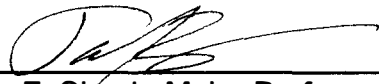


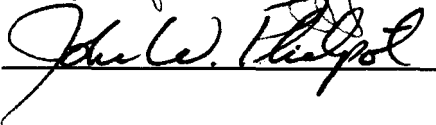
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I am submitting herewith a thesis written by Jay Douglas Franklin entitled "The Rime of the Ancient Miners." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of the Arts, with a major in Anthropology.

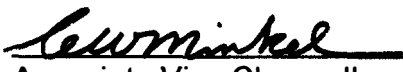

Jan F. Simek, Major Professor

We have read this thesis
and recommend its acceptance:





Accepted for the Council:


Associate Vice Chancellor and
Dean of the Graduate School

THE RIME OF THE ANCIENT MINERS

**A Thesis Presented
for the Degree of
Master of the Arts
The University of Tennessee, Knoxville**

**Jay Douglas Franklin
August 1999**

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Abstract

Terminal Archaic hunter-gatherers explored and heavily utilized deep passages of 3rd Unnamed Cave, which lies at the bottom of the Western Cumberland Plateau Escarpment in north central Tennessee. Footprints, torch stoke marks, chert mining pits with digging stick marks, flintknapping debris accumulations and associated fireplaces, and petroglyphs remain as evidence of this intensive utilization. The focus of this thesis is largely technological, centering on the chert mining and subsequent reduction activities that followed. Specifically, insight into four major issues is developed, including the nature of the flintknapping activities practiced deep within 3rd Unnamed Cave, the goal(s) of the reduction episodes, the chronology of the mining exploitation, and the possible reasons for this exploitation. The first two issues concern techniques and technology and are addressed primarily through core refitting. Refitting is the most reliable and straightforward means by which to address the technological questions. Core refitting has demonstrated that the prehistoric miners tested and reduced cobbles using the bipolar, or split cobble, technique. Objects of export were relatively large exterior flakes. Refitting was also used to test the general utility of three other methods of lithic analysis. Results suggest that refitting provides a much finer-grained analysis and that other methods may not be generally applicable. Mass analysis was used as an independent line of analysis to complement the refitting and to test whether the flintknapping

concentrations are primary accumulations or secondary deposits. Mass analysis indicates a homogeneous assemblage composed of generalized core reduction accumulations in primary position. Periodicity of chert mining in 3rd Unnamed Cave was determined by radiometric dating of numerous and stratigraphically variable flintknapping concentrations as well as core refitting. Lastly, although no archaeological site can be properly understood apart from its cultural and economic milieu, it is suggested that the exploitation of this source was not solely a response to raw material constraints.

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I. INTRODUCTION

The caving prowess of prehistoric peoples in the eastern woodlands of North America has become increasingly evident to the archaeological community over the last three decades (Watson, ed. 1974; Watson et al. 1969; Crothers 1987; Munson and Munson 1990). This realization stems largely from the pioneering work of Patty Jo Watson and colleagues (1969, 1974) in Salts and Mammoth caves, Kentucky. Not only did prehistoric peoples extensively explore the many miles of dark zone (that portion beyond any reach of light) therein, they intensively mined passages for minerals and occasionally for chert (Watson 1986). Radiocarbon dates from Mammoth Cave indicate intensive utilization during the Late Archaic and Early Woodland periods spanning at least several hundred years (Kennedy 1996). Archaeological investigations of Wyandotte Cave, Indiana have indicated intensive chert mining during the Late/Terminal Archaic Period as well as intensive mineral mining during the Woodland Period (Munson and Munson 1990). Crothers (1987) has documented extensive exploration and utilization of Big Bone Cave, Tennessee beginning in the Terminal Archaic Period and culminating in the Woodland Period. The documentation of elaborate artwork in Mud Glyph Cave, Tennessee indicated that Mississippian peoples also used deep cave environments (Faulkner, ed. 1986). Further, it is now evident that cave art traditions flourished in the mid south for at least four millennia (Faulkner 1997). The work of the above researchers and others suggests that prehistoric cave exploitation was not only

quite varied but persisted for thousands of years.

The Cave Archaeology Research Team (CART) from the Department of Anthropology at the University of Tennessee has spent the last two years painstakingly documenting a particular archaeological record of both unique preservation and associations. This impressive example of aboriginal cave exploitation lies pristinely preserved in northcentral Tennessee. Prehistoric hunter-gatherers entered deep, dark zone passages of 3rd Unnamed Cave to mine and work chert nodules on an intensive and highly concentrated scale, primarily in a remote passage hereafter referred to as the primary mining and workshop chamber. Hundreds of piles of chert debris resulted from these activities, which remain in place today on cave sediment surfaces as if just abandoned by the ancient miners. Radiometric dates on associated fireplaces put the mining activities in the Terminal Archaic Period, circa 3000 years ago. These are among the oldest deep cave chert mining ages documented in the eastern United States. Only the dates associated with chert mining in Wyandotte Cave compare with those from this cave (Munson and Munson 1990:62-63) .

The entrances to 3rd Unnamed Cave are situated approximately 20 meters above a tributary of the Cumberland River at the bottom of a precipitous gorge that is an incised division of the Western Cumberland Plateau Escarpment (Sasowsky 1992:13). This stream has cut its gorge over 300 meters below the surface of the Cumberland Plateau. Here, Terminal Archaic hunter-gatherers trekked over 1000 meters into the cave to mine and work chert nodules on a

scale unparalleled anywhere else in deep cave environments, including Wyandotte Cave in Indiana. However, what makes this archaeological record truly remarkable are its incredible preservation and its unique associations, which include footprints, torch stoke marks, mining pits, piles of flintknapping debris, and cave art. Petroglyphs are evident on the ceiling of the primary mining and workshop chamber, perhaps suggesting a ceremonial aspect to this exploitation, but it is clear that one of the miners' principal objectives was the acquisition of raw material necessary for stone tool production. As such, the focus of my research is predominantly technological. More specifically, my goals are to determine the reduction techniques practiced by the ancient miners and the objects they removed from the cave. Given the pristine preservation of these archaeological deposits, I have used refitting as the primary method of analysis in order to identify the lithic reduction strategies/techniques practiced by the ancient miners of 3rd Unnamed Cave. Following the definition offered by Van Peer, I use the term reduction strategy in this thesis to refer to,

“the conceptual framework within which a reduction sequence, [or *chaîne opératoire*], will be carried out. The strategy relates to the selection of a particular volume, the organization of the volume in view of its reduction and the range of possible options to be taken in the course of that reduction” (Van Peer 1992:131).

Refitting was used as the primary method of analysis because it is the most straightforward and least biased way of identifying lithic reduction strategies. During the course of my research, it became apparent that the refitting program designed for this study could be more broadly used to empirically test the utility

of certain methods of flake debris analysis commonly employed in an organization of technology approach. In other words, how robust are more conventional methods of lithic analysis? This has important implications for how archaeologists interpret prehistoric cultures and technologies. Finally, my research focused on defining the *chaîne opératoire*, or technological sequence, used in this cave.

Ultimately, the question to address is why prehistoric hunter-gatherers journeyed into this cave to obtain tool stone. This question cannot be answered by studying 3rd Unnamed Cave alone. Raw material sources themselves do not necessarily provide information concerning group mobility, inter-group relationships, or technological organization (Ingbar 1994:45). Still, the task must logically begin in 3rd Unnamed Cave, because it represents a primary raw material source:

“Raw material sources and the sourcing of toolstone provide convenient starting points for the study of technological flow. However, the utility of a raw material source is not determined by intrinsic properties of the source but by tool needs that the source may satisfy.” (Ingbar 1994:54).

Of paramount importance then, is gaining insight into the temporal and technological components of this exploitation. Only then can the mining activities that took place in 3rd Unnamed Cave be incorporated into larger social, economic, and technological realms.

Archaeologists in North America typically use an organization of technology approach to do this, while Old World scholars use the *chaîne*

opératoire approach. And as one of the goals of this study is to test the strengths of models used in an organization of technology approach by refitting (predominantly an Old World technique), a review of how scholars have approached technology and its integration into larger frameworks, including the relative strengths and weaknesses of various approaches, is thus warranted.

Hunter-Gatherer Research: An Overview

Stone tools and the waste byproducts, or debitage, generated during their manufacture and maintenance are more abundant in the archaeological record of hunter-gatherers than any other artifact class (Collins 1975; Cahen et al. 1979; Ahler 1989a; Morrow 1997). In most cases, they are all that remains. Stone artifacts, by their composition, are resistant to weathering and other post-depositional processes that can destroy or adversely alter other artifacts. The vast majority of human history is recorded and documented through the study of stone artifacts (Sassaman 1994:99). In addition, over 99% of human history is characterized by hunter-gatherer lifeways (Fagan 1998:26). Understanding stone tools and the technologies that produced them, therefore, is tantamount to understanding human history. From a pragmatic standpoint, then, it is mandatory for scholars to study prehistoric stone tool technologies.

In North American prehistoric hunter-gatherer research, the dominant paradigm is the "organization of technology" approach. Nelson (1991:57) describes the organization of technology as,

"the study of the selection and integration of strategies for making,

using, transporting, and discarding tools and the materials needed for their manufacture and maintenance. Studies of the organization of technology consider economic and social variables that influence those strategies."

According to Kelly, the organization of technology alludes to,

"the spatial and temporal juxtaposition of the manufacture of different tools *within* a cultural system, their use, reuse, and discard, and their relation not only to tool function and raw-material type and distribution, but also to behavioral variables which mediate the spatial and temporal relations among activity, manufacturing, and raw-material loci" (Kelly 1988:717; emphasis added).

Finally, Carr (1994a:35) states that,

"The goal of studies of technological organization is to determine which technological strategy or combination of strategies were used prehistorically and how these are related to human behavior and culture change."

The organization of technology approach stems almost entirely from Binford's ethnoarchaeological research among the Nunamiut (Binford 1977, 1978, 1979, 1980). In regards to technology, Binford (1979) states that technologies are organized, organization varies from one culture or context to the next, and there are material manifestations of this variability. However, the crux of Binford's argument appears to be that hunter-gatherer raw material procurement strategies are embedded within larger socio-economic frameworks (1979:266). " The presence of exotic cherts may simply be a fair measure of the mobility scale of the adaptation appearing as a consequence of the normal functioning of the system, with no extra effort expended in their procurement" (Binford 1979:261). In a later paper, Binford reiterates and clarifies this position,

"Most raw material is obtained *incidentally* during the course of the normal subsistence-related mobility in the habitat and one should not estimate procurement cost as if it were a direct cost incurred by an exclusive trip made to obtain materials" (Binford and Stone 1985:152; emphasis added). The underlying assumption is that technology is directly correlated with mobility.

Previously, Binford (1977) made a distinction between curated and expedient technologies. Curated technologies are very organized and involve the recycling, or removal and continued use and maintenance, of tools. Expedient technologies, conversely, are less organized (Binford 1977:34). Tools are often conveniently manufactured, used, and discarded at the same location.

In another seminal paper, Binford (1980) examines hunter-gatherers using a forager/collector strategy dichotomy. Foragers and collectors are not meant to represent mutually exclusive strategies, rather, extremes in a continuum (Binford 1980:19). In other words, certain hunter-gatherer groups may tend toward either or both depending on a variety of conditions. Viewed archaeologically, this is problematic. However, Binford states that foragers are generally characterized by residential mobility. As a group, they "map on" to resources. Collectors, on the other hand, are logistically mobile. Certain members of the group, subgroups in any case, locate resources and bring them back to residential locations (Binford 1980:10). Whether considering foragers and/or collectors, however, the mobility of a group is a primary factor in determining archaeological visibility. Again, Binford assumes direct relationships

between technologies and mobility. According to Binford, highly mobile hunter-gatherers will tend to produce fine-grained assemblages, while less mobile groups will produce coarse-grained assemblages (Binford 1980:17). Fine-grained assemblages are ones in which the resolution between specific activities is good. Coarse-grained assemblages are ones where the distinction is not so visible.

Thus, the organization of technology approach in North American archaeology originates in the work of Binford. Technologies are organized, they vary, and this variability can be seen archaeologically. Because Binford explicitly links technology and mobility, technologies vary because group mobility varies. Further, tool needs vary. Generally speaking, there are marked differences between curated and expedient technologies, foraging (residential mobility) and collecting (logistical mobility) strategies, and fine-grained (high mobility) and coarse-grained (low mobility) assemblages. Lastly, and perhaps most critically, Binford presumes a causal relationship between mobility and technology. In other words, mobility patterns condition technologies. Variations in mobility patterns generate variations in technologies. From its inception, therefore, the organization of technology approach has been inextricably linked to human mobility (Carr 1994b:2-3).

Applications of Binford's models to prehistoric hunter-gatherer stone tool technologies have been many and varied. Recently, some researchers have expanded the implications of these models. For example, Parry and Kelly (1987)

attempt to explain the shift from curated stone tool technologies to more expedient ones in prehistoric North America as a response to decreased mobility (although see Abbott et al. 1996 for a different interpretation). Curated technologies are ones in which "formal" tool types such as bifaces and/or blades are produced and maintained. Expedient technologies, where no intentional core preparation is practiced, produce "informal" tools like nondescript flakes (debitage) that may be used in a variety of functions. Their conclusion is that the emergence of more expedient technologies roughly coincides with, and is likely determined by, a marked increase in sedentism. This suggests that as group mobility decreases so does the need for curated technologies. However, this view appears contradictory to Binford's model wherein expediency is more often associated with foragers, who are not sedentary. On the other hand, Parry and Kelly, like Binford, clearly infer an explicit link between technology and mobility.

More recently, Andrefsky (1994a, 1994b) has suggested that these connections between the organization of technology and mobility are too simplistic. He argues that such studies must take into account raw material availability, both in terms of quantity and quality. Andrefsky's research in three different regions indicates that prehistoric stone tool technologies are not solely influenced by mobility but by raw material constraints or lack thereof. This has serious implications for the place of technologies within cultural systems. As noted previously, Binford suggests that raw material procurement is embedded within cultural systems. However, the work of Andrefsky and others would

suggest that this is not necessarily the case (e.g. Amick 1984; Carr 1994a). As will be seen, it is difficult to suggest that the acquisition of chert from 3rd Unnamed Cave was the result of embedded behavior and not direct procurement.

In Tennessee, the Binfordian forager/collector model has been applied to infer technological organization as measured by raw material constraints. Two examples have focused primarily on stone tool and debitage analysis, with varying success. This research may have direct implications for researching the ancient miners of 3rd Unnamed Cave. According to Amick (1984:18), varying organizational strategies are required to deal with spatial variability in lithic resources. In the central Duck River Basin of Tennessee, Amick examined apparent organizational changes from the Middle Archaic Period (ca.8000-5000 B.P.) to the Late Archaic Period (ca. 5000-2700 B.P.). These were largely due to demographic and climatic factors (Amick 1984:100). Two hypotheses were tested in the study: 1) if bands of hunter-gatherers were non-logistically organized (foragers essentially), then more intensive exploitation of local resources is to be expected; and 2) if bands of hunter-gatherers were non-logistically organized, then greater expediency is expected (Amick 1984:107-109). Amick concluded that Late Archaic groups were more logistically organized than Middle Archaic groups. They exploited local (lithic) resources less, and they were less expedient in their stone tool technologies (1984:157). Middle Archaic groups were more residually mobile. In other words, they tended toward the

foraging end of the spectrum, while Late Archaic groups tended toward the collecting end. Further, Amick sees the beginning of craft specialization and task group organization in the Late Archaic. However, there is reason to believe that Late Archaic hunter-gatherers in southcentral Tennessee were employing expedient technologies as well, using local raw materials (Franklin 1994).

In another study conducted in the central Duck River Basin, Carr assessed the mobility patterns of prehistoric hunter-gatherers as evidenced at the Hayes Site (1994a:35). Lithic analysis of the debitage resulting from raw material procurement and stone tool manufacture at the Hayes Site was used in this endeavor (Carr 1994a:39). In general, Carr maintains that the Hayes Site lithic data support Amick's model. Middle Archaic occupants are seen as foragers, while Late Archaic groups are determined to be collectors. However, Carr does point out that there are some problems with the data making interpretation less than straightforward (1994a:40-42).

While these studies have interpreted Archaic hunter-gatherer mobility and organizational strategies with some success, and the scholars recognize that the differences between foragers and collectors are ones of degree and not type, they have also tried to order prehistoric groups into static categories. This is potentially dangerous as it suppresses the variability that likely exists between both residually and logistically mobile groups and between expedient and curated technologies. Carr does make reference to this danger, "The realization that foragers and collectors are both likely to use curated and expedient tools

underscores that mobility and technological strategy are not directly correlated" (1994a:36). There is further jeopardy in inferring group mobility and/or technological organization based solely on the assemblage(s) from a single site. As noted previously, this has direct implications for the study of 3rd Unnamed Cave. Issues such as mobility and technological organization cannot be adequately addressed by examining the 3rd Unnamed Cave assemblage alone. However, that is where the examination must begin. The *context specific* techniques and lithic reduction trajectories practiced by the prehistoric hunter-gatherers who mined 3rd Unnamed Cave may be inferred. How these relate and fit into their overall organizational strategies and socio-economic realms can only be hypothesized until more local and regional research is undertaken.

In Old World Lithic analysis, the predominant paradigm is the *chaîne opératoire*, which originated in the work of Leroi-Gourhan (1964). According to Sellet (1993:106), the *chaîne opératoire* "is a chronological segmentation of the actions and mental processes required in the manufacture of an artifact and in its maintenance into the technical system of a prehistoric group." As in an organization of technology approach, there is an interest in tracking cryptocrystalline stone from point of procurement through manufacture, use, and maintenance of stone tools and finally loss and discard. Further, there is a fundamental concern with the place of these activities within larger socio-economic realms. However, inherent in the *chaîne opératoire* is an emphasis on decision making as opposed to material objects themselves (Edmonds 1990:57;

Kuhn 1995:142).

After the Les Eyzies Conference in 1964, a general concern with a behavioral approach to lithic analysis appeared to be emerging in both Old and New World archaeology. For reasons not entirely clear, however, this concern seems to have largely been abandoned in North American lithic analyses during the 1970s (Jelinek 1965, 1991; Sellet 1993). One possible reason is that with the ascendancy of the processual approach in North America came an emphasis on the search for nomothetic generalizations to study and interpret human behavior (Binford 1965:205). That is not meant to imply that North American scholars disregarded situational contingencies reflected in the archaeological record (Binford 1978:343-344; Nelson 1991:88), but rather the focus was placed on constructing models that could be applied cross-culturally or in a variety of temporal and spatial contexts. Conversely, a striking undercurrent of the *chaîne opératoire* is the notion of situationally dependent operational chains in lithic reduction trajectories (Edmonds 1990:56; Sellet 1993:110; Simek 1994:119). This implies a “succession of mental operations and technical gestures, in order to satisfy a need [immediate or not], according to a preexisting project” (Perlès 1987:23). In other words, the chain of operations decided upon and undertaken at a given site was driven by situational constraints, both in terms of raw material quantity and quality as well as social parameters (but see Andrefsky 1994a, 1994b for similar considerations in an organization of technology framework). A particular chain identified at a site or within an assemblage is not a model that

can *necessarily* be applied to another site or assemblage. Socio-cognitive considerations and raw materials were no doubt highly variable. A specific sequence or series of sequences must be identified and defined in each case, since affinities in archaeological assemblages can sometimes be the result of different behaviors (Cross 1983:91).

Another point of departure between the *chaîne opératoire* and the organization of technology approach is the relative use of refitting as an analytical technique. In the *chaîne opératoire* approach, refitting is not only an integral part of the paradigm, it is a mandatory one (Pelegrin 1990:116; Inizan et al. 1992:21-22; Karlin et al. 1993:318; Sellet 1993:108-109; Karlin and Julien 1994:154; Schlanger 1994:145; Simek 1994:119). This is not the case in North America, much less any paradigm or approach employed in North American archaeology, including the organization of technology. This is not to suggest that North American scholars are unaware of the analytical value of refitting, nor that it has not been used to varying degrees. But, the application of refitting to archaeological problems is certainly not routine (Johnson 1993:47-48, 1995:142; Amick and Carr 1996:55-56). Consequently, North American scholars have routinely omitted a powerful and proven technique in the study of prehistoric technologies.

Research Goals

My primary research goal is to identify and elucidate the stone tool technology used to exploit chert resources in 3rd Unnamed Cave. In addressing

this goal, this thesis is organized according to the sequence of analyses undertaken in trying to understand the archaeological record of 3rd Unnamed Cave. Throughout the course of this research, I adjusted my approach to the analysis of the archaeological materials under study given the results of preceding analyses. Thus, my presentation follows these stages in temporal order, articulating the analytical decisions guiding the particular directions taken. It was my original intention to use core refitting as the primary method of analysis to address my research goals, and to use three other methods of debitage analysis typically used in North American archaeology to aid in this endeavor. As my studies progressed, it became apparent that core refitting could be used to test the performance of the three other methods. In this way, I was able to examine the 3rd Unnamed Cave lithic materials from a variety of independent perspectives as well as determine which methods were most effective in addressing my research objectives. The three more common approaches all yielded essentially the same generalized results. Thus, I continued my research using only core refitting and mass analysis. Core refitting served to most effectively reveal the specific nature of lithic reduction in 3rd Unnamed Cave. Mass analysis was used as a quick and independent means of examining the assemblage for homogeneity in content, i. e. to determine whether or not the lithic concentrations were all the results of the same reduction techniques. Furthermore, mass analysis allowed me to test whether the deposits were primary or secondary accumulations. I present these results according to

the following outline.

In Chapter II, the environmental setting of 3rd Unnamed Cave is presented. First, the history of archaeological investigations is briefly summarized. Next, the physiography and geology of the area are described. This unique backdrop certainly conditioned the exploitation of this cave.

In Chapter III, the culture history of the area is presented. It is important to point out that much of the culture history of this area has been defined based on research in adjacent areas, like the Ridge and Valley Province to the immediate east and the Highland Rim to the west. The culture histories of these areas may not be entirely appropriate or applicable to the Cumberland Plateau. Therefore, explaining the significance of 3rd Unnamed Cave in a regional sense is difficult. Nevertheless, what is known about the culture history of the area, including previous archaeological research, is summarized.

In Chapter IV, field methods employed in the investigations of 3rd Unnamed Cave are outlined. Archaeological research concerning the cave has continued for nearly two decades and by several research groups. As such, a concerted effort has been made to maintain continuity in research design and field techniques. The methods used by the Cave Archaeology Research Team from the Department of Anthropology at the University of Tennessee were specifically formulated to deal with the unique nature of this archaeological record as well as to incorporate previous research and artifact collections from the cave.

In Chapter V, the mining and flintknapping activities in 3rd Unnamed Cave are placed in their chronological context. Radiocarbon age assays and one diagnostic stone tool place them in the Late/Terminal Archaic Period, ca. 3000 years ago. The ages are comparable to those from Wyandotte Cave, the only other known deep cave environment where prehistoric peoples so intensively mined chert nodules.

In Chapter VI, the analytical methods used to examine the technological sequence practiced by the ancient miners of 3rd Unnamed Cave are discussed in some detail. Given the pristine preservation of the lithic assemblage of 3rd Unnamed Cave, the use of core refitting has always been and remains the primary method of analysis. It is the most straightforward, least biased way to gain insight into the lithic technologies of prehistoric peoples. Initially, however, I planned to use three other methods of lithic analysis to examine all ten of the lithic concentrations recovered from the cave, for two reasons. First, employing multiple, or independent, lines of analysis should always be standard practice in archaeology (Binford 1987). This allows for independent checks of analytical results. If methods produce different or conflicting results, it serves as a useful starting point for examining ambiguities. Second, because core refitting is an empirical method of analysis, it could be used to test the three other methods of lithic analysis which are largely based on experimental research. Put simply, core refitting was used to see if the other methods work before investing great time and energy in using them. The results of the pilot study presented in

Chapter VI indicate that the three other methods used are situationally dependent and not universally applicable to the archaeological record. Factors such as raw material constraints have to be considered. Package size and internal quality greatly affect how well raw materials can be predictably fractured. Without core refitting, the specific nature of lithic reduction in 3rd Unnamed Cave would have remained unclear.

In Chapter VII, mass analysis (Ahler 1989a) of the 3rd Unnamed Cave materials is presented and discussed. All three of the more conventional methods of analysis tested in Chapter VI yielded essentially the same generalized results. Thus, it seemed redundant to use all three to examine the entire assemblage. Core refitting, while simple in nature, is very time consuming. Mass analysis served as an independent means of quickly and effectively examining the archaeological materials for homogeneity in content and assemblage formation processes. Indeed, mass analysis indicates the materials to be accumulations of core reduction debris that have not been disturbed from their original context.

Chapter VIII presents the complete refitting analysis and description. In sum, ten discrete lithic concentrations were collected and examined. Core refitting also indicates homogeneity in assemblage content, but to a much finer degree. Core refitting indicates that the method of core reduction practiced in 3rd Unnamed Cave was bipolar, or split cobble, reduction. The goal of the ancient flintknappers was to detach relatively large exterior flakes that were much easier

to remove from the cave than cores. The flakes could be crafted into a variety of stone tool forms at other, presumably open-air, locations.

Finally, in Chapter IX, the results of this research are summarized. In addition, the implications of the utilization of 3rd Unnamed Cave are discussed. It is suggested that raw material constraints were not necessarily the only reason for this exploitation.

II. ENVIRONMENTAL SETTING

Site History

In 1975, cavers began exploring the deep gorge where 3rd Unnamed Cave lies in search of “big caves”. In the summer of that year, 3rd Unnamed Cave was discovered. During the two years of survey that followed, several footprints were noted in the deep recesses of the cave. The cavers contacted Patty Jo Watson and asked her to visit the cave to examine the footprints. Watson first visited the cave in 1977. She was escorted to the “footprint room” via a lower trunk of the cave (P. J. Watson, personal communication). Watson verified the cavers’ suspicion that the footprints were indeed prehistoric. However, Watson did not see the chert mine that lay only 60 meters farther down the footprint passage.

Watson again visited the cave in 1981, this time entering the cave via an upper entrance. Nearly 1000 meters into the dark zone, she began to notice worked chert along the sides of the meander passage (Figure 1). Watson and company then climbed into a higher chamber where they came upon masses of chert flaking debris. Watson remarked that it must have been an immense quarry and workshop (P. J. Watson, personal communication). It was during this same visit that petroglyphs were first noticed on the ceiling of the primary mining and workshop chamber (Bill Deane, personal communication).

Late in 1981, graduate students from the Department of Anthropology at the University of Tennessee under the direction of Dr. Charles Faulkner, began archaeological testing of the primary mining and workshop chamber. The group

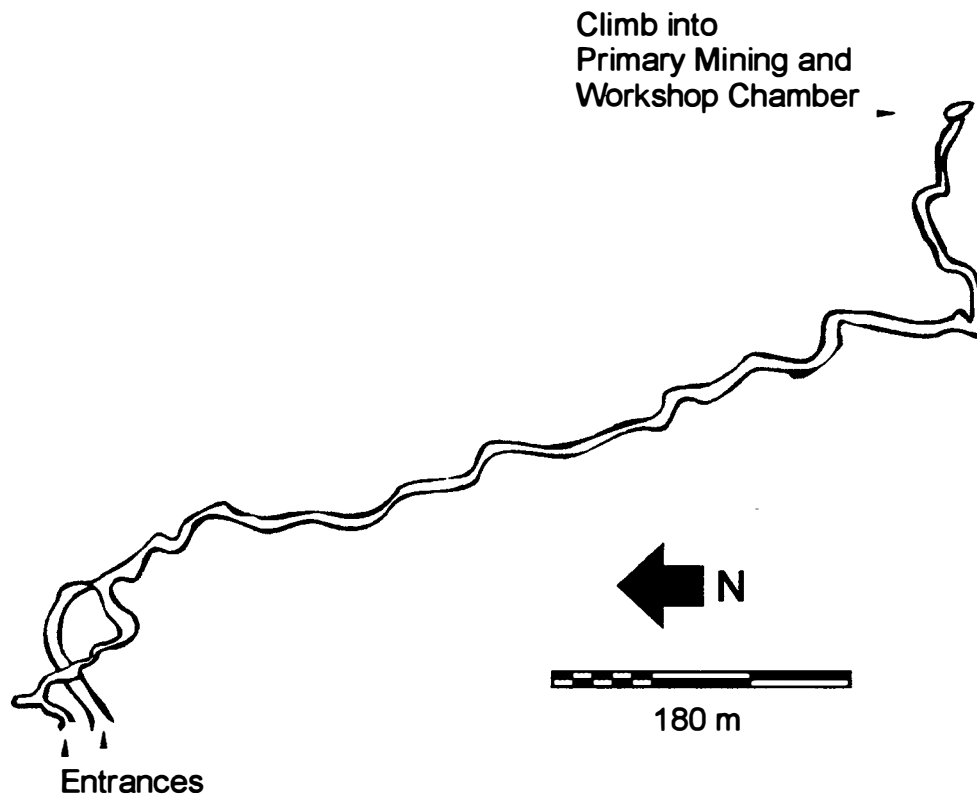


Figure 1. Plan View Schematic of the Meander Passage.

spent six days in the cave mapping, collecting, and excavating. Four discrete flintknapping concentrations were arbitrarily selected for collection and excavation (Areas A-D). In addition, an approximate map was made of 600 m² of the chamber. Results of this testing project were never formally published.

In the spring of 1996, the Cave Archaeology Research Team (CART) from the University of Tennessee renewed archaeological investigations of 3rd Unnamed Cave. Over the last two years, more than 20 trips have been made into the cave. Four more flintknapping concentrations were specifically targeted and collected (Areas E-H). Several more petroglyphs have been identified and documented. *In situ* and bulk sediment samples have been taken for micromorphology, microdebitage, and geological analyses. Numerous charcoal samples have been recovered for radiocarbon dating (Simek et al. 1998). Lastly, cane charcoal and torch stoke mark distributions have been mapped in the meander passage leading to the primary mining and workshop chamber, and a more detailed map of the chamber itself has been initiated (Figure 2).

Physiography

3rd Unnamed Cave and the western escarpment of the Cumberland Plateau lie entirely within the very western boundary of the Cumberland Plateau division of the Appalachian Plateaus Province as defined by Fenneman (1938). The Appalachian Plateau itself is part of the more broad Appalachian Highlands. To the immediate west of the Cumberland Plateau lies the Highland Rim section of the Interior Low Plateau Province. The Highland Rim is a region which

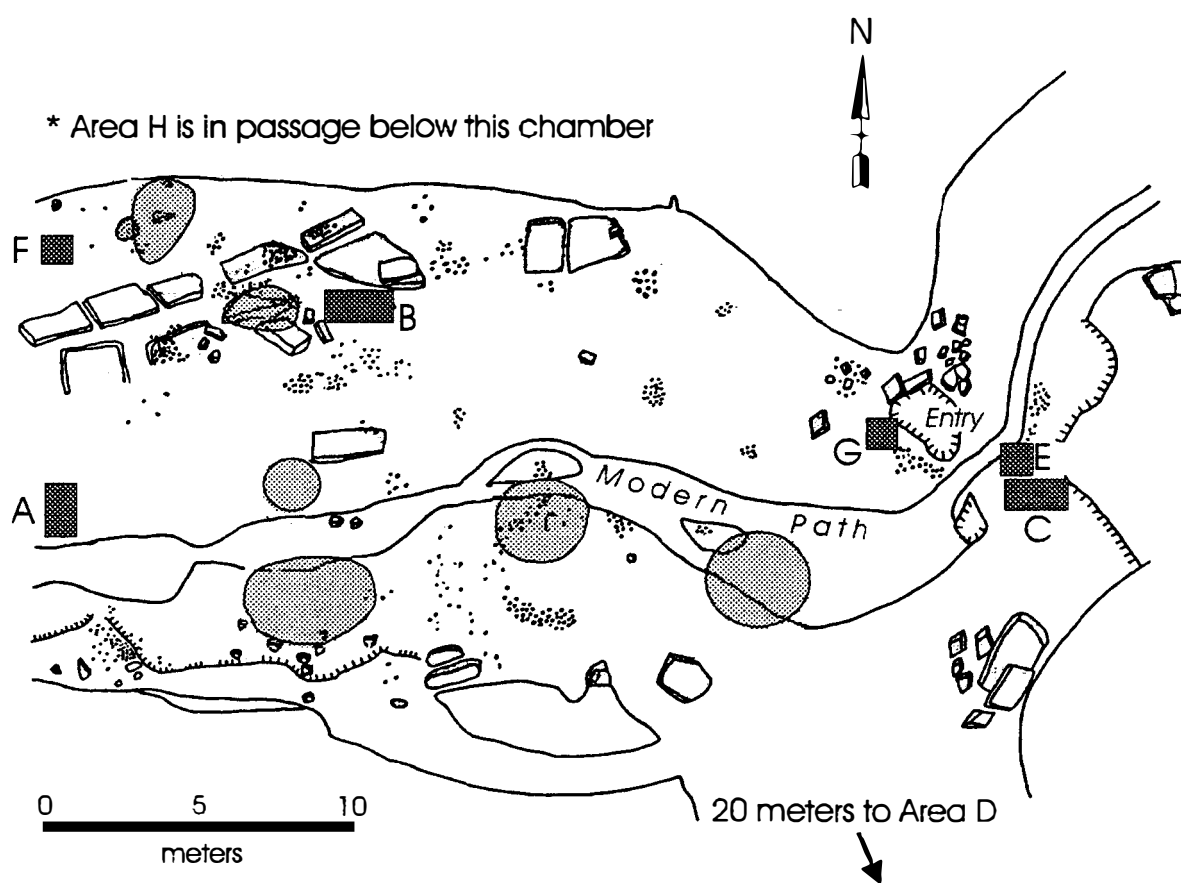


Figure 2. Plan View Schematic of the Primary Mining and Workshop Chamber (after Simek et al. 1998: 665, Figure 1). The labeled squares are lithic collection areas. Circled areas are petroglyph panels.

contains abundant chert resources. Conversely, the Cumberland Plateau is a chert-poor region, except in areas where erosion has cut away the caprock, e. g. the western escarpment.

The Cumberland Plateau region is characterized by a Mixed Mesophytic Forest dominated by beech, tuliptree, basswood, sugar maple, chestnut, sweet buckeye, red oak, white oak, and hemlock (Braun 1950:40). Other characteristic species which do not generally attain "canopy position" include dogwood, magnolia, sourwood, striped maple, redbud, ironwood, hop-hornbeam, holly, and service-berry (Braun 1950:43). 3rd Unnamed Cave and the western escarpment lie in the "Cliff Section" of the Mixed Mesophytic Forest region. According to Braun (1950:88),

"The rugged and ragged western edge of the southern half of the plateau presents conditions unlike all the rest of the plateau. Ecologically, this is an area of great interest because of the occurrence here of endemic species and of disjuncts, an area where rich mesophytic forests in the gorges alternate with pine-clad promontories and dry oak uplands."

Geology

3rd Unnamed Cave is a limestone karst cavern as are nearly all caves (Ford 1976). At 11.3 km, it is one of the ten longest caves in Tennessee, which boasts over 7900 recorded caves. The cave is located near the bottom of the escarpment (Hardeman 1966; Sasowsky 1992). The escarpment is a well-defined, nearly uninterrupted boundary, although it bears many incisions where westward draining streams have cut into it, sometimes deeply (Sasowsky

1992:5). In the area of 3rd Unnamed Cave, the Cumberland Plateau is approximately 60 km wide. It is bounded to the west by the Eastern Highland Rim of the Interior Low Plateau Physiographic Province and to the east by the southern section of the Ridge and Valley Physiographic Province. 3rd Unnamed Cave is formed entirely within the Monteagle Limestone. The Monteagle is a light-gray, fragmental and oolitic limestone. It ranges from approximately 55 to 92 meters in thickness. Blocky chert erodes from the base of the formation. Other chert-bearing limestones which underlie the Monteagle, such as the St. Louis, Warsaw, and Fort Payne, are not exposed in this area of the Obey River Gorge. Therefore, the chert which occurs in 3rd Unnamed Cave is certainly Monteagle and not Lost River Chert (actually Wyandotte Chert) as identified by Sasowsky (1992:9). This is supported by Des Jean and Benthall (1994:115) who posit,

“Numerous rivers and streams have scoured deep gorges into the usually resistant sandstones and have exposed some of the chert deposits associated with the underlying Monteagle formation limestone. This occurs, especially along the western boundary in the large river and stream channels, where deep drainages in the limestone have sapped the sandstone caprock at its edges.”

The Monteagle is capped by the Hartselle Formation, which is composed of sandstone, shale, and limestone. This is important because the Hartselle is a distinct boundary between two limestones, the Monteagle and the Bangor. It is often used as a reference stratum to locate caves that occur in the Monteagle Limestone just below (Alan Cressler, personal communication). The Hartselle is

overlain by the Bangor Limestone and the Pennington Formation, both Mississippian in age. These are capped by two Pennsylvanian age formations. The Fentress Formation is composed of shale with minor siltstone, sandstone, and coal deposits. The Sewanee Conglomerate is a conglomeratic sandstone and sandstone, which is the resistant caprock of the Plateau here (Hardeman 1966; Sasowsky 1992:11).

Sasowsky (1992:115) identifies 3rd Unnamed Cave as a "Cumberland Style" cave. Caves of this style are among the very longest caves in Tennessee, and are formed primarily in the walls of re-entrant valleys of the western escarpment of the Cumberland Plateau on the down-dip side of the valleys. They are formed almost exclusively in the Monteagle Limestone, particularly where the overlying Hartselle and Bangor have been exposed by erosion. The broadest and longest passages of this style of caves tend to be parallel to the valley and correspond to inferior surface topographic irregularities. Further, they are developed on several fairly distinct levels (Sasowsky 1992:132).

Thus, systematic research has been conducted on the physiography and geology of this karstic area. In Chapter III, the culture history of the area is described. As will be discussed, little systematic archaeological research has been conducted in the area. Much of the culture history is borrowed from adjacent areas and applied to the Cumberland Plateau.

III. CULTURE HISTORY

The Archaic Period (10,000-2700 BP)

The Archaic Period in Tennessee is the longest defined prehistoric cultural period spanning over 7,000 years. The beginning of the Archaic Period roughly coincides with the Pleistocene/Holocene glacial boundary at about 10,000 years ago. The period ends with the florescence of both ceramic technology and more intense horticulture, hallmarks of the succeeding Woodland Period. One of the original defining features of the Archaic Period was literally the absence of pottery (Chapman 1985:38). The name is derived from the period's antiquity. In general, Archaic settlement patterns are characterized by small groups of highly mobile hunter-gatherers. Aggregation locales where larger groups of people congregated at certain times of the year are not uncommon, especially as the Archaic Period progresses (Griffin 1952:355). Archaic peoples subsisted by hunting many large and small game animals, primarily white-tailed deer (Steponaitis 1986:371). Archaic hunters probably did not use bow and arrow technology, but instead used spears. Unlike their Paleo-Indian precursors, they were aided in this endeavor by the atlatl, or spearthrower, which allowed them to hurl their projectiles with greater velocity. Spear points were, on average, much larger than those used in the later Woodland Period. In addition to hunting, acorns and other arboreal seeds were exploited (Steponaitis 1986:371).

The lifeways of Archaic peoples, however, were not uniform and

homogenous for the entire 7,000 year period. Archaeologists have typically divided the Archaic Period into three sub-periods to delineate significant cultural and environmental changes. These are: the Early, Middle, and Late Archaic periods (Chapman 1975:5). Some researchers also define a Terminal Archaic period which marks the Archaic/Woodland Period cultural transition.

The Early Archaic Period (10,000 - 8000 BP) was one of great transition. The end of the Pleistocene brought environmental changes in both flora and fauna. Megafauna, such as the mammoth and mastodon, that dominated the Pleistocene epoch became extinct (Martin 1973). The early Holocene, (the Anathermal) was cool and moist but warmer than the previous epoch, one factor that may explain the megafauna extinctions (Grayson 1984). In addition, grasslands and savannahs were replaced by oak/hickory forests all over the Southeast (Delcourt et al. 1986:347). These changes do not appear to have adversely affected prehistoric peoples. Rather, they adapted well to them (Bense 1994; Chapman 1985).

In East Tennessee, there are two major cultural variants of the Early Archaic represented by projectile point/knife (PPKs) types. These are the earlier Kirk and later Bifurcate traditions (Chapman 1977). Two forms of Kirk PPKs are recognized. One is a generally large corner-notched point, while the other is a straight-stemmed and often serrated edge form. The corner-notched form chronologically precedes the latter. Kirk peoples subsisted largely by hunting deer and turkey but also relied on acorn and hickory nuts. There is evidence for

seasonal base camps at the Icehouse Bottom and Rose Island sites on the Little Tennessee River (Chapman 1975, 1985). The Bifurcate Tradition differed from the Kirk primarily in the shape of their PPKs. Bifurcate points were notched both on the sides and bases. Subsistence was very similar to that of the Kirk peoples.

At the end of the Early Archaic Period, the region became very warm and much drier. This climatic change, termed the Altithermal (Hypsithermal), marks the beginning of the Middle Archaic Period at about 7500 BP. The number of recorded Middle Archaic sites is lower than that recorded for the Early Archaic, suggesting that perhaps this climatic change precipitated migrations to and from certain biotic provinces (Chapman 1985:50; Faulkner and McCollough 1973). Subsistence appears to have remained largely the same, although with the addition of a new pattern. Middle Archaic peoples intensively harvested fresh water riverine resources, especially shellfish. The archaeological record shows vast accumulations known as shell middens (Griffin 1967:178); these can be a few meters thick at Middle Archaic base camps, like the Eva (Lewis and Lewis 1961) and Hayes (Klippel and Morey 1986) sites in central Tennessee. In East Tennessee, Middle Archaic cultures are distinguished again primarily by PPK types including Morrow Mountain, Stanly, and White Springs. Ground stone atlatl weights (or bannerstones) used to hone balance and velocity, make their appearance in the Middle Archaic. There is also increasing evidence of intentional burial of the dead during this time (Dowd 1989).

The Late Archaic Period begins at the apex of the Altithermal about 5000 BP. Conditions approximating those of the present day were reached by 4000 BP. In evolutionary terms, many changes were rapidly occurring during this last phase of the Archaic Period. Population size increased significantly (Griffin 1967:178). The number of larger aggregation sites in this period far exceeds that in the Middle Archaic. Ceramic technology has its genesis during the Late Archaic (Griffin 1967:180). There has been little Late Archaic pottery recovered in Tennessee, and it is thick and crude and often fiber-tempered. The beginnings of plant domestication and horticulture also first appear during this time. For example, Feature 11 at the Higgs Site (40LD45), associated with a Terminal Archaic living floor, yielded charred remains of sunflower seeds, acorns, and chenopod seeds (McCollough and Faulkner 1973). McCollough and Faulkner maintain that both the acorns and chenopod seeds could have been collected; however, "the achene size of the sunflower species recovered leaves little doubt that it was cultivated" (1973:61-62). Intensive deep cave exploration and utilization occurs during the Late Archaic (Munson and Munson 1990; Crothers 1987; Kennedy 1996). The earliest recorded cave art in the Southeast is believed to have been produced by Late Archaic peoples (Simek et al. 1998; DiBlasi 1996). Projectile point forms become more variable during the Late Archaic. Early on, both the western and eastern Tennessee River valleys are characterized by large, asymmetrical, straight-stemmed types. However, in the western valley, this type is called Ledbetter and made of chert or flint. In the

eastern valley, they are termed Appalachian Stemmed and are made largely of quartzite. Later, forms become more varied. Deep corner-notched forms (i.e. Wade and Motley) are found in the western valley, small straight-stemmed and undifferentiated-stemmed (i.e. Iddins) types in the eastern valley, and shallow side-notched forms (i.e. Damron and Matanzas) in the Cumberland Plateau region. However, it is important to note that these types are not exclusive to these respective geographic regions.

There is also substantial archaeological and paleobotanical evidence in the Late Archaic for significant human impact on the natural environment. By this time humans were clearing large tracts of land, presumably for horticultural purposes. This assumption is based largely on pollen profiles from archaeological sites (Delcourt et al. 1986, 1998).

Thus, the Archaic Period, including its constituent phases and traditions, is essentially defined by its great age, lack of pottery until late in the period, and projectile point forms. Small, mobile groups of hunter-gatherers, exploiting a wide variety of terrestrial and marine resources, dominated the landscape. Larger groups of people aggregated at certain times of the year at seasonal base camps in the major river valleys in order to form alliances and find mates (Griffin 1952:355). Archaic hunter-gatherers explored and exploited a vast and diverse array of ecological niches.

The Early Woodland Period (2700 BP-AD 1)

The Woodland Period is essentially characterized by the fluorescence of

ceramic technology, increased sedentism, the widespread occurrence of (burial) mound construction and associated ceremonial behavior, bow and arrow technology, the rise of social stratification, and a growing reliance on gardening and horticulture (Chapman 1985:56; Steponaitis 1986:379). The Woodland, like the Archaic, has typically been divided into three sub-periods, early, middle, and late. However, only the Early Woodland Period is discussed here.

Except for the wholesale addition of pottery, the Early Woodland Period (2700 BP-AD 1) does not differ markedly from the preceding Late/Terminal Archaic Period (Steponaitis 1986:378-379). Beginning with the Early Woodland, however, archaeological phases and cultures are identified by pottery types (based on tempering agents and surface treatments) rather than projectile point types. In fact, over 100 pottery "types" have been identified for the Early Woodland throughout the Southeast (Smith 1986:35). McCollough and Faulkner (1973) have proposed a chronology for the Early Woodland of East Tennessee based on relative percentages of ceramic types. It is important to note that most cultural chronologies developed for the Upper Cumberland Plateau are based on research actually conducted in adjacent areas, such as the Ridge and Valley Province. However, there is reason to suspect that Woodland peoples on the Cumberland Plateau may have been more influenced by cultures farther south and south. For example, ceramic fragments recovered from Redbud Cave in Fentress County, Tennessee appear to be similar to Flint River Brushed pottery from Alabama (Charles Faulkner, personal communication).

The earliest phase in McCollough and Faulkner's (1973) scheme is the Watts Bar Phase which consists entirely of quartz and sand-tempered fabric and cord-marked ceramics. The next phase is the Greeneville which is composed of primarily quartz-tempered Watts Bar pottery and secondarily limestone-tempered Long Branch pottery. Lastly, the Long Branch Phase is characterized exclusively by Long Branch Fabric Marked limestone-tempered pottery (McCollough and Faulkner 1973:93). Swannanoa Cord Marked grit-tempered ceramics, generally more characteristic of western North Carolina and upper East Tennessee, have also been recovered from firmly dated Early Woodland features at Site 40RE108, however (Schroedl 1990:49,93). Characteristic projectile points of the Early Woodland are large and triangular in shape. They are variously identified as Greeneville, Camp Creek, Nolichucky, and McFarland. These triangular forms persist into the Middle Woodland, however.

There is some reason to suspect Adena influence in the region during the Early Woodland (Smith 1986:42). Adena, or Adena-like, projectile points were recovered from Early Woodland burials at Calloway Island. In addition, other artifacts typically associated with Adena were also recovered from burials at Calloway Island (Chapman 1985:68).

Previous Archaeological Research in the Area of 3rd Unnamed Cave

Other than survey projects, little systematic research has been carried out in the Upper Cumberland Plateau region of Tennessee, which essentially comprises all of Cumberland, Morgan, and Scott counties, most of Fentress and

Campbell counties, and parts of Anderson and Claiborne counties. Des Jean and Benthall (1994:115) define the region as such:

“The Upper Cumberland Plateau includes uniform formations of Pennsylvanian age which are bounded by the escarpment of Waldens Ridge and the Cumberland Mountains on the east, by a continuous escarpment of caprock along the western edge, on the north by the Cumberland River, and on the south by everything north of the Sequatchie Valley.”

A total of 76 Archaic sites has been identified and recorded on the Upper Cumberland Plateau of Tennessee (Tennessee State Site Files). Although, according to Des Jean and Benthall (1994:120), many more Archaic Period sites exist in the myriad rockshelters of the Upper Cumberland Plateau. Of the recorded total, 26 sites are Early Archaic, 16 are Middle Archaic, and 34 are Late Archaic. Some of these sites represent multi-component sites, such as the Forbus Site (40FN122) which contains both an Early Archaic and a Late Archaic component. During the Early Archaic, the Forbus Site served as a camp where hunting and tool manufacture and maintenance were the primary activities carried out. The Late Archaic component is ephemeral at best (Bradbury 1997:88-89).

Likewise, the Moore Bottom Site (40JK145) located in the adjacent Eastern Highland Rim contains Early, Middle, and Terminal Archaic components. The Early Archaic component was the most intensive occupation, followed by the Terminal Archaic component. The Early and Terminal Archaic occupations appear to have been geared more toward tool production and

maintenance, while the Middle Archaic component was geared more toward core reduction (Bradbury and Kim 1994:6).

In sum, Archaic Period sites on the Upper Cumberland Plateau are still poorly understood. Diagnostic artifacts for the entire Archaic sequence have been identified and recorded (Des Jean and Benthall 1994), but the systematic research which characterizes the Late Archaic/Terminal Period rockshelters of the Western Cumberland Plateau Escarpment in Kentucky is lacking in Tennessee (Cowan et al. 1981; Ison 1988; Tankersley 1981). Generally speaking, the Upper Cumberland Plateau was most intensively occupied and utilized during the Early and Late Archaic. During the Middle Archaic, the region appears to have been largely abandoned as prehistoric peoples responded to the warmer, drier conditions of the Hypsithermal and moved into the lower river valleys of the Eastern Highland Rim and the Ridge and Valley provinces.

3rd Unnamed Cave was most heavily used during the Late Archaic Period. In the next chapter, archaeological investigations of the cave are presented in greater detail.

IV. FIELD METHODS

Field methods employed by both the 1981 team and CART involve similar and compatible strategies. In fact, the research strategy beginning in 1996 was specifically designed to be both time-effective and capable of integrating the 1981 data.

Four areas were targeted for collection during the 1981 field season, designated A-D. An attempt was made to obtain a representative cross-section of the entire assemblage. In addition, areas were chosen that could "be fairly quickly collected and, if possible, contained most of the debris from at least one concentration of chipped stone" (L. Ferguson 1982:4). Areas were also selected so as to minimally disturb surrounding deposits.

The first area to be collected was Area A located on a small mound of sediments. The lithic concentration on the surface of Area A measured approximately 1 x 2 meters. It was truncated on its northern fringe by two prehistoric mining pits and on its eastern side by another. Initially, each artifact was point-provenienced and given an individual catalog number. However, this proved to be entirely too time consuming. It took over four hours to map, collect, and bag 150 artifacts. Nonetheless, an adequate plan view map was generated for Area A (Figure 3). Thereafter, surface concentrations were simply collected by placing 50 x 50 cm wooden frames gridded at 10 cm intervals over the area. The lithic debris in each 10 cm square was bagged according to that provenience designated by the north and east coordinates of its southwest

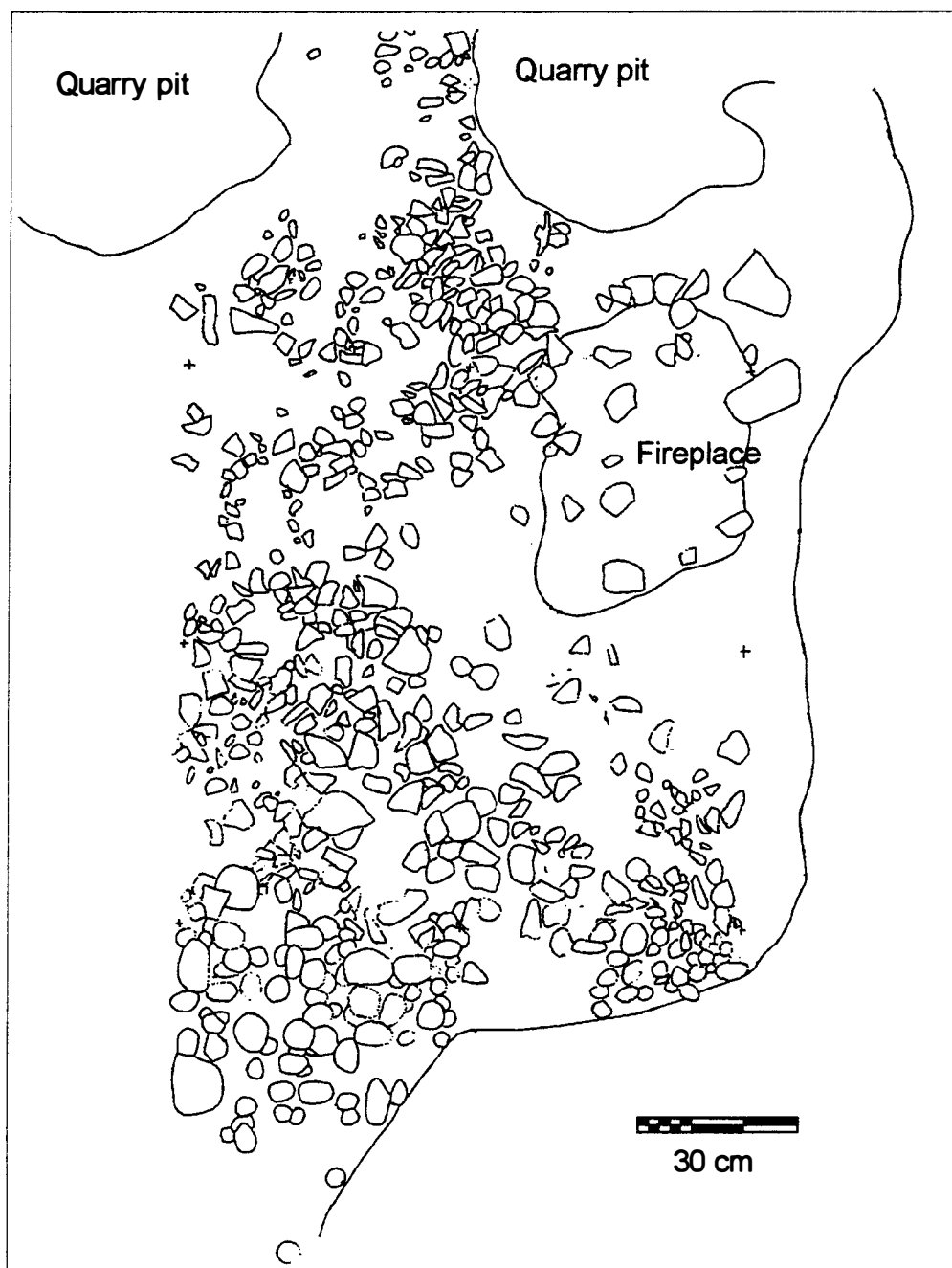


Figure 3. Plan View Schematic of Area A.

corner. Upon completion of the surface collection, two 50 x 50 cm test units were laid out with the eastern edges positioned along the edge of the mining pit on the eastern side of Area A. The sediments directly below were excavated in 10 cm arbitrary levels within natural strata. The debris from each level was hand sifted through 1/4" screen, and only those artifacts larger than 1/4" were retained. At a depth of approximately 70 cm below the present sediment surface, a second flintknapping concentration was encountered which rested on a white calcified surface. Among the debris in the buried concentration was a small, shallow side-notched projectile point which has subsequently been identified as a Matanzas point (Justice 1987; Des Jean and Benthall 1994). It is heavily patinated and may or may not be made from the chert in the cave (Figure 4). It was hypothesized that the excavations might reveal a series of buried knapping floors as chert debris was exposed in the profile of the prehistoric mining pit. However, the excavations revealed only one buried concentration separated from the surface concentration by sediments that appeared to have been redeposited by the aboriginal miners themselves (L. Ferguson 1982:5-6).

The next area collected (Area B) was situated on a piece of limestone breakdown approximately 10 meters northeast of Area A. The remains of most of one flintknapping concentration lay on the slab. However, associated pieces of lithic debris were also collected from the sediment surface directly below the breakdown, and many more may have slipped through cracks and holes that lead to the smaller, meander passage below (L. Ferguson 1982:7).

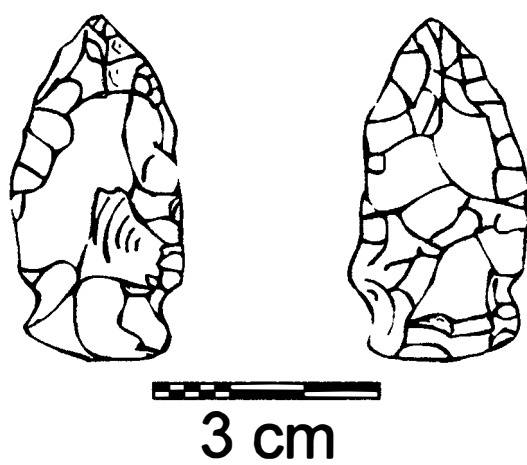


Figure 4. Matanzas Projectile Point Recovered from Area A.

The third area collected (Area C) was situated on the sediment surface just above the crawlway entrance into the chamber. Area C contained two quite distinct, but small lithic concentrations (L. Ferguson 1982:7). The area also contained a hearth, but the charcoal collected from it for dating purposes was apparently lost in the field.

The last area collected during the 1981 investigations (Area D) was positioned on a large limestone breakdown clast approximately 20 m into a passage adjacent to the primary mining and workshop chamber. Initially, it appeared that Area D comprised four small lithic concentrations. Upon collection, however, it was revealed that much of the lithic debris was covered by mud. Area D probably represents at least two episodes and perhaps three (L. Ferguson 1982:8).

Beginning in 1996, four more areas (labeled E-H) were targeted for collection. Three were collected in 1996 from the primary mining and workshop chamber. The last was collected in 1997 in the meander passage directly below. One meter square aluminum frames were constructed and strung at 20 centimeter intervals with nylon shock cord. The frames were placed over specific lithic concentrations, oriented by cardinal directions, and datum points were established. Each concentration was then totally collected by 20 centimeter collection squares. Bulk sediment samples to be used in microdebitage analyses were taken from the sandy sediments directly below each lithic concentration. Charcoal samples from small hearths associated with each concentration were

collected for purposes of obtaining radiocarbon ages.

Area E was collected in May 1996. It was situated directly on the sediment surface above the crawlway entrance to the chamber and just north of where Area C had been positioned. Area E was a large lithic concentration and may represent at least two flintknapping episodes.

Area F was located approximately 10 meters north of Area A under a 1.5 meter high ledge where the sediments appear to have been completely dug out in an effort to follow the chert-bearing facies in the north wall of the chamber. Area F is small and likely represents a single, brief flintknapping episode. It was collected in October 1996.

Area G was also collected in October 1996. It probably represents a single, but intense, flintknapping episode. It was located 2 meters west of the entrances to the chamber.

Area H was located in the meander passage below the mining chamber. It was collected in May 1997. Area H was positioned along the footpath to the mining chamber and removed for two purposes. First, the concentration was in danger of being disturbed by modern caving traffic. Second, it was collected in an effort to determine if flintknapping activities practiced in this lower passage were similar to those practiced above in the primary chamber and to seek temporal separation if there were any.

By the time of the 1996 field investigations, five radiocarbon dates had already been obtained from 3rd Unnamed Cave. The dates indicated utilization

during the Late and Terminal Archaic Periods. In Chapter V, a more detailed discussion of the chronology of 3rd Unnamed Cave is presented.

V. CHRONOLOGY

To date, fifteen radiocarbon age determinations have been obtained from various contexts within 3rd Unnamed Cave (Table 1). Seven of the dates were obtained from charcoal samples recovered from the primary mining and workshop chamber and effectively date those activities. Four come from the remnants of small fireplaces associated with particular flintknapping concentrations (Areas A and E). One comes from a chert quarry pit, one from the floor of the chamber, and the last from a large piece of charred wood that was re-buried by mining activities. The ages range from 2908 BP to 3258 BP, clearly placing these activities within the Terminal Archaic Period. These dates are consistent with radiocarbon assays that date chert mining and flintknapping in Wyandotte Cave, Indiana, the only other known dark zone cave site where chert mining was undertaken on such an intensive scale (Munson and Munson 1990:62-63). As there are buried flintknapping concentrations in the primary mining and workshop, it was originally thought that there may be great time depth to the mining activities. For example, Area A excavations revealed two knapping concentrations separated by more than 70 cm of sediments and what appeared to be a buried surface. However, charcoal samples obtained from fireplaces associated with each of the concentrations both yielded the exact same radiocarbon assay (Figure 5). This is further confirmation that the mining and knapping are confined to the Terminal Archaic. Moreover, the lone diagnostic stone tool recovered from 3rd Unnamed Cave comes from the buried

Table 1. Chronometric Age Determinations from 3rd Unnamed Cave.

Sample number	Radiocarbon assay	Calibrated date	Calibrated age
SI-5063†	2805 ± 75	1015 BC	2973 BP
SI-5064†	3115 ± 65	1370 BC	3328 BP
SI-5065‡	2745 ± 75	950 BC	2908 BP
SI-5066‡	2950 ± 65	1190 BC	3148 BP
SI-5067†	4350 ± 60	3025 BC	4983 BP
Beta-96623‡	2950 ± 110	1175 BC	3133 BP
Beta-96624‡	3060 ± 50	1300 BC	3258 BP
Beta-114172‡	2970 ± 40	1220 BC	3178 BP
Beta-114173‡	2970 ± 40	1220 BC	3178 BP
Beta-126038†	3330 ± 70	1650 BC	3608 BP
Beta-126041†	3360 ± 60	1645 BC	3603 BP
Beta-126040†	2010 ± 60	30 BC	1988 BP
Beta-126039†	690 ± 60	1310 AD	648 BP
ISGS-4232‡	3050 ± 70	1275 BC	3233 BP
ISGS-4234†	3060 ± 70	1305 BC	3263 BP

†Meander passage

‡Primary mining and workshop chamber

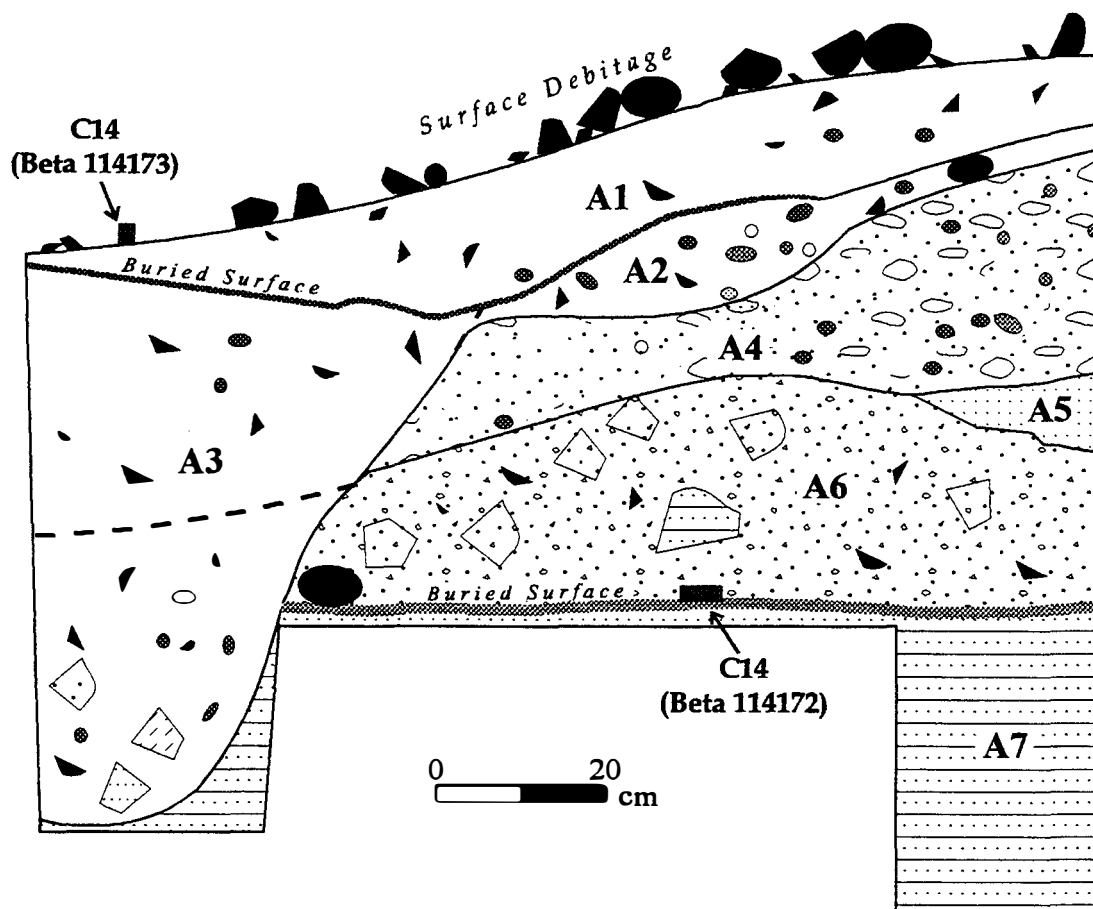


Figure 5. Area A: West Profile (after Simek et al. 1998:668, Figure 4).

knapping concentration at Area A radiocarbon dated to 2970 ± 40 BP. It is a Matanzas projectile point/knife (PPk). Matanzas points are indicative of the Late Archaic Period (Justice 1987:119). Their occurrence is not common in Tennessee, although several have been recovered from other contexts on the Upper Cumberland Plateau (Des Jean and Benthall 1994:130). The occurrence of the Matanzas point in the primary mining and workshop chamber is consistent with the radiocarbon assays.

Six other Archaic radiocarbon age determinations have been obtained from 3rd Unnamed Cave. These come from charcoal samples recovered from the meander passage directly below the primary mining and workshop chamber. The prehistoric miners did, in fact, enter the upper chamber via this lower passage. One date comes from a fireplace associated with the flintknapping concentration, Area H (3330 ± 70 BP). A date of 3060 ± 70 BP was obtained from a very large chunk of charred wood associated with a flintknapping concentration approximately 10 meters from Area H. Another date obtained from charcoal on the passage floor near survey station M58 yielded a similar date (3360 ± 60 BP). Charcoal from the passage floor between M41 and M42 (outer passage) yielded a date of 2805 ± 75 BP, and charcoal from near M77 (inner passage) yielded a date of 3115 ± 65 BP. However, charcoal from a ledge very near Area H (between M73 and M74) yielded a date of 4350 ± 60 BP, placing visitation to 3rd Unnamed Cave well into the Archaic Period. While the standard deviations for all of these radiocarbon assays, except the last one mentioned above, likely

overlap, it is probable that exploration and mining began in the meander passage before it was undertaken in the primary mining and workshop chamber.

The final two chronometric age determinations were obtained from charcoal recovered from farther out (toward the cave entrance) in the meander passage. Charcoal from the passage floor near M35 yielded a date of 2010 ± 60 BP, placing it in the early Middle Woodland Period. Lastly, charcoal from the passage floor near M25 (closest to the cave mouth) yielded a Mississippian Period date of 690 ± 60 BP (1310 AD). These age determinations were obtained from cane charcoal far removed from any mining or flintknapping activity areas, and likely date subsequent exploration of the cave by later peoples. This does, however, have important implications for current understanding of prehistoric activities within the dark zones of caves. It has been suggested that Archaic peoples entered dark zone caves primarily to explore and that more intense activities, such as mining and the production of artwork, were indicative of later Woodland and Mississippian peoples (Crothers 1987:83). In the case of 3rd Unnamed Cave, the reverse appears to have occurred. The most intensive activities undertaken in 3rd Unnamed Cave date to the Late/Terminal Archaic Period, while pure exploration expeditions to the cave appear to have occurred during later prehistoric periods. The locations of the charcoal that yielded the later dates might also indicate that Woodland and Mississippian peoples did not venture into the cave as far as Archaic peoples did. More radiocarbon dates are certainly needed before these apparent patterns can be considered definitive.

VI. ANALYTICAL METHODS

Preliminary examination of the lithic debris recovered by the 1981 team of UTK archaeologists revealed that refitting of some of the nodules was possible. Refitting core nodules is a very reliable approach to gaining insight into not only the reduction strategies employed in flintknapping episodes within 3rd Unnamed Cave, but also possible items of export from the cave. In this chapter, information gained by core refitting is used as an empirical baseline by which to evaluate three commonly employed models of lithic analysis in North America. As is demonstrated in this pilot study, refitting of the 3rd Unnamed Cave debitage has provided a more fine-grained analysis to complement the other methods. The methods under examination are: mass analysis, as defined by Ahler (1989a) and Ahler and Christensen (1983), a modified version of Sullivan and Rozen's (1985) "interpretation-free" approach (Kuijt et al. 1995), and Magne's debitage stage model (1985).

Methods

Conceptually, refitting is quite simple. "Refitting a stone industry...consists of the reassembling of the various artifacts [in the order of their removal]-tools, flakes, and fragments-that have been knapped from the same block" (Cahen et al. 1979:663). However, an important issue concerns the method's utility, particularly when measured against cost. It has been argued that refitting has two primary strengths (Larson and Ingbar 1992). The first concerns post-depositional change. Artifacts that were originally deposited in direct association

with each other may have been subjected to a plethora of post-depositional processes, natural and cultural, that altered their relative positions, both horizontally and stratigraphically. Conversely, artifacts that now lie in close proximity to one another might reflect natural agents rather than shared cultural affiliations. Refitting can lead to detection of the post-depositional processes that may have caused these juxtapositions (Hofman 1992a). It can also be used as a powerful method of testing previous assumptions. The most famous example of this comes from the Acheulean site of Terra Amata where Henry de Lumley excavated a series of "structures" represented by stone clusters. Refitting of stone artifacts challenged this assumption. Forty percent of the refitted artifacts were stratigraphically separated, archaeologically and geologically (Villa 1982:282). In sum, clusters of artifacts at Terra Amata likely represent post-depositional disturbances rather than living floors and houses.

The second strength of refitting is anthropological in nature. It can be used empirically to infer the behavior of prehistoric peoples. Basically, it may be the best method of determining "the movement of artifacts during their lives by determining where they were made, utilized, and rejected" (Cahen et al. 1979:663). Refitting provides insight into reduction strategies and techniques, specific gestures, and decision making. Based on refitting at the Mesolithic site of Meer II, Cahen and Keeley (1980) were able to reconstruct the activities of two individuals, one right-handed and one left-handed. It is the only method of lithic analysis in which prehistoric behavior is observed, albeit *post hoc*. This, in

turn, can provide insights into the technologies responsible for the movement of artifacts as well as the cultural systems and selective pressures responsible for the technologies.

As with any methodological approach, there are certain problems that are encountered in refitting endeavors. While technically simple, refitting is also very time consuming. This is problematic in many cases because time spent on analysis is directly constrained by funding. In North America, where most archaeological research is conducted as part of cultural resource management projects, refitting analyses are particularly inhibited. However, the information gained from refitting even a few artifacts can often far outweigh the vast amounts of time taken to do so.

Thus, two factors largely conditioned the use of refitting in this study: 1) the empirical strength of refitting, and 2) the pristine preservation of discrete flintknapping episodes in 3rd Unnamed Cave. It is the primary method of analysis for the lithic materials recovered from 3rd Unnamed Cave. Because lithic knapping episodes are preserved on the ground, it is posited that refitting is the best initial approach to inferring the technological nature of this assemblage.

Mass analysis is rapidly becoming a common approach to lithic analysis in North American archaeology (Schott 1994). It is relatively quick and easy as it does not require a detailed knowledge of waste flake morphology. Mass analysis is offered as a more objective means of lithic analysis since no technology-specific attributes are assigned to individual pieces of debitage. It is also very

useful when dealing with particularly large assemblages. Conversely, because mass analysis depends upon aggregate information, some resolution may be lost. This is potentially a problem when the archaeological assemblage under examination is composed of mixed technologies or reduction techniques, since only an overly general view of the assemblage nature is produced (Morrow 1997:56). In short, mass analysis focuses on characteristics of arbitrarily defined size classes of debitage, namely count, weight, and cortex distributions, rather than attributes possessed by individual pieces, in order to distinguish reduction and percussor types. In this line of analysis, the emphasis is not on attributes of individual flakes, but rather “observations on a batch or some subset of the complete batch of debris *from a single context*” (Ahler 1989a:87, emphasis added). Raw data are recorded, including counts, weights, counts of cortex-bearing flakes, and average weight of flake per size-grade. It must be noted that comparatively large numbers of smaller sized debitage are produced in all stages of lithic reduction. However, the theoretical assumption is that larger size classes will be over-represented early in a reduction sequence, and smaller size classes over-represented in later reduction sequences. Further, as lithic reduction is a subtractive technology, the number of cortex-bearing flakes should decrease as reduction continues from early to late stages. (Ahler 1989a:89-93).

An experimental assemblage is mandatory for Mass Analysis (Ahler 1989a:98, 112), and it should reflect reduction activities believed to be represented in the archaeological record. In a 1983 pilot study, Ahler and

Christensen defined and used five experimental reduction "groups": Group 1 is Hard Hammer Freehand Cobble Testing; Group 2: Hard Hammer Freehand Core Reduction and Flake Production; Group 3: Hard Hammer Bipolar Core Reduction and Flake Production; Group 4: Hard Hammer Biface Edging; and Group 5: Soft Hammer Biface Thinning. Mass Analysis was conducted on the experimental assemblage, and the size class data were converted into percentage variables to be used in multiple discriminant function analysis. For example, if five of twenty flakes were produced during an experiment, the new variable would be 25(%). Based on the new variables, each group should exhibit its own reduction characteristics distinguishable from the others. Using the statistical software package SPSS®, Ahler and Christensen achieved a correct classification rate of 88.9%. The groupings were used to classify archaeological samples into the most statistically probable group affiliations. Given this correct classification rate, they placed a high degree of confidence in their results and interpretations.

Following Ahler and Christensen (1983), an experimental assemblage was created for the analysis of the 3rd Unnamed Cave materials. This assemblage was produced using chert obtained in the cave itself. Passages both adjacent to and far removed from the primary mining and workshop chamber in 3rd Unnamed Cave contain abundant chert nodules that were never exploited prehistorically by the ancient miners. In certain areas, these deposits were likely never found as they are located in still active subjacent cave

passages. As in the primary chamber, however, some of the chert nodules collected for experimental purposes were removed from primary positions in the limestone walls of the cave and some were collected from secondary positions in cave sediments.

Enough chert nodules were collected during several visits to 3rd Unnamed Cave to conduct 53 flintknapping experiments. All the experiments were conducted by Andrew Bradbury and myself. All experiments were conducted over a drop cloth or tarp to permit 100% collection of the debitage, even the very smallest debris. The debris was then hand sorted and size-graded into 6 classes: Size 5 ($>1"$), Size 4 ($<1">\frac{3}{4}"$), Size 3 ($<\frac{3}{4}">\frac{1}{2}"$), Size 2 ($<\frac{1}{2}">\frac{1}{4}"$), Size 1 ($<\frac{1}{4}">\frac{1}{8}"$), and Size 0 ($<\frac{1}{8}"$). Following Ahler (1989a:91), all debris was hand sorted based on whether flakes would fit through the diagonal opening of a particular screen size. In addition, as noted by Behm (1983:12),

“By hand sorting each flake individually through each screen, edge damage to the flake is reduced to a minimum. As a consequence of hand sorting through the screens, individual flakes may be assigned to a different (lower) size grade than if they had been simply shaken through the screens.”

Sets of experiments were conducted with four specific reduction tasks in mind.

Reduction “groups” employed in this study follow those of Ahler and Christensen (1983) and Bradbury (1995).

Experimental Group 1, Hard Hammer Cobble Testing, comprised those experiments in which the goal was simply to test raw material quality. In these experiments, the purpose was to drive off one or more flakes from a chert nodule

by hard hammer (hammerstone) percussion. If the quality of the chert was poor, the experiment was halted and the remainder of the nodule was discarded. If the quality of the chert was deemed suitable, the experiment was ended and the nodule retained for further reduction. In both cases, the resulting debitage was retained for analysis. A total of 13 experiments was conducted for Group 1.

Experimental Group 2, Hard Hammer Freehand Core Reduction, involved experiments in which the goal was to produce usable flakes from chert nodules by means of hard hammer freehand percussion. Experiments were ended when the chert nodule, or resulting core, was exhausted (in other words, when usable flakes could no longer be obtained from the core). All debitage was collected and retained for analysis. Suitable flakes were marked for further reduction later into stone tools. A total of 15 experiments was conducted for Group 2.

Experimental Group 3, Hard Hammer Bipolar Core Reduction, consisted of experiments in which the method was to open and fragment the core by placing it on an anvil stone and then striking it with a hammerstone in an effort to obtain usable flakes from small and/or rounded nodules where freehand percussion was not a viable option. As with Group 2, the experiments were ended when the cores were exhausted. Again, the resulting debitage was collected and retained for analysis. Suitable flakes for further reduction were noted. A total of 18 experiments was conducted for Group 3.

Group 4, Soft Hammer Tool Production, comprised those experiments in which the goal was to fashion a stone tool by means of soft hammer percussion.

This involved using deer antler billets and/or deer antler tines to flake and shape certain suitable flakes generated in the previous cobble testing and core reduction experiments. Five of the experiments involved the production of bifaces and two involved the production of unifacial tools (scrapers) for a total of seven.

Interpretation-free analysis is defined by Sullivan and Rozen (1985). In this method, so-called interpretation-free categories are created in an effort to develop impartiality and replicability. According to Sullivan and Rozen (1985:758), this is accomplished “by means of a hierarchical key”, which is essentially based on waste flake completeness. Here, the relative percentages of flake portions are variable between reduction techniques. Briefly, primary reduction is largely characterized by complete flakes and blocky shatter. Tool manufacture, on the other hand, tends to produce more flake fragments and broken, platform remnant bearing (PRBs) flakes (Sullivan and Rozen 1985:773). There are two primary problems with this approach. First, Sullivan and Rozen did not test their approach experimentally. Some researchers who have employed lithic reduction experiments to test the method have obtained less than satisfactory results. In short, the method has been shown to be insensitive to raw material variability, too general, and not interpretation-free at all (Amick and Mauldin 1989, 1997; Prentiss and Romanski 1989; Bradbury and Carr 1995). Yet other researchers have found the approach to be quite useful (Kuijt et al. 1995). Like mass analysis, it is a relatively fast and easy method and can

reveal general trends in lithic reduction trajectories.

In a recent *Lithic Technology* article, Kuijt and colleagues (1995) employ a modified version of the interpretation-free model. They conducted nine bipolar experiments that were used to classify an archaeological sample. They hypothesize that in general, bipolar reduction is characterized by approximately 12% complete flakes, <2% PRBs and split flakes, and 43% each for flake fragments and blocky shatter (Kuijt et al. 1995:122). This version of the interpretation-free approach was employed in the pilot study of the 3rd Unnamed Cave materials.

The last method tested is Magne's (1985) debitage stage model. This model is a form of individual flake attribute analysis. Each waste flake from an archaeological sample is analyzed individually for a series of independent attributes, which varies depending upon the analyst. Individual flake attribute analyses can be very time consuming, labor intensive, and require a skilled lithic analyst with a detailed knowledge of waste flake morphology and variation. On the other hand, these types of analyses can potentially provide very fine-grained resolution. In Magne's model, debitage is first separated into PRBs, Shatter, or non-PRBs, Biface Reduction Flakes (BRFs), and Bipolar Reduction Flakes (BPOs). Bifacial and bipolar reduction are identified as discrete technologies (Magne 1985:107,128). An attempt was then made to sort the PRBs and Shatter into "debitage stages". Magne defines early stage reduction as all forms of core reduction. Middle stage reduction involves the initial edging of tools, and late

stage reduction is typified as the latter half of tool manufacture. For PRBs, Magne found platform facet counts to be the most robust factor in determining stage. Briefly, 0 or 1 platform facet indicates early stage reduction, 2 middle stage, and 3 or more late stage. For shatter, dorsal scars were the best indicator. Again, 0 or 1 scar represents early stage, 2 middle, and 3 or more late.

Results

As noted previously, eight knapping areas have been systematically collected from 3rd Unnamed Cave which represent a qualitative cross section of the assemblage. While refitting has been undertaken for all areas, three were arbitrarily selected for the purposes of the pilot study. Only interpretations derived from the refits are presented here. A complete and more detailed description of the refits is given in Chapter VIII.

Area C consists of two abutting concentrations, which appear to represent discrete knapping episodes. Refitting of cobbles confirms this interpretation. No debris from the western concentration has been refit to any piece from the eastern one or vice versa. However, a large flake from the eastern concentration of Area C was conjoined to a refitted nodule from Area E which lie adjacent to Area C to the immediate north.

The western concentration was composed of 427 pieces of debris, of which 336 are >¼" in size. A total of 93 pieces has been conjoined to form 26 cores, core fragments, or conjoined flakes. The refits point to a bipolar or split cobble technique of reduction, wherein one end of a chert nodule is placed on

an anvil stone and the other struck with a hammerstone. The resulting forces yield percussion generating from both ends. No obvious anvil stones have been recovered, although several knapping concentrations do lie on large pieces of limestone breakdown which may have served as expedient anvils. Several large sandstone cobbles, collected from the sediments within the concentrations, may also have been used as anvils. Several hammerstones were recovered (one from this concentration), and these are made of chalcedony. No unmodified nodules of chalcedony have been found inside the cave, though they are abundant on the slopes outside. The hammerstones were likely brought in as part of the miners' toolkit.

Refitting also suggests the types of pieces taken from the cave. One refitted nodule in particular provides such data. The nodule was struck once on the rounded end, detaching a large, thin flake. It was struck again on the flat end, shattering it into three pieces, and was subsequently discarded (Figure 6). All pieces have been recovered except the first flake removed. As the area was subjected to a near 100% collection, it is likely that the flake was removed by the prehistoric miners themselves.

Refits from the eastern concentration of Area C indicate cobble testing and core reduction. Twenty-nine pieces of a total 366 (270 > 1/4") have been conjoined to form 10 cores or core fragments. Cobble testing and core reduction appear to have been done using the a bipolar technique. Many nodules exhibit flat surfaces where they broke naturally along internal fracture planes.

Superior view

Posterior view

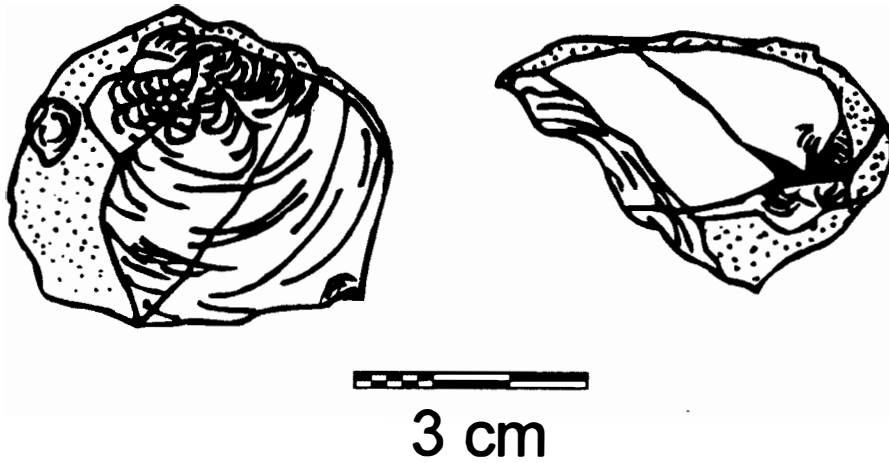


Figure 6. Area C (west): Refit #1.

Apparently, the miners still used the flat ends as striking platforms but placed the rounded ends of the nodules on anvil stones.

Area F represents a single, brief knapping event comprised of 213 debitage pieces ($210 > \frac{1}{4}$ "). A total of 80 pieces has been conjoined to form 21 cores or core fragments. The refits from Area F show that aboriginal miners tested cobbles and reduced cores by the split cobble method.

Area G represents a single, but complex episode. A total of 538 debitage pieces was collected ($520 > \frac{1}{4}$ "). One hundred thirteen pieces of debitage have been conjoined to form 33 refits. Again, refitting suggests bipolar reduction. In addition, one nodule was recovered that bears the characteristic bipolar bashing at both ends, but was discarded before it was broken open.

In general, then, refitting efforts indicate that the miners tested cobbles by split cobble, or bipolar, percussion. Core reduction appears to have been accomplished by the bipolar technique as well. It bears noting that refits from the other collected areas exhibit evidence of bipolar reduction as well. Items of export appear to have been relatively large uniform exterior flakes.

Reconstructing individual nodules empirically demonstrates reduction techniques by virtue of refitting flakes and debris in the reverse order of their removal. The results of the refitting efforts are now compared with the results of the aforementioned lithic analysis models employed in North American archaeology, which are largely based on experimental analogy.

Four separate models of mass analysis were conducted for the

examination of the lithic assemblage from 3rd Unnamed Cave. As noted previously, an experimental assemblage is necessary to conduct mass analysis. Ideally, this assemblage should be generated from the same raw material(s) as the archaeological samples under examination. However, Ahler (1989a:113) suggests, "Even if controlled experiments have not been conducted for the particular raw materials and archeological samples in question, many of the extant data sets,..., provide a useful model for interpretation of archeological samples." With this avenue of analysis in mind, the raw data from experiments conducted with Knife River Flint (KRF) by Ahler and Christensen (1983) were used initially for classification of the lithic debris from Areas C, F, and G of 3rd Unnamed Cave. However, due to perceived variability in raw materials, cortex variables were omitted from my analysis. In addition, I did not use Ahler and Christensen's Size Grade 4 data (the approximation of my Size 1 data). The recovery methods employed in the collection of lithic debris from 3rd Unnamed Cave were not designed to recover large numbers of very small sized debitage, at least *en masse*. The 1981 team recovered only debitage >1/4" (Size 2). The current research team did collect microdebitage samples, but only from selected squares within the collection areas. As such, only raw data from Ahler and Christensen's Size Grades 1-3 were used (see Tables 2 and 3 for comparative purposes). In the KRF pilot study, a 3/4" screen was not used, and thus, I

Table 2. Size Grade Divisions, after Ahler (1989a:100, Table 4).

Actual Screen Size (in.)	Actual Screen Size (mm)	Size Grade: Ahler (1989a)
1.00"	25.4	1
0.500"	12.7	2
0.223"	5.66	3
0.100"	2.54	4
0.0465"	1.18	5

Table 3. Size Grade Divisions (present study).

Actual Screen Size (in.)	Actual Screen Size (mm)	Size Grade: Franklin (1999)
1.00"	25.4	5
0.75"	19.05	4
0.50"	12.7	3
0.25"	6.35	2
0.125"	3.175	1
N/A	N/A	0

collapsed my Size 4 and 3 debitage into one category for this analysis. The nine variables used for the first discriminant function analysis are listed in Table 4.

Stepwise discriminant analyses were run in the statistical software package SAS® to eliminate variables that did not contribute significantly to the model. This was accomplished by three methods: forward, stepwise, and backward. In a forward selection discriminant analysis, the process begins with no variables in the model. At each step the most discriminating variable is entered. This process continues until none of the unselected variables meet the entry criterion. Stepwise selection is similar to forward selection. The model is analyzed at each stage. The variable that augments the power of the model the least is dropped, while the most powerful variable not already in the model is entered. The process continues until all variables in the model satisfy the entry requirements and others not in the model fail the entry standard. In a backward elimination, all variables are initially entered in the model, save those that are linearly dependent upon others variables in the model. At each step, the least discriminating variable is dropped from the model. In all three cases, the gauge to be in the model is measured by Wilks' lambda (SAS Institute Inc. 1989:1494-1495).

In the end, the five variables retained by forward and stepwise selection proved to be the most discriminating and were thus used in the discriminant function analysis (Table 4). Three significant functions were obtained (@ $p=0.05$). Function 1 maximally separates Hard Hammer Freehand Cobble

Table 4. Mass Analysis Variables for Discriminant Function Analysis #1.

1. Percentage by count of Size 5 flakes†
2. Percentage by count of Sizes 4 & 3 (combined) flakes†
3. Percentage by count of Size 2 flakes*
4. Percentage by weight (g) of Size 5 flakes
5. Percentage by weight (g) of Sizes 4 & 3 (combined) flakes*†
6. Percentage by weight (g) of Size 2 flakes
7. Mean flake weight: Size 5*†
8. Mean flake weight: Sizes 4 & 3 (combined)*†
9. Mean flake weight: Size 2*†

* Variables retained in the model after forward and stepwise selection discriminant function analysis.

† Variables retained in the model after backward elimination discriminant function analysis.

Testing (Group 1) from Soft Hammer Biface Thinning (Group 5) and accounts for 80.7% of the model's variance. Function 2 maximally separates Hard Hammer Bipolar Core Reduction (Group 3) from Soft Hammer Biface Thinning (Group 5) and accounts for 13.1% of the model's variance. Function 3 distinguishes between Hard Hammer Freehand Core Reduction and Flake Production (Group 2) and Soft Hammer Biface Thinning (Group 5) and accounts for 6.2% of the model's variance (Table 5). However, correct reduction group classification rates were not satisfactory.

Discriminant function analyses in SAS® present correct classification rates two ways. First, a resubstitution classification rate is generated. This rate tends to be overly optimistic as it allows an experiment (observation) to be used to classify itself. Second, a cross-validation classification rate is generated. This rate is more robust and conservative. The actual correct classification rate lies somewhere in between the two.

For this first analysis, the resubstitution correct classification rate obtained was 68.7% (Table 6). The cross-validation correct classification rate was 62.6% (Table 7). The omission of Size 1 variables likely contributed to these poor results. In addition, raw material variability was probably a factor. Due to the poor results, the KRF experimental data were not used to classify the archaeological samples from 3rd Unnamed Cave (Figures 7, 8, and 9).

Bradbury (1995) generated an experimental assemblage made from Ft. Payne Chert collected from various sources in Cumberland County, Kentucky

Table 5. Canonical Discriminant Functions Measured at Group Means (#1).

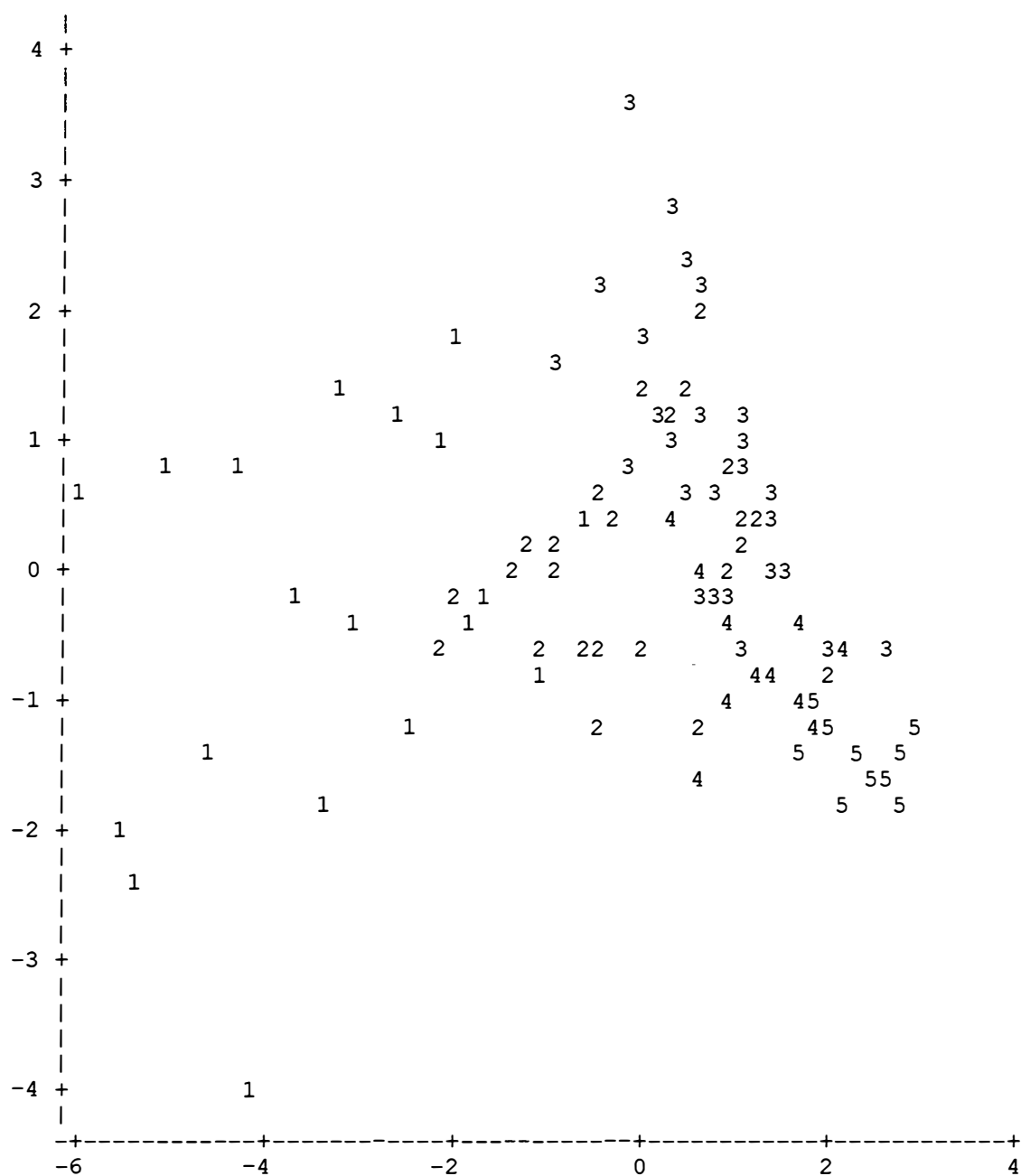
Group	Function 1	Function 2	Function 3
HHCT	-3.32	-0.36	-0.29
HHCR	-0.07	0.10	0.77
BCR	0.74	0.89	-0.35
HHBE	1.27	-0.57	0.20
SHBT	2.18	-1.24	-0.48

Table 6. Resubstitution Summary for the KRF Experimental Data Set.

From	To				
	HHCT	HHCR	BCR	HHBE	SHBT
HHCT	16	3	0	0	0
HHCR	1	16	5	2	1
BCR	0	2	18	8	2
HHBE	0	1	0	8	4
SHBT	0	0	1	1	10

Table 7. Cross-validation Summary for the KRF Experimental Data Set.

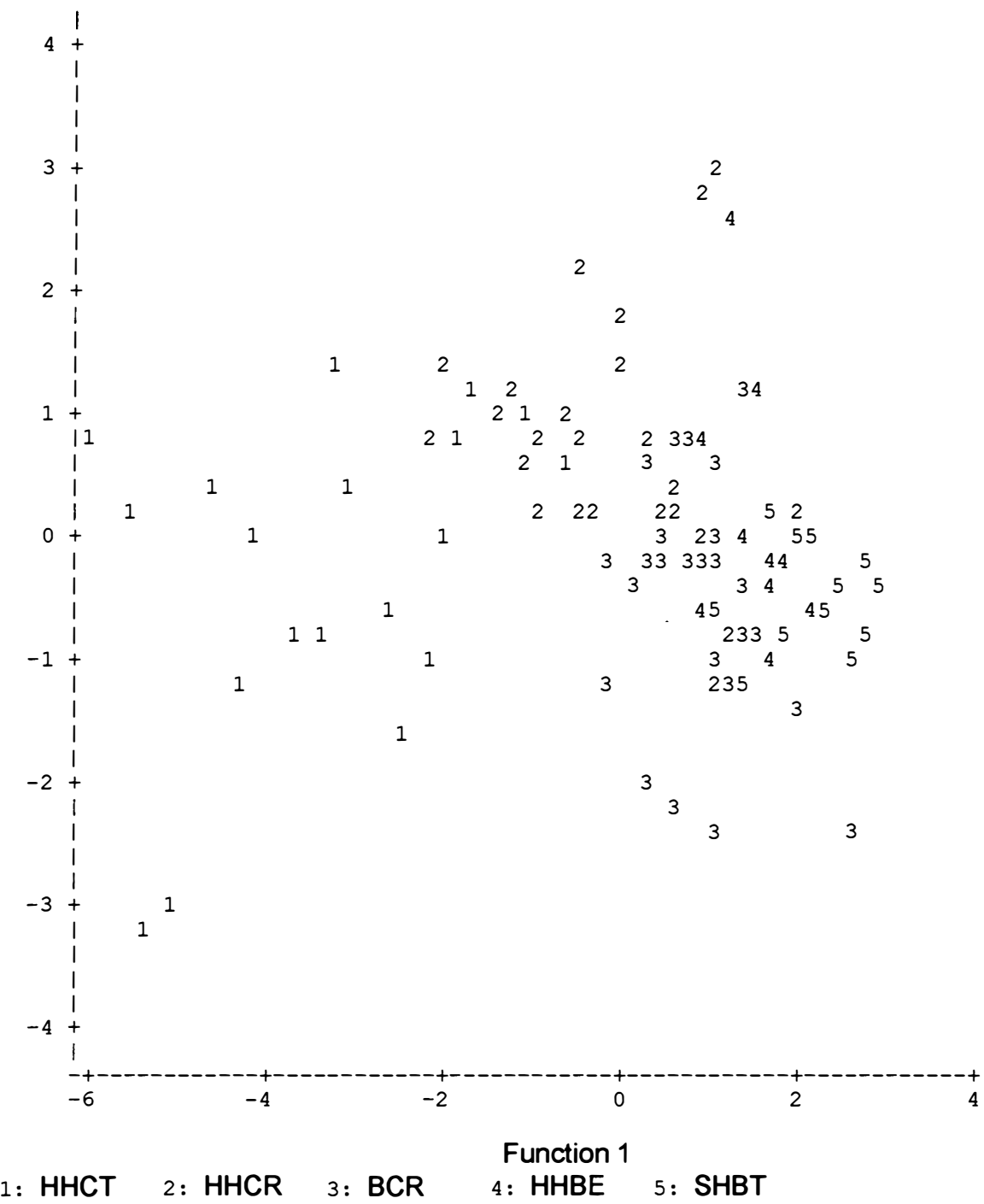
From	To				
	HHCT	HHCR	BCR	HHBE	SHBT
HHCT	14	5	0	0	0
HHCR	1	16	5	2	1
BCR	0	3	17	8	2
HHBE	0	3	0	6	4
SHBT	0	0	1	2	9



Function 1
 1: HHCT 2: HHCR 3: BCR 4: HHBE 5: SHBT

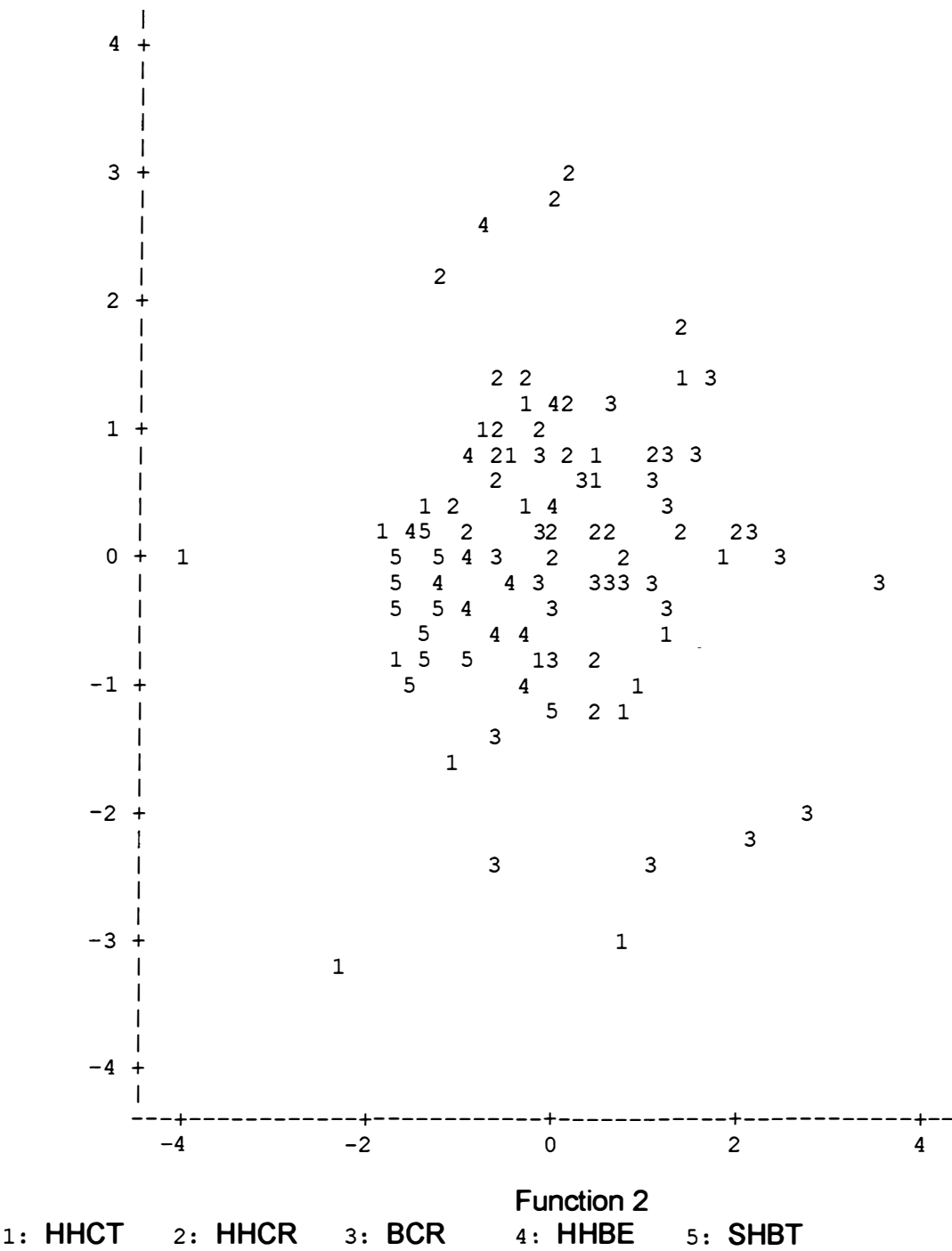
NOTE: 9 observations hidden.

Figure 7. Plot of Discriminant Functions 1 & 2 for the KRF Data.



NOTE: 9 observations hidden.

Figure 8. Plot of Discriminant Functions 1 & 3 for the KRF Data.



NOTE: 7 observations hidden.

Figure 9. Plot of Discriminant Functions 2 & 3 for the KRF Data.

(CCFP, hereafter). The assemblage comprises seven reduction groups and a total of 88 individual experiments. In his analysis, Bradbury was able to achieve an overall correct classification rate of 84.7%.

I arbitrarily selected 40 of Bradbury's experiments for examination. These 40 most closely resemble Ahler and Christensen's reduction groups for consistency. Hard Hammer Biface Edging was omitted this time because Bradbury only conducted two of this type of experimental reduction. As such, there were only four experimental groups in this analysis: 1) Hard Hammer Freehand Cobble Testing, 2) Hard Hammer Freehand Core Reduction, 3) Hard Hammer Bipolar Core Reduction, and 4) Soft Hammer Biface Thinning. In addition, Bradbury's size grades correspond to mine thus permitting the use of 12 variables for the stepwise discriminant analyses (Table 8). Again, however, neither cortex variables nor Size 1 variables were used (The Size 1 data for the CCFP experiments were not readily available). For the CCFP data, a backward elimination stepwise discriminant analysis provided the most robust correct classification rates (Table 8).

Two significant functions were obtained in Discriminant Function Analysis #2. Function 1 maximally separates Hard Hammer Freehand Cobble Testing from Soft Hammer Biface Thinning and accounts for 87.8% of the model's variance. It secondarily distinguishes cobble testing from bipolar reduction. Function 2 maximally separates Hard Hammer Freehand Cobble Testing from Hard Hammer Freehand Core Reduction and accounts for 10.1% of the model's

Table 8. Mass Analysis Variables for Discriminant Function Analysis #2.

1. Percentage by count of Size 5 flakes‡
2. Percentage by count of Size 4 flakes
3. Percentage by count of Size 3 flakes
4. Percentage by count of Size 2 flakes‡
5. Percentage by weight of Size 5 flakes‡
6. Percentage by weight of Size 4 flakes‡
7. Percentage by weight of Size 3 flakes
8. Percentage by weight of Size 2 flakes
9. Mean flake weight of Size 5 flakes‡
10. Mean flake weight of Size 4 flakes
11. Mean flake weight of Size 3 flakes
12. Mean flake weight of Size 2 flakes‡

‡ Variables retained in the model after backward elimination stepwise discriminant analysis.

variance. It secondarily separates cobble testing from bipolar reduction (Table 9). In this analysis, the overall resubstitution correct classification rate obtained was 87.5%, while the overall cross-validation correct classification rate was 75% (Tables 10 and 11, respectively). Even with a limited set of Bradbury's experiments and less variables, I was essentially able to duplicate Bradbury's success (Figure 10). The CCFP data were then used to classify the archaeological samples from Areas C, F, and G of 3rd Unnamed Cave.

Both concentrations (eastern and western) from Area C and Areas F and G were all classified as representative of Group 1: Hard Hammer Freehand Cobble Testing in this analysis (Table 10). While it is likely that cobble testing played a significant role in the reduction of the 3rd Unnamed Cave materials, the primary mode of reduction appears to have been bipolar, at least based on the refitting. Discriminant Function Analysis #2 using the CCFP data should have been able to significantly distinguish between bipolar reduction and cobble testing based on the significant functions and associated correct classification rates. As can be seen in Tables 10 and 11, there is very little overlap between Group 1 (Hard Hammer Freehand Cobble Testing) and Group 3 (Bipolar Core Reduction). Most of the Group 1 misclassifications were to Group 2, and most of the Group 3 misclassifications were to Group 4. Therefore, while the correct classification rates obtained for experimental reduction groups were more robust with the CCFP data than with the KRF data, a fine-grained assessment of the 3rd Unnamed Cave archaeological materials using mass analysis was not achieved.

Table 9. Canonical Discriminant Functions Measured at Group Means (#2).

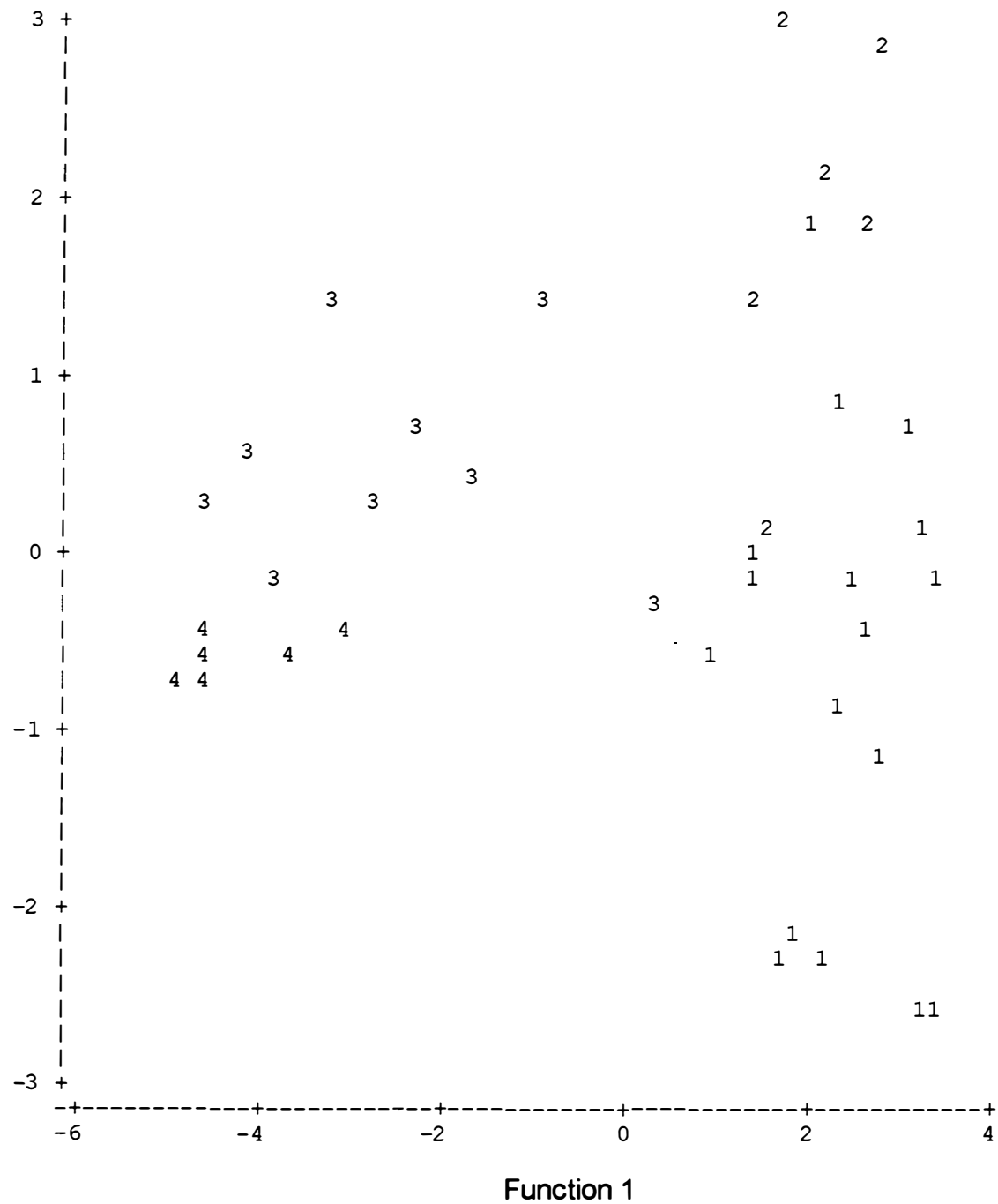
Group	Function 1	Function 2
HHCT	2.28	-0.68
HHCR	2.02	1.90
BCR	-2.56	0.55
SHBT	-4.30	-0.59

Table 10. Resubstitution Summary for the CCFP Experimental Data Set.

From	To			
	HHCT	HHCR	BCR	SHBT
Area C (east)	†			
Area C (west)	†			
Area F	†			
Area G	†			
HHCT	17	1	0	0
HHCR	1	5	0	0
BCR	1	0	6	2
SHBT	0	0	0	7

Table 11. Cross-validation Summary for the CCFP Experimental Data Set.

From	To			
	HHCT	HHCR	BCR	SHBT
HHCT	14	4	0	0
HHCR	1	5	0	0
BCR	1	0	5	3
SHBT	0	0	1	6



1: HHCT 2: HHCR 3: BCR 4: SHBT

NOTE: 2 observations hidden.

Figure 10. Plot of Discriminant Functions for the CCFP Data.

Clearly, the CCFP experimental data set are not suitable for evaluating the lithic assemblage from 3rd Unnamed Cave.

As discussed previously, culturally unmodified nodules of chert, quite variable in size and shape, were collected from passages in 3rd Unnamed Cave removed from the primary mining and workshop chamber. These nodules were used to conduct 53 mass analysis experiments for purposes of evaluating the archaeological samples. Flakes believed to be suitable for further reductions were subjectively pulled from the analyses (see Ahler 1989a; Magne 1985).

Initially, the Size 1 ($\frac{1}{8}$ ") data from the 3rd Unnamed Cave experimental data set (hereafter, 3UCE) were not recorded or used in a mass analysis because the recovery techniques employed in collecting the archaeological samples from 3rd Unnamed Cave did not lend themselves to the recovery of very small debitage, i.e. Size 1. Therefore, it was thought that using the 3UCE Size 1 data to classify the archaeological samples would be biased. For Discriminant Function Analysis #3, sixteen variables were initially entered in the model (Table 12). A forward selection stepwise discriminant analysis for choosing the most discriminating variables proved to yield the most consistent and robust correct classifications (Table 12).

Discriminant Function Analysis #3 yielded two significant functions. Function 1 maximally separates Group 1 (HHCT) from Group 4 (SHTP) and secondarily serves to separate all hard hammer experiments (Groups 1-3) from the soft hammer ones (Group 4). Function 1 accounts for 95.2% of the model's

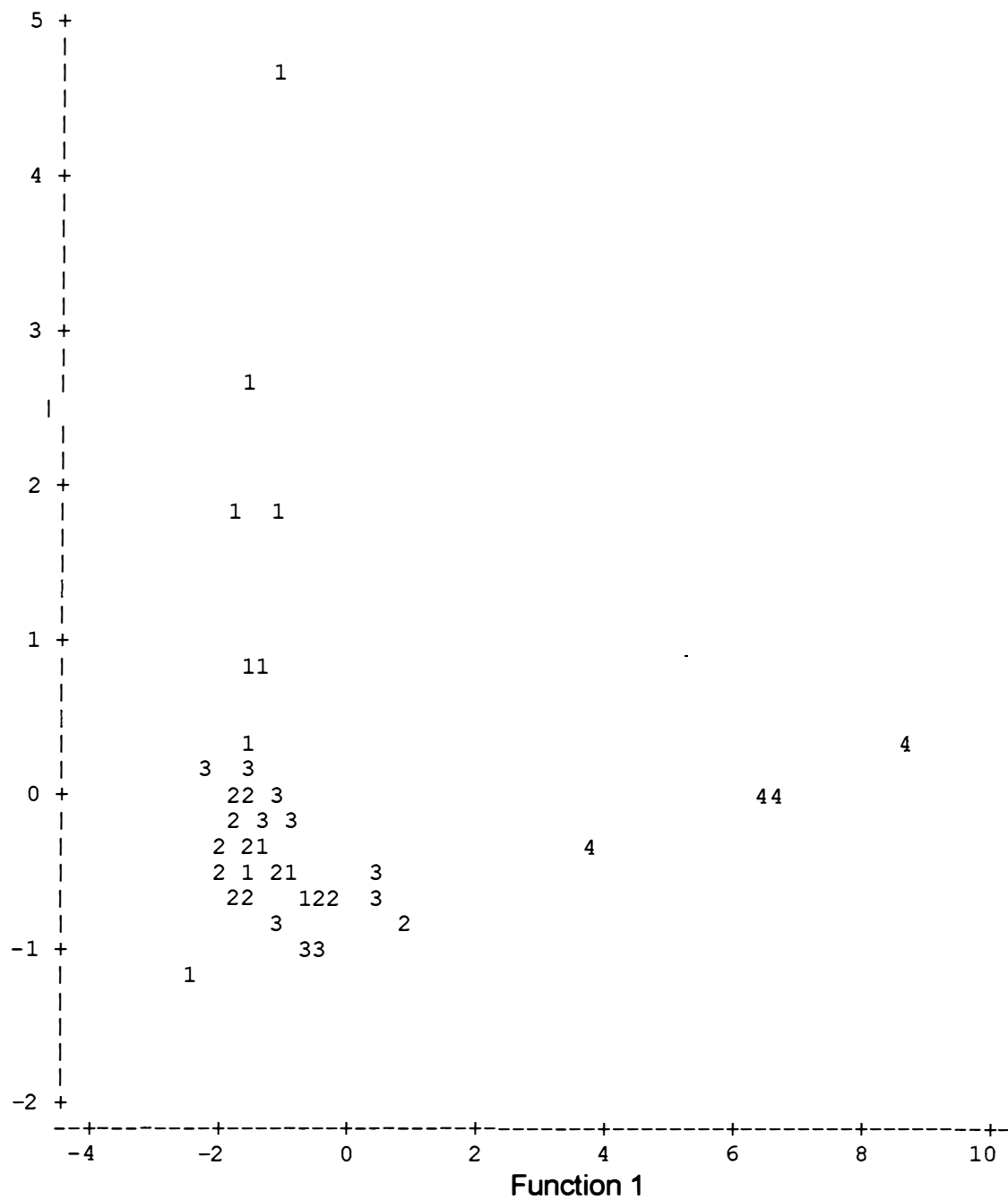
Table 12. Mass Analysis Variables for Discriminant Function Analysis #3.

1. Percentage by count of Size 5 flakes†
2. Percentage by count of Size 4 flakes
3. Percentage by count of Size 3 flakes
4. Percentage by count of Size 2 flakes
5. Percentage of Size 5 cortex-bearing flakes
6. Percentage of Size 4 cortex-bearing flakes
7. Percentage of Size 3 cortex-bearing flakes
8. Percentage of Size 2 cortex-bearing flakes
9. Percentage by weight (g) of Size 5 flakes
10. Percentage by weight (g) of Size 4 flakes
11. Percentage by weight (g) of Size 3 flakes
12. Percentage by weight (g) of Size 2 flakes†
13. Mean flake weight: Size 5
14. Mean flake weight: Size 4
15. Mean flake weight: Size 3
16. Mean flake weight: Size 2

†Variables retained in the model after forward selection discriminant analysis.

variance. Function 2 maximally distinguishes between Group 1 (HHCT) and Group 3 (BCR) and secondarily between Groups 1 (HHCT) and 2 (HHCR) (Figure 11). Function 2 accounts for only 4.8% of the model's variance (Table 13). Both the resubstitution and cross-validation summaries yielded the exact same overall and individual group correct classification rates for this analysis: 66% (Table 14). As can be seen in Table 14, all four archaeological samples from 3rd Unnamed Cave were classified as representative of hard hammer freehand core reduction. This is contrary to the results of the refitting analysis, which suggests an emphasis on bipolar core reduction. However, the most misclassifications in this analysis were in fact between Groups 2 and 3. In fact, individual group correct classifications for the hard hammer experiments were obtained in little more than 50% of the experiments. This analysis was able to correctly classify the soft hammer experiments in every case. Therefore, great success is achieved in distinguishing between hard hammer and soft hammer percussion, and by extension, between core reduction experiments and tool production experiments.

It has been suggested that the addition of 1/8" lithic data (Size 1, in this study) should greatly aid in the delineation of experimental reduction groups (Stan Ahler, personal communication). For this reason, as well as the fact that the correct classification rates for the 3UCE data without the Size 1 data were poor, a fourth discriminant function analysis was conducted using 22 variables including Size 1 variables (Table 15).



1: HHCT 2: HHCR 3: BCR 4: SHTP

NOTE: 17 observations hidden.

Figure 11. Plot of Significant Functions for Discriminant Analysis #3.

Table 13. Canonical Discriminant Functions Measured at Group Means (#3).

Group	Function 1	Function 2
HHCT	-1.38	1.09
HHCR	-1.31	-0.42
BCR	-0.79	-0.48
SHTP	7.39	0.09

Table 14. Resubstitution and Cross-validation Summaries for Discriminant Function Analysis #3.

From	To			
	HHCT	HHCR	BCR	SHTP
Area C (east)		†		
Area C (west)		†		
Area F		†		
Area G		†		
HHCT	7	4	2	0
HHCR	0	11	4	0
BCR	0	8	10	0
SHTP	0	0	0	7

Table 15. Mass Analysis Variables for Discriminant Function Analysis #4.

1. Percentage by count of Size 5 flakes†
2. Percentage by count of Size 4 flakes
3. Percentage by count of Size 3 flakes
4. Percentage by count of Size 2 flakes†
5. Percentage by count of Size 1 flakes†
6. Percentage by weight (g) of Size 5 flakes†
7. Percentage by weight (g) of Size 4 flakes†
8. Percentage by weight (g) of Size 3 flakes†
9. Percentage by weight (g) of Size 2 flakes
10. Percentage by weight (g) of Size 1 flakes
11. Percentage of Size 5 cortex-bearing flakes
12. Percentage of Size 4 cortex-bearing flakes†
13. Percentage of Size 3 cortex-bearing flakes
14. Percentage of Size 2 cortex-bearing flakes
15. Percentage of Size 1 cortex-bearing flakes†
16. Mean flake weight: Size 5
17. Mean flake weight: Size 4
18. Mean flake weight: Size 3
19. Mean flake weight: Size 2
20. Mean flake weight: Size 1
21. Mean flake weight per experimental reduction
22. Number of flakes generated per experimental reduction

†Variables retained in the model after backward elimination stepwise discriminant analysis.

Discriminant Function Analysis #4 yielded two significant functions.

Function 1 maximally separates Group 1 (HHCT) from Group 4 (SHTP) and secondarily separates Groups 2 (HHCR) and 3 (BRC) from Group 4. It accounts for 94% of the model's variance. Function 2 maximally distinguishes between Groups 1 and 3 and secondarily between Groups 1 and 2 (Figure 12). However, it accounts for only 5.1% of the variance (Table 16). The resubstitution overall correct classification rate was 73.6% (Table 17), while the cross-validation overall correct classification rate was 64.2% (Table 18).

In the case of the 3UCE data, the incorporation of Size 1 variables does not add to the discriminatory power of the analysis. As with Discriminant Function Analysis #3, this analysis was incapable of significantly distinguishing between various forms of early stage reduction. As such, no attempt was made to classify the archaeological samples from 3rd Unnamed Cave.

What factors account for the discrepancies between the results of this study and the ones conducted by Ahler and Christensen (1983) and Bradbury (1995)? One possibility is that the correct classification rates achieved by Ahler and Christensen were statistically too optimistic. The software they used was not designed to conduct cross-validation summaries which serve to prevent individual observations (experiments, in this case) from being used to classify themselves, thereby reducing potential bias. A second, and more likely explanation, is the effect of raw material variability. Knife River Flint and the Cumberland County Ft. Payne both occur in large, tabular form. The chert in 3rd

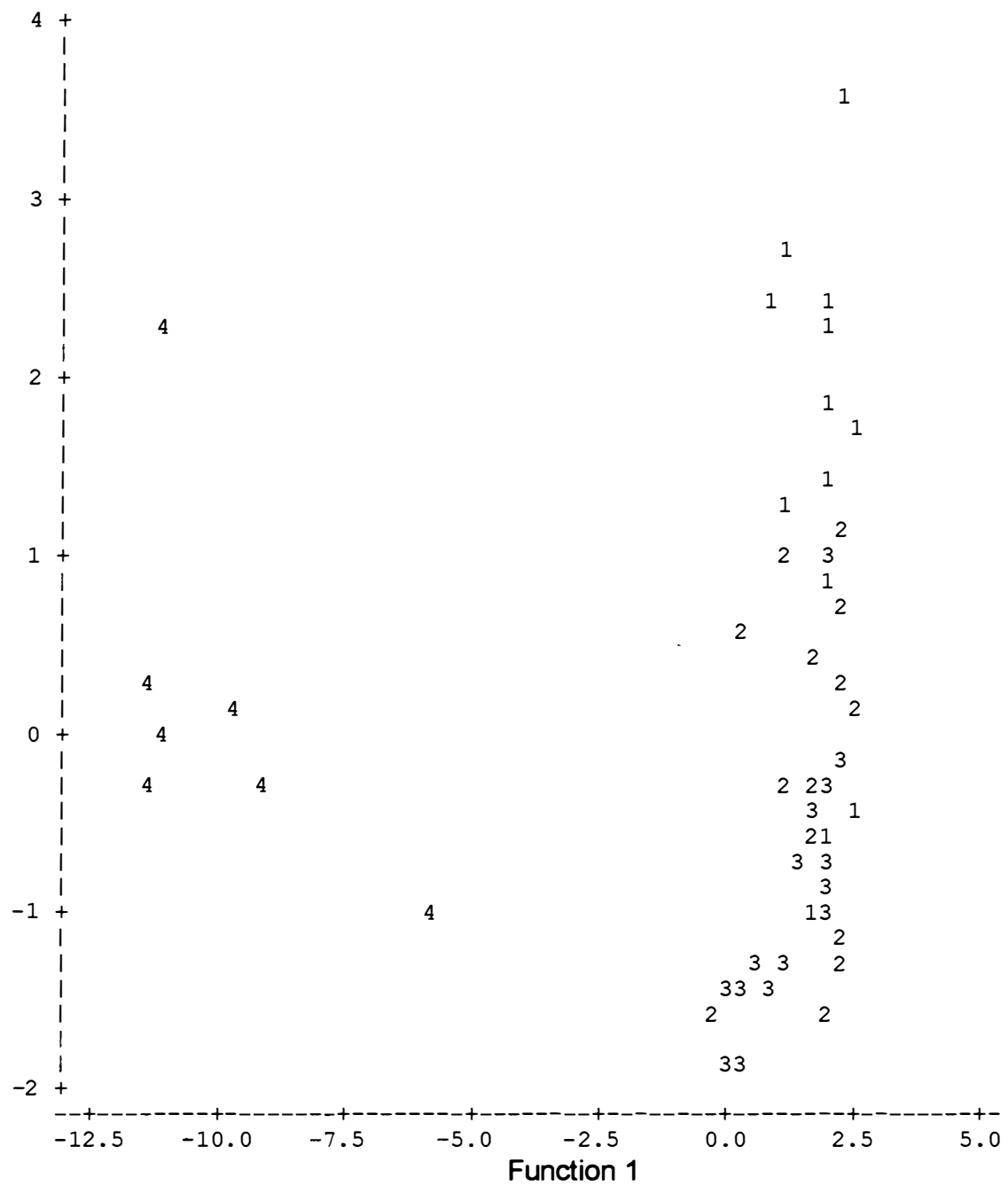


Table 16. Canonical Discriminant Functions Measured at Group Means (#4).

Group	Function 1	Function 2
HHCT	1.82	1.43
HHCR	1.66	-0.15
BCR	1.17	-0.96
SHTP	-9.93	0.14

Table 17. Resubstitution Summary for Discriminant Function Analysis #4.

From	To			
	HHCT	HHCR	BCR	SHTP
HHCT	9	3	1	0
HHCR	3	9	3	0
BCR	1	3	14	0
SHTP	0	0	0	7

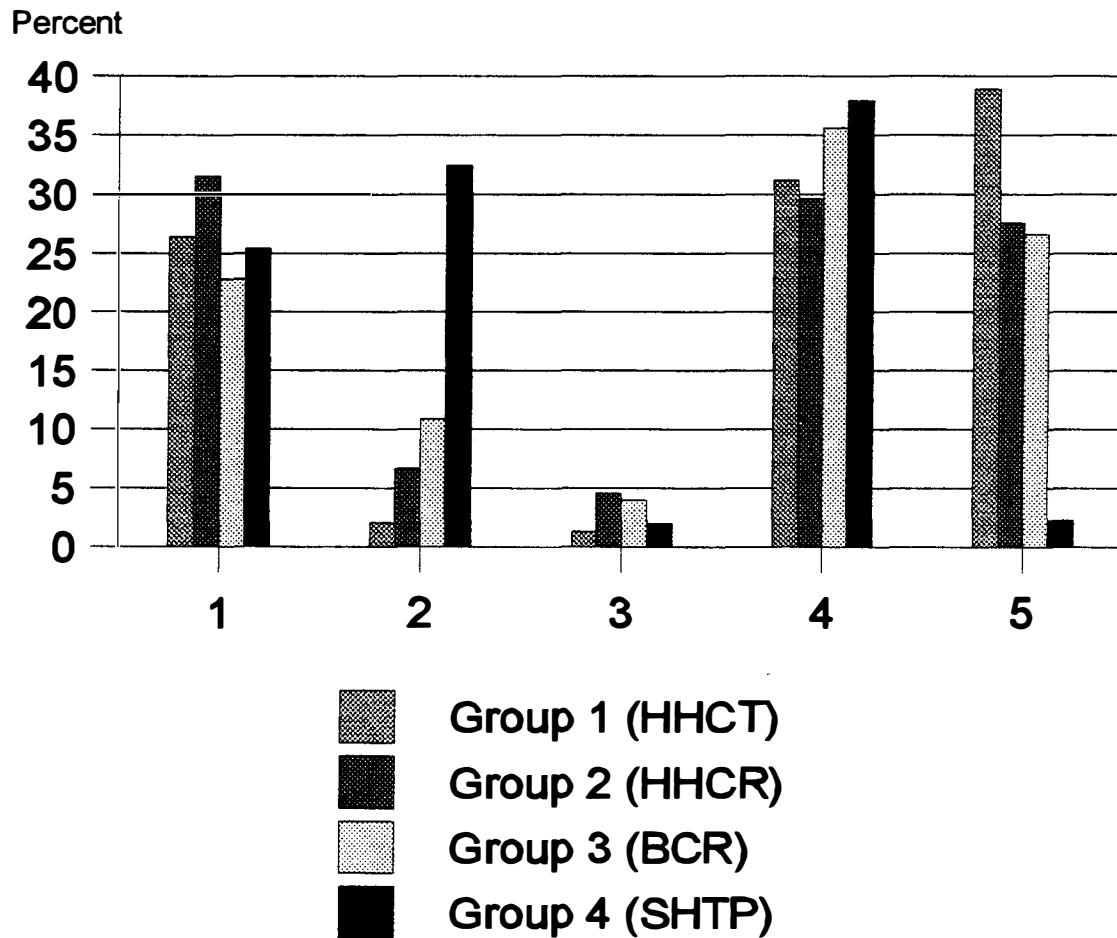
Table 18. Cross-validation Summary for Discriminant Function Analysis #4.

From	To			
	HHCT	HHCR	BCR	SHTP
HHCT	8	4	1	0
HHCR	4	6	5	0
BCR	1	4	13	0
SHTP	0	0	0	7

Unnamed Cave is smaller in size and occurs in nodular form. Further, many nodules, although very high quality at their centers, contain many internal fracture planes which no doubt affect the workability of the chert. Indeed, mass analysis is intended to characterize human controlled breakage patterns in tool stone and not naturally determined fracture patterns (Stan Ahler, personal communication). Still, it does not produce a fine-grained analysis.

The next approach examined was the flake portion method, or interpretation-free approach. Twenty experiments, comprising the same groups used in the mass analysis, were arbitrarily selected to 1) test the hypothesis outlined by Kuijt et al. (1995), and 2) assess the overall utility of Sullivan and Rozen's approach for the analysis of the 3rd Unnamed Cave archaeological materials. The percentages for each flake type (portion) for each group were used in discriminant analysis to test for distinguishable group profiles. While the 3UCE bipolar experiments (Group 3) exhibit a similar mean profile to the one illustrated by Kuijt et al. (1995:123), so do the 3UCE hard hammer freehand experiments (Groups 1 and 2). Groups 1-3 cannot be separated statistically. Only the soft hammer (Group 4) experiments are significantly distinguished based on flake types (Figure 13). There was significant variation in the results of the stepwise discriminant analyses. Forward selection indicated the retention of only one variable, while backward elimination indicated that none of the variables could be removed from the model (Table 19).

Discriminant Function Analysis #5 employed the model suggested by



- 1: Complete Flakes
- 2: Platform Remnant Bearing Flakes (PRBs)
- 3: Split Flakes
- 4: Flake Fragments
- 5: Blocky Shatter

Figure 13. Plot of Flake Type Distributions for the 3UCE Data.

Table 19. Variables for Discriminant Function Analysis #5.

1. Percentage of complete flakes
2. Percentage of platform remnant bearing flakes (PRBs)†
3. Percentage of split flakes
4. Percentage of flake fragments
5. Percentage of blocky shatter

†Variable retained in the model after forward selection stepwise discriminant analysis.

forward selection as retaining all variables would introduce linear dependency into the model. This analysis yielded one significant function for the interpretation-free model, which maximally separates Group 1 from Group 4 and secondarily Group 4 from Groups 2 and 3. Function 1 accounts for 100% of the variance. As only one significant function was generated, group classifications are meaningless and were not attempted. By extension, no attempt was made to classify the archaeological samples either. Based on the flake portion approach, the archaeological samples from 3rd Unnamed Cave are best viewed as the products of generalized core reduction.

Lastly, the same 20 experiments used to assess the interpretation-free approach were used to evaluate the debitage stage method. The debitage from each of the 20 experiments were separated into early, middle, and late stage using the criteria defined by Magne (1985). Further, Biface Reduction Flakes (BRFs) and Bipolar Reduction Flakes (BPOs) were classified as such if the piece exhibited at least three attributes typically associated with their respective flake types (see Ahler 1989b:210; Magne 1985:100) (Tables 20 and 21). Then, numbers of early, middle, and late stage debitage, BRFs, and BPOs for each experiment in each reduction group were converted into percentage variables for use in discriminant function analysis. Both the forward selection and backward elimination stepwise discriminant analyses yielded the same subset of significant variables for this analysis (Table 22).

Table 20. Attributes Used to Define Bifacial Reduction Flakes.

Bifacial Reduction Flakes (BRFs) should exhibit at least 3 of the following attributes:
A. a lipped platform
B. at least 3 platform facets if platform is not lipped
C. a thin, curved longitudinal appearance in cross section
D. a minimum of 3 dorsal scars, at least one of which must appear to originate opposite the striking platform
E. a distended flake shape

Table 21. Attributes Used to Define Bipolar Reduction Flakes.

Bipolar Reduction Flakes (BPOs) should exhibit at least 3 of the following attributes:
A. traces of percussion from both ends as evidenced by crushing
B. exaggerated ripple marks generating from one or both ends
C. a pointed and/or fragmented platform with little or no surface area
D. no definitive positive bulb of percussion
E. a sheared bulb of percussion
F. an angular, polyhedral transverse cross section with steep lateral edge angles

Table 22. Variables Used in Discriminant Function Analysis #6.

1. Percentage of early stage reduction flakes
2. Percentage of middle stage reduction flakes†
3. Percentage of late stage reduction flakes†
4. Percentage of BRFs
5. Percentage of BPOs†

†Variables retained in the model after stepwise discriminant analysis.

Two significant functions were obtained in Discriminant Function Analysis #6. Function 1 maximally distinguishes between Groups 3 and 4 and accounts for 59.6% of the variance. Function 2 predominantly separates Group 1 from Group 4, but distinguishes between Groups 1 and 2 on the one hand and Groups 3 and 4 on the other. It accounts for 39.1% of the variance (Table 23).

The overall correct classification rate for the resubstitution summary was 80%, while the same for the cross-validation summary was 75% (Tables 24 and 25). Both concentrations from Area C were classified as representative of Group 1 (HHCT). Area F was categorized as Group 3 (BCR), and Area G as Group 1. As can be seen in Figure 14, however, Area C (west) appears to fall within the range of Group 3 but was actually classified into Group 1.

While the debitage stage model yielded the best results, the classifications are still not very robust. Further, correct classification rates over 80% would be optimal. It is possible that the subjective identification of BRFs and BPOs contributed to the success of this analysis, relatively speaking (*contra* Magne 1985:107). So-called BPOs are in fact generated by reduction methods other than bipolar reduction (Ahler 1989b:211; Cross 1983:91). In his experiments, Magne (1985) did not include blocky shatter in the analysis. Both the 3rd Unnamed Cave experimental data (3UCE) and the 3rd Unnamed Cave archaeological samples are composed of large amounts of blocky shatter apparently due to internal fracture planes. It thus appears that the omission of the blocky debris improves the overall correct classification rates. As noted

Table 23. Canonical Discriminant Functions Measured at Group Means (#6).

Group	Function 1	Function 2
HHCT	-0.11	-1.79
HHCR	-0.75	-0.95
BCR	3.07	1.30
SHBT	-2.74	2.26

Table 24. Resubstitution Summary for Discriminant Function Analysis #6.

From	To			
	HHCT	HHCR	BCR	SHBT
Area C (east)	†			
Area C (west)	†			
Area F			†	
Area G	†			
HHCT	5	1	0	0
HHCR	2	3	0	0
BCR	1	0	4	0
SHBT	0	0	0	4

Table 25. Cross-validation Summary for Discriminant Function Analysis #6.

From	To			
	HHCT	HHCR	BCR	SHBT
HHCT	5	1	0	0
HHCR	2	3	0	0
BCR	1	0	3	1
SHBT	0	0	0	4



Figure 14. Plot of Discriminant Functions for the Debitage Stage Analysis.

previously, this has been offered as a possibility for the poor results obtained in this study (Stan Ahler, personal communication).

Discussion

All three experimental models separate early stage reduction from later stage reduction, and hard hammer percussion from soft hammer. However, each exhibited difficulty in distinguishing between the various hard hammer early stage reduction types. Without the addition of core refitting as an analytical technique, only generalized core reduction can be inferred with any degree of certainty for the 3rd Unnamed Cave archaeological samples, and that would be a logical assumption. Bipolar cobble testing and bipolar core reduction have been confirmed by refits. To date, the refits do not confirm freehand core reduction.

It bears noting that both the experimental and archaeological data can be manipulated in a variety of ways in order to obtain acceptable correct classification rates. For example, if the 3UCE Group 2 (HHCR) data are omitted (because there are no refits to suggest this type of reduction) as well as three of the bipolar experiments that essentially functioned as cobble tests, then correct classification rates for Discriminant Function Analysis #3 would be over 96%. Then mass analysis would appear to be quite robust. But, it cannot necessarily be assumed that hard hammer core reduction was not a technique used in 3rd Unnamed Cave simply because there are no refits to suggest it. Furthermore, in every discriminant analysis conducted for this thesis, the correct classification rates obtained well-exceeded the null hypotheses of correct classifications by

chance. However, to suggest that an analytical method is adequate because it can accurately predict the technological make-up of an archaeological assemblage in 6 out of 10 cases would be misleading at best. In any case, refitting has provided a finer-grained picture of the 3rd Unnamed Cave lithic assemblage but only by empirical observation and not analogy or statistical manipulation.

The researchers who defined the analytical models tested in this study have suggested general applicability for their models. At the same time, they have noted that their results are preliminary and much more experimental research is warranted. Based on the 3rd Unnamed Cave materials (both experimental and archaeological), I would argue that these experimental models for lithic analysis are situationally dependent. That is, they are constrained by raw material variability, especially by initial nodule size and configuration. This study, like the ones it is modeled after, is but one example. However, it aptly illustrates situational contingencies represented in the archaeological record. Extensive application of any model across lithic raw materials of varying quality and geographical regions is mandated before its utility can be truly assessed (e.g., Franklin and Bradbury 1997, 1999). This statement underscores another significant point of departure between refitting and the other methods tested in this study; whenever and wherever refitting has been used as an analytical technique, it has provided important insights into prehistoric behavior. In short, it works. It has been demonstrated to be a proven and powerful method in both

Old and New World archaeology (e.g. Cahen et al. 1979; Frison 1968).

The refitting program initiated for 3rd Unnamed Cave will likely continue. As Hofman (1992b) pointed out, though, this should in no way detract from its interpretative power. It is already clear that refitting should be an integral part of North American lithic analysis whenever possible. It can be difficult, time consuming, and it is largely an intuitive process; there are no specifically defined criteria that are prerequisites for using refitting. Yet, its empirical utility is evident. Although refitting is the primary means of analysis employed in this study, other models were evaluated independently, and these were also used to augment the refitting and strengthen inferences made about the mining and flintknapping activities practiced in 3rd Unnamed Cave during the Terminal Archaic. As noted previously, employing multiple and independent lines of evidence should be standard practice in lithic analysis and archaeology in general. In all likelihood, there is no one set of reduced variables capable of explaining the variation noted in the archaeological record (Odell 1989). Using multiple methods is an ideal way by which to test that assumption. In the case of the 3rd Unnamed Cave lithic assemblage, however, essentially the same general information was gained from three independent lines of analysis. The best avenues for the analysis of the entirety of the recovered assemblage are discussed in the next chapter.

VII. MASS ANALYSIS

As none of the more customary lithic analysis methods evaluated in the pilot study could do little more than suggest generalized core reduction in the 3rd Unnamed Cave assemblage, it seemed redundant and far too time consuming to continue the analysis along all three lines. Therefore, it was decided to use only mass analysis to augment the refitting for the rest of the archaeological samples. This was done for a variety of reasons. First, as addressed previously, the accurate identification of certain flake types is often difficult and subjective. For example, at least one biface thinning flake has been identified in the archaeological materials, but none of the analyses have suggested anything but cobble testing and/or core reduction. The identification of flake portion can sometimes be difficult as well. Further, according to Cotterell and Kamminga (1987:675), "It is not always a straightforward matter distinguishing tools from flaking debitage." In the case of 3rd Unnamed Cave, the delineation of flaking debris from core fragments was at times problematic and difficult. The natural state of the chert did not readily lend itself to this process. In many cases, the chert was blocky and broke along naturally occurring internal fracture planes. It has been suggested that the blocky debris that broke in this manner be removed from the analysis so as to gain greater clarity concerning the nature of lithic reduction in 3rd Unnamed Cave (Stan Ahler, personal communication). In the end, it was decided that this was not a befitting line of analysis. The bulk of the 3rd Unnamed Cave lithic assemblage is composed of such blocky debris. To

remove it from consideration would inherently change the nature of the assemblage. To complicate matters, core refitting indicates that bipolar reduction was the primary reduction technique practiced in 3rd Unnamed Cave. In bipolar reduction, a core often breaks into a couple to several pieces of approximately equal size and proportion. As addressed by Cotterell and Kamminga (1987:685),

“Such pieces, though often chunky and extensively damaged in their initiation area by hammer impact, are still flakes by our definition. These compression flakes are sometimes misidentified as bipolar cores because they are chunky, lack prominent conchoidal features, and tend to retain distinctive fracture damage from hammer impact.”

For purposes of clarification, Cotterell and Kamminga (1987:676) define a flake as “any fragment detached from a nucleus. It is not limited to the conchoidal variety.” Further complicating matters is the fact that bipolar reduction is often unpredictable in its consequences. Therefore, “it is difficult to characterize the full range of potential morphological variability found in bipolar flakes” (Andrefsky 1998:120). Following this logic, for the 3rd Unnamed Cave lithic analysis, if a piece could not be positively identified as a core or core fragment, it was designated as blocky shatter and included in the debitage analyses. In sum, as delineation of particular flake types and the distinction between flaking debris and core fragments is sometimes difficult and subjective, mass analysis was employed as the first line of lithic analysis for the 3rd Unnamed Cave assemblage. It is relatively objective, not too time consuming, and in contrast to Magne’s debitage stage approach, mass analysis easily incorporates blocky

debris.

Lastly, the use of mass analysis permits a more detailed examination of the nature of the lithic concentrations themselves, i. e. the potential to address site formation processes. A particular application of mass analysis employed by Behm (1983) allowed for the easy delineation of primary and secondary lithic debris deposits. By comparing the ratio of Size 1 ($\frac{1}{8}$ ") flakes to Size 2 ($\frac{1}{4}$ ") flakes, determinations can be made. Primary concentrations should have a mean ratio of approximately 2:1. Conversely, when this ratio falls below about 1.5, concentrations should be considered secondary (Behm 1983:13-14). Additionally, when primary concentrations are presented graphically in the form of density contour maps, a more or less circular to oval image should be the norm. It is argued that making this distinction in the archaeological record is difficult if not impossible (Behm 1983:9). The 3rd Unnamed Cave lithic assemblage is ideally suited for this line of analysis, however. The only significant post-depositional alteration to the lithic concentrations was subsequent prehistoric mining activity. The specific concentrations that were collected were not even subjected to that. Therefore, the density contour maps should reflect primary concentrations.

Macrodebitage Analysis

The mass analysis selected for the examination of the entire 3rd Unnamed Cave assemblage was Discriminant Function Analysis #3 from the pilot study. While only an overall correct classification rate of 66% was obtained, all of the

tool production experiments were correctly classified. This suggested that a mass analysis simply separating core reduction from tool production might be more robust. In fact, when the experiments are re-coded as either core reduction (n=46) or tool production (n=7), a 100% correct classification rate is achieved in both the resubstitution and cross-validation summaries. In addition, all 10 archaeological samples are classified as representative of core reduction (Table 26) . Clearly, the samples represent a homogeneous assemblage.

One function which accounts for 100% of the model's variance was generated in this analysis. As such, no graphical display of the function is possible. However, as with Discriminant Function Analysis #3, the most discriminating variables for the two reduction group analysis are Variables 1 and 12 (percentage by count of Size 5 flakes and percentage by weight of Size 2 flakes, respectively). A scatter plot of these two variables adequately depicts the relationship between the experimental assemblage and the archaeological samples. Further, it clearly demonstrates that the lithic concentrations are products of generalized core reduction (Figure 15).

Microdebitage Analysis

Only materials from lithic concentration Areas E-H were used in this analysis as bulk sediment samples were not collected from Areas A-D by the 1981 UTK archaeology team. While Behm (1983) has suggested a ratio of approximately 2:1 of Size 1 to Size 2 flakes for primary lithic concentrations, an attempt was made distinguish between primary concentrations which resulted

Table 26. Resubstitution and Cross-validation Summaries for Two Group Discriminant Analysis.

From	To	
	Core Reduction	Tool Production
Core Reduction	46	0
Tool Production	0	7
Area A (surface)	*	
Area A (buried)	*	
Area B	*	
Area C (east)	*	
Area C (west)	*	
Area D	*	
Area E	*	
Area F	*	
Area G	*	
Area H	*	



Figure 15. Plot of Significant Variables for the Two Group Mass Analysis.

from different types of reduction techniques. Again, the data from the 53 experimental reductions were used in this line of analysis. Counts of Size 1 and 2 flakes along with the resulting ratios were used as variables in a discriminant function analysis, and stepwise analyses indicated that all three of these variables were significant. The results were poor and will only be summarized here. When four reduction groups are defined for the analysis, overall correct classification rates of 56.6% and 50.9% were obtained in the resubstitution and cross-validation summaries, respectively. The mean ratio of Size 1 flakes to Size 2 flakes was 3.7 for the cobble testing experiments, 4.3 for the freehand core reductions, 4.9 for the bipolar core reductions, and 12.2 for the soft hammer tool productions. The ratios for the three early reduction groups are not statistically distinguishable. However, when the experimental reductions are simply separated into two groups, the results are much more robust. A 90.6% overall correct classification rate was achieved in both the resubstitution and cross-validation summaries with the ratio of Size 1 to Size 2 flakes being the most discriminating variable. The ratio for the core reduction experiments was 4.4 as compared to 12.2 for the tool production experiments, and these are statistically distinguishable. In this analysis, all four lithic concentrations (Areas E-H) are classified as representing primary core reduction concentrations (Table 27). This is no surprise and is consistent with the other discriminant analyses conducted for this thesis. While the ratio for Area G is just below the mean of 2, it does exceed the minimum of 1.48 as suggested by Behm (1983:14). Lastly, density

Table 27. Ratio of Size 1:Size 2 Flakes for Areas E-H.

Area	Count: Size 1	Count: Size 2	Ratio
E	897	412	2.2
F	172	73	2.4
G	132	74	1.8
H	982	399	2.5

contour maps of all four lithic concentrations exhibit the characteristic circular to oval form that Behm (1983) suggests is indicative of primary concentrations (Figure 16).

Given the results of both the macrodebitage and microdebitage analyses and the fact that these particular lithic concentrations are devoid of post-depositional disturbance, there is no reason to doubt that they are the result of generalized core reduction in primary context. The specific nature of the generalized core reduction undertaken in 3rd Unnamed Cave is explored in the following chapter on core and refitting analysis.

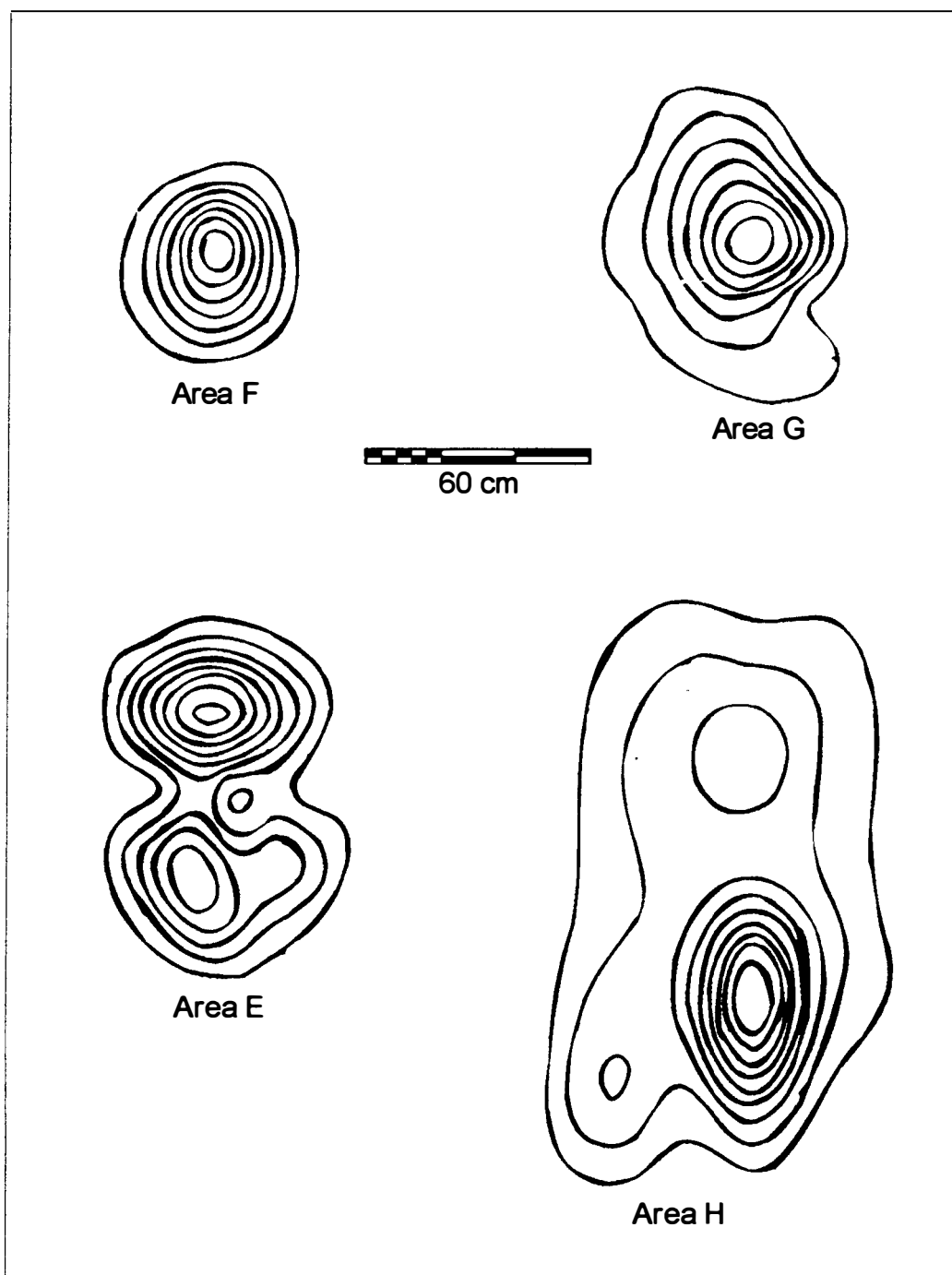


Figure 16. Density Contour Schematics for Areas E-H.

VIII. CORE AND REFIT ANALYSIS

An examination of the cores and core fragments recovered from 3rd Unnamed Cave proceeded along two lines. First, cores and core fragments were identified and removed from the mass of the lithic debris. Second, the refitted cores and core fragments were examined. An attempt was then made to categorize each core or core fragment. Based on the range of variation observed, cores were identified as tested cobbles, blocky, bipolar, multidirectional, or some combination thereof. No exclusively unidirectional cores could be positively identified. Blocky cores were those that broke mainly along naturally occurring fracture planes within the nodules and thus reveal nothing about the intent or technique of the knapper. It must be emphasized that many of the cores and core fragments (whether refit or not) recovered from 3rd Unnamed Cave are not technologically significant. In other words, they reveal more about the nature of the raw material itself than of the reduction technique(s) practiced in the cave. While there are numerous attributes that can be characteristic of bipolar cores (e.g. Hayden 1980:3), bipolar cores in the 3rd Unnamed Cave assemblage were identified as such based largely on the presence of two opposed striking or initiation surfaces. Experimental research has also suggested that there is not necessarily a mutually exclusive set of attributes or defining characteristics for bipolar cores (Hayden 1980:3). Secondly, the presence of a wedging initiation with an approximate striking angle of 90° was used as a defining criterion (Cotterell and Kamminga

1987:689). The occurrence of exaggerated ripple marks on interior surfaces generating from one or both ends was also used as a defining criterion, but only in a supplemental fashion. Multidirectional cores are identified based on multiple striking surfaces resulting in flake removals emanating from more than one direction. "Multidirectional cores must be turned or rotated to remove flakes from the different striking platforms" (Andrefsky 1998:15). Bipolar cores are often multidirectional cores as well. The cores, core fragments, and refits from each lithic concentration are summarily described hereafter.

A total of 1708 lithic artifacts was collected from the surface concentration of Area A. In addition, 3 unmodified chert nodules and one retouched flake were recovered. The retouched flake was not examined for use wear. Twenty-two cores or core fragments were identified consisting of 1 tested cobble, 10 blocky cores, 4 bipolar cores (1 exhibited a wedging initiation surface), and 6 nondescript core fragments. Of the total, 89 pieces were conjoined to form 35 refits. Refit #1 consists of two pieces which were originally part of the same removal. The refit represents a multidirectional core fragment. Refit #2 consists of two pieces which represents one exterior split flake. Refit #3 consists of four pieces resulting in a bipolar core fragment with a wedge initiation. The posterior portion of the nodule is missing due to a break along a fracture plane. Refit #4 conjoins two pieces into one exterior flake. The second flake was driven off at 90° to the first removal. Refit #5 consists of two pieces conjoined into an external piece. The nodule was then rotated approximately 140° for the second (or next)

removal resulting in an overshoot (*outrépassé*). Refit #6 consists of two pieces resulting in a bipolar core fragment and exhibits a wedge initiation. The refit displays removals from both faces. Refit #7 (2 pieces) is also a bipolar core fragment and exhibits a wedge initiation. The nodule was rotated 90° for the second removal. Refit #8 consists of two pieces and represents one exterior split flake. Refit #9 consists of two pieces which likely represent the same removal that resulted in an overshoot. The common interior face of the refit exhibits a break along a fracture plane. Refit #10 consists of two pieces. For the second removal the piece was rotated 90° and exhibits crushing at both ends indicating bipolar reduction. Refit #11 (4 pieces) represents one event which also generated a posterior vertical split. The nodule was opened using a bipolar technique. The rounded posterior end was placed on an anvil stone and the flat superior end was struck with a hammer stone (Figure 17). This is significant because it demonstrates that even when the miners were presented with flat striking surfaces suitable for freehand reduction on larger nodules, they appear to have opted for the bipolar technique. Refit #12 (2 pieces) is a nondescript core fragment. Refit #13 consists of four pieces of thermal shatter and is therefore nondescript. Thermally shattered debris was recovered from all lithic concentration areas indicating that the fires the miners lit to provide light must have been left burning or smoldering when they left the cave. Refit #14 (2 pieces) is an exterior split flake. Refit #15 consists of two pieces that share a common platform and thus indicating at least one but no more than two events.

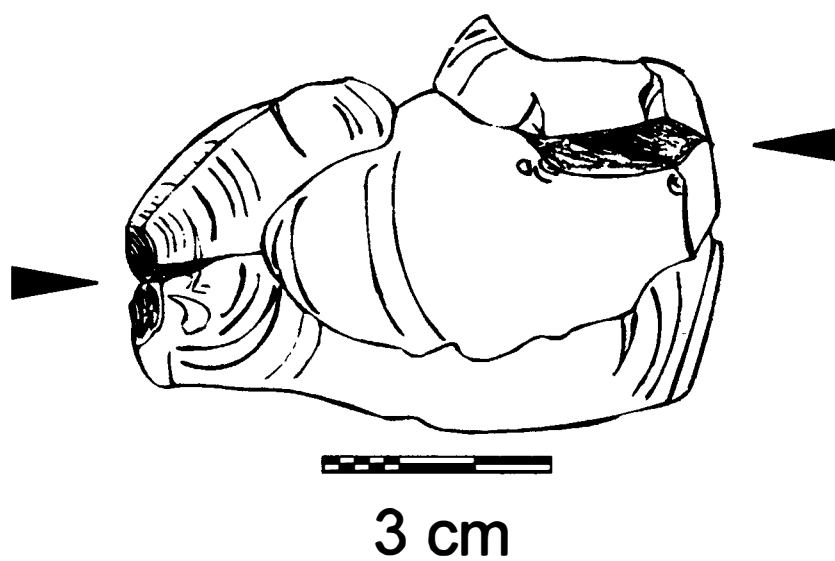


Figure 17. Area A (surface): Refit #11.

Refit #16 represents the same scenario as Refit #15. Refit #s 17 and 18 are both large blocky core fragments that broke into several pieces along naturally occurring fracture planes upon impact. Refit #19 (2 pieces) is a tested cobble. Refit #20 (2 pieces) represents a nodule that was opened using a bipolar technique. It was rotated approximately 50° and struck again. Refit #21 was also opened using a bipolar technique. It was then rotated 90° and struck again resulting in an *outrépassé*. Refit #22 appears to have been opened with a bipolar technique. At least three attempts were made to open the nodule as represented by small flake scars on the exterior of the nodule. Once the nodule was opened, a single flake was struck from the interior surface of the larger of two pieces. The nodule was then discarded. Both Refit #s 23 and 24 appear to represent bipolar reduction as evidenced by wedge initiations and minor crushing. Refit #25 represents a nodule opened using bipolar reduction. Refit #26 demonstrates a wedge initiation and thus likely represents bipolar reduction. However, several fracture planes make this determination difficult. Refit #27 (3 pieces) is a nondescript core fragment. Refit #28 appears to exhibit a wedge initiation. Refit #29 consists of two flakes generated from the same platform surface. Refit #30 also consists of two flakes generated from the same platform surface. It represents a multidirectional core exhibiting removals opposed by 180°. Refit #31 represents a blocky, but multidirectional core with removals opposed by 90°. Refit #32 is a blocky, nondescript core fragment. Refit #33 (2 pieces) represents a large exterior flake but nondescript as to its technological

origin. Refit #s 34 and 35 (5 pieces) represent breaks along fracture planes and thus are nondescript. Both refits certainly represent the same nodule although they themselves could not be conjoined.

A total of 573 lithic artifacts was recovered from the buried concentration at Area A. Fourteen cores or core fragments were initially identified from this concentration. Seven of the cores are blocky cores which shattered along fracture planes. One tested cobble and one multidirectional core fragment were recovered. Three bipolar cores, all exhibiting wedge initiations, were also recovered. Altogether, 82 pieces from buried context were conjoined to form 27 refits. Refit #1 is composed of two exterior flakes which indicate a multidirectional core. Refit #2 is a blocky core fragment which broke along fracture planes. Refit #3 is a bipolar core fragment exhibiting a wedge initiation. It also possesses fracture planes. Refit #4 is a core fragment which exhibits a wedge initiation. Refit #5 is a multidirectional core. The first removal was a relatively large uniform exterior flake. The nodule was rotated 90° and struck again resulting in an *outrépassé*. The nodule was then discarded. Refit #6 is a blocky core fragment with numerous fracture planes. Refit #7 is a tested cobble of poor quality. Refit #8 is a nondescript core fragment but appears to have a wedge initiation. Refit #9 is a multidirectional core exhibiting a definite wedge initiation. At least two and possibly three large exterior flakes were successfully removed before the remaining fragment split into two pieces (Figure 18). Refit #10 is a multidirectional bipolar core fragment with a wedge initiation. Refit #11

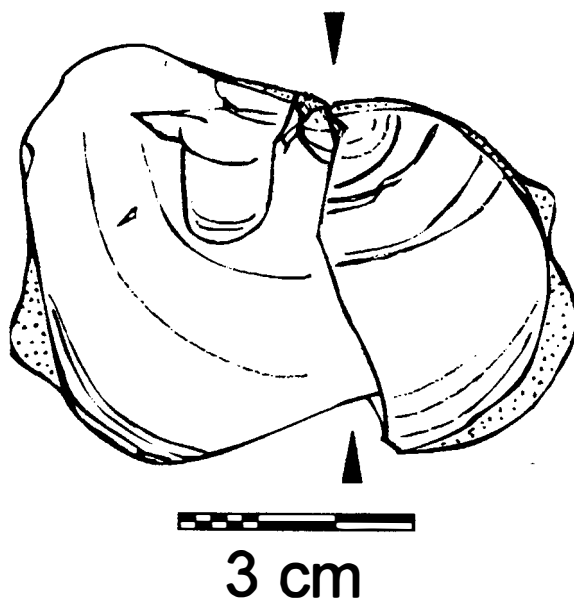


Figure 18. Area A (buried): Refit #9.

is a blocky core fragment with many fracture planes. Refit #s 12 and 13 are both nondescript core fragments that may be bipolar given the size and shape of the nodules. Refit #14 appears to represent the same removal. Two flakes were generated from the same flat surfaced platform. The third was generated from an opposing angle of over 150° on a rounded portion of the nodule. Again, this is an indication that even when presented with flat surfaces where freehanded percussion likely was possible, the miners opted for the bipolar technique. Refit #15 is comprised of two flakes which were generated from the same platform. This refit exhibits crushing on the distal end indicating bipolar reduction. Refit #s 16 and 17 are both nondescript core fragments. Refit #18 exhibits a wedge initiation but is also marred by fracture planes. Refit #19 represents an exterior split flake. Refit #20 is a core fragment which exhibits a wedge initiation. Refit #21 is a nondescript core fragment. Refit #22 consists of two flakes generated from the same platform and probably the same removal. It resulted in a hinge/step termination. Refit #23 is a small rounded nodule which exhibits a wedge initiation. Refit #s 24 and 25 are both nondescript fragments which are certainly parts of the same nodule but could not be refit together. Refit #26 is a bipolar core fragment with a wedge initiation. Two large fragments were conjoined with an exterior flake that was located in the sediments approximately 20 cm above the buried concentration and perhaps as much as 70 cm horizontally removed. This is an indication that the miners reworked the sediments in their quarrying activities. Refit #27 is a nondescript core fragment

which consists of two pieces that were located in the sediments approximately 10 cm above that buried concentration. No debris from the surface concentration was refit with any from the buried concentration, however.

A total of 1459 lithic artifacts was collected from Area B. Three unmodified chert nodules were also collected. Thirteen artifacts were cores or core fragments. Five of the cores are blocky cores that broke primarily along fracture planes. Two other nondescript core fragments were also recovered. One bipolar tested cobble was recovered. Two bipolar cores, two multidirectional bipolar cores, and one multidirectional core were recovered as well. A total of 57 pieces was conjoined to form 22 refits. Refit #1 was opened using the bipolar technique and subsequently discarded. Refit #2 is a blocky core fragment that exhibits a wedge initiation. Refit #3 exhibits a wedge initiation and very exaggerated ripple marks emanating from the initiation. Refit #4 is a bipolar cobble test. Refit #5 appears to be a multidirectional bipolar core fragment. Refit #6 is a multidirectional core. A large exterior flake was driven off in the first removal; the nodule was subsequently shattered. Refit #7 is a bipolar core. Refit #s 8 and 9 are blocky core fragments with fracture planes. Refit #10 is a nondescript core fragment. Refit #11 represents a single exterior flake generated from one side of a rounded nodule. Refit #12 is a bipolar cobble test or core reduction which exhibits a wedge initiation. Refit #13 is a bipolar core fragment. Refit #14 is an exterior multidirectional core fragment. After one removal the piece was rotated approximately 160° and struck again. It appears to be the

result of bipolar reduction. Refit #15 is a multidirectional core fragment which exhibits a wedge initiation and some fracture planes. Refit #16 is a multidirectional core fragment with wedge initiations and likely a bipolar core as well. Refit #17 appears to exhibit a wedge initiation as the striking angle appears to be too severe for free hand reduction. It contains numerous fracture planes making positive identification difficult. It almost certainly is part of the same nodule as Refit #15. Refit #18 is a bipolar core fragment. One good exterior flake was removed before it was broken into unusable pieces. Refit #19 is a bipolar core fragment and may be the result of one or two events; in either case the result was an *outrépassé*. Refit #20 is two conjoined exterior flakes. One was driven off and then the nodule was rotated 90° counterclockwise and the second flake removed. Refit #21 consists of two flakes that were generated from the same platform and likely the same event resulting in a hinge/step termination. Refit #22 is a bipolar core fragment. It exhibits scars from repeated attempts to split it open.

A total of 428 lithic artifacts was recovered from Area C west. One of these is a chalcedony hammerstone which exhibits extensive battering along one side. Five blocky core fragments exhibiting numerous fracture planes were also recovered. Ninety-three pieces were conjoined to form 26 refits. Refit #1 was described in the chapter on the pilot study. It is a bipolar core from which a relatively uniform exterior flake was detached before it was broken and discarded. Refit #2 is a nondescript exterior portion of a large rounded nodule of

poor quality raw material. Refit #s 3-8 are all nondescript core fragments where the nodules broke along naturally occurring fracture planes. Refits #s 9 and 10 are core fragments which exhibit wedge initiations but also many fracture planes. Refit #11 is an amorphous core fragment. Refit #12 exhibits definite signs of percussion from one rounded end of the nodule, however, a perpendicular fracture plane split the nodule in half removing the other end. Refit #13 is a small rounded nodule which is a multidirectional bipolar core exhibiting a wedge initiation. Refit #14 is an indistinct core fragment. Refit #15 is an ovate nodule that was reduced using a bipolar technique. It exhibits removals from both faces. Refit #16 is a bipolar core fragment that was struck several times and exhibits a wedge initiation. Refit #17 appears to be a multidirectional bipolar core fragment with removals from two faces. It exhibits extensive crushing and ripple marks. Refit #18 is one half of a small rounded nodule that is a multidirectional bipolar core fragment with a wedge initiation. Refit #s 19 and 20 are conjoined split flakes. Refit #s 21 and 22 both consist of two flakes generated from the same rounded exterior (cortical) platform surface and probably the same event. Refit #23 is a bipolar core fragment that consists of two conjoined flakes which were generated from the same rounded platform surface which exhibits extensive crushing. The larger flake also shows crushing at the distal (opposed) end. Refit #24 consists of three flakes that share the same crushed platform. The largest also exhibits another removal at 90°. It thus appears to be a remnant multidirectional core. Refit #25 consists of two flakes that were generated from

the same rounded platform surface and event. Refit #26 consists of two flakes that were originally one after the first event. The second event, generated at 90° from the first, separated the two.

A total of 367 lithic artifacts was recovered from Area C east. In addition, one retouched flake was also recovered. Use wear examination indicates this piece was used for woodworking (Maureen Hays, personal communication). It may be that this tool was used re-sharpen digging sticks in the cave and subsequently discarded. Twenty-nine pieces of debris were conjoined into 10 refits. Refit #1 is multidirectional bipolar tested cobble. The flaking quality of this nodule is very poor. Refit #2 is an undistinguished core fragment that broke along a fracture plane. Refit #3 is a large, probably bipolar core fragment that exhibits faint ripple marks on interior surfaces emanating from opposite directions. Refit #4 is a core fragment which exhibits extensive crushing on the one rounded end. Refit #5 is a nondescript core fragment that almost certainly is part of the same nodule as Refit #4. Refit #6 is a bipolar core which exhibits percussion from two opposed ends. Refit #7 is a multidirectional, and probably bipolar, core. Refit #8 is an amorphous core fragment with several fracture planes. Refit #9 is a multidirectional core with a wedge initiation and several fracture planes. Refit #10 is a bipolar core with several fracture planes.

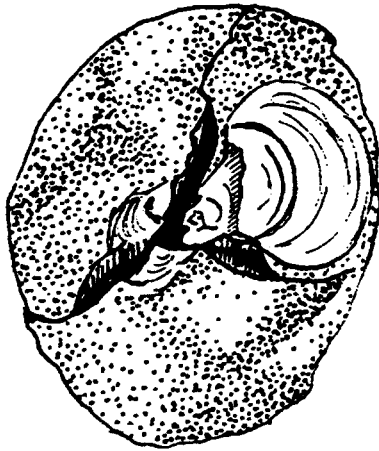
A total of 1155 lithic artifacts was recovered from Area D. One unmodified chert nodule was recovered as well. Three tested cobbles, nine indistinct core fragments, three apparently bipolar core fragments, one blocky core, and one

multidirectional core fragment make up the recovered cores with no refits. Fifty-two pieces of debris were conjoined to form 20 refits. Refit #1 is a bipolar core exhibiting a wedge initiation. Refit #2 is an interior fragment of a large nodule with many fracture planes. Refit #3 is a multidirectional core fragment that may be bipolar as well. Refit #4 consists of three flakes. The original nodule was small and rounded with one flat face from which all three of these flakes were generated. Refit #5 is a nondescript core fragment. Refit #6 consists of three flakes generated from the same platform. After each removal, the core was rotated clockwise, perhaps suggesting a right-handed knapper (Schick and Toth 1993:142). Refit #7 consists of three flakes generated from the same exterior face and split at the striking point of impact. Refit #8 consists of four conjoins. The two end pieces were knocked off during the first event. The third piece was struck from the interior surface of the fourth and largest piece. Refit #9 is an amorphous interior core fragment. Refit #10 is one half of a large rounded nodule and a multidirectional core fragment. Refit #11 is an indistinct core fragment. Refit #12 is composed of four conjoins that appear to be part of the same large flake and one removal. It exhibits a wedge initiation. Refit #13 is an undistinguished core fragment. Refit #14 exhibits a wedge initiation and one good removal exposing high quality, fine-grained chert. Refit #15 is an amorphous core fragment. Refit #16 is a multidirectional core fragment. Refit #17 is a nondescript core fragment. Refit #18 consists of two flakes conjoined to form an indistinct core fragment. The second flake was removed from the interior

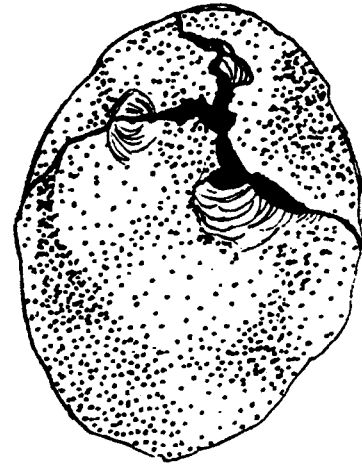
surface of the larger piece. Refit #19 is an exterior split flake. Refit #20 is a bipolar core fragment.

A total of 2476 lithic artifacts was collected from Area E. In addition, one unmodified chert nodule was recovered. One hundred thirty-six pieces of debris were conjoined to form 52 refits. The vast majority of these are technologically nondescript. Refit #1 is a small rounded nodule that exhibits crushed platforms at opposing ends (Figure 19). The fracturing is consistent with bipolar reduction. Further, the battering and crushing is very similar to experimental bipolar cores that have been refit. Refit #s 2-34 all represent blocky cores that broke along the many internal fracture planes exhibited by these nodules. Many of these refits likely represent some of the same nodules; this was not confirmed by refitting, however. Refit #s 35-38 are conjoins that represent blocky shatter. Refit #s 39 and 40 are both nondescript core fragments. Refit #41 consists of two flakes and represents a multidirectional core as the platforms are opposed by 90°. Refit #42 consists of two conjoined flakes. Refit #43 is a refit broken exterior flake with a step termination. Refit #44 is an amorphous core fragment. Refit #45 is a multidirectional core fragment. It consists of a core fragment and two flakes detached from it. Refit #46 is a small rounded nodule which exhibits a wedge initiation and contains several fracture planes. Refit #s 47-49 represent broken flakes. Refit #50 is a bipolar core fragment. Refit #51 consists of two flakes which represent a multidirectional core fragment as the platforms are opposed by 90°. Refit #52 is a fairly large rounded nodule with one flat surface. The

Superior view



Posterior view



3 cm

Figure 19. Area E: Refit #1.

nodule was reduced using a bipolar technique with the flat surface serving as the striking platform. The opposed rounded end exhibits extensive crushing. Perhaps most interestingly, a large flake from Area C east was conjoined to this refitted core. Areas C and E lie adjacent to each other, and it may be that the lithic concentrations in both were generated during the same visit. The conjoins were separated by approximately 1 m, and this represents the farthest horizontal displacement between refits. This is further confirmation that post-depositional disturbance in the cave is minimal. Refit #53 consists of two flakes that share the same exterior striking surface.

A total of 213 lithic artifacts was recovered from Area F. Eighty pieces of lithic debris have been conjoined to form 21 refits. Refit #1 is a small rounded nodule that was tested using bipolar percussion. The nodule split in half and was discarded. Refit #2 is a small rounded nodule that was tested/reduced by multidirectional and bipolar percussion. Refit #3 was completely refit. It is an amorphous-shaped nodule with one large flat face. It was tested using bipolar percussion and exhibits a wedge initiation. Refit #4 consists of two flakes and exhibits evidence of multidirectional and bipolar reduction. Refit #5 was opened using split-cobble percussion and exhibits a wedge initiation. It broke largely along fracture planes. Refit #6 exhibits a wedge initiation and is probably a bipolar core. Numerous fracture planes make this determination difficult, however. Refit #7 is a nondescript core fragment with several fracture planes. Refit #8 is a multidirectional bipolar core with crushing, pointed platforms, and

very pronounced ripple marks on ventral surfaces. Refit #9 consists of two large flakes and is probably from the same nodule as Refit #8. Refit #10 is a multidirectional core fragment with exaggerated ripple marks. It, too, is likely from the same nodule as Refit #8. Refit #11 is a split flake with a crushed platform. It exhibits evidence of multidirectional reduction. Refit #12 is an amorphous core fragment. Refit #13 consists of four pieces which may or may not have initially been one piece but were nevertheless generated from the same platform. Refit #14 is an indistinct core fragment. Refit #s 15 and 16 are multidirectional core fragments with several fracture planes. Refit #s 17-19 all represent broken flakes. Refit #20 consists of two flakes generated from the same platform surface. Refit #21 is an indistinguishable core fragment.

A total of 538 lithic artifacts was collected from Area G. One unmodified chert nodule and tested cobble were also collected. It is a very small rounded nodule with one small flat face. Attempts were made to open this nodule using the split cobble technique but to no avail. The nodule was subsequently discarded. One hundred thirteen pieces of lithic debris were conjoined to form 33 refits. Refit #1 is a bipolar core with a wedge initiation. An exterior flake is missing from the core. Refit #2 is one half of a bipolar core and exhibits extensive crushing at both ends. Refit #3 contains many fracture planes but exhibits evidence of percussion from two opposed ends. Refit #s 4-11 are blocky core fragments that contain and broke along numerous fracture planes. Refit #12 is a nondescript core fragment. Refit #13 is a broken flake with an exaggerated

hinge termination. Refit #14 is a bipolar core fragment with crushing and negative flake scars on both ends. Refit #15 consists of two flakes generated from the same striking surface. Refit #16 is a bipolar core fragment that exhibits evidence of percussion from both ends. Refit #17 consists of three flakes generated from the same striking surface. Refit #18 is a bipolar core fragment with evidence of percussion on both ends. Refit #19 appears to be bipolar. An absolute determination is difficult. Refit #20 is a multidirectional bipolar core fragment that exhibits no positive bulb of percussion. It was struck repeatedly. Refit #21 exhibits sheared interior surfaces but no platforms. Refit #22 is an amorphous core fragment. Refit #23 is one half of a large nodule which exhibits shearing and crushing and is probably bipolar. Refit #24 is a multidirectional core fragment. Refit #25 is an indistinct core fragment. Refit #26 consists of two flakes generated from the same striking surface. Refit #27 consists of a nondescript core fragment and a flake removed from its interior surface. Refit #s 28-30 are all conjoins of blocky shatter. Refit #31 consists of two flakes. Refit #32 is a bipolar core fragment. Refit #33 is an indistinguishable core fragment.

A total of 3450 lithic artifacts was recovered from Area H. One hundred forty-four pieces were conjoined to form 51 refits. Refit #s 1-3 are very typical of many of the refits thus far described. They are bipolar core fragments with wedge initiations and fracture planes that exhibit signs of percussion from two opposed ends. Refit #2 exhibits extensive battering and crushing on both ends. Refit #4 is a bipolar core fragment with evidence for percussion on both ends.

One end exhibits extensive crushing. Refit #5 is a core fragment with fracture planes and exhibits a wedge initiation. Refit #6 is a tested cobble. The angle of percussion suggests a wedge initiation and is probably bipolar. The core itself possesses the positive bulb of percussion. Refit #7 exhibits a wedge initiation and some crushing. Refit #8 is blocky shatter. However, interior negative flake scars suggest bipolar percussion. Refit #9 is also blocky shatter. The last event resulted in an *outrépassé*. Refit #10 is a multidirectional, if not bipolar as well, core fragment. Refit #11 is a core fragment with a positive bulb of percussion. Refit #12 is a nondescript core fragment. Refit #13 exhibits pronounced ripples on its interior surfaces as well as an exaggerated negative hinge termination. Refit #s 14 and 15 are bipolar core fragments exhibiting signs of percussion from both ends. Refit #16 is an indistinct core fragment. Refit #s 17 and 18 are blocky fragments with several fracture planes. Refit #19 is a nondescript core fragment with many fracture planes. Refit #s 20 and 21 are bipolar core fragments with fracture planes. Refit #22 is a blocky fragment with several fracture planes. Refit #23 exhibits a wedge initiation and fracture planes. Refit #24 is a bipolar core fragment with pointed platforms and shearing and crushing on both ends. Refit #25 is an amorphous core fragment with fracture planes. Refit #26 is a blocky fragment with fracture planes. Refit #27 is a nondescript fragment with fracture planes. Refit #28 is a bipolar core fragment. Refit #29 is an indistinct core fragment. Refit #30 is a blocky fragment with fracture planes. Refit #31 is a large exterior flake which appears to represent a split cobble. Refit #32 exhibits a

wedge initiation on one end and fracture planes. Refit #33 is a bipolar core fragment. Refit #34 exhibits extensive shearing on its interior surface. Refit #35 is a blocky fragment with several fracture planes. Refit #36 is a tested cobble. Refit #37 is probably a bipolar core fragment. Refit #s 38-45 are conjoins of blocky shatter. Refit #46 is a nondescript core fragment. Refit #47 is a broken flake which exhibits a sheared bulb of percussion and exaggerated ripple marks. It shows signs of multidirectional reduction. Refit #48 is also a broken flake showing signs of multidirectional percussion. Refit #49 is a nondescript core fragment. Refit #50 is a multidirectional bipolar core fragment. Refit #51 consists of 14 pieces and represents the shell, essentially, of a chalcedony hammerstone. It appears that exterior flakes shattered off during cobble testing and core reduction. These have been refit; only the interior portion is missing. This is inconsistent with the pattern observed in the chert core refits where exterior flakes are missing. This discrepancy, along with the fact that several chalcedony hammerstones have been noted and/or recovered, indicates that the miners were not flintknapping the chalcedony itself, but rather, knapping with it. The reduced hammerstone from Refit #51 was presumably taken from the cave by the miners.

To summarize, ten lithic concentrations from eight collection areas were recovered from the primary mining and workshop chamber and two adjacent passages of 3rd Unnamed Cave. A total of 12,367 lithic artifacts was recovered from these contexts. This total consists of lithic debris, core fragments,

hammerstones, and three stone tools. Of the total, 877 pieces of debitage were conjoined to form 298 cores, core fragments, or other fragments (i.e., split and broken flakes and blocky shatter). From the refitting efforts and subsequent analysis, a consistent pattern, or *chaîne opératoire*, has emerged.

The technological sequence observed in all ten lithic concentrations is invariable. As noted previously, much of the chert in the cave is of poor quality and contains numerous internal fracture planes. As such, there are vast amounts of blocky shatter in every lithic concentration. However, there is plenty of chert that is very fine-grained and of good to high quality. In either case, cobble testing and core reduction was done using a bipolar (split cobble) technique. As discussed previously, in bipolar reduction, a nodule is placed on an anvil stone of some sort. The superior end of the nodule is struck with a hammerstone. This generates “a force rebound from the anvil to produce fracture from the distal end, as well as primary fracture from the proximal end receiving the force application” (Sollberger and Patterson 1976:40). In bipolar reduction, “The flaking techniques are not intended to control the form of the resulting flakes. Cores are not preformed or prepared in any way. Instead, they are struck almost randomly, shattering into pieces of variable of size and shape” (Parry and Kelly 1987:287).

The above characterization adequately describes the lithic assemblage from 3rd Unnamed Cave as demonstrated by refitted nodules. Individual pieces of lithic debris from 3rd Unnamed Cave may or may not exhibit characteristic

bipolar attributes. Once refit, however, many cores clearly indicate bipolar reduction as evidenced by battering/crushing at both ends, wedge initiations at the striking surface, and pronounced ripple marks emanating from one or both ends. Other characteristic features exhibited by many cores and refits from 3rd Unnamed Cave include negative flake scars on interior surfaces originating from two opposed ends, crushed and/or pointed platforms, sheared bulbs of percussion, lack of positive/negative bulbs of percussion on flakes or core fragments, and abrupt terminations such as hinge and step terminations (Stafford 1977:27). The ancient miners of 3rd Unnamed Cave employed a true bipolar reduction technology. Nodules were struck dead center with a wedge initiation; many exhibit extensive battering indicating repeated attempts to fracture the nodules. Based on the refits, no attempts were made to drive flakes off the edges of cores. Even when presented with flat exterior surfaces of mostly rounded nodules, the miners opened nodules using bipolar percussion. The goal of this technique appears to have been relatively large exterior flakes that could have been fashioned into a variety of stone tools at other, presumably open-air, locations.

What factors conditioned the use of the bipolar technique in 3rd Unnamed Cave? First, the nodules are generally small in size and rounded and/or amorphous in shape. These factors make freehand percussion difficult, if not impossible. Second, light and time certainly must have been constraints on the miners. It is apparent that the miners packed in their own firewood as the mining

areas are removed from the entrances by some 1000 meters. Only so much firewood could likely be carried into the cave and negotiated through certain passages. Further, there were two facets to this exploitation, (1) the mining and (2) the cobble testing and core reduction. Mining activities no doubt required much time and therefore light as well. An appreciable portion of the firewood was probably exhausted during these activities, leaving only a certain amount for reduction activities. Lastly, although this has not been tested experimentally, the nature of the lighting itself may have constrained more elaborate or technical flintknapping practices. Poor lighting would certainly have affected the ability of the miners to engage in precision flaking. Additionally, smoke produced from the pine and cedar fires in the chamber might have constrained the miners. On the positive side, the sheer numbers of chert nodules in the cave lessened the impact of uncontrolled and unpredictable reduction techniques such as bipolar reduction. In other words, while expediency may be indicated by the quality of the raw material and factors such as available light and time, it is not indicated by raw material quantity. Depletion of this chert source was apparently never achieved. A few of the flintknapping concentrations still contained unmodified chert nodules. Many more have been noted on the sediment surfaces of the primary mining and workshop chamber and other passages. Further, dozens still sit in primary positions in the walls of adjacent passages. Thus, there is no evidence for depletion of this source or for scavenging. The ancient miners could apparently be somewhat selective in the items they curated.

There is much contention about what bipolar percussion signifies. Some researchers believe “that true bipolar flaking simply represents errors, accidents, or unskilled technique by individual craftsmen” (Sollberger and Patterson 1976:40). They further maintain that bipolar reduction does not represent industries. This seems a difficult position to maintain as archaeological evidence of bipolar percussion is found throughout the world from the Lower Palaeolithic well into the historic era (Schick and Toth 1993; White 1977). However, bipolar percussion is best viewed or described as a technique rather than a method. Method insinuates complex conceptual schemes, while technique is simply a physical action. A particular method may involve one or more techniques (Inizan et al. 1992:34, 91). Further, it is best to view bipolar reduction as a function of situational constraints rather than the result of accidental or poor craftsmanship. It is not necessarily technologically advantageous compared to other techniques. It also produces vast amounts of unusable waste debris, and 3rd Unnamed Cave is a prime example of this. “Bipolar flaking does allow for an economical use of small pieces of raw material” (White 1977:6). Given the vast amounts of chert in 3rd Unnamed Cave and constraints such as time and light, expediency in technique best served the ancient miners.

“It is clear from numerous ethnographic observations, that individuals using bipolar techniques were minimally concerned with ‘control’ of the medium, and most concerned with simply obtaining usable pieces of stone” (Hayden 1980:4).

In this chapter, the *chaîne opératoire*, or technological sequence used by

the 3rd Unnamed Cave miners has been revealed through the examination of refit cores. In addition, reasons for the particular techniques practiced therein have been discussed. A potentially more important issue is why prehistoric peoples ventured so far into 3rd Unnamed Cave for raw materials. An explicit need for chert would seem to be an obvious answer. As will be discussed in the final chapter, however, this may not have been the only reason.

IX. SUMMARY AND DISCUSSION

Prehistoric hunter-gatherers in Middle Tennessee trekked into remote passages of 3rd Unnamed Cave to mine and work chert nodules on an intensive scale. Radiometric age assays place this activity in the Terminal Archaic Period about 3,000 years ago. These ancient miners entered the cave and traversed the meander passage to the primary mining and workshop chamber. Numerous torch stoke marks on the passage walls and cane charcoal on the floor are evidence of this route. The miners used digging sticks to quarry thousands of chert nodules from the floor sediments of the mining chamber. They also extracted nodules from primary positions in the limestone walls of the chamber. Once the miners procured the nodules, they extensively tested and reduced them. Chalcedony hammerstones were presumably imported as no chalcedony source has been located inside the cave. Small fires of pine and red cedar were lit to illuminate these activities. Numerous quarry pits (many with digging stick marks in profile) and hundreds of piles of flintknapping debris remain as evidence of this endeavor.

Initial core refitting of the debris from three of the lithic concentrations indicated that bipolar reduction was the technique used by the ancient miners. Core refitting was also used to test three other methods of lithic analysis, which are largely based on experimental analogy. Results indicated that these methods are not necessarily universally applicable. Further, they provided only coarse-grained results. The remainder of the archaeological materials were thus

examined using only core refitting and mass analysis.

Mass analysis of the lithic debris recovered from 10 flintknapping concentrations has indicated homogeneity in content of this massive assemblage. It has further revealed that the debris accumulations are in primary position and the result of generalized core reduction.

Core refitting of the lithic debris has also indicated homogeneity but with much finer detail. The *chaîne opératoire* used in 3rd Unnamed Cave by the ancient miners was invariable. Nodules were tested and reduced using the bipolar, or split cobble, technique. The ancient knappers struck nodules dead center with a wedge initiation of 90°. In many cases, the nodules were struck repeatedly before they split open. Nodules were often rotated to test another striking surface. Items of export were relatively large, uniform exterior flakes. Many high quality interior pieces were abandoned by the miners.

Large amounts of culturally unmodified chert still remain in the cave. Most of it is located in a passage joined to the mining chamber. However, much of it is located in the mining chamber itself. There are even unworked nodules within some of the flintknapping concentrations. Thus, there is no reason to believe that this raw material source was ever exhausted. Further, there is no evidence of scavenging. The flintknapping concentrations remain undisturbed with the exception of some that were buried by subsequent quarrying activities. As noted above, many usable pieces were left behind. The miners were apparently unconcerned with raw material conservation.

This cave was exploited for chert for perhaps 400 years during the Terminal Archaic Period and then its use apparently changed. Radiocarbon dates and one diagnostic stone tool confirm this interpretation. Radiocarbon dates also indicate that later Woodland and Mississippian peoples entered the cave. However, later peoples apparently only explored the cave.

The acquisition of raw materials for stone tool manufacture was clearly a major objective of the ancient miners. However, exterior raw material sources in the area of 3rd Unnamed Cave are numerous (*contra* T. Ferguson 1988). In fact, an open-air outcrop of the same Monteagle Chert has been located 2 km downstream from the cave. It is situated at the same elevation as the rich chert-bearing contact in the primary mining and workshop chamber of 3rd Unnamed Cave. Every exposed nodule in this outcrop has been chipped open by human hands as evidenced by crushed striking platforms and negative flake scars. Although systematic sourcing has yet to be undertaken in the immediate area, it is probable that this chert-bearing geologic contact is continuous throughout the river gorge (Ira Sasowsky, personal communication). In addition, outcrops of Fort Payne and St. Louis Cherts are often exposed along this deeply incised portion of the western escarpment of the Cumberland Plateau, particularly farther downstream (Hardeman 1966). Raw material sources have also been located farther away from 3rd Unnamed Cave. There are outcrops of St. Louis Chert along the Wolf River and Caney Creek (Bradbury 1997). Further, nodules of St. Louis Chert are found in the gravel deposits of Caney Creek. Both of these

sources are less than 30 km from 3rd Unnamed Cave. Monteagle Chert outcrops farther north along Langham Branch in Wayne County, Kentucky. Again, little systematic research has been undertaken, but it does appear that the area possesses locally abundant raw material sources available to prehistoric peoples. Why, then, the difficult and dangerous expeditions into 3rd Unnamed Cave? Was there a ceremonial or ritual aspect to this exploitation? This is the only known cave where there is an association between art production and chert mining. The petroglyphs on the ceiling of the primary mining and workshop chamber would seem to stress the enormity of the associated mining and knapping activities (Simek et al. 1998).

As mentioned in the introduction, hypotheses as to why Archaic hunter-gatherers exploited 3rd Unnamed Cave so intensively cannot be formed by studying the cave alone. 3rd Unnamed Cave has served as the logical starting point, however. As Watson (1990:47) has argued, "If we want to gain adequate understanding of culture history in the extensive karst areas of the Southeast, then we must follow the prehistoric cavers into those regions of eternal darkness." This has been done in 3rd Unnamed Cave. The task now at hand is to follow the ancient miners out of the cave and begin systematic investigations of the surrounding region, including the many caves. In so doing, perhaps the activities undertaken within 3rd Unnamed Cave can be properly placed within greater cultural and economic milieus of Archaic hunter-gathers in Middle Tennessee.

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VITA

Jay Douglas Franklin was born in Albany, Georgia on February 10, 1966. He attended four schools in four states during his first grade year, finishing the year in Nashville, Tennessee. Jay completed his primary education in Nashville in 1978. Subsequently, he moved to Chattanooga, Tennessee where he graduated from Hixson High School in May 1984. Jay enrolled in the University of Tennessee in September 1984 with no idea what he wanted to be when he grew up. His first exposure to archaeology came when a close friend, Patrick Gilligan, talked him into taking an introductory prehistoric archaeology class, then being taught by Dr. Charles Faulkner. The following quarter he enrolled in a class on early European prehistory taught by Dr. Jan Simek. The rest, as they say, ... Jay graduated from the University of Tennessee in May 1992 with a Bachelor of Arts degree in Anthropology. He spent the next two years in contract archaeology working on projects in Tennessee, Georgia, Arkansas, Missouri, and North Dakota. Jay enrolled in the Master's Program in Anthropology at the University of Tennessee in the fall of 1994. His primary research interests are prehistoric stone tool technologies and cave archaeology. Jay received a Master of the Arts degree in Anthropology with a minor in Statistics from the University of Tennessee in August 1999. He is currently enrolled in the Doctoral Program in Anthropology at the University of Tennessee. Jay Franklin married Kandi Hopper on July 20, 1991. They have two sons, Conor and Miller.