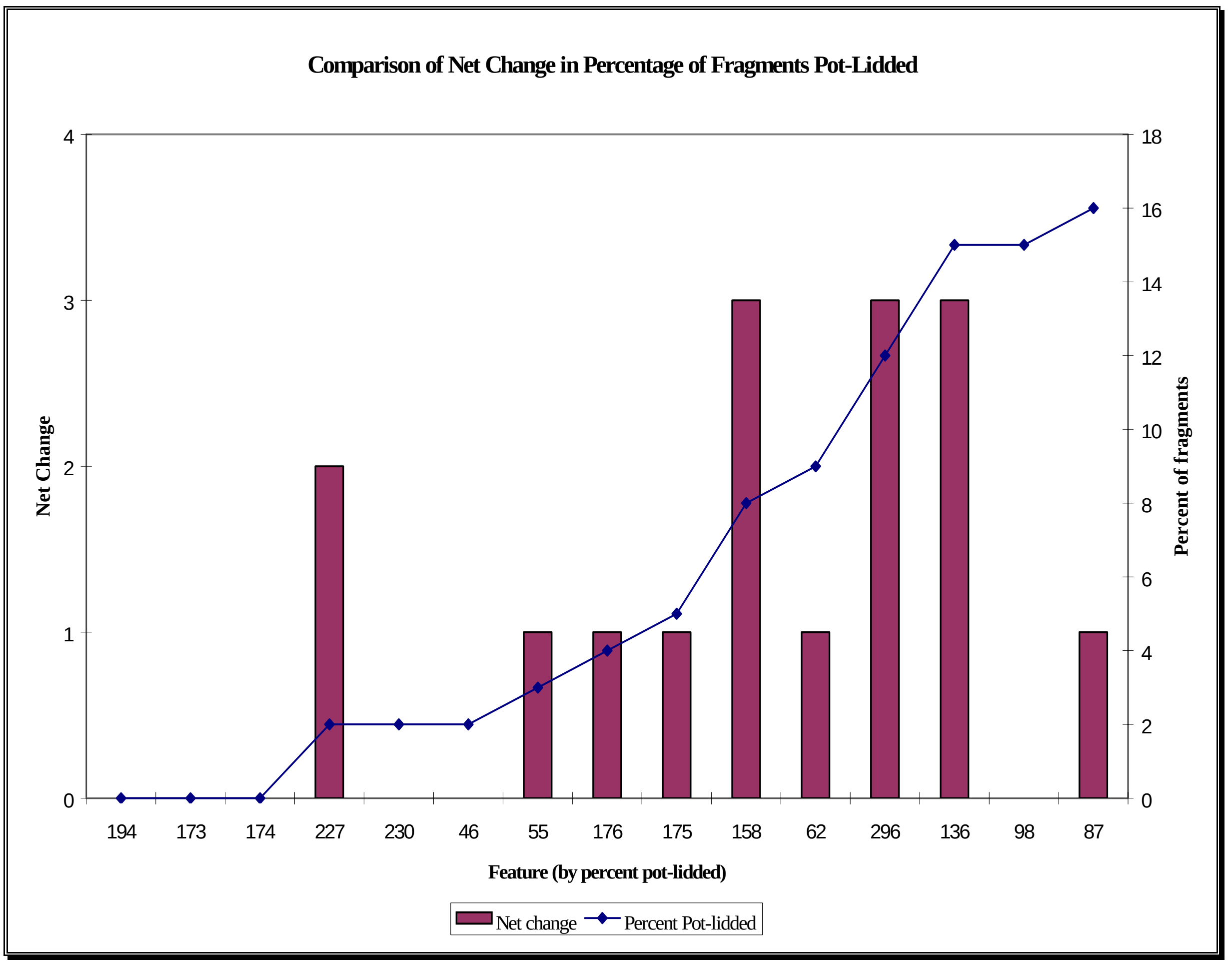

Figure 11.39 Comparison of Net Change in Percent of Fragments Pot-lidded

Estimations of fragment size can be further assessed by comparisons of the mean weight of the features. Mean weights were calculated for each feature, based on the total number of fragments and their combined weight. The mean weights displayed variation between features, but overall tended to exhibit a negative correlation with counts (Figure 11.40) suggesting that a slight tendency for fragments contained in features with high counts to be smaller and more highly fragmented. Feature 194 contained the highest mean weight (439.2 g) and fewest overall pieces (5), which ranged from 84.6 to 834 g in weight.

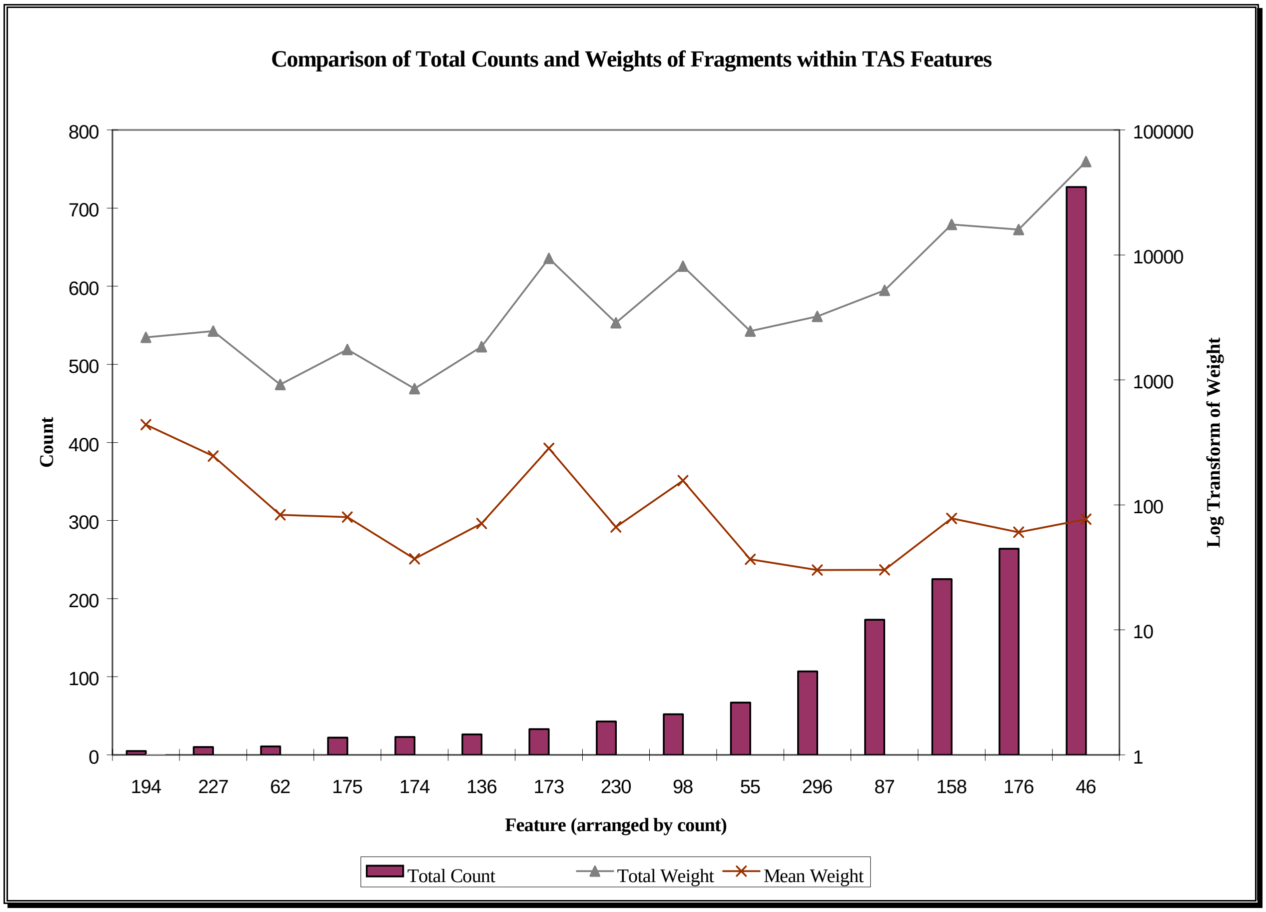

Figure 11.40 Comparison of Frequency and Weights of Fragments within TAS Features

This result was anomalous within the group and separated this feature from the rest of the assemblage. Feature 227 also exhibited a relatively high mean weight of 246 g for the 10 fragments that it contained, implying in both cases that these features contained larger sized fragments of TAS than other features (a trend that was not observed when only total weight was considered). The curve becomes more regularized between Features 62, 175, 174, and 136 with only a slight deviation that suggested Feature 174 contained relatively smaller sized fragments. Anomalies in the curve occurred, as with total weight, for Features 173 and 98, which both exhibited increased total mean weight with an increased count, counter to the rest of the curve. This again suggested that fragments contained within these features were generally larger in size than those contained within the rest of the sample features. Another slight increase of mean weight occurred with Features 158, 176, and 46. However, given that these features had much higher overall counts, the chances were greater for the inclusion of a few larger fragments within the feature that would increase the total mean weight. Therefore, it is considered that this slight discrepancy does not undermine the general trend that suggested a negative correlation between mean weight and total count. When the features were arranged by mean weight and compared, two main clusters were identified: 1) Features 296, 87, 55, 174; and 2) Features 176, 230, 136, 46, 158, 175, and 62 (Figure 11.41). The remaining four, Features 98, 227, 173, 194 all displayed disparity from the rest of the assemblage and each other, which suggested a degree of difference in the fragment sizes within these features.

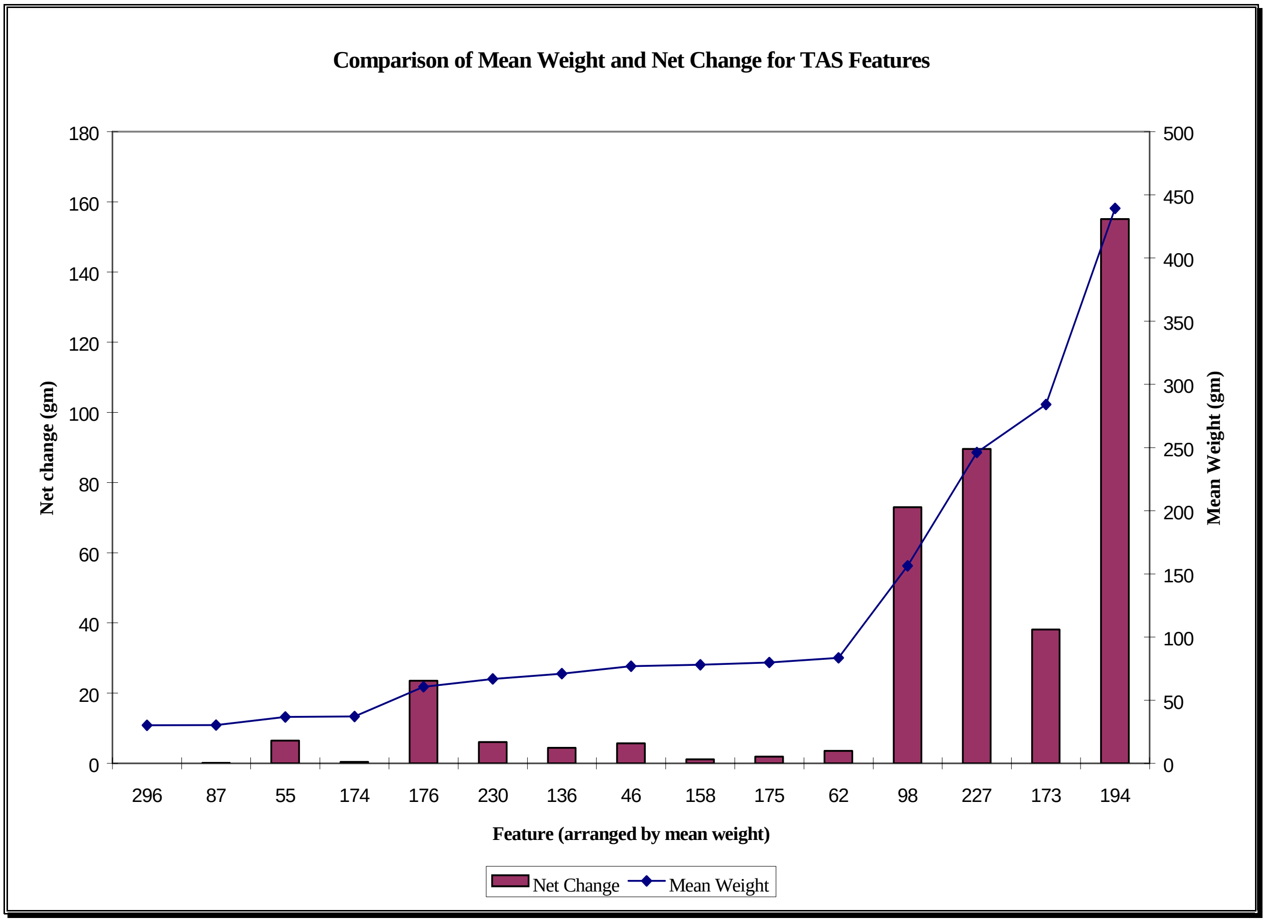

Figure 11.41 Comparison of Mean Weight and Net Change for TAS Features

The fracture percentages of each feature were calculated in order to compare the amount of breakage that occurred within and between the features. Fracture percentage was determined by summing the occurrence of pebbles, cobbles, and fire-cracked rock that remained 100 percent complete and did not refit with other fragments (i.e., whole stones that exhibited reddening or crazing but did not fracture into multiple fragments). This sum was then subtracted from the total number of fragments and this result divided by the total number of fragments within the feature to represent the amount of breakage present within the stones. A comparison of fracture percentages between features arranged by total count is depicted in Figure 11.42.

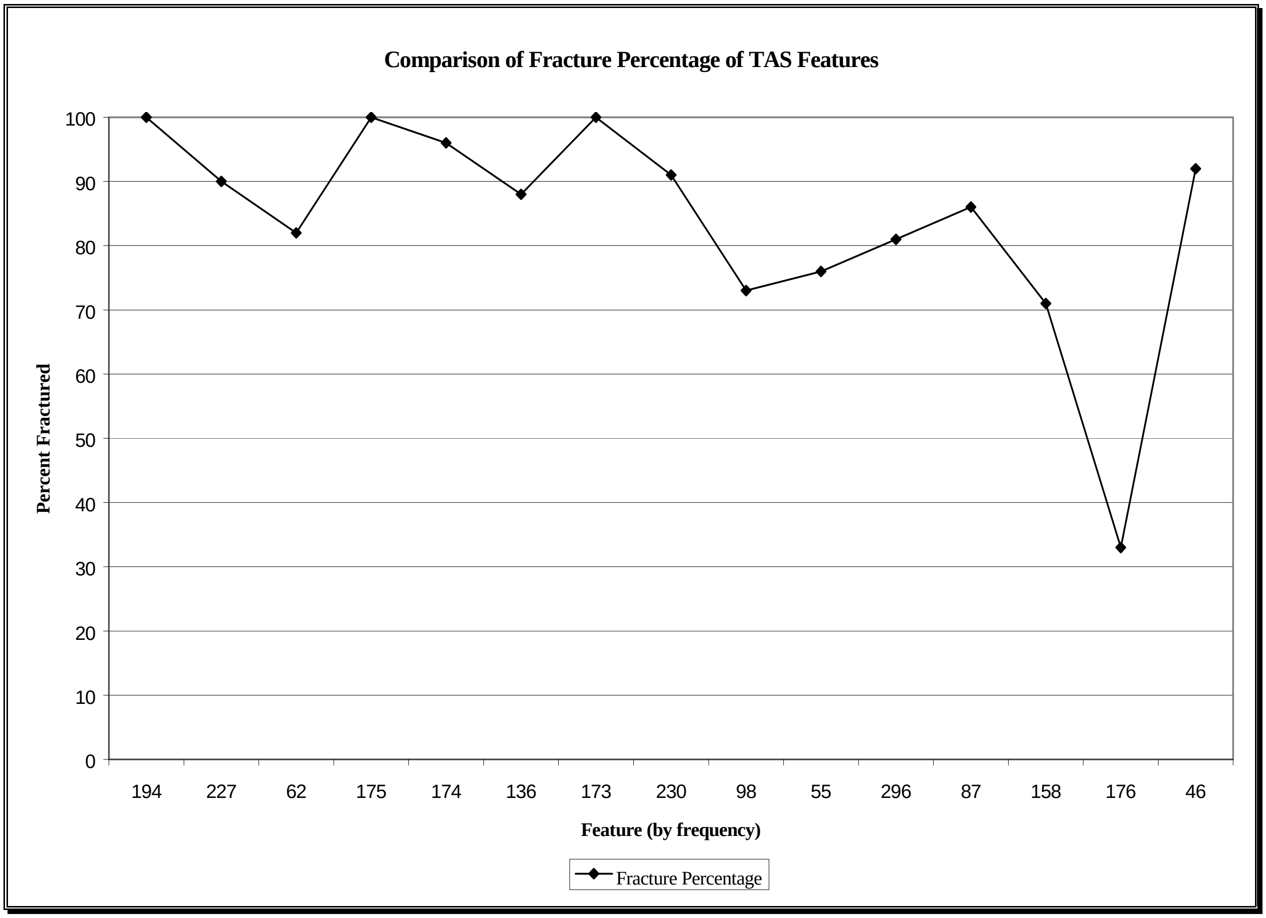

Figure 11.42 Ratio of Fracture Percentage to Total Count of TAS Features

A positive correlation between total number of fragments and fracture percentage was not obtained. Large total counts did not always indicate high rates of fracture. The curve oscillated, punctuated by features that were completely fractured. In fact, the smaller features, in terms of total number of fragments, displayed a negative correlation with fracture percentage, for example, Features 194, 227, and 62 and then again between Features 175, 174, and 136. A positive association was established between some of the larger features, such as Feature 98, 55, 296, 87, and 46, but was interrupted by the negative relation of Features 158 and 176.

The calculated results of the fracture percentages revealed a degree of variation between the features (Figure 11.43). Feature 176 was at the low end of the range and had a fracture percentage of only 33 percent, which was significantly lower than any of the other features within the sample study. This feature contained the highest number and percentage of pebbles that also displayed no visible signs of heat alteration. The next cluster consisted of Features 158, 98, and 55, and ranged from 71-76 percent fractured. After this group, the clusters became less clear as the assemblage began to increase in fracture percentage in small, steady increments, such that the largest deviation between features was only 4 percentage points. A small cluster consisted of Features 296 and 62, with fracture percentages of 81-82 percent. The next group had percentages that steadily increased from 86-92 percent fractured and consisted of Features 87, 136, 227, 230, and 46. The final group of features had fracture percentages of 96-100 percent, and included Features 174, 194, 173, and 175. Although the degree of difference between the fracture frequencies of the features was not very great, aside from Feature 176, it provided another level of quantification to assess the variation within the assemblage.

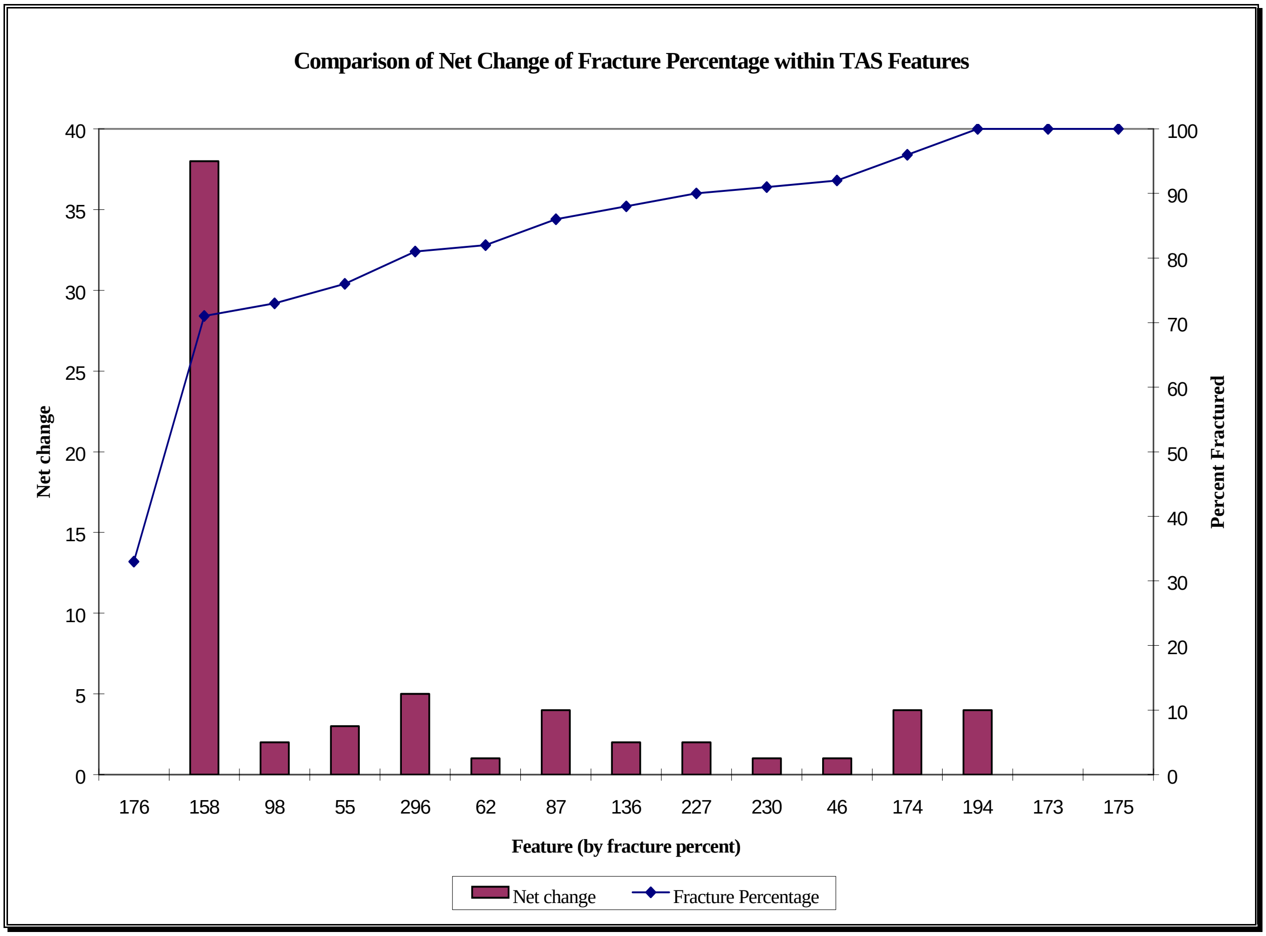

Figure 11.43 Comparison of Net Change of Fracture Percentage within TAS Features

Refit percentage was calculated for each feature based on the total number of fragments and not individual stone lots, and was used to indicate the overall degree of refitting. The calculation was obtained by adding all fragments within a feature that were primary refits (directly conjoins) and dividing this sum by the total number of fragments within the feature. For example, if three pieces connected together it would be counted as three, and not one, refit. Secondary refit percentages were also calculated in the same manner, with the number of secondary refits divided by the total number of fragments. This was implemented for comparative purposes and to assess the degree to which fragments may or may not have been removed from the feature clusters. Finally, both primary and secondary refits were added to arrive at the total number of refits, and divided by the total number of fragments for quantification of the total refit percentage (Figure 11.44).

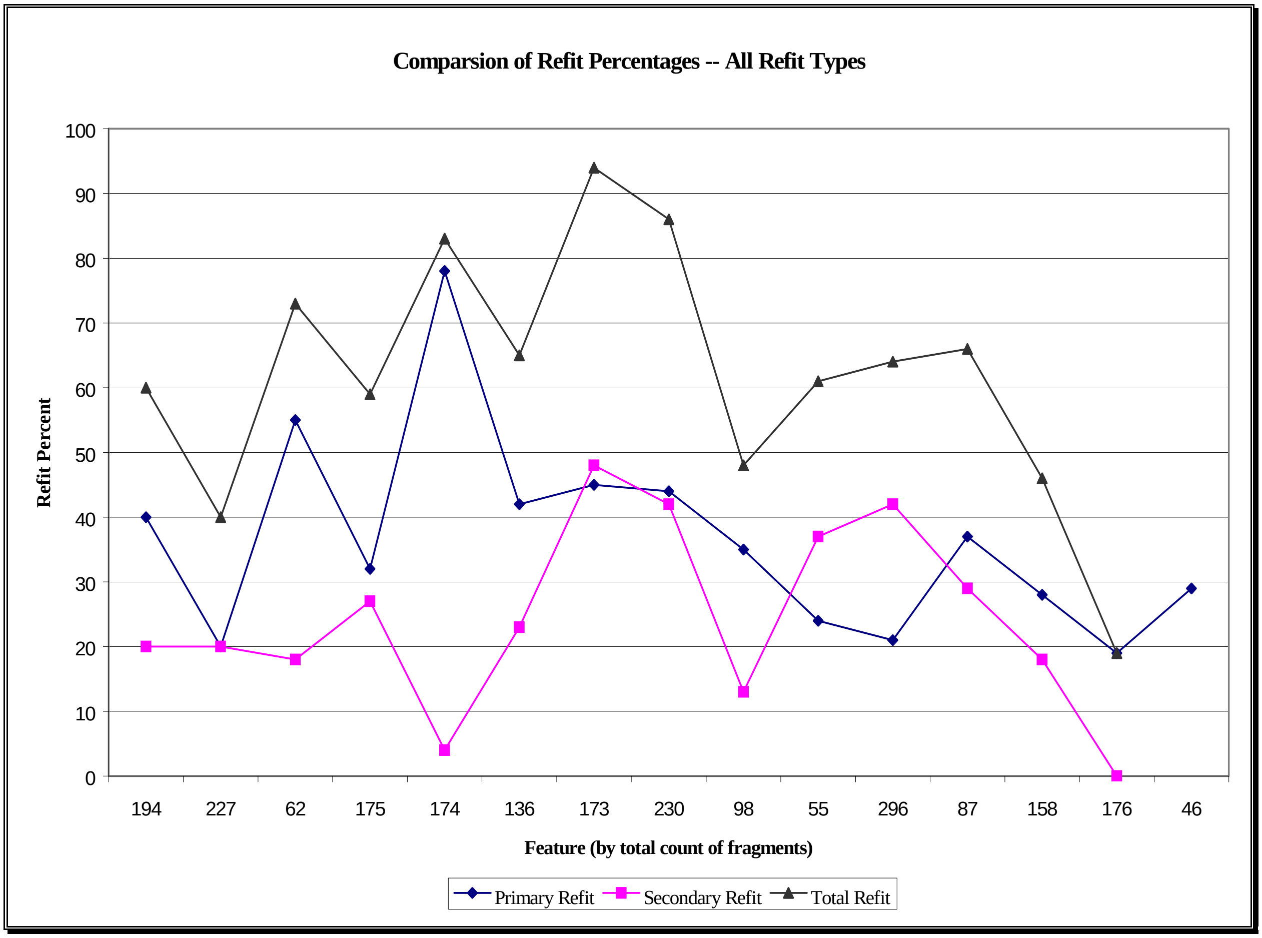

Figure 11.44 Comparison of Refit Percentages - All Refit Types

Comparison of primary refit percentages and the total count of stones per feature did not reveal consistent patterning. High total counts did not necessarily result in higher or lower refit percentages. A negative correlation developed for features within the middle range of total counts. Between Features 136, 173, 230, 98, 55, and 296 increased total counts had lower primary refit percentages, which suggested that fragments may have been removed from within feature boundaries, through either natural or cultural processes, or that the fragments had broken down too small to facilitate refitting. The highest primary refit percentage was attained for Feature 174 at 78 percent. It comprised 23 fragments that conjoined into two refit groups for a total of only six stone lots. Feature 62 had the next highest primary refit percentage at 55 percent, which was considerably lower than Feature 174. The majority of the features ranged between refit percentages of 28-45 percent, without large differences between them (Features 158, 46, 175, 98, 87, 194, 136, 230, and 173). The lowest refit percentages ranged from 19-24 percent, for Features 176, 227, 296, and 55. The lowest refit percentage corresponded to Feature 176, and was reflective of that feature containing the most unaltered pebbles, cobbles, and non-fractured TAS, which therefore could not be refit.

Comparisons of secondary refit percentage to total count also did not result in clear patterning. In general, secondary refit percentages seemed to display a greater variation between features, while maintaining a smaller total range of 0-48 percent. Feature 176 had the lowest secondary refit percentage, related to its high number of non-fractured pebbles and cobbles. The next lowest secondary refit percentage was attained for Feature 174, which contained the highest primary refit percentage. This negative correlation was not surprising given the low number of total stones and the high number of primary refits. Feature 98 had a 13 percent secondary refit percentage, which was also negatively correlated to its primary refit percentage. Features 194, 62, 136, and 176 displayed a similar negative disparity between primary and secondary refit percentages. In contrast, Features 227, 175, 230, 87, and 158 had relatively similar refit percentages, and secondary refits remained lower than primary refits. Conversely, the refit percentage for Feature 173, which was the highest overall secondary refit percentage, was actually higher than its primary refit percentage. This single refit group represented a large fragmented boulder with the numerous smaller spalls being the fragments that could not be directly conjoined. Features 55 and 296 were the only other features to display distinctly greater secondary to primary refit percentages resulting in a negative correlation.

The previous results were then combined to assess the total refit percentage for the features. The combination of primary and secondary refits did not produce any unexpected results. It did, however, highlight Features 173 and 230, which had comparable primary and secondary refit percentages, and thus, high overall total refit percentages. This result was anticipated for Feature 173, which comprised only three stones, one of which was a large and fragmented boulder. Feature 230, on the other hand, consisted of 43 total fragments, that, after the high refit percentages, represented only 18 stone lots. Comparisons of refit percentages between features displayed a fair amount of variation with few clear clusters of similar features based on this trait (Figure 11.45). Although high refit percentages suggested that the stones were fragmented and in close spatial proximity, taken alone it could not determine the amount of the stone that remained within the feature. A highly fragmented stone could produce a high refit percentage, which could mask attributes for the rest of that feature or result in a refit group that was still only a small portion of the total stone.

To assess the amount of initial stone still present within identified TAS feature boundaries, the attribute of percent completeness was needed to overcome the limitations of refit percentages. Whereas total weight and mean weight related to questions of fragment size and fracture and refit percentages were concerned with intensity of use and depositional integrity, percent completeness considered the portion of stone still present within a feature to assess reuse and discard. Percent completeness can only be estimated for stones that were 50 percent or greater complete. Higher percent completeness percentages indicated that more of the stone was present. Percentages of less than 50 percent indicated that the stones were highly fragmented and were missing significant amounts of the stone, due to displacement by either natural post-depositional agents or by cultural practices.

Analysis of percent completeness was necessarily conducted at the level of stone lots rather than individual fragments. For a base level of comparison, material types were summarized by their frequency of percent completeness to determine the level of influence material type may have on percent completeness. No correlation or pattern was established between material and percent completeness. Instead, the results were consistent with the sample sizes (i.e., no material type exhibited a range outside what would be expected based on the number of stone lots of that material type). As a result, material type could be eliminated as a significant factor that influenced the range of variation between features related to percent completeness. Therefore, variations would be related to some other factor specific to the feature itself.

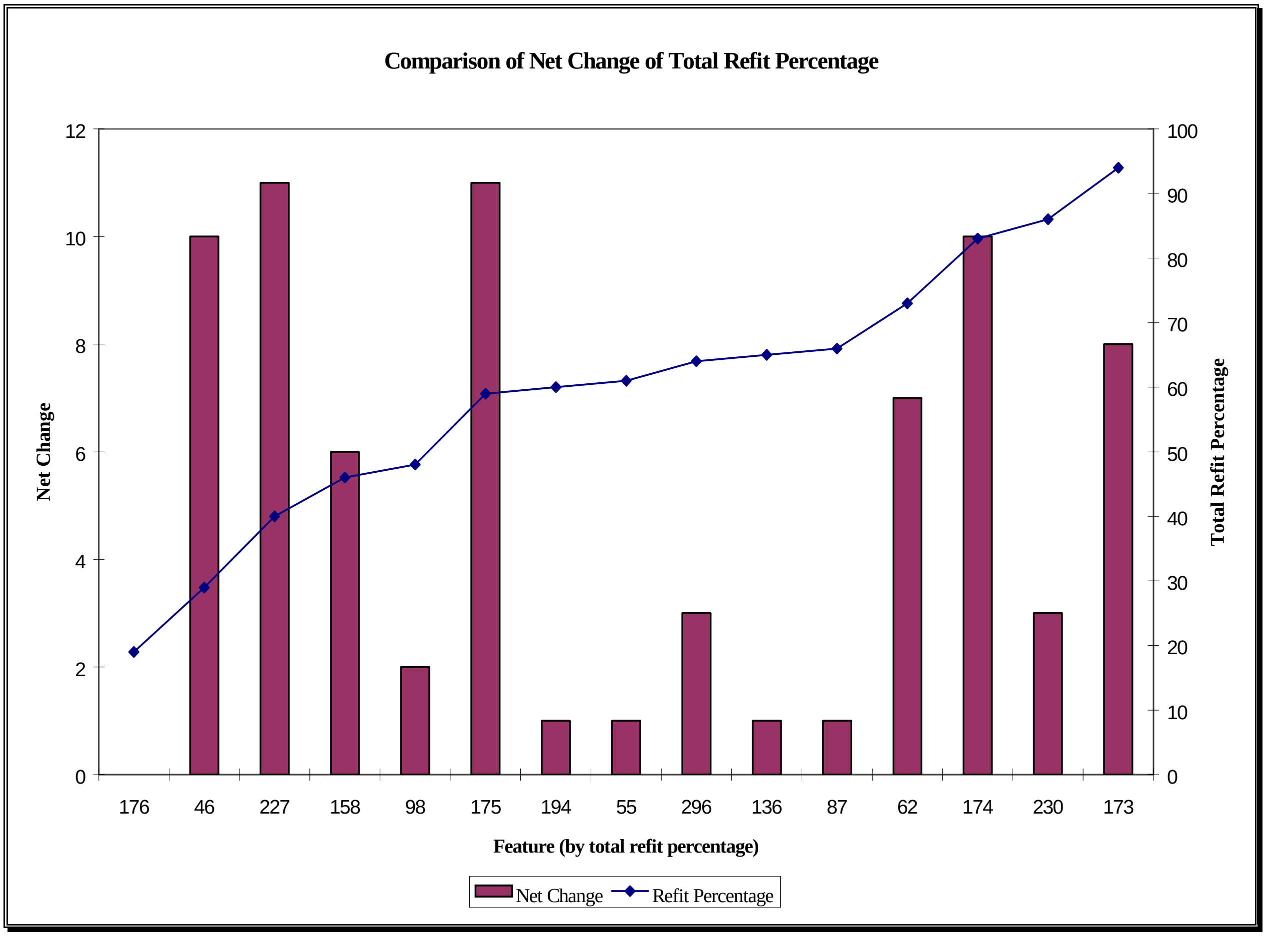

Figure 11.45 Comparison of Net Change of Total Refit Percentage

The greatest amount of percentage variation between features was exhibited in the categories of less than 50 percent complete and 100 percent complete. The other subdivisions exhibited some variability in the 50-59 percent and 90-99 percent complete categories, but overall these were less obvious differences. The 50-59 percent category displayed a peak at Feature 136 (27 percent of the feature), but otherwise only ranged from 0-6 percent of a given feature. More variation occurred in the 90-99 percent category, which peaked in Feature 62 (14 percent), and showed high spots in Features 158 (12 percent) and 296 (10 percent). For the remaining features, values for this category ranged between 0-8 percent. The other percent completeness categories: 60-69 percent, 70-79 percent, and 80-89 percent displayed little variation and all tended to range between 0-11 percent of any given feature (Figure 11.46).

The majority of features within the sample study had a greater percentage of stones within the less than 50 percent complete category than any other category. The anomalies were Features 62 and 176, which both had a greater percentage of complete stones. There was a slight negative correlation between the less than 50 percent complete category and the total number of stone lots. Features with more total stones tended to have slightly more variation and therefore lower percentages of stones that were less than 50 percent complete. This trend was exaggerated by Features 173, 62, 136, 176, and 46. Feature 173 was only composed of three stone lots, however, one of which was greater than 50 percent complete. Features 62 and 176 were mentioned already for being anomalies that had more complete stones, which therefore skewed the curve. Feature 136 showed a higher degree of variation than most features, and contained 15 stone lots so that sample size did not inflate the variation. It did, however, change the curve of the less than 50 percent complete category. Feature 46, with the greatest number of stone lots, had less diversity than other features, with the less than 50 percent complete category accounting for 78 percent of the stones.

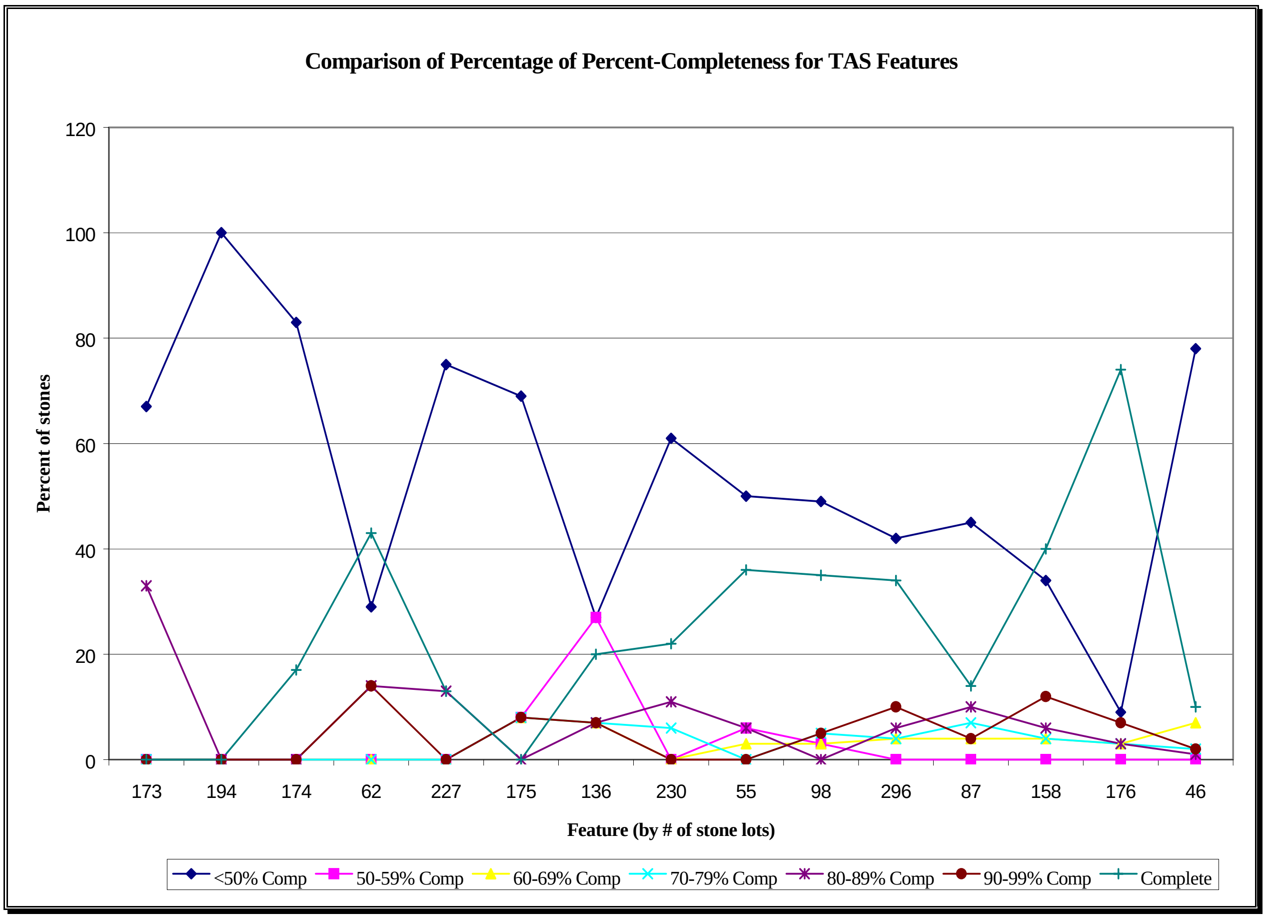

Figure 11.46 Comparison of Percentage of Percent-Completeness for TAS Features

The complete stones category also displayed variation between features, which did not correlate with total number of stone lots. Instead, this category ranged between features independent of sample size, and may be a better indicator of difference between features. As mentioned, Features 62 and 176 both contained higher percentages of complete stones than any other category. Feature 62 also had a high percentage of stone lots that were 90-99 percent complete, which suggested that it was relatively intact. Feature 176 contained the highest percentage of complete stones with 74 percent, which was not unexpected given its high number of pebble and cobbles inclusions that were visibly unaltered and not fractured. Features 55, 98, and 296 also displayed higher than average percentages of complete stones that ranged from 36-

34 percent. Conversely, Features 87 and 46 had lower than average percentages of complete stones, with only 14 percent and 10 percent respectively.

RESULTS OF TAS ANALYSES

A variety of different sources were used to evaluate and interpret the TAS features encountered at Hickory Bluff, including detailed descriptive analysis of the features, review of previous experimental literature, review of ethnographic and historical documents, and participation in, and review of, a Native American Sweat Lodge Ceremony.

Feature 46 was by far the largest TAS feature in terms of total fragment count, stone lots, and total weight, and included the greatest diversity of material type. For these attributes alone, Feature 46 was unique within the wider TAS feature assemblage. Interestingly, when percentages were considered in favor of total counts, Feature 46 was not a standout feature. In terms of material type, like most other features, Feature 46 was dominated by quartz and quartzite. The 48 percent frequency of quartz and 28 percent frequency of quartzite, however, were not significantly greater than that found within the natural gravel sample. The inclusion of sandstone/siltstone within Feature 46 was the same as the frequency within the natural gravel sample. This result suggested that the type of material was less important for this feature then having a high mass; that is, whatever stones were available were included into Feature 46 to increase its size. The stones contained within Feature 46 showed a high incidence of thermal altering. The percentages of crazing and reddening were similar, with the former being slightly higher, and both remained near the median range when compared to the rest of the assemblage. The frequency of pot-lidding was low within the feature, but was average in comparison to the rest of the assemblage. Also, refit groups 46-2G and 46-3D had differential degrees of reddening between conjoining pieces that may suggest either location within the fire, or re-use after the initial breakage. The fracture percentage was higher than average (92 percent) while the mean weight was within the average range for the assemblage. This suggested that the feature stones were highly fragmented and small in size, often an indicator of intensity of use. Feature 46 had a low refit percentage at 29 percent, and a high frequency of stones that were less than 50 percent complete. These various results suggested that the larger fragments of Feature 46 were likely removed for reuse within other features, which resulted in the low refit percentage, low mean weight, and a high frequency of stones less than 50 percent complete.

Feature 55 was a low density scatter of TAS fragments dispersed over a wider area than many of the other features within the assemblage. It comprised mostly quartz and quartzite (72 percent), which was within the average frequency for these material types combined. However, its 8 percent inclusion of sandstone/siltstone was lower than average, while its inclusion of “other” materials was higher than the average (19 percent). In terms of heat alteration, Feature 55 was 84 percent heat altered but displayed no real distinctions from the rest of the assemblage for the different types. The 76 percent fracture percentage of Feature 55 was near the average for the entire assemblage and its mean weight fell within the normal range displayed by the assemblage. However, the refit percentage was low at 24 percent, and percent completeness displayed more variation than most features. It had an above average frequency of complete stones (36 percent), but still maintained a majority of stones less than 50 percent complete.

Feature 55 was an average feature overall, except for its inclusion of several diverse material types. The inclusion of several material types suggested that the material composition was not the main consideration for the construction of this feature, which likely had a more generalized function. As a result, it was likely that Feature 55 was a small rock hearth that had become dispersed over time through natural and/or cultural processes. This resulted in the low refit percentage and frequency of stones less than 50 percent complete.

Feature 62 was a small and discrete feature comprised of only 11 total fragments. It consisted of several material types, including a higher than average frequency of sandstone/siltstone (29 percent of the feature), 14 percent "other" material, and only 14 percent quartzite. Although the total number of stones was low, the range of materials present suggested a less strict selection preference. The feature displayed a degree of variation within its visible heat alteration, and had both one of the highest percentages of crazing (91 percent) and lowest percentages of reddening (55 percent) within the assemblage. The fracture percentage (82 percent) remained within the average range for the assemblage. However, the refit percentage was high at 55 percent and Feature 62 was one of only two features that contained more complete stones than stones that were less than 50 percent complete. It also had a high frequency of stones 90-99 percent complete. These results suggested that the feature was utilized with relatively low intensity and that the spatial boundaries of the feature were mostly intact, with high refit percentages and fragments that conjoined to form complete stones.

Feature 87 consisted of 173 TAS fragments scattered across a wide area. It was one of the larger features in terms of both total count and number of stone lots. The majority of stones (43 percent) were quartz, which was common within the assemblage and comparable to the natural gravel sample. The frequency of quartzite within Feature 87 (19 percent) was also the same as the natural sample. The frequency of sandstone/siltstone was slightly higher than the natural gravel sample, while the inclusion of "other" material was higher than average when compared to both the natural gravels and the rest of the assemblage. This range suggested a less specific selection preference for material type. Frequencies were within average for reddening and crazing, 70 percent and 55 percent respectively, but were higher than average for pot-lidding (16 percent). This high incidence of pot-lidding was likely more a result of the diverse material types included within the feature than an indication of intensity. Both fracture percentage and refit percentage of Feature 87 were average for the assemblage. Mean weight was very low by comparison, which suggested that the fragments comprising the feature were small relative to the rest of the assemblage. Although the majority of stones were less than 50 percent complete, they displayed diversity within the range of percent completeness, with slightly higher than average frequencies of complete stones (14 percent) and those 80-89 percent complete (10 percent).

Feature 98 consisted of 52 TAS fragments, which lined a small shallow basin. The stones that comprised the feature consisted of 51 percent quartzite, which was a higher frequency than most other features within the assemblage and far greater than the natural gravel samples. Quartz accounted for only 32 percent of the feature, sandstone/siltstone 11 percent and "other" materials 5 percent; all of these represented lower frequencies than those encountered within the natural gravel sample. These results suggested the deliberate selection of quartzite over all other materials for use within this feature. Reddening and crazing percentages were similar for the feature, with the latter being slightly higher. Both were within the average for the assemblage, albeit at the low end of the range for reddening. Pot-lidding (15 percent of the fragments) was the highest recorded for the assemblage. This was interesting given the paucity of materials other than quartzite, which as a material, showed a low frequency of pot-lidding. Calculations for both total and mean weights suggested that, on average, the fragments that comprised Feature 98 were larger than those in most other features. Fracture percentage was at the lower end of the range for the entire assemblage, at 73 percent. Refit percentage was comparable to the rest of the assemblage, but included a lower frequency of secondary refits. Variability occurred in percent completeness for the stones of Feature 98, as the percentage of stones less than 50 percent complete was within the average for the assemblage at 49 percent, while the frequency of complete stones was higher than average, at 35 percent. The remaining divisions displayed similar frequencies and were similar to the other features of the study.

Feature 98 was unique at the site, as the only TAS feature to be lining a small basin. Its material type frequencies suggested careful selection for quartzite, which was likely selected for its durability and resistance to heat alteration. The variable heat alteration patterns observed were also different than most features, especially with the higher frequency of pot-lidding noted. The high ratio of complete stones within the feature and an average refit percentage all suggested the specialized function of this feature, likely as a small roasting pit. Studies have shown that stones embedded in soils fail to crack, and explained the high frequency of complete stones (Topping 1998).

Feature 136 was a small scatter of 26 TAS fragments. Of the fragments, 53 percent were quartzite, which was higher than the average for the assemblage and considerably higher than the natural gravel samples. Quartz accounted for only 27 percent of the fragments, which was low for the assemblage and in comparison to the natural sample. Sandstone/siltstone and “other” material frequencies also were low, but near average for the assemblage. The mean weight of the fragments, fracture percentage, and refit percentage also were average for the assemblage. More variability was observed within the visible heat alteration of the stones. Of them, 92 percent were reddened, which was above average within the assemblage, as was pot-lidding at 15 percent of the fragments. Crazing also was at the high end of the range within the assemblage at 69 percent. These high frequencies suggested a high intensity fire or use, particularly considering that the majority of the stones were quartzite, a material resistant to heat alteration. Percent completeness of the stones also displayed some variation, with 20 percent being complete, 27 percent less than 50 percent complete, 27 percent being 50-59 percent complete, and the remaining categories all about 7 percent. The high incidence of heat alteration, specific material selection, and variability within percent completeness all suggested a specific function and high intensity of use.

Feature 158 was a dense, tiered cluster of 225 TAS fragments and represented one of the largest features in terms of total count and density. Quartz accounted for 58 percent of the feature, which was one of the highest incidences for the assemblage. The quartzite composition was average for the assemblage at 31 percent, while sandstone/siltstone and “other” materials were at the low end of the range at only 5 percent each. These frequencies implied a careful selection preference was made for material type. Heat alteration was visible on 85 percent of the fragments. Feature 158 was within the average range for all heat alteration types, albeit at the low end for crazing (48 percent) and the high end for reddening (77 percent). The higher incidence of reddening to crazing was noteworthy given the high frequency of quartz, a material that displayed a tendency towards crazing over reddening. Stone Lots 158-2B and 158-4G displayed differential reddening between conjoining fragments, which suggested possible differential use of stones after initial breakage occurred. Both the fracture percentage at 71 percent and the refit percentage at 46 percent (total) were lower than most features. These results suggested that the fragments, although becoming reddened and/or crazed, were not fracturing as frequently as other features, and therefore, led to lower refit percentages. The percent completeness supported this contention, as 40 percent of the stones were considered complete and another 12 percent were from 90-99 percent complete. The mean weight for the fragments was average for the assemblage and the total weight increased proportionally with the rest of the assemblage, suggesting an average fragment size.

The variations that were present within several variables tended to separate Feature 158 from the rest of the assemblage. The stones displayed both a high degree of visible heat alteration, low fracture percentages and high frequencies of complete or nearly completed stones. These results suggested a lower intensity fire, or a specialized function for the feature. The material types showed a high degree of selection preference as well, which also suggested a specific function for the feature. It was spatially associated with Feature 176, and the two likely represented a stone boiling association, with Feature 158 representing the processed stones, and Feature 176, the pre-sorted raw material (Figure 11.47). The high proportion of quartz, high heat alteration, and variability in fracture patterns are consistent with stones used in boiling.

Figure 11.47 Features 158 (center) and 176 (foreground) Showing Processed Stones and Presorted Stones

Feature 173 consisted of a single quartzite boulder that was fragmented into 31 pieces, and two other stones of quartz and quartzite (Figure 11.48). All of the fragments were reddened but displayed no other visible heat alteration, which was atypical for the assemblage. The feature was 100 percent fractured and the majority of the fragments consisted of smaller spalled pieces. The mean and total weights of the feature were high, 284.1 g and 9375.6 g, respectively. These suggested that the fragments were larger in comparison to the other features. This relation was emphasized when considering only the largest eight portions of the boulder, which had a higher mean weight of 1148.5 g. The refit percentage was also the highest of any feature at 94 percent, when both primary and secondary refits were considered. The high refit percentages, fracturing, and visible heat alteration suggested that this boulder was substantially heated in place, which finally caused it to fracture.

Figure 11.48 Artifactual Components of Feature 173 (Quartzite Boulder)

This feature was unique among the Hickory Bluff assemblage. In addition to the heat alteration and fracturing, the large fragments of the boulder displayed a high degree of battering and pecking on their surfaces, which suggested its use as an anvil or grinding platform. Given the large size of the boulder, it was likely re-used repeatedly at the site and served different functions at different times. The eventual breakage and reddening suggested that the stone was extensively heated, and this may have been done to serve as an indirect cooking source. The quartzite boulder would have been heated up and then food sources placed onto its flat surface to be cooked, as its large size and material would have retained heat for a considerable time.

Feature 174 consisted of 23 fragments of TAS, which represented only six stone lots. The majority of these fragments (17) came from a single large siltstone cobble, while the remaining stones were quartz, quartzite, and jasper. This variety of materials suggested a less specific selection preference for material type, which might imply a more generalized function for the feature or expedient construction. Of the fragments, 96 percent were reddened, which was one of the highest frequencies within the assemblage. Crazing was noted only on 13 percent of the fragments, lower than the average incidence. Feature 174 had a fracture percentage of 96 percent and a refit percentage of 83 percent, both above average for the assemblage. The mean weight for the feature was low at 37.1 g and implied that the fragments were small. The majority of the stones were less than 50 percent complete, which suggested that fragments had been displaced or reused elsewhere.

This feature was different from others within the assemblage. Its high fracture percentage, heat alteration, and low mean weight could be attributed to the inclusion of a single large siltstone, a material less resistant to heat alteration. The high refit percentage suggested that the stones were in situ. However, the low percent completeness and lower mean weight tempered that conclusion somewhat, and suggested that larger fragments were re-used or displaced from the feature.

Feature 175 consisted of 22 TAS fragments in a small, discrete cluster. Quartz and quartzite accounted for 69 percent of the stones, which was average for the assemblage. The sandstone/siltstone frequency of 23 percent was above average for the assemblage and implied a less specific selection preference for material type that could relate to a more generalized feature function. All of the stones were fractured and showed some variety in heat alteration. Reddening was noted on 77 percent of the fragments and crazing was noted on 59 percent, both of which were average incidences for the assemblage. The refit percentage was also average, but tended toward the low end of the range. The total and mean weights for the feature were also within the expected range for the assemblage, and suggested a relative uniformity of fragment size. Sixty-nine percent of the stones of the feature were less than 50 percent complete, which was slightly above average for the assemblage. Only 8 percent of the stones were 90-99 percent complete and none were complete, which suggested that many of the fragments had been displaced from the spatial limits of the feature.

Overall, Feature 175 represented a baseline feature and fell within the average range for most variables considered. The variety of material types present was the only indicator that suggested differences from other features, especially the high percentage of sandstone/siltstone. It is likely that this feature represented a general function and had a moderate to low use. Its close proximity to Feature 173 suggested that it may have served as the source for heating the large quartzite boulder (Feature 173).

Feature 176 consisted of 264 fragments and represented one of the larger features within the assemblage in terms of total count. Quartz accounted for 76 percent of the stones within the feature, which was the highest incidence for the assemblage. The remaining material type categories were necessarily low with quartzite at 12 percent, sandstone/siltstone at 6 percent, and "other" material at 7 percent. These results suggested a high selection preference for quartz over other materials. The materials also displayed a low incidence of heat alteration, with only 45 percent having any visible heat alteration. Reddening was the most frequent type for the feature at 37 percent of the fragments, but represented the lowest occurrence of reddening within the assemblage. Stone Lot 176-5X displayed differential reddening between conjoining fragments, which may suggest differential use after initial breakage. Crazing was found on 35 percent of the fragments, which was also below average for the assemblage. The fracture and refit percentages were the lowest for the assemblage at 33 percent and 19 percent (total refits), respectively. In terms of percent completeness, Feature 176 had the greatest frequency of complete stones (74 percent) and the lowest frequency of less than 50 percent complete (9 percent). The total and mean weights were also below what was expected based on the wider assemblage, which suggested that the stones of Feature 176 were, on average, slightly smaller.

The number of attributes that displayed wide differences within Feature 176 set it apart from the rest of the assemblage and suggested it served a specific function. In this case, the high proportion of quartz and complete stones, and the low incidence of fracturing and heat alteration, suggested that this feature may represent a cache of selected materials to be used for stone boiling. This interpretation was enhanced by its spatial proximity to Feature 158, which had an almost inverse relationship to Feature 176 (i.e., reciprocal fracture rates and heat alteration, with similar percentages of material type) (Figure 11.48).

Feature 194 consisted of five fragments, three of which were from one large sandstone cobble, and two that were individual quartzite stones. The low number of stones tended to skew some comparisons with the wider assemblage, but was an important attribute. The stones were all crazed and 60 percent were reddened, which suggested an intensity of heat. All of the stones were fractured and only the sandstone fragments refit. Feature 194 had the highest mean weight of any feature, which suggested that it had larger fragments than other features. However, despite the large fragment size and refit percentage, all of the stones were less than 50 percent complete, which suggested that other large fragments may have been removed for re-use in other features.

Although the inclusion of a single large sandstone cobble was unique for the assemblage, Feature 194 displayed some similarity to other features. The fact that the feature consisted mostly of a single cobble was similar to Feature 173, which was a larger, more tabular, quartzite boulder. Both showed high mean weights, total fracturing, high incidences of reddening, and similar refit percentage. Unlike Feature 173, Feature 194 did not exhibit the same kind of use wear on its surfaces and was not a flat, tabular slab. The large size of the fragments in Feature 194 suggested that it served limited use and its inclusion of sandstone suggested a more generalized function.

Feature 227 consisted of 10 TAS fragments that, when refit, represented eight stone lots. Seventy-five percent of these stones were quartzite, with sandstone and siltstone accounting for the remaining 25 percent. The feature exhibited one of the highest mean weights of any feature, which suggested that the size of the stones was larger than average. Coupled with the diversity of material, this suggested that size of the stones was more important than material type for this feature, and implied a more generalized function. Reddening was observed on 70 percent of the fragments, while crazing was noted on only 10 percent,; pot-lidding was visible on 20 percent of the fragments. All of the stones were fractured, but had a low overall refit percentage (only 40 percent). In terms of percent completeness, 75 percent were less than 50 percent complete, 13 percent were complete, and 13 percent were 80-89 percent complete, which suggested that fragments had been removed from the spatial proximity of the feature.

The high mean weight, fracture percentage, heat alteration and diverse materials associated with Feature 227 were similar to Feature 194. Both had small spatial boundaries and total number of fragments, and both seemed to favor size of the fragments over material type. Also the low percent completeness in both features was similar and suggested that fragments had been removed. Feature 227 likely represented a small fire location of generalized function and moderate use.

Feature 230 consisted of 43 TAS fragments, which represented 18 stone lots. Quartz and quartzite comprised equal portions of the feature (44 percent each). The remainder of the feature consisted of sandstone and siltstone. The fragments of Feature 230 displayed a high degree of heat alteration, as 91 percent were reddened and 72 percent were crazed; 9 percent had no visible alteration. The fracture percentage was 91 percent and Feature 230 had one of the highest overall refit percentages at 86 percent. The mean weight for the feature was average for the assemblage, and the total weight fit within the rest of the assemblage. Both of these implied that the fragments were of relatively the same size as the rest of the assemblage. In terms of percent completeness, Feature 230 had a frequency of 61 percent of stones less than 50 percent complete, which was on the high end of average, and 22 percent of complete stones, which was about average for the assemblage.

The patterns observed within Feature 230 suggested an intense fire with limited use. The size and weight of the materials were consistent with the rest of the assemblage, while their visible alteration patterns were different. The high incidence of fracturing and visible heat alteration was suggestive of intense heat, while the high refit percentage suggested more limited use as the stone fragments were still present. The materials included suggested a careful selection strategy likely related to its use.

Feature 296 consisted of 107 fragments that represented 50 stone lots. Quartz and quartzite accounted for 54 percent and 30 percent of the stones, respectively. These frequencies were on average for quartzite, and above average for quartz. Siltstone accounted for only 4 percent of the feature stones, which was low for the assemblage. These values suggested a careful selection preference for quartz and quartzite. The stones displayed a high degree of heat alteration, as 74 percent were reddened and 69 percent were crazed, which tended to be at the high end of average for the assemblage. Pot-lidding was recorded on 12 percent of the fragments, a frequency above average for the assemblage. Primary refit percentage was low at 21 percent, while secondary refits, at 42 percent, were above average for the assemblage. They combined for a 64 percent total refit percentage, which was average for the assemblage. Fragment size was also considered average within the assemblage, based on comparisons of mean and total weights for the feature. Percent completeness of the stones showed more diversity than other features. Only 42 percent were less than 50 percent complete, considered low for the assemblage. At the same time, 34 percent of the stones were complete, a high frequency for the assemblage. The other categories of percent completeness ranged from 4-10 percent of the stones, a wider range than was apparent in most of the other features.

The attribute analysis revealed several distinctive traits for Feature 296. The high frequency of quartz and quartzite and absence of sandstone, and the relative uniformity of the size of the stones, based on mean and total weight comparisons, suggested careful selection preferences for this feature. Furthermore, the high frequencies of all types of heat alteration were suggestive of a high intensity of heat or use. The simultaneous low frequency of primary refits and high frequency of secondary refits suggested that elements of the stone were missing, but remained in close spatial proximity.