To the Graduate Council:

I am submitting herewith a thesis written by Thomas R. Whyte entitled "Lithic Artifact Burning and Archeological Deposit Formation on Three Early Archaic Sites in East Tennessee." 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 Arts, with a major in Anthropology.

Jefferson Chapman, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

The Graduate School

LITHIC ARTIFACT BURNING AND ARCHEOLOGICAL DEPOSIT FORMATION ON THREE EARLY ARCHAIC SITES IN EAST TENNESSEE

A Thesis

Presented for the

Master of Arts

Degree

The University of Tennessee, Knoxville

Thomas R. Whyte

August 1984

DEDICATION

This thesis is dedicated to my parents,

Richard W. Whyte

and

Fay G. Whyte

ACKNOWLEDGMENTS

In accomplishing this work I depended upon a number of individuals for professional advice, assistance, friendship, and fun. My committee members and good friends Dr. Jefferson Chapman, Dr. Gerald F. Schroedl, and Dr. Richard L. Jantz showed much patience. I am honored to have their friendship. Dr. William M. Bass, Department Head, is also thanked for his friendship and concern for student progress and well-being. I am also very grateful to Dr. Clarence R. Geier, Dr. William P. Boyer, and Billy L. Oliver for kindling my interest in anthropology at James Madison University, Virginia.

My dear friends and colleagues Brett Riggs, Cliff Boyd, Norman Jefferson, Larry Kimball, Bob Pace, Steve Davis, Bill Baden, and Jeff Gardner were very generous with professional advice. For information and assistance I am indebted to Bob Entorf, Jeff Gardner, Mike Morris, Terry Ferguson, Brett Riggs, Miles Wright, Neal Brunn, Doug Wall, Norman Jefferson, Dr. Benny C. Keel, Oscar Blevins, and especially, Bob Pace. Data used in this study are derived from research funded by U.S. Army Corps of Engineers contract DACW-83-C-0104.

One of my goals in life is to laugh a lot. I must thank Larry Kimball, Bill Baden, Miles Wright, Lee Ann Wilson, Cliff and Donna Boyd, Brett and Pan Riggs, "The Blue Light Specials," Linda Carnes, Mike Morris, Jeff Gardner, Norman Jefferson, Steve

Paquette, Bob Pace, and Rick Stoops, who have made graduate school a lot of fun.

Finally, my most heartfelt thanks go to my parents and siblings, whose love has guided me in this achievement.

ABSTRACT

The accurate interpretation of archeological data requires investigations of processes that may have altered artifacts and deposits since their formation. Failure to investigate along these lines may lead to the misinterpretation of behaviorally relevant archeological patterning. This thesis evaluates deposit integrity on three wooded, Early Archaic sites on the Cumberland Plateau of East Tennessee. These sites are 40ST76, 40ST79, and 40ST80. As an initial step to avoiding pattern misinterpretation on these sites, this thesis (1) investigates present and past environmental features that may have influenced preservation on sites in the region, (2) determines that forest fire, bioturbation, cryoturbation, and trampling were active on the sites, (3) determines by experimentation how these natural and cultural processes have caused post-depositional artifact burning and breaking, and (4) by cross-mending burned and subsequently broken chert artifacts, evaluates the extent of postdepositional deformation that has occurred on the sites.

The study reveals that forest fires, trampling, and possibly freezing have caused artifact breakage. The cross-mending experiment and artifact distributional studies reveal that the deposits of the three sites have been homogenized to the degree that much of the original spacial patterning attributable to human behavior is distorted beyond reconstruction and interpretation.

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INTRODUCTION

This thesis operates at the analytical level of archeological theory by investigating and implementing a method of studying archeological site integrity. Specifically, it investigates the effects of postdepositional cultural and natural processes on flaked-stone artifacts and their contextual relationships, and prescribes cross-mending burned flaked-stone artifacts as a means of measuring post-depositional movements of artifacts within an archeological deposit.

Archeologists have only recently recognized the anthropological importance of subtle patterns found within archeological sites and assemblages. Not all patterning in the archeological record, however, is behaviorally relevant (Schiffer 1976). Binford's (1964) referral to the archeological site as a fossilized record of human behavior has drawn much criticism by archeologists who have shown that postdepositional disturbances such as trampling, bioturbation, and cryoturbation may dramatically alter artifacts and their contextual relationships over time (Schiffer 1983). Schiffer (1983) reminds us that these processes may produce a new patterning in the archeological record mistakable for patterning induced by the human activities originally responsible for artifact deposition. Consequently, as Schiffer (1983:696) warns:

> The first order of business for the archaeologist is to identify the nature of the cultural and noncultural formation processes that created a given deposit or set of deposits.

In light of this, archeologists have begun to conduct ethnoarcheological and laboratory experiments, and develop new techniques for evaluating the integrity of archeological sites and artifacts (e.g., Bonnichsen and Hoch 1983; DeBoer 1983; Hoffman 1982; Kirkby and Kirkby 1976; Yellen 1977). Two techniques commonly used to identify postdepositional disturbances on sites are refitting and cross-mending (e.g., Bunn et al. 1980; Cahen et al. 1979; Hofman 1981, 1983a; Kay 1983; Villa 1982). The technique of refitting--most often involving lithic artifacts--refers to the matching of flake ventral surfaces to flake scars on other flakes, or on blanks or cores from which the flakes were detached. Flakes detached in bifacial thinning or in core reduction, however, may be immediately sorted through, and certain ones retained for later use as tools (e.g., Gould 1980). In this way, some of the flakes become spacially separated prior to their deposition. The assumption that a stone flake entered the archeological record in the place of its manufacture and where its parent core or conjoinable flakes were deposited is, therefore, unwarranted. Consequently, the technique of refitting is not recommended for identifying postdepositional horizontal movements of artifacts. The technique has proven useful in delineating archeological strata and functional relationships of distinct site loci (Cahen et al. 1979); however, it is most appropriate in studies of lithic technology (e.g., Ahler 1983; Frison 1983; Marks and Volkman 1983; Wyckoff 1983).

Cross-mending usually involves the conjoining of fragments of ceramic vessels (Burgh 1959; South 1977), bones (Bunn et al.

1980; Villa 1982), or stone tools (Ahler 1983; Kay 1983). Use of this technique to monitor postdepositional horizontal disturbance assumes that (1) the fragments of an object were deposited together, or that an object became broken during or after its deposition, and (2) that fragments of an object not recovered together were somehow spacially separated after their deposition. These assumptions may be more valid for some artifact classes than others. The application of cross-mending to a lithic assemblage to identify postdepositional disturbance in horizontal space, however, necessitates certain theoretical precautions. Stone artifacts may have become broken during manufacture or use. Because of unhafting, resharpening, recycling, or the tossing of the portion remaining in hand, it cannot be assumed that the fragments of an artifact were deposited aside one another (Binford 1973; Keeley 1982). It follows then, that only the cross-mending of lithic artifacts known to have been broken after their deposition will reveal that their fragments were laterally separated since deposition.

One way to determine that a flaked-stone artifact--especially of cryptocrystalline rock--had been broken after deposition is to show that it had been burned prior to its breaking (Whyte 1983a). As will be shown later, the burning of lithic artifacts (not to be confused with heat treating) is primarily a fortuitous postdepositional event resulting from forest fires, cooking fires, and so on. Burned and crazed chert and chalcedony artifacts which are broken after burning often exhibit a texture on the fracture surface that appears grainy or sugary in comparison to the texture of surfaces flaked prior to burning (Collins and Fenwick 1974). Since the burning of lithic artifacts is primarily a postdepositional event, it can be assumed that burned artifacts having this texture on their fracture surfaces were broken after their deposition by processes such as trampling and freezing (see Appendices). Consequently, the cross-mending of these fragments as opposed to unburned ones is a more accurate means of monitoring postdepositional disturbance within an archeological deposit. It is also easier because the necessary artifact sample is reduced to include only those having post-burning fractures.

This thesis investigates postdepositional disturbances on three Early Archaic period sites in East Tennessee (40ST76, 40ST79, 40ST80) which are ecologically and functionally similar. The 40ST79 lithic assemblage provides a sample for an experiment in cross-mending burned chert artifacts to determine the extent of postdepositional disturbance that may have taken place on sites in the study region. In addition, three experiments (Appendixes A, B, C) are conducted to determine some causes of postdepositional artifact burning and breaking on sites.

CHAPTER I

FIRE AND FLAKED-STONE ARTIFACTS

Flaked-stone artifacts were thermally altered either intentionally by humans, or fortuitously by humans and nature. This chapter discusses intentional heat treatment and fortuitous burning, and the attributes by which they may be distinguished.

Intentional Heat Treatment

Intentional heat treating of siliceous rock was conducted in prehistoric times to improve material tractability (Collins and Fennick 1974; Mandeville 1973; Mandeville and Flenniken 1974; Purdy 1974). The precise physical changes imparted by heating to improve the material are somewhat a mystery; nevertheless, they allow the removal of longer, thinner flakes with greater ease (Patterson 1979). Purdy (1974) and Rick (1978) propose that heating causes the melting and fusing of nonsilica minerals in chert, thus creating a more homogeneous material for uninterrupted fracture. This allows the fracture to pass through silica crystals rather than around them. The resulting surface shows a smoother microtopography with a higher luster. Anderson (1979) suggests that because of material homogenization, sharper cutting edges may also be produced by the flaking of heat treated rock.

Intentional heat treatment was costly in terms of time expenditure, and because of potential material damage, involved some risk (Lurie 1982). It was likely more prevalent in regions yielding only tough or poor quality rock that was improvable by heat treating (e.g., Johnson 1981). Some cherts, especially fine grained ones, cannot be improved through heat treatment and will explode at a rather low temperature (Price et al. 1982; Whyte 1983b). Grainy materials are more amenable to improvement and are also less vulnerable to damage by thermal shock (Rick 1978).

The size of a specimen also has some bearing on its response to heat. Crabtree and Butler (1964) note that larger, thicker blanks are more apt to craze or explode with temperature rise. Consequently, blanks intended for heat treatment should be made as thin as possible.

Heat treated artifacts can often be identified by unnaturally high luster on their flaked surfaces (Rick 1978). A color change may also occur, but is not a characteristic that distinguishes an intentionally heat treated artifact from one fortuitously burned (Collins and Fenwick 1974). Likewise, fortuitous burning may effect a luster increase, but only subsequent flaking will reveal the change; and the fact that a piece was flaked after heating (except in the case of artifact scavenging) most likely implies that it was intentionally heat treated. Heat treatment should not be identified as an element of a culture's technology unless it is conspicuous in an assemblage.

Fortuitous Burning

Fortuitously burned artifacts are ubiquitous on some archeological sites. They are found associated with hearths (Frison 1984), human cremations (Deller and Ellis 1983; Hofman 1983b), and burned structures (Polhemus 1983), or dispersed throughout archeological deposits (Price et al. 1982). Too often they have been misinterpreted as evidence of intentional heat treatment conducted to improve raw material tractability (Pavlish and Sheppard 1983); yet experimental studies reveal that they are usually distinguishable from those made of heat treated material (Collins and Fenwick 1974; Price et al. 1982).

Crazing, potlidding, and crenated fracture are signs of thermal damage resulting from fortuitous burning (Crabtree 1972). Crazing refers to the thorough cracking of a rock from expansion caused by rapid temperature rise (Purdy 1975). Potlidding, usually occurring with crazing, is the explosion of lens-shaped spalls from a rock's surface (Purdy 1975). This is also caused by rapid temperature rise. Crenated fracture is the transverse splitting of a rock. The fracture has a wavy or scalloped surface that shows no point of fracture origin (Crabtree 1972). Purdy (1975) proposes that crenated fracture results from rapid cooling.

Chert which exhibits any or all of these features is defective and usually unworkable. Mildly crazed chert can sometimes be flaked, revealing a texture that is grainy or sugary in comparison to its natural surface texture (Figure 1). Artifacts having sugary texture

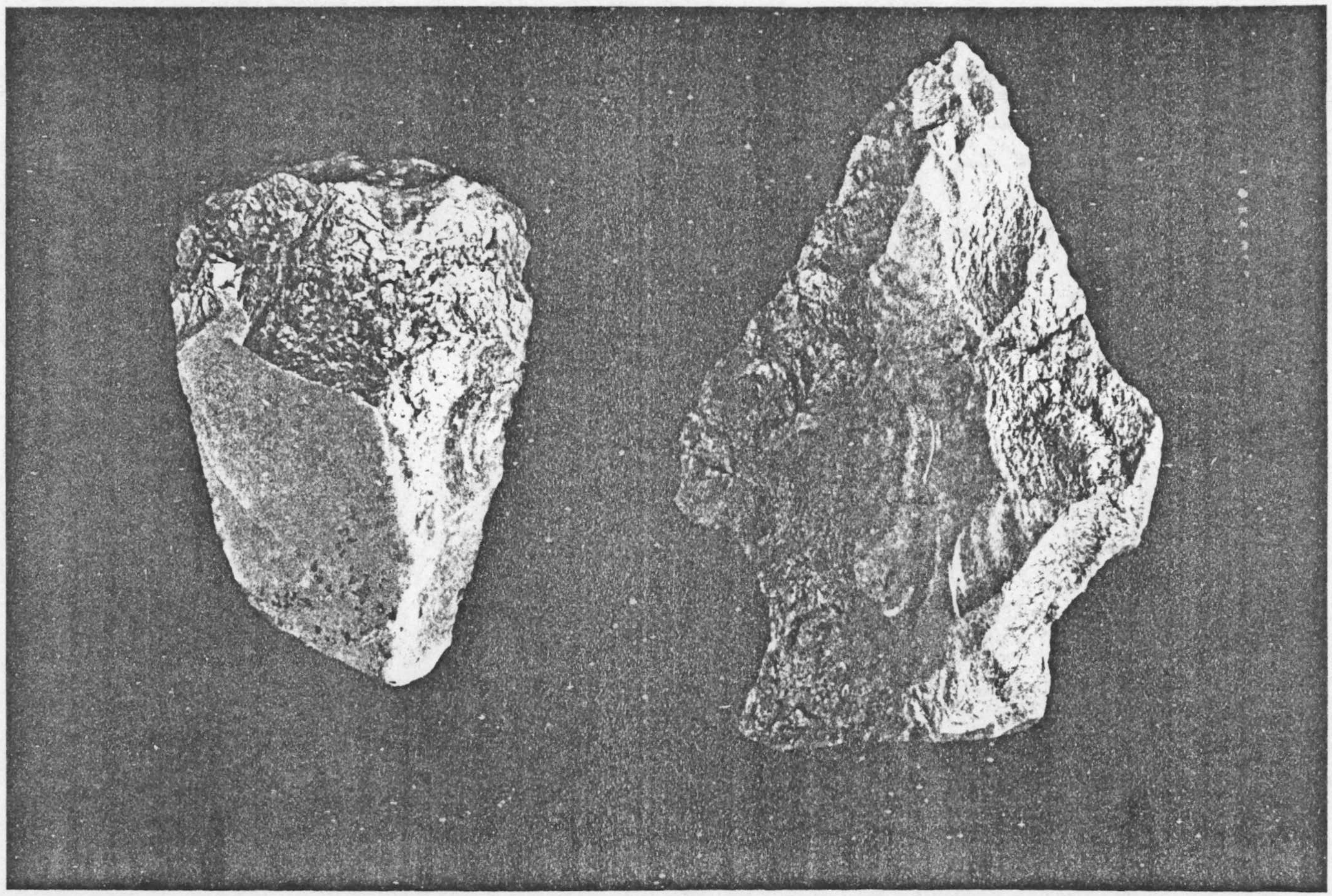


Figure 1. Burned chert artifacts showing sugary texture on retouch flake scars.

on flake scars are probably burned items which had been scavenged and then retouched for further use. Fracture surfaces produced by the breaking of crazed artifacts may also show a sugary texture in comparison to those produced prior to burning (Figure 2).

Thermal damage may have occasionally resulted from unsuccessful attempts at heat treatment. Its occurrence in assemblages where clear evidence of intentional heat treatment is lacking, however, is so commonplace as to argue that it most often represents fortuitous burning (e.g., Frison 1984; Price et al. 1982).

Fires on Archeological Sites

Archeological sites have been affected by natural and man-made fires during and after their habitation. Among these are domestic fires, structure fires, and prescribed and wild forest fires.

Wildfires. Forest fires caused by lightning and human carelessness have affected many prehistoric sites (Anderson 1983; Eisler et al. 1978; Kelly and Mayberry 1980). Little temperature data are available for wildfires, but experimental information suggests that surface temperatures may exceed 700°C (DeBano et al. 1977). Archeological investigations subsequent to the Young's Butte Fire in Ochoco National Forest, Oregon (Eisler et al. 1978) and a wild fire in Bandelier National Monument, New Mexico (Anderson 1983) demonstrated that chert and obsidian artifacts on the surface were damaged by the fires. Chert artifacts were

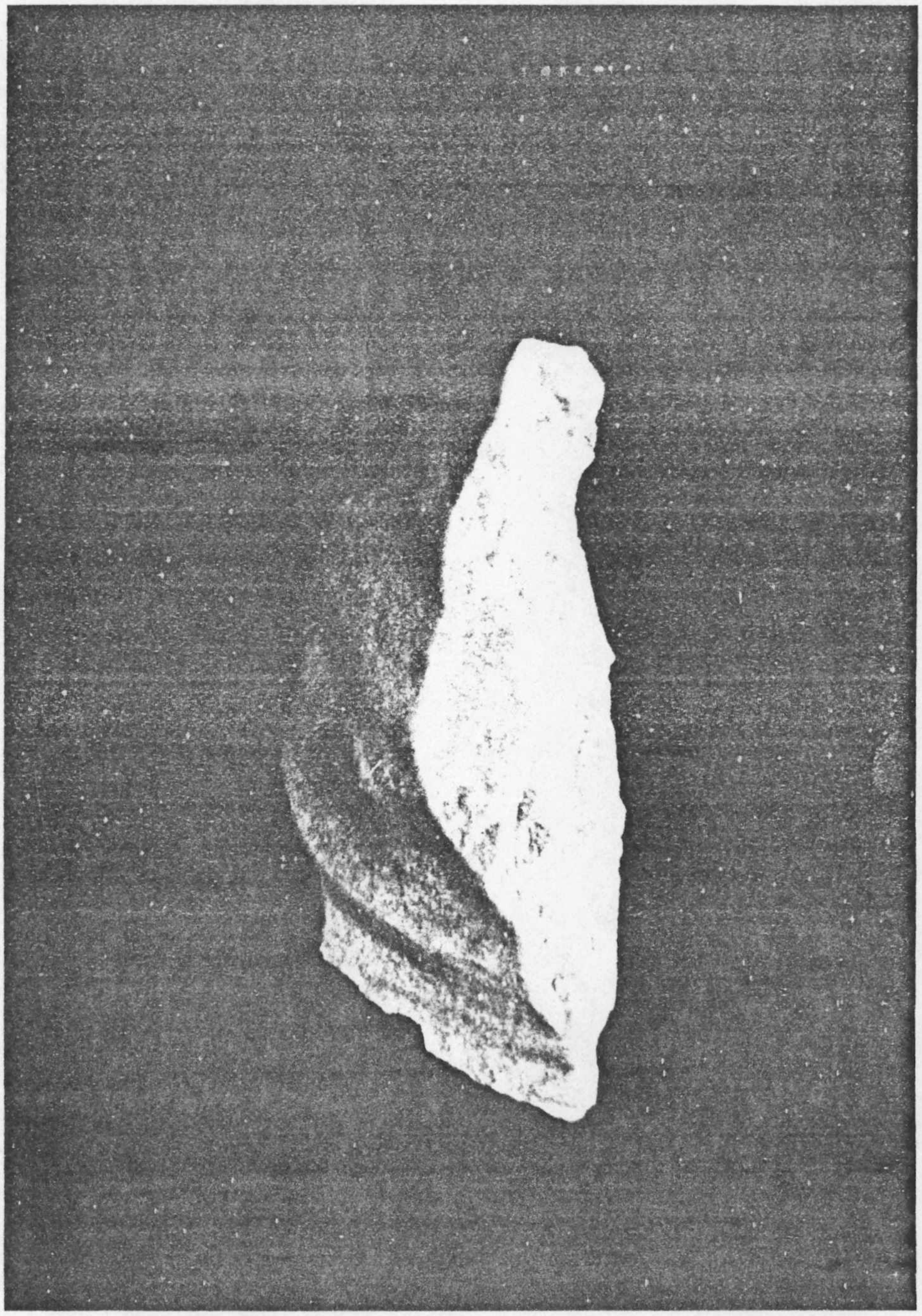


Figure 2. Chert artifact broken after burning, showing sugary texture on the break surface.

fractured and potlidded (Eisler et al. 1978), while obsidian artifacts underwent color change and dehydration (Anderson 1983). At one site in Young's Butte Fire, Eisler et al. (1978) noted that most of the surface artifacts had been visibly altered.

Intentional burns. The intentional burning of grasslands and forest understory in North America probably began thousands of years ago. Such fires were employed by Indians (1) in the hunt (Arber 1910; Beverley 1855; Byrd 1967; Lawson 1967), (2) for vermin control (Williams 1936), (3) in clearing the woods to facilitate passage (Morton 1932), and most importantly, (4) to encourage the growth of edible plants for human consumption, and browse to attract herbivores (Guffey 1977).

Until recently, historic farmers in the East maintained the practice for similar reasons. Forest leaf litter was annually burned off in late fall or early spring to expose mast and encourage fresh growth for cattle grazing, as well as encourage the growth of huckleberries for human consumption (Jefferson 1979).

In dry areas of the United States the Park Service conducts prescribed burns to maintain reduced fuel conditions in the event of a wildfire (Kelly and Mayberry 1980). This practice has recently drawn the interest of archeologists concerned with the potential adverse impacts of prescribed burns on artifacts and sites.

Surface temperatures of prescribed burns are much lower than those of wildfires, probably seldom exceeding 700°C. DeBano et al. (1977) suggest a range of 250°C to 700°C for the surface, and less than 200°C at one inch beneath the surface. These temperatures are sufficient to alter or damage lithic artifacts.

Domestic fires. Prehistoric groups employed a variety of on-site fires including those for heating, lighting, cooking, pottery firing, human cremation, and saunas. These fires differed in temperature, duration of use, amount of flame, and the degree of ground disturbance characteristic of their functions, yet many of them have affected lithic artifacts in and on the ground beneath them (Appendix A) (see also Deller and Ellis 1983; Frison 1984; Hofman 1983b). There may also have been instances, although perhaps infrequent, when lithic artifacts were inadvertently tossed or swept into a fire or hearth (e.g. Densmore 1929; Hayden 1977).

Experiments in the use of prehistoric domestic fires are common (De Graff 1961; Layard 1922; O'Kelly 1954; Shepard 1968). Observations on the incidental effects of such fires on soils and objects in the ground, however, are rare (e.g., De Graff 1961; Price et al. 1982). But data from field experiments investigating the intentional heat treatment of stone provide some insight as to the effects of fires on stone artifacts in the ground (Mandeville and Flenniken 1974; Shippee 1963; Verrey 1981).

Prehistoric domestic fire temperatures were highly variable. Meat or hide smoking fires, for example, while producing quantities of smoke and charcoal, achieved relatively low temperatures and produced little blaze (Catlin 1913). At the other extreme, the firing of aboriginal pottery produced temperatures near 1000°C (Shepard 1968). Mandeville's (1973) experiments with outdoor fires produced maximum surface temperatures of about 500°C for charcoal fires, and 800°C for wood fires. These temperatures are well beyond the range needed to adversely affect lithic artifacts (see Appendix A).

Structure fires. Burning of aboriginal houses in North America is well documented archeologically (Hally 1980; Polhemus 1983) and ethnohistorically (Hewitt 1895; Lawson 1967; Le Clercq 1968; Wallis and Wallis 1955). The most common cause of house fires was probably the careless use of the internal hearth, yet houses were also burned intentionally during warfare and site abandonment (Hunt 1960). Sudden fires resulting from accident or warfare often prevented the rescue of household valuables and the escape of occupants (Le Clercq 1968; Polhemus 1983).

According to experimental evidence, prehistoric structure fires produced temperatures (in excess of 1000°C) sufficient to damage lithic artifacts in and on the ground beneath them (Bankoff and Winter 1979; Faulkner and McCollough 1974; Friede and Steel 1980; Hansen 1962, 1966). This is archeologically substantiated, for example, by the recovery of the exploded fragments of a chert sword and other lithic artifacts from a burned structure (Structure 14) at the Toqua Site (40MR6) in East Tennessee (Polhemus 1983). Excluding the burned sword fragments, 57% of the chert artifacts from the floor of the structure are crazed or potlidded, while only 28% recovered from the floor of an unburned structure (Structure 2) were burned. These data indicate that burning structures did affect lithic artifact refuse on the floor, as well as stone items placed or stored within them.

Patterns of Burning on Sites

From the foregoing discussion of the kinds of fires that may have contributed to artifact burning on archeological sites it is apparent that, given minimal postdepositional contextual disturbance, the lateral distribution of burning among artifacts should generally reflect the lateral dimensions of fires which burned them. It has been shown, for example (Appendix A), that a campfire will only affect artifacts in and on the ground directly beneath it. Logically, the same is true for any other kind of fire. We can, therefore, expect relatively undisturbed sites that have staged scattered domestic and structure fires to exhibit clustered incidents of burning among lithic artifacts. Forest fires, conversely, may produce a less patchy distribution, although still revealing "hot spots" fueled by denser or dryer vegetation.

Summary

It is important at this point to stress that fires, for the most part, affected lithic artifacts already in archeological context. Occasional instances have been cited where lithic artifacts were fortuitously placed in fires, or where objects were stored or placed in a structure which burned. The majority of artifact burning, however, resulted when domestic fires, structure fires, and natural fires burned over a portion of ground containing them. Furthermore, artifacts deeper than 6 cm beneath a fire were probably unaffected by it (Appendix A).

A second point that must be stressed is that many sites, especially those on cleared agricultural lands, may have been wooded at one time and subjected to forest fire. Even buried archeological deposits on floodplains may yield high proportions of burned lithic artifacts that resulted from forest fire. The possibility of forest fire influence must always be considered where high proportions of burned artifacts are recovered.

CHAPTER II

POSTDEPOSITIONAL DISTURBANCE PROCESSES

In addition to fires, many postdepositional disturbance processes effecting artifact damage and movement are manifested on archeological sites (Schiffer 1983). The recent increase in concern for site and data integrity has generated a florescence of studies investigating these processes. This chapter outlines the more common postdepositional disturbance processes and their effects on artifact breakage and movement.

Trampling

Trampling refers to any process--walking, kneeling, sitting, vehicle use--that involves the impaction or mashing of surficial debris. Experiments and ethnoarcheological studies have shown that trampling by humans and animals affects artifacts in three ways:

1. Through fragmentation they become smaller and more numerous (DeBoer 1983; DeBoer and Lathrap 1979; Kirkby and Kirkby 1976).

2. Lithic artifacts receive edge damage and striations distinguishable from those caused by their use (Clark and Kurashina 1981; Keeley 1980; Tringham et al. 1974).

3. Small artifacts are pushed downward into the ground whereas large ones are upraised, exposed, and sometimes dislodged

(DeBoer and Lathrap 1979; Stockton 1973). A fourth effect of trampling seldom considered is the fortuitous displacement or broadcasting of surficial debris as a result of walking, scuffing, or other kinds of movement (Foley 1981).

Trampling may occur during or after site occupation by humans, domestic or wild animals and wheeled machinery. The trampling of artifacts may have been most concentrated during initial occupation when they were still on or near the ground surface, and activities were more concentrated directly on the site where artifacts lay.

Bioturbation

Bioturbation refers to the homogenization of soils or archeological deposits by roots, treefalls, insects, worms, and burrowing animals (Wood and Johnson 1978). Given certain environmental conditions these processes may completely rearrange an archeological deposit within a few hundred years (Denny and Goodlett 1956). The actions of burrowing animals and insects, for example, may cause deeply buried artifacts to be brought to the surface. Earthworms, in recycling soil and depositing it on the surface, cause rocks and artifacts to move downward in a deposit (Wood and Johnson 1978).

Root disturbance and treefalls are common features on wooded sites, and are capable of destroying artifacts, features, and contextual relationships. Roots push items aside as they grow.

When roots decay they are replaced by surrounding soil, and it is estimated that the upper soil horizons in the northern hardwood forests of North America are completely turbated by roots and treefalls every 500 years (Denny and Goodlett 1956; Wood and Johnson 1978). Treefalls, usually caused by high winds, uplift masses of soil leaving large depressions where the trees once stood. Archeologists have been known to locate archeological sites in forest areas by examining artifacts among the uplifted roots and soils of fallen trees. Treefalls tend to be oriented with prevailing winds and downslope (Wood and Johnson 1978). This means that artifacts and soil uprooted with a tree will also move in that direction.

Cryoturbation

Cryoturbation refers to the movements of objects and soil as a result of freezing and thawing, and is especially active in regions with frequent diurnal freeze-thaw cycles (Bonnichsen and Hoch 1983). It may effect either the upward, downward, or lateral movements of artifacts and soil. Bonnichsen and Hoch (1983), for example, found that frost heaving may cause the uphill movements of surface artifacts. They also propose that wind and sunlight acting on ice pedestals supporting artifacts may influence the directionality of movement.

Soil Creep

Soil creep refers to the gradual downslope movement of soil as a result of wetting-drying, sheetwash, rill erosion, and biotic activity (Wood and Johnson 1978). Culling (1963) notes that the rate of creep on a surface is proportional to the degree of slope. Rick (1976) monitored dramatic downslope movement of artifacts on a site in Peru, where large items moved further downslope than small ones.

Summary

Archeological sites, depending upon their setting, may have been subjected to several of the postdepositional disturbance processes just discussed. Certain of these processes may be identified by patterns of soil and artifact redistributions, while others may not. Furthermore, since two processes may have contradicting effects on a deposit, their concurrence may be indiscernible by patterns of soil and artifact distributions (Schiffer 1983). Table 1 lists the potential adverse effects of some processes on artifacts and deposits and illustrates how some confusion may arise in the interpretation of archeological patterning when several processes cooperate to disturb a site. Wooded sites characterized by intense biotic activity and frequent treefalls, for example, may undergo severe homogenization, thus yielding no interpretable patterning.

Table 1. Postdepositional effects of some processes on artifacts and artifact movement.

Processes	Breakage	Vertical Movement	Horizontal Movement
Cultural			
Trampling	x	x	x
Kicking/scuffing	x	?	x
Feature construction	x	x	x
Fires	x	-	x
Timbering	x	x	x
Natural			
Treefalls	x	x	x
Root growth	?	x	x
Burrowing	?	x	x
Trampling	x	x	x
Forest fire	x	-	x
Freezing/thawing	x	x	x
Soil creep	?	x	x

CHAPTER III

THE CROSS-MENDING EXPERIMENT

Natural and cultural processes are shown to have some potential for adverse postdepositional influence on artifacts and their contextual affiliations. The burning of chert artifacts in an archeological deposit causes a change in physical appearance, and sometimes their breakage. Subsequent trampling, bioturbation, and cryoturbation may cause further breakage and movements of artifacts. One possible sequence of postdepositional events is as follows:

1. Fortuitous burning of artifacts situated in an archeological context.

2. Breaking of burned and unburned artifacts by trampling, bioturbation, cryoturbation, etc.

3. Spacial displacement of burned and unburned artifacts and artifact fragments by trampling, cryoturbation, bioturbation, etc.

Based upon this hypothetical sequence of events, it is proposed that the cross-mending of lithic artifacts broken after burning is an accurate means of identifying postdepositional movements of artifacts within an archeological deposit.

This chapter applies the technique of cross-mending to investigate postdepositional artifact breakage and movement on three shallow, Early Archaic sites (40ST76, 40ST79, 40ST80) in

East Tennessee. These three sites, collectively called the Bandy Creek sites, were excavated in 1983 as a phase of the archeological research of the University of Tennessee in conjunction with the Big South Fork National River and Recreation Area project (report in preparation).

The Bandy Creek Sites

Environmental setting. The sites are located in an upland hardwood forest on the dissected eastern portion of the Cumberland Plateau in Scott County, Tennessee (Figure 3). They are situated within 500 m of one another on flat ridgetops. The forest lies within the Humid Mesothermal Subtropical Climatic Region (Koppen 1931), but because of altitude, experiences a more temperate climate (Ferguson et al. n.d.).

Historically, the forest has been periodically timbered and has been plagued with forest fires, many of which were caused by lightning (Ogden 1953). It is likely that these fires were also frequent in prehistoric times (see Guffey 1977). Until 1948 when the Range Law was implemented in Scott County, the forest understory was annually burned in early spring to encourage fresh growth for cattle grazing (Oscar Blevins, local informant, personal communication 1983). None of the sites has been plowed.

Excavation. At 40ST79 a 5 X 5 m block was excavated in 1 m squares, each of which, for better provenience control, was

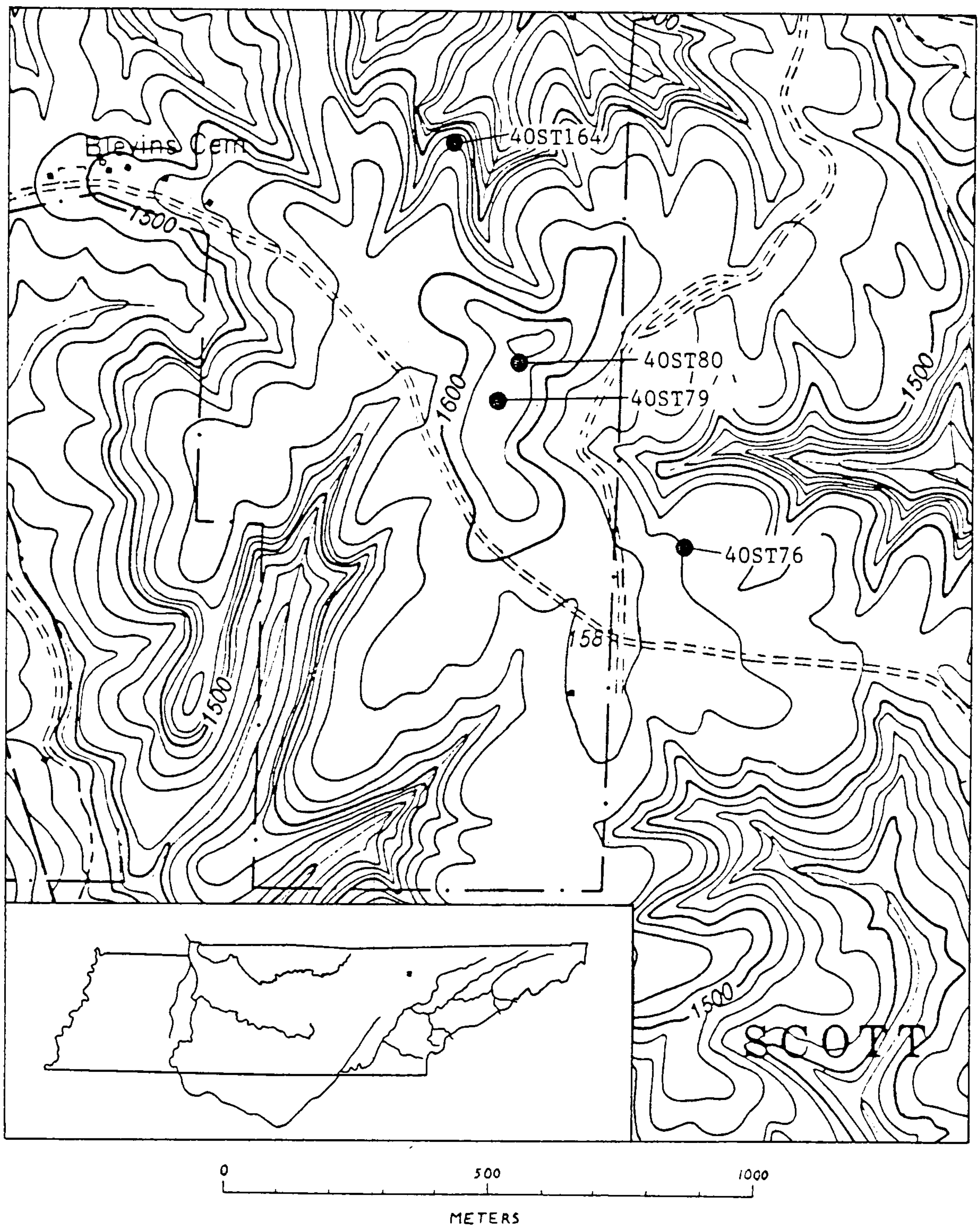


Figure 3. Bandy Creek study area showing site locations.

further divided into 0.5 m squares. Two additional 1 m squares flank the 5 m block excavation, but for the sake of symmetry, are not considered in this study. Three arbitrary 10 cm levels were excavated using flat shovels and trowels. All fill was screened through 1/8 inch mesh.

Blocks consisting of 22 m^2, and 15 m^2 were excavated at 40ST76 and 40ST80, respectively. These were excavated in the same way as 40ST79 except that only two 10 cm levels were removed at 40ST80. At each of the three sites a 1 m unit was excavated in 10 cm levels to sterile soil (between 50 and 70 cm deep). Since artifacts were recovered using standard 1/8 inch mesh hardware cloth, they were also size sorted for analysis using the English measurement system. In this thesis, consequently, artifact sizes are referred to in English measurement, while excavation proveniences are metric.

Deposit nature and assemblage content. Only flaked stone artifacts of fine grained chert and chalcedony were recovered from the three sites. These were found scattered throughout the upper 30 cm of soil, but were most abundant between 5 and 20 cm. A few very small artifacts were found between 30 and 70 cm in the deep test units. No distinct cultural strata or features were identified within the deposits. Moreover, no evidence of geological sedimentation was observed. If multiple occupations are represented, their residues appear to have been mixed. Possible soil turbation was evinced by a complex network of small krotovina between the surface and 70 cm deep.

The assemblages of the three sites are very similar in composition (Table 2). Local, fine grained, grey chert from the Monteagle formation is represented by approximately 90% of the artifacts. The assemblages are predominantly soft-hammer bifacial thinning and core reduction flakes, and include very few implements (Figure 4). The latter include flake and blade tools, Kirk Corner Notched type projectile points (Coe 1964), and projectile point preforms (Figure 5). Kirk Corner Notched type projectile points in East Tennessee have been radiocarbon dated to roughly 9,500 B.P. (Chapman 1975).

Early Archaic hunter-gatherers of the Eastern Woodlands archeologically represented by Kirk Corner Notched type points are believed to have been collectors operating within what Binford (1980) defines as a logistical subsistence-settlement strategy (Davis 1981; Kimball 1981). The Bandy Creek lithic assemblages are proposed as representing short duration field camps or hunting stands within this system. Activities reflected in the assemblages are hunting, retooling, and perhaps meat processing.

Artifact distributions within the 5 m excavation block of 40ST79 are diffuse, suggesting postdepositional deposit homogenization (Figure 6). Individual artifact categories are similarly distributed showing no apparent clusters from which to identify patterns of space utilization.

Table 2. Assemblage compositions of the Bandy Creek sites.

Group	40ST76	40ST79	40ST80
Soft-hammer flakes	397	1305	366
Hard-hammer flakes	141	161	60
Decortication flakes	275	421	99
Bipolar flakes	0	0	1
Core rejuvenation flakes	1	1	0
Untypable flakes	1367	3053	946
Shatter	33	104	30
Blades	5	26	7
Flake and blade tools	4	35	7
Bifacial preforms	4	9	2
Projectile points	0	7	2
Drills	0	0	1
Cores	0	1	0
Total	2227	5123	1521

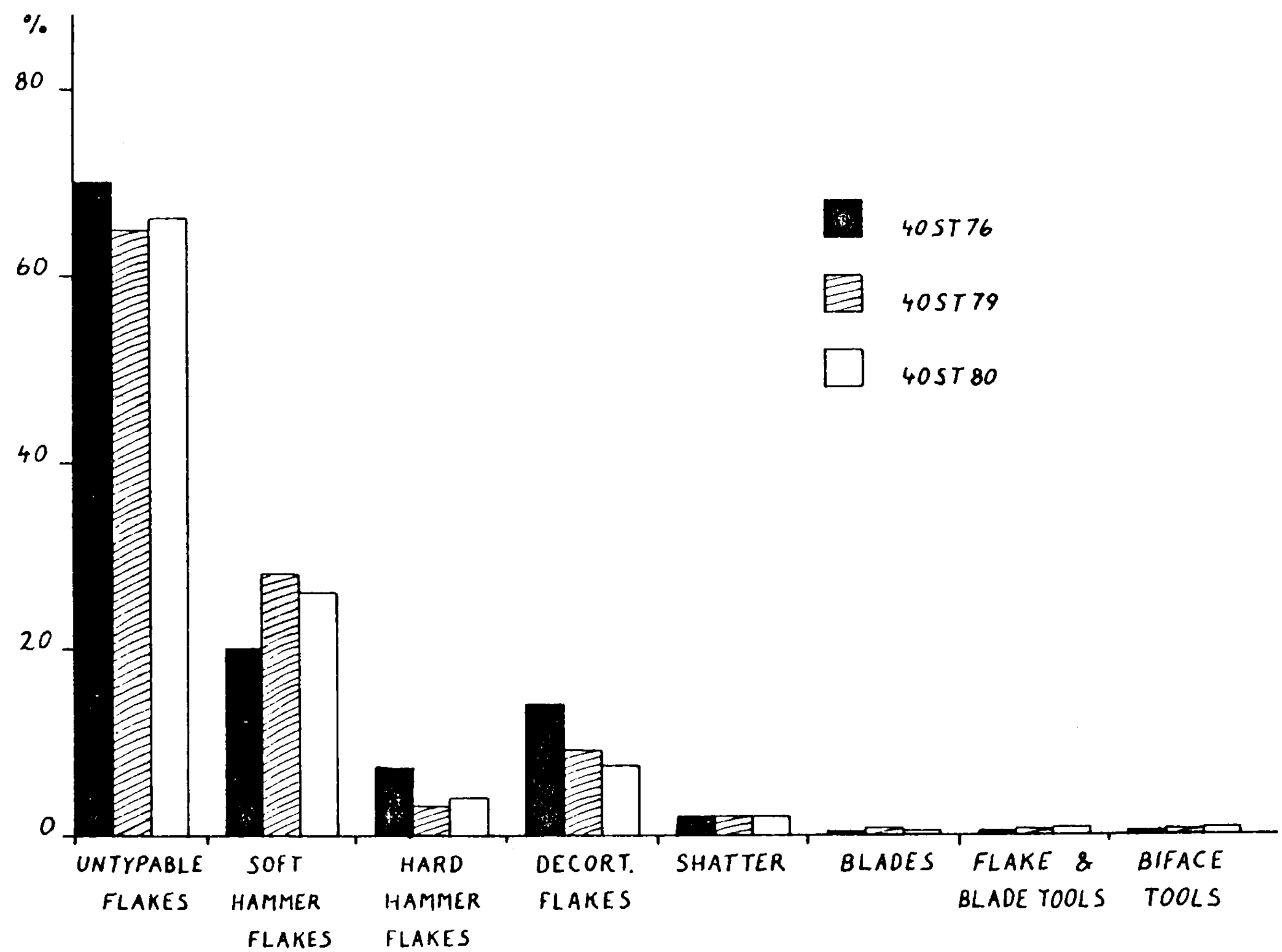


Figure 4. Assemblage comparisons among the Bandy Creek sites.

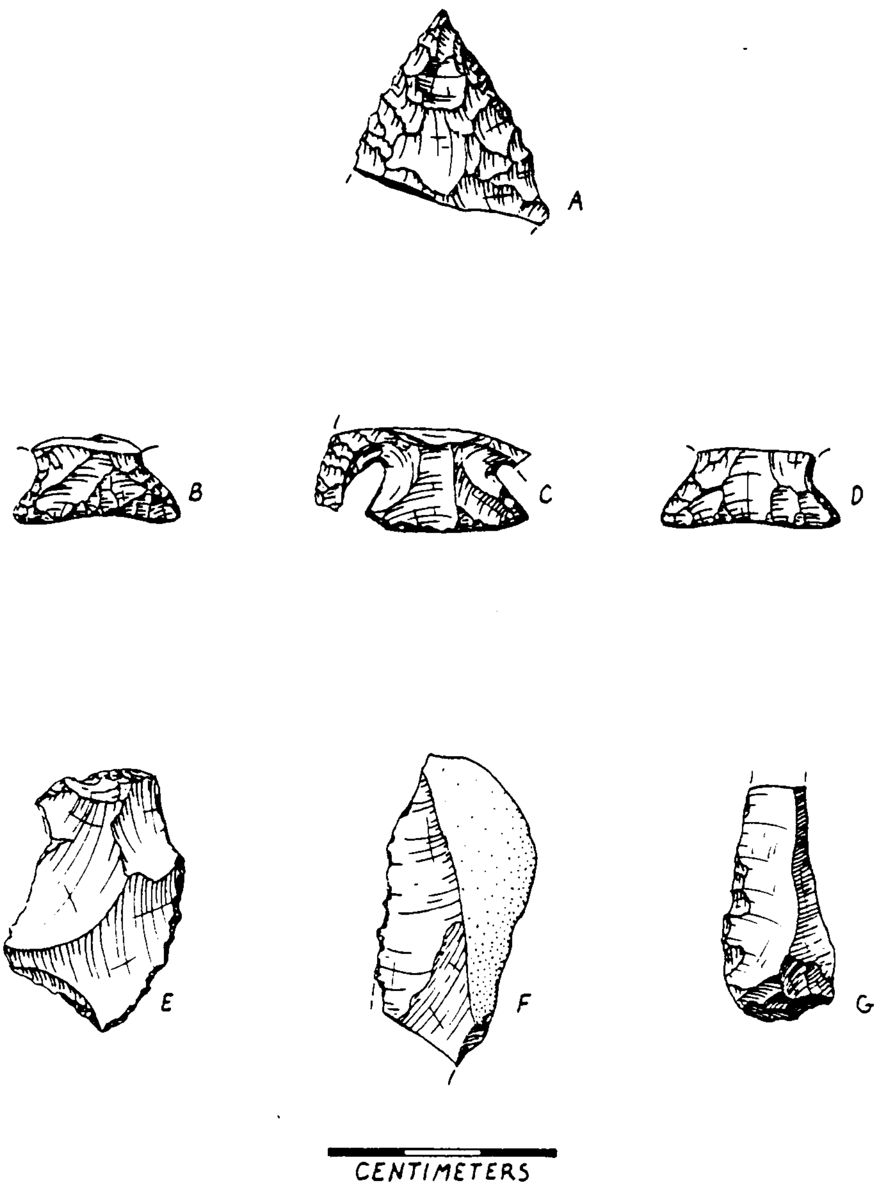


Figure 5. Tool examples from 40ST79. (A-D) Kirk Corner Notched type projectile points; (E-G) flake and blade tools.

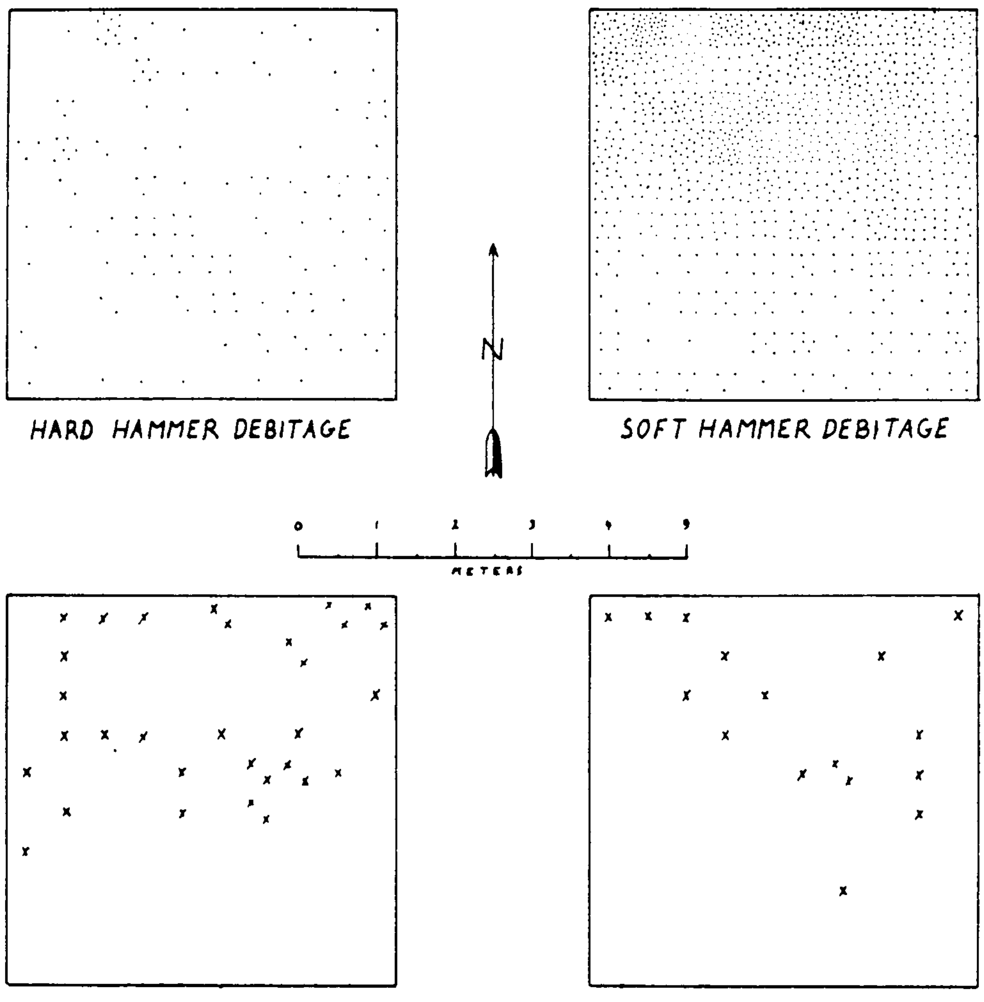


Figure 6. Artifact distributions within 40ST79 excavation.

Evidence of burning. A preliminary review of the assemblages was made to determine if indeed forest fires had affected lithic artifacts in the Bandy Creek assemblages. The proportions of burned artifacts--based upon the presence of crazing or potlidding--are as follows:

40ST76 - 63.39%

40ST79 - 48.56%

40ST80 - 55.38%

These are unusually high percentages considering proposed site functions and occupation durations (cf. Price et al. 1982). Moreover, the horizontal pattern of burning within each site is rather diffuse, revealing no clear "hot spots" to suggest burning by domestic fires (Figure 7). The relative frequencies of artifact burning by excavation level for each site are also unpatterned (Table 3), indicating that fires occurred periodically during the slow homogenization process of the sites, or that the artifacts were burned while closer to the surface prior to homogenization.

Based on this information, the following possible causes of artifact burning are proposed:

1. Domestic fires operating during site-use caused the burning; and subsequent soil turbation led to the dispersal of burned artifacts.

2. Forest fires, probably occurring periodically on the sites, burned artifacts before or during the homogenization process.

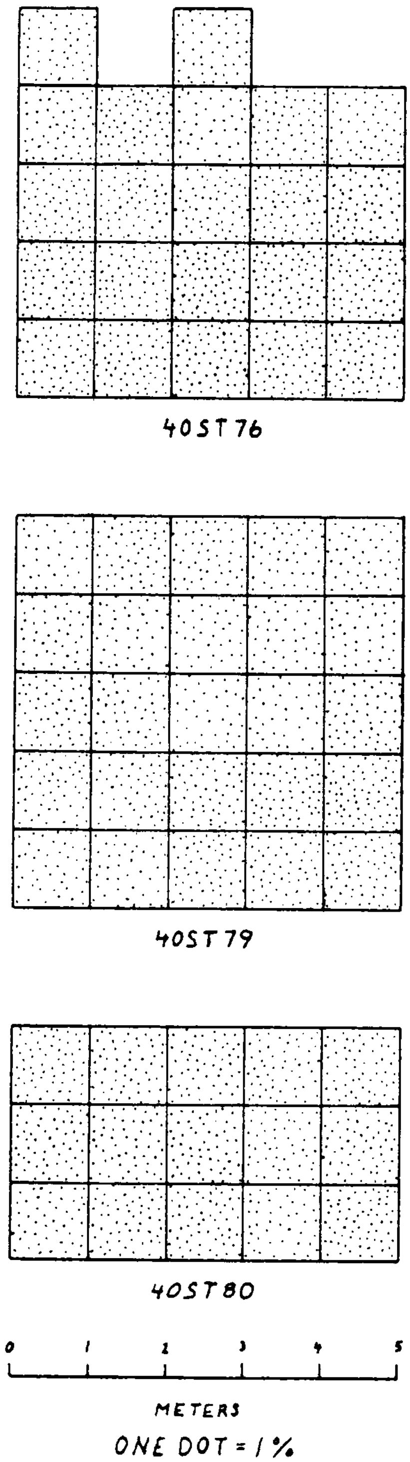


Figure 7. Spacial distribution of burning among artifacts.

Table 3. Relative frequency of burning among artifacts by level in each assemblage.

	40ST76		40ST79		40ST80	
	n	%	n	%	n	%
Level 1 (0-10 cm)	720	66	1463	45	682	57
Level 2 (10-20 cm)	652	61	1736	50	690	55
Level 3 (20-30 cm)	414	62	1154	47	Not Excavated	

It is doubtful that domestic fires caused the burning of approximately half the artifacts in the assemblages. Neither of the Bandy Creek sites produced burned cobbles, fired soil, charcoal concentrations or other evidence of hearths. Furthermore, if artifacts were primarily burned by isolated domestic fires rather than forest fires, we would expect burning to favor some categories and not others. This expectation is based on the assumption that different categories--flake tools, blades, soft hammer flakes--were not deposited in exactly the same spot on a site (see Binford 1978; Schiffer 1976). The placement of a fire on ground containing the byproducts of latter phase biface reduction, for example, would have resulted in higher incidents of burning among soft hammer debitage.

To test this, the distribution of burning across functional categories of artifacts is examined in each assemblage. Sample size deficiencies are mitigated by grouping artifacts into three major categories: tools, hard hammer flakes, and soft hammer flakes. It must be cautioned, however, that the size of an artifact will have a bearing on its response to heat. Large blocky artifacts are more apt to become thermally damaged than small thin ones (Crabtree and Butler 1964; Price et al. 1982).

Figure 8 suggests that burning is indeed correlated with artifact size in the Bandy Creek assemblages. The distribution of burning across functional categories (Table 4), however, also shows a pattern: soft hammer flakes show the least burning, while tools show the most. Initially, this would appear to indicate that isolated domestic fires were primarily responsible for the burning. As a group, however, tools are larger and blockier than soft hammer flakes, and therefore, more vulnerable to thermal damage. The distribution of burning across size groups within artifact categories (Figure 9) shows that artifact size, not category, is correlated with thermal damage.

Additional evidence favoring forest fire as the primary cause of artifact burning is that a nearby rockshelter site (40ST164) (Figure 3, page 23) characterized by very low fuel conditions (no vegetation) yielded only 2% burned artifacts. This is remarkably lower than the proportions of burned artifacts from the study assemblages. A forest fire would not have affected artifacts within this shelter.

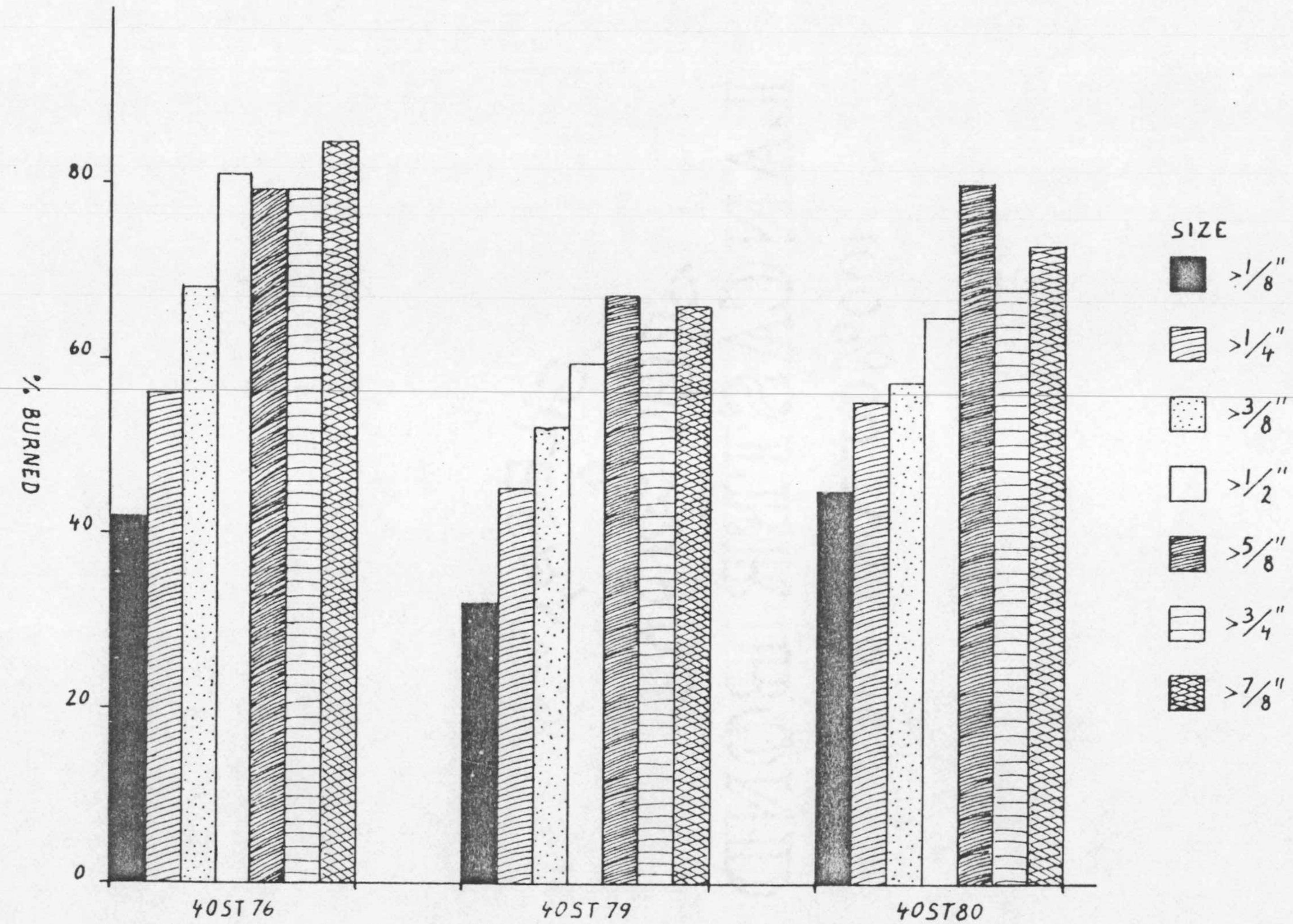


Figure 8. Distribution of burning across artifact size groups.

Table 4. Frequency of burning among artifact groups.

Group*	n	% Burned	$\bar{X}$ Size (in.)
	40ST76		
Tools	8	63	0.63
Hard-hammer flakes	141	53	0.51
Soft-hammer flakes	397	46	0.35
	40ST79		
Tools	52	68	0.71
Hard-hammer flakes	161	40	0.51
Soft-hammer flakes	1305	32	0.31
	40ST80		
Tools	12	58	0.63
Hard-hammer flakes	60	64	0.51
Soft-hammer flakes	366	40	0.31

*Five groups are excluded because of small sample size.

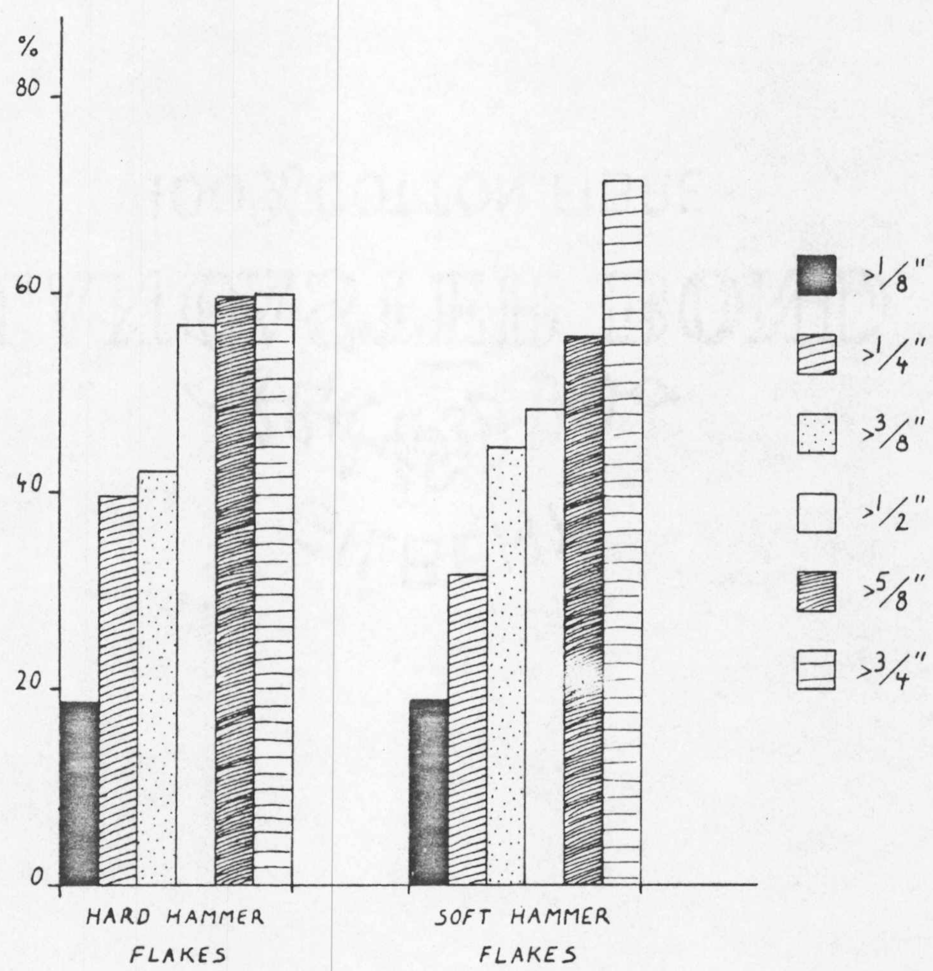


Figure 9. Distribution of burning by size within flake categories in the combined assemblages.

Experimental Methods

Site 40ST79, because of excavation symmetry and higher artifact frequencies, was utilized as a sample in the cross-mending experiment. The experiment began with the extraction of all (482) chert artifacts with sugary texture on their break surfaces indicating that they had been broken after burning. Potlids and artifacts with potlid fractures (290) were excluded because of the difficulty in cross-mending these kinds of fragments. The artifacts--each labeled as to provenience--were placed in their respective proveniences on a covered gridded table so that the spacial juxtapositions of conjoinable pieces could be viewed.

In conducting refitting studies, archeologists have found that the process is facilitated by grouping artifacts into raw material categories. Raw material variation in the 40ST79 assemblage, however, is subtle. Moreover, the repeated burning of some fragments may cause them to be colored differently than their conjoinable counterparts and, therefore, more difficult to identify (Figure 10).

In this experiment cross-mending was accomplished by three procedures in addition to chance discoveries. Besides allowing a systematic examination of provenience relationships, these procedures expedited the study by limiting the number of permutations that had to be examined.

Within-unit procedure. Each 0.5 m unit was examined for conjoinable fragments. Cross-mending of fragments within units is a reliable indicator of postdepositional movement only if the

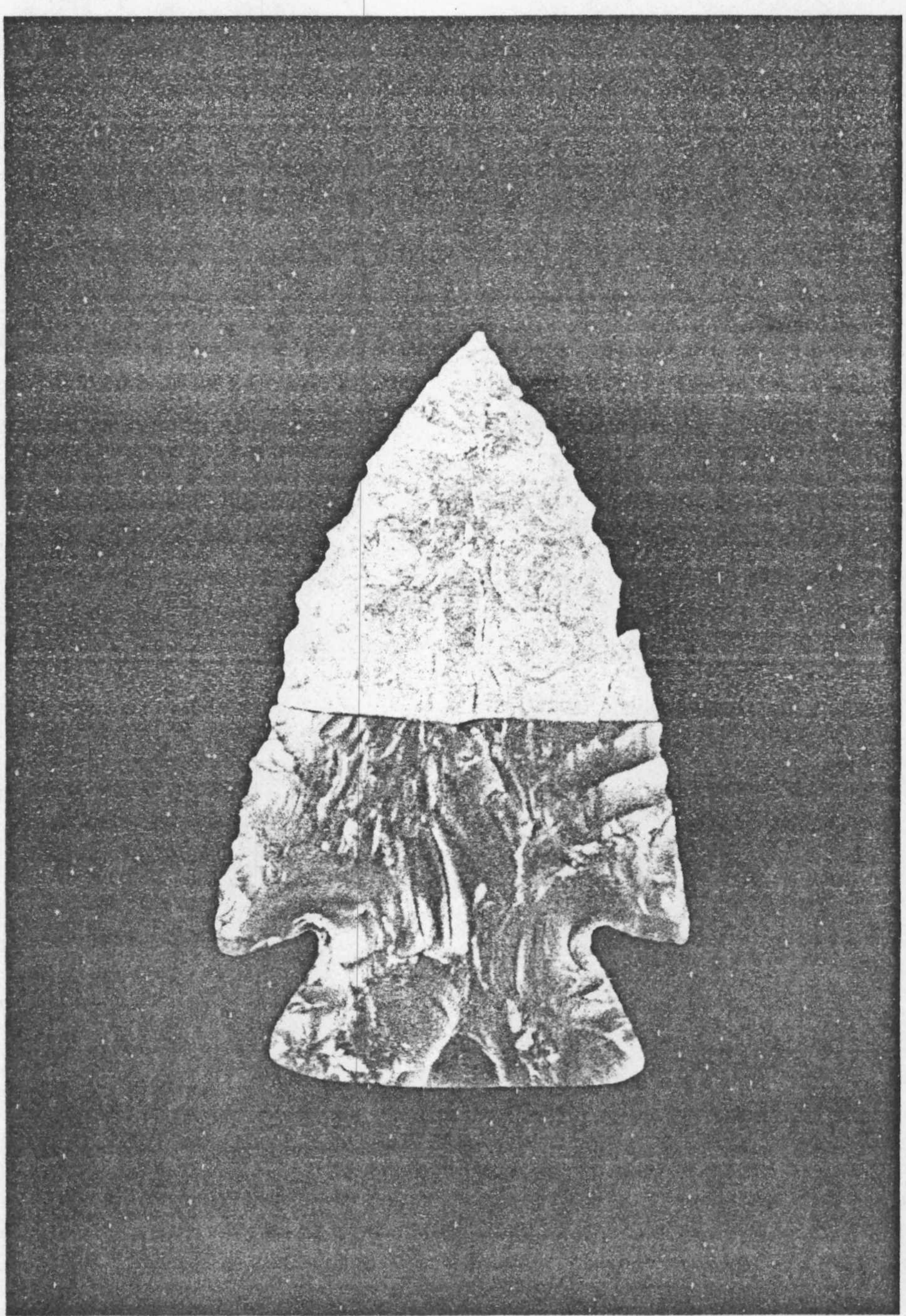


Figure 10. Differentially burned fragments of a projectile point replica.

fragments are separated by 10 cm excavation level. This is because of the possibility that fragments were in reality only separated by the level plane superimposed by excavation.

Between-unit procedure. The units surrounding each unit were searched for pieces conjoinable to those within the center unit (Figure 11). This allowed the potential discovery of all possible mends between adjacent 0.5 m units. Mends made by this system are only meaningful if they link levels or diagonal units--again because of the possibility that pieces were only separated by the vertical plane superimposed by excavation.

Across-unit procedure. The units surrounding and situated one unit beyond each 0.5 m unit were searched for pieces conjoinable to those within the center unit (Figure 11). Mends made using this procedure are reliable evidence of postdepositional artifact movement.

Results

The cross-mending experiment took 40 hours to complete. Of the 482 burned, then broken artifact fragments utilized in the study, 127 were conjoined to make 59 artifacts. These 59 include 52 paired, six tripled, and one quintupled groups.

Within-unit mends. Sixty-eight artifacts were reduced to 30 by cross-mending within units (Table 5). Few of these appeared to be fresh breaks from excavation and processing. The majority

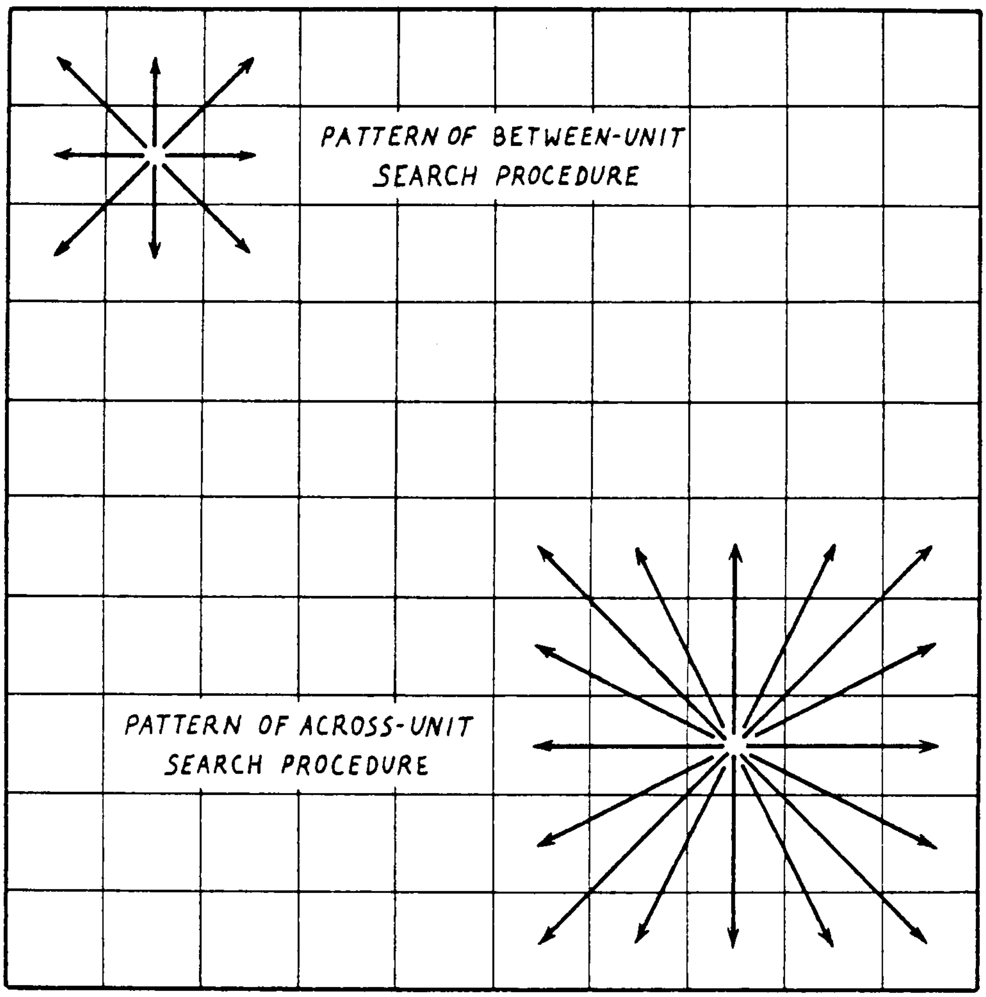


Figure 11. Procedures used in searching for conjoinable fragments between and across 0.5 m excavation units.

Table 5. Fragments conjoined within units (0.5 m units are numerically ordered from west to east, north to south).

Cat. No.	Unit	Level
27-284	2	3
27-296	2	3
28-085	4	1
28-352	4	3
28-329	4	3
28-347	4	3
31-033	9	1
31-046	9	1
31-051	9	1
22-048	21	1
22-049	21	1
22-111	21	2
22-112	21	2
22-124	21	2
22-126	21	2
22-132	21	2
23-122	23	2
23-123	23	2
23-101	23	2
23-121	23	2
24-051	25	1
24-042	25	1
24-142	26	2
24-155	26	2
25-038	27	1
25-062	27	1
26-091	29	2
26-143	29	3
23-184	33	3
23-201	33	3
23-200	33	3
23-206	33	3
23-192	33	3
23-199	33	3
23-202	33	3
25-106	37	2
25-109	37	2
25-126	37	2

Cat. No.	Unit	Level
25-113	37	2
25-137	37	2
25-078	38	1
25-098	38	1
25-103	38	1
25-104	38	1
18-040	44	1
18-045	44	1
18-152	44	3
18-153	44	3
20-097	57	2
20-109	57	2
21-016	59	1
21-035	59	1
15-103	68	3
15-104	68	3
15-106	68	3
15-075	68	2
15-078	68	2
14-001	75	1
14-004	75	1
8-037	86	2
8-040	86	2
7-020	93	3
7-021	93	3
10-002	99	1
10-008	99	1
10-003	99	1
10-004	99	1
10-009	99	1

Note: Items between underlines are conjoinable.

appeared to have been broken by natural or cultural processes prior to excavation. One within-unit mend links Levels 1 and 3 (a separation of 10 cm) indicating some vertical mixing of artifacts within that unit.

Between-unit mends. Eighteen artifacts were reduced to nine by cross-mending between adjacent and diagonal units (Figure 12). Four mends linking diagonal units, three linking diagonal levels, and one linking nonadjacent levels (Table 6) monitor potential postdepositional movement.

Across-unit mends. Fifteen mends link units separated by one unit (Figure 12), thus monitoring significant postdepositional movement. With respect to excavation levels, however, the vertical separation of conjoinable fragments in this group is not necessarily meaningful; the exact relationship between an arbitrary excavation level in one unit and that in a distant unit is uncertain.

Long distance mends. Six mends were by chance established linking widely separated units (Figure 12). These combinations, because of the distances they span, most clearly evince the degree of postdepositional artifact movement that has taken place within the deposit.

Unconjoined pieces. The 355 burned fragments that were not conjoined can be explained in three ways: (1) their counterparts were too small for recovery using 1/8 inch mesh; (2) their

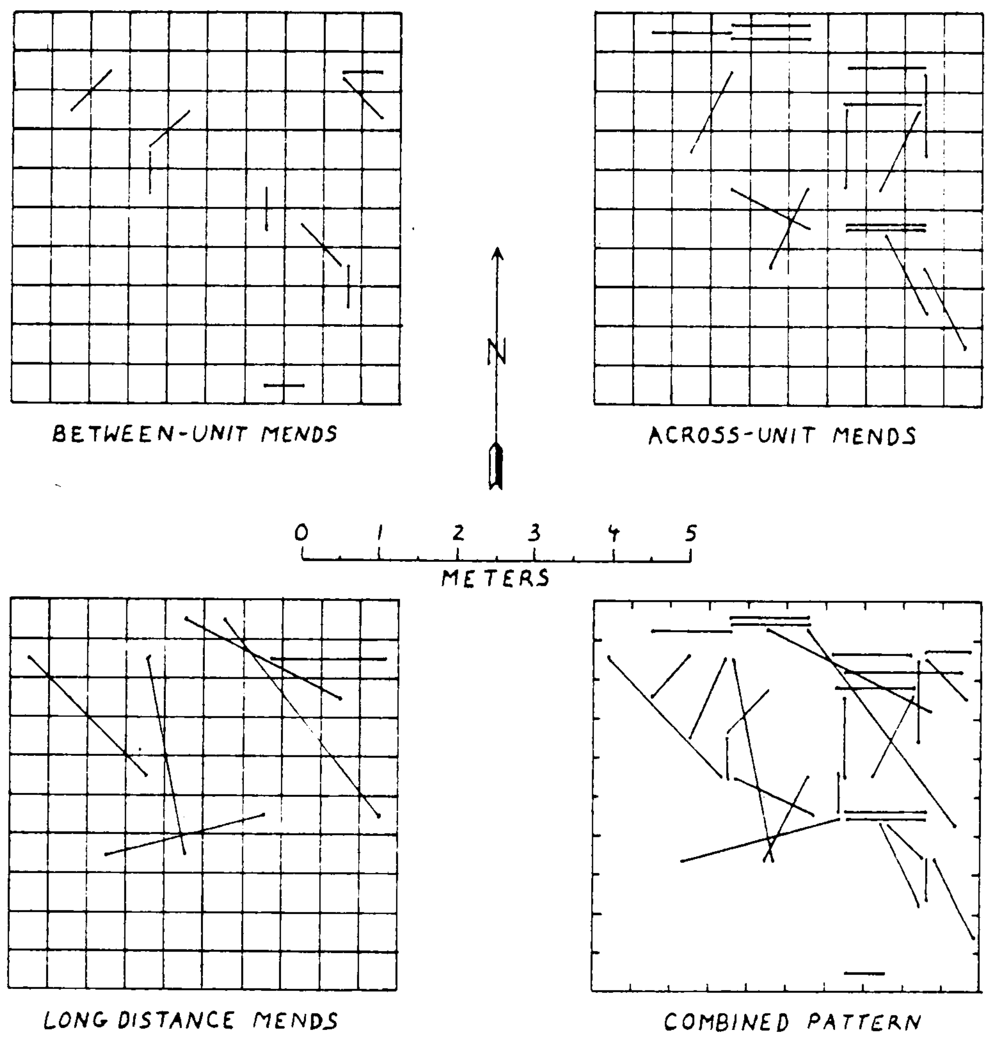


Figure 12. Plots of 40ST79 cross-mends.

Table 6. Fragments conjoined between and across units (0.5 m units are numerically ordered from west to east, north to south).

Cat. No.	Unit	Level	Cat. No.	Unit	Level
Between-Unit Mends					
28-123	13	2	31-024	19	1
22-127	22	2	26-057	30	1
31-085	19	2	20-150	58	2
31-143	20	2	16-088	59	3
24-132	25	2	16-001	80	1
23-275	34	3	9-020	97	2
23-176	34	2	9-039	98	2
18-042	44	1			
20-030	47	1			
20-014	57	1			
Across-Unit Mends					
27-024	2	1	20-158	57	3
28-082	4	1	21-103	59	2
28-329	4	3	20-150	58	2
29-085	6	1	16-001	80	1
28-347	4	3	16-062	69	2
29-085	6	1	10-047	90	2
30-022	17	1	28-254	14	2
31-085	19	2	23-198	33	3
31-089	19	2	26-037	29	1
26-134	39	3	20-065	48	1
25-166	27	2	19-177	46	3
26-083	29	2	14-045	65	2
25-017	27	1	20-003	57	1
20-017	47	1	21-030	59	1
18-105	44	2			
19-058	56	1			
Long Distance Mends					
29-264	5	3	30-022	17	1
26-041	29	1	31-143	20	2
27-201	11	3	20-011	57	1
18-039	44	1	13-028	63	2
29-082	6	1	28-361	14	3
21-086	60	1	14-045	65	2

Note: Items between underlines are conjoinable.

counterparts were not situated within the portion of the deposit excavated; or (3) their counterparts were recovered but were not discovered by the search methods used in the cross-mending experiment.

CHAPTER IV

INTERPRETATIONS

The cross-mending project illustrates that dramatic changes regarding the physical and contextual aspects of artifacts have taken place at 40ST79 over the past 9,500 years. The problem remains to explain the possible causes of these changes, and determine if original artifact depositional patterns can be reconstructed and interpreted.

Studies of postdepositional disturbance processes, reviewed in Chapter II, reveal that a number of factors, particularly on a 9,500 year old, wooded site may have brought about artifact breakage and movement. In order to identify the specific processes which have caused artifact breakage and movement within the deposits of the Bandy Creek sites, three sources of evidence are studied: (1) the kinds of fractures present on burned artifacts; (2) the directional trends of lines connecting conjoinable fragments; and (3) artifact size distributions in horizontal and vertical space.

Postdepositional Artifact Breakage

Seven hundred and seventy-two artifact fragments from 40ST79 show signs of post-burning breakage. This means that possibly 386 artifacts (half) were broken to make these fragments--an overall postdepositional artifact frequency increase of nearly 9%. There are probably four ways that these artifacts became broken: (1) by burning; (2) by freezing; (3) by trampling; and (4) by archeological recovery and processing. With the exception of recovery and processing, these processes were also capable of effecting the postdepositional movements of artifacts within the deposit.

Burning. It has been established that forest fires contributed to artifact burning on the Bandy Creek sites. Potlids and artifacts with crenated and potlid fractures are common in the assemblages (over 6%) indicating that burning contributed to postdepositional breakage. Moreover, the burning of lithic artifacts causes them to become weaker (Shepherd 1972) and more susceptible to breakage by trampling, freezing, and excavation (see Appendices B and C). Figure 13 reveals the positive correlation (significant at the .001 level) between artifact burning and breaking at the combined sites. This indicates that the burning of artifacts not only caused breakage, but probably allowed a higher frequency of subsequent breakage by trampling and freezing.

Freezing. Expanding ice in a cracked rock may exert a pressure of one ton per square inch (Shepherd 1972), causing a rock to fracture (Oakley 1957; Winkler 1973). Cracks in a burned chert artifact will absorb water which, upon freezing, can cause the artifact to spall (Appendix C) with a fracture that is identical to heat spalls produced by initial burning. Many such fractures are present among the Bandy Creek artifacts, although it is impossible to distinguish those caused directly by burning from

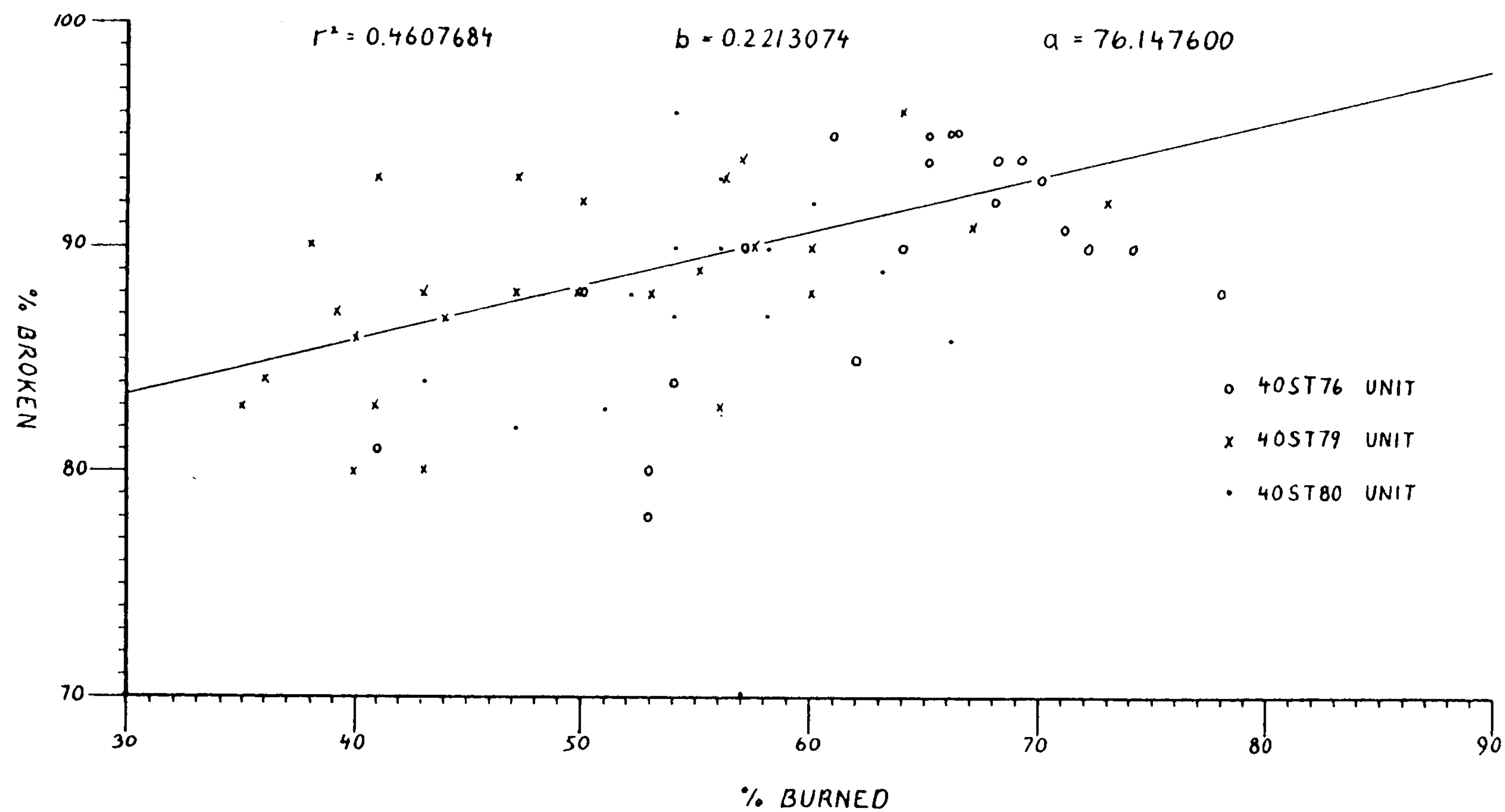


Figure 13. Scatter plot and fitted regression line showing significant positive correlation between burning and breaking by excavation unit.

those caused by freezing. Sub-zero temperatures are common in the region, and maximum frost penetration is estimated at 20 inches (Johnson 1952). Burned artifacts on or below the surface, therefore, may have been fractured by freezing.

Trampling. Most of the 482 artifact fragments utilized in the cross-mending experiment show snap fractures that emanate from one face or the other, suggesting that external force was applied to break them. Appendix B presents an experiment in trampling which produced similar kinds of fractures among both burned and unburned chert flakes. The experiment indicates that burned flakes are physically weaker and more vulnerable to breakage by trampling because of material weakening.

Some of the burned artifact breakage observed may have resulted from trampling by humans during initial site occupation. Since artifact burning was primarily caused by subsequent forest fires, however, it is probable that much of this breakage occurred later. A great deal of damage may be attributable to the hooves of deer and elk frequenting the sites over a 9,500 year period, and of cattle grazing on the sites in more recent times.

Trampling in the Bandy Creek area was probably most intense during timbering operations. The felling of trees and the use of skids and draft horses to haul logs away may have been a major cause of artifact breakage and movement. The use of heavy wheeled machinery on archeological sites is also known to be detrimental to artifacts and deposits (Anderson 1983; Eisler et al. 1978).

Horizontal Trends

Crossmends linking nonadjacent units at 40ST79 evince the postdepositional lateral movements of artifacts. The mean lateral vector of cross-mend lines connecting the centers of widely separated units is 121.3° (Figure 14). This direction, although derived from a very small sample of lines (n=6), aligns very closely with the direction of downhill-uphill slope (Figure 14), suggesting that treefalls and soil creep may have contributed to artifact movement within the deposit. It cannot be known, however, whether one, the other, or both fragments of a conjoinable pair have moved; and some may have moved uphill, while others moved downhill (see Bonnichsen and Hoch 1983).

Size distributions along the slope vector between the northeast and southeast corners of the site fluctuate (Figure 15). Size distributions along the northeast-southwest vector, however, show a gradual decrease in the relative frequency of small (less than 1/2 inch) items toward the southwest (Figure 15). There is no slope along this vector so the cause of this trend is uncertain. Local prevailing winds are from the southwest (Tennessee Division of Forestry, personal communication 1984). Perhaps treefalls caused by wind have influenced size distributions in this direction (see Wood and Johnson 1978).

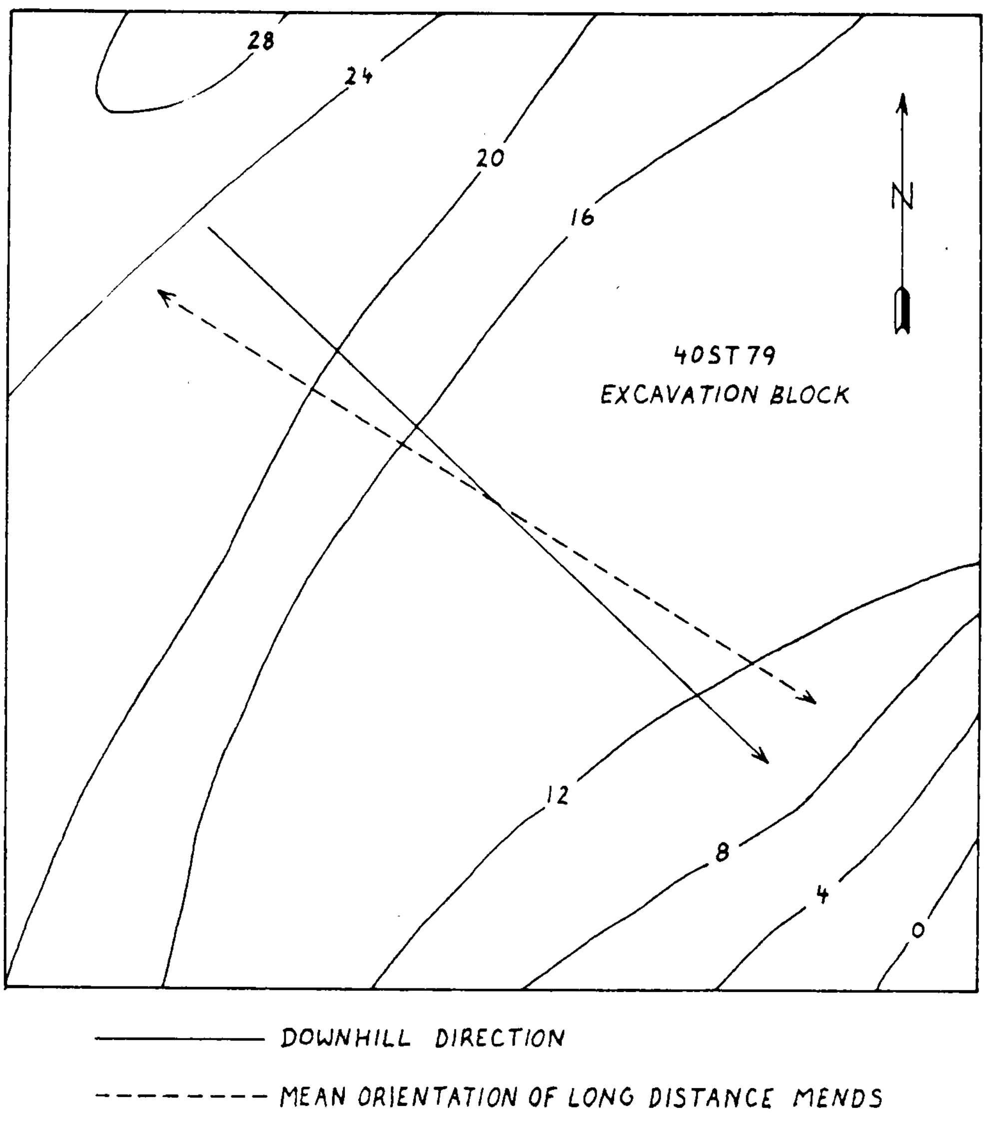
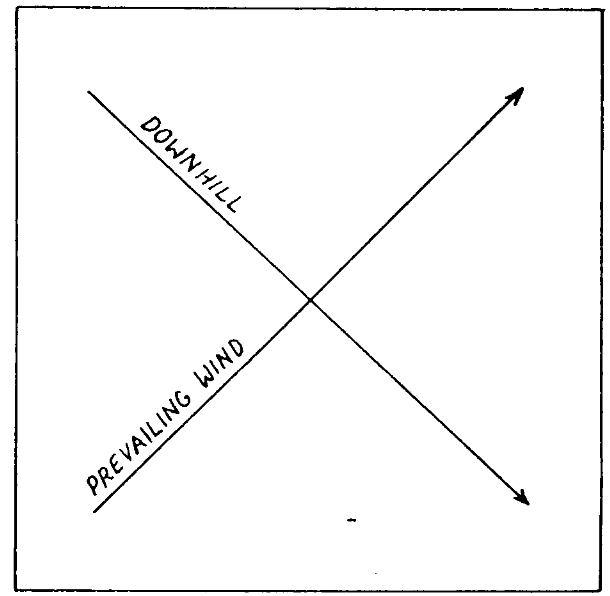


Figure 14. Four centimeter contour map of 40ST79 excavation block surface showing slope and long distance mend orientations.

.78	.71	.79	.90	.89
.76	.77	.83	.86	.84
.75	.80	.81	.78	.78
.73	.78	.75	.72	.77
.76	.69	.71	.73	.71

PROPORTION OF ARTIFACTS < ½ INCH IN EACH 1 M UNIT



WIND AND SLOPE DIRECTIONS

Figure 15. Comparison of artifact size distributions to wind and slope directions across the 40ST79 excavation block.

Vertical Trends

Cross-mends linking Levels 1 and 3 at 40ST79 evince vertical movements of artifacts within the deposit. Further evidence of postdepositional vertical movement is provided by the recovery of small (less than 1/4 inch) flakes down to a depth of 60 cm. Artifact size distributions across levels at each site are patterned with smaller artifacts favoring Level 3 and larger ones favoring Level 1 (Figure 16). This kind of pattern may result from cryoturbation, bioturbation, or trampling (Wood and Johnson 1978). The presence of small flakes among numerous krotovina at a depth of 60 cm, however, strongly suggests the influence of burrowing insects, roots, and rodents.

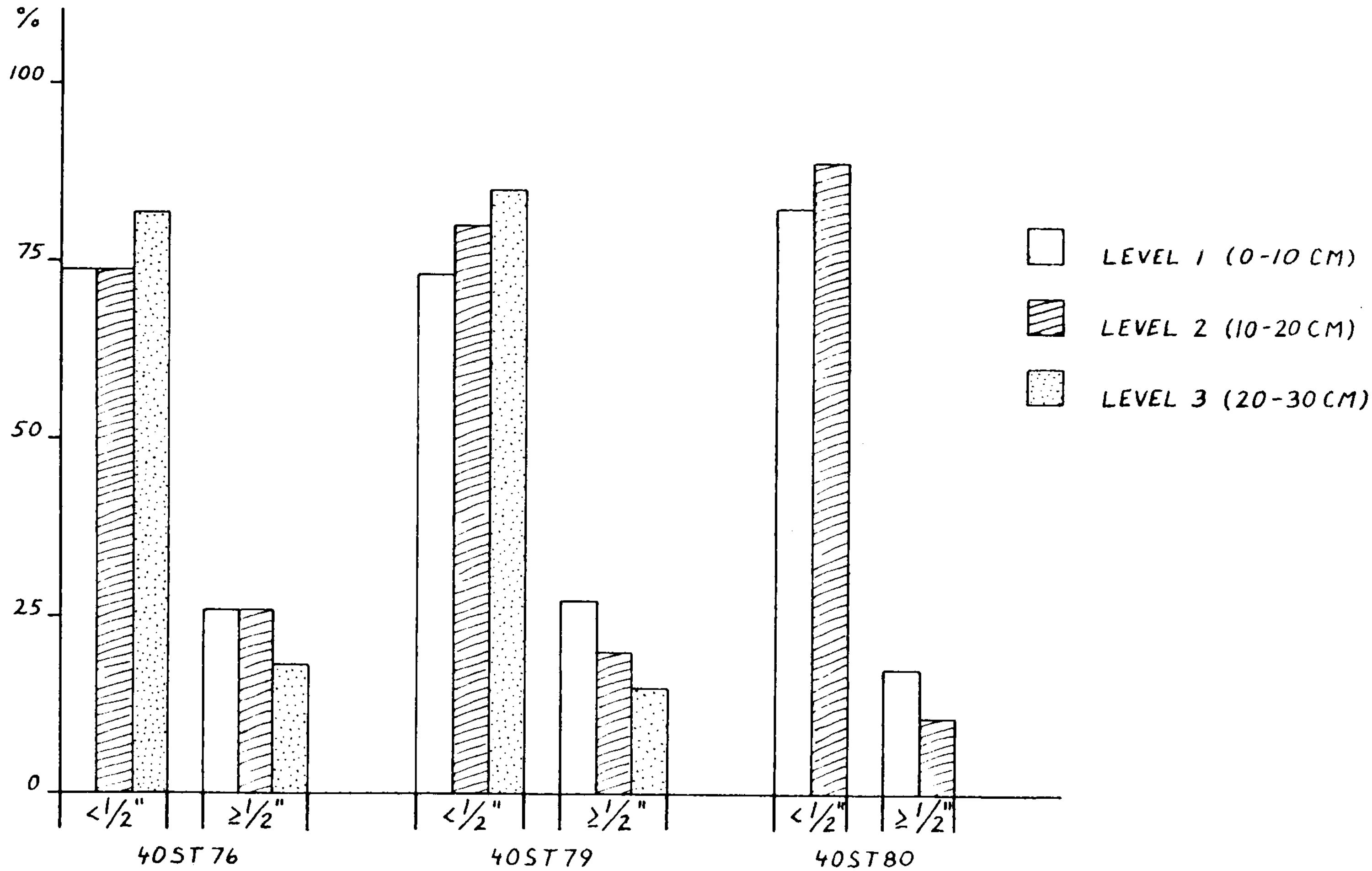


Figure 16. Artifact size distribution by level.

CHAPTER V

SUMMARY AND CONCLUSIONS

The accurate interpretation of archeological data requires preliminary investigations of processes that may have deformed artifacts and deposits since their formation (Foley 1981; Schiffer 1983). Failure to investigate along these lines may lead to behavioral interpretations of irrelevant archeological patterning. In an attempt to evaluate the contextual integrity of the Bandy Creek sites, several patterns were discovered that could have been interpreted as the direct products of human behavior. The prevalence of smaller artifacts in the lower levels, for example, may have been interpreted as evidence that they, for some reason, had been deposited first. Similarly, the relatively even horizontal distributions of different kinds of artifacts at 40ST79 may have been interpreted to mean that multiple activities occupied the same space.

As an initial step to avoiding such misinterpretations of the Bandy Creek data, this thesis (1) investigated present and past environmental features that may have influenced preservation on sites in the region, (2) determined that forest fires, bioturbation, cryoturbation, and trampling were active on the sites, (3) determined by experimentation how these natural and cultural formation processes cause postdepositional artifact burning and breaking, and (4) by cross-mending burned and subsequently broken artifacts, evaluated the extent of postdepositional deformation that has occurred on the sites.

The Bandy Creek sites were formed by small groups of hunter-gatherers at approximately 9,500 B.P. Physical evidence of site activities is limited to flaked-stone artifacts of chert. During site use, these were deposited, some of them trampled, and some possibly burned. Soon after initial site formation, the natural processes of bioturbation, cryoturbation, and erosion began to rearrange the deposits by mixing artifacts vertically and horizontally. Natural and man-made forest fires may have been common events on the sites, causing the burning and breaking of artifacts that happened to be on or near the ground surface. After instances of fire, further artifact damage was caused--perhaps by freezing and trampling. During historic times, annual fires, grazing cattle, and timbering operations undoubtedly caused more artifact and deposit damage.

The cross-mending study indicates that deposit deformation was thorough. Artifacts have moved at least 0.6 m downward, and 2.5 m horizontally. Moreover the postdepositional breaking of artifacts caused their numbers to multiply and their sizes to reduce, thus skewing original frequency and size distributions.

The horizontal plots of artifact distributions (Figure 6, page 29) show that much behaviorally relevant patterning is lost because of thorough postdepositional homogenization. No distinct activity areas or evidence of differential waste disposal are observable in the present patterning. Schiffer (1983:677), however, proposes that original patterning may at times be reconstructed:

> Because formation processes themselves exhibit patterning, the distortions can be rectified by using appropriate analytic and inferential tools built upon our knowledge of the laws governing these processes. . . .

This may be true for sites affected by one or two simple processes. Regarding more complex situations, however, Schiffer (1983:680) offers the following:

> Even when multiple lines of evidence are brought into the analysis, the exact genesis of complex deposits formed by many processes may, in our present state of knowledge, remain uncertain.

This is certainly the case for the Bandy Creek sites. Although certain of the processes acting on the deposits are known, and the degree to which they have collectively disturbed the deposits has been estimated, it is presently impossible to determine exactly how they have deformed the original patterns. Consequently, the distortions cannot be "rectified." It is important, however, that through an awareness of the extent of distortion, appropriate precautions can now be taken in the anthropological interpretation of the patterns identified. Moreover, future archeological investigations of open sites in the wooded Bandy Creek area are expedited. Strict provenience control such as piece plotting, for example, would have little utility, and can be avoided in future research in the area.

Aside from identifying and evaluating postdepositional disturbance on the Bandy Creek sites, a major accomplishment of this thesis is the implementation of a cost-effective analytical tool that has world-wide application to the study of archeological site disturbance. Cross-mending, when applied to an assemblage of burned, then broken flaked-stone artifacts, is one tool that can be used with a high degree of confidence to identify postdepositional movements of artifacts within an archeological deposit. The ability to do this allows anthropologically relevant information to be extracted and interpreted with finer accuracy.

It is stressed that this technique of deposit evaluation should not be restricted to open, wooded sites. Buried floodplain sites, often presumed to have been protected from the postdepositional disturbance processes characteristic of surficial wooded sites, may at one time have been wooded, or adversely affected by the influences of flooding and other natural processes. The technique of cross-mending burned, broken lithic artifacts, given sufficient numbers of them, would be especially useful in evaluating such deposits.

There are a number of other insights gained from this research that have application to the study of any lithic assemblage. It was noted, for example, that forest fires can cause stone artifacts to break or become more susceptible to breaking by other influences. This postdepositional breakage exaggerates artifact frequencies and reduces artifact sizes. It is also the case that unburned artifacts must experience some postdepositional breakage. The result is a recovered lithic assemblage that is very different from the one deposited, yet archeologists seldom consider that stone may undergo degradation as do bone and wood.

A second problem that may be encountered in the analysis of lithic assemblages containing heated artifacts involves the distinction between fortuitous burning and intentional heat treatment. Several cases have been cited by Pavlish and Sheppard (1983) where archeologists mistook burned artifacts for ones made of heat treated stone, yet it has been shown in this thesis and elsewhere (Collins and Fenwick 1974; Price et al. 1982; Whyte 1983a) that the two are not difficult to distinguish. Where heated stone artifacts are suspected, the possibility of fortuitous burning must be investigated.

The effects of forest fires, trampling, bioturbation, cryoturbation, and other processes on sites are deleterious. Through time, these processes gradually diminish the amount and quality of anthropologically relevant information that can be gained from a site. It was suggested earlier, for example, that the Bandy Creek sites, because of postdepositional disturbance, have lost much contextual integrity that may have yielded important information regarding intrasite structure. The ability to recognize this information loss has important ramifications for archeological resource management projects. Wooded sites like those in the Bandy Creek area may be managed with higher expedience and less cost, because strict provenience controls are unnecessary. Evaluations of site significance should consider this information loss so that attentions may be focused on better preserved sites.

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APPENDICES

APPENDIX A

EXPERIMENT IN FORTUITOUS BURNING OF CHERT ARTIFACTS

Experimental, historical, and archeological information pertaining to fires on archeological sites suggests that fires of various kinds have caused the alteration and destruction of stone artifacts. The purpose of the experiment presented here was to determine how chert artifacts are affected by the heat of a campfire fortuitously placed over an artifact-bearing deposit. A report of this experiment was included in a paper presented at the Southeastern Archaeological Conference (Whyte 1983a).

Materials and Methods

An area of level ground was cleared for the fire. A trench was prepared extending along a radius from the center of the hearth to 30 cm beyond its periphery (Figure 17). While filling this trench with sand, flakes of Knox Black chert between 1 and 3 cm long were placed at intervals of 15 cm, 30 cm, and 45 cm from the hearth center, and at depths of 0, 2, 4, 6, 8, and 10 cm at each interval. A second radius of specimens was similarly prepared in the natural clay loam of the site (Figure 17).

A fire was then constructed over the arrangement, taking care not to disturb the surface specimens. A mixture of available hard and soft woods was used for fuel, and a portable pyrometer was used to gauge surface and subsurface temperatures. The fire

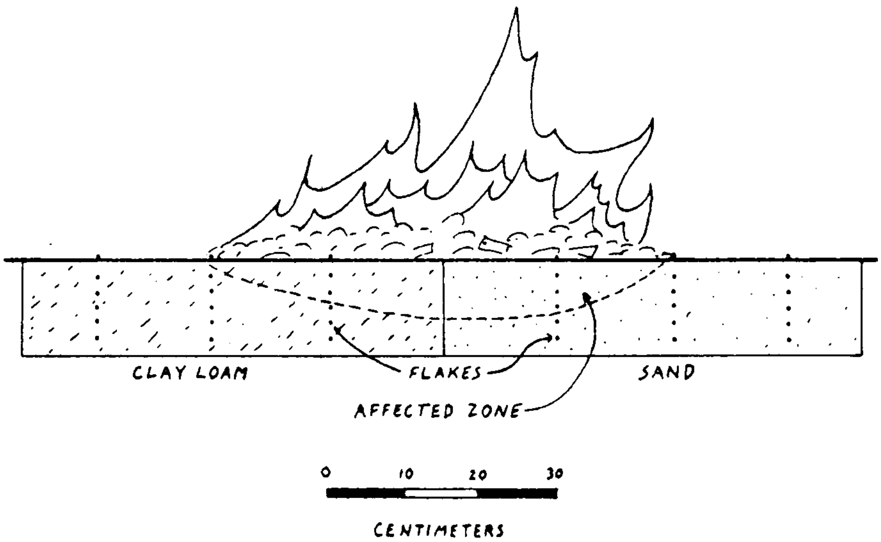

Figure 17. Structure of experiment in fortuitous burning.

was maintained for four hours, attaining a maximum temperature of 800°C at the surface and 290°C at 2 cm beneath the surface. After four hours, the fire was allowed to die and cool for 24 hours. Specimens were then recovered by hand and observed for signs of thermal alteration.

Results

Specimens visibly altered were either directly in contact with the coals at the surface or situated within 6 cm beneath the fire (Table 7). One flake at 6 cm within the sand matrix showed a tonal value change. Otherwise, no differences between the insulating properties of the two soils were evident. The flakes which became altered show varying degrees of thermal damage, depending upon their distance from the fire center. Those at the surface were most damaged, exhibiting potlids, severe crazing, and a dramatic increase in tonal value (from black to light grey) which is coincidental with crazing (Whyte 1983b). The specimens positioned at 2 cm and 4 cm beneath the fire which became altered show mild crazing and a moderate increase in tonal value (Table 7). At 6 cm beneath the fire, only one specimen--in the sand matrix--became altered, showing a very slight increase in tonal value. Flakes below 6 cm were not visibly altered.

Interpretations

This experiment shows that some domestic fires were capable of damaging chert artifacts on and beneath the ground surface.

Table 7. Results of fire experiment.

Specimen No.	Distance from Fire Center (cm)	Depth (cm)	Damage	Color Change (Munsell)
		Clay Loam Matrix		
1	30	0	mild crazing	7.5R2.5/0 to 3/0
2	15	0	mild crazing	to 5/0
3	15	0	mild crazing	to 4/0
4	15	2	mild crazing	to 4/0
5	15	2	mild crazing	to 4/0
6	15	4	mild crazing	to 4/0
		Sand Matrix		
7	15	0	severe crazing, potlids, fracture	to 5/0
8	15	0	severe crazing, potlids, fracture	to 5/0
9	15	2	mild crazing	to 4/0
10	15	2	mild crazing	to 4/0
11	15	4	mild crazing	to 4/0
12	15	4	mild crazing	to 3/0
13	15	6	none	to 3/0

They probably would not have affected artifacts beyond their lateral periphery. Structure fires and forest fires are capable of generating similar or higher temperatures (De Bano et al. 1977; Friede and Steel 1980) and, based on this experiment, have probably affected chert artifacts in similar ways.

APPENDIX B

TRAMPLING EXPERIMENT

Trampling may have been a major cause of postdepositional damage to artifacts. The purpose of this experiment was to test the effects of human trampling on chert artifacts. Both unburned and burned artifacts were tested to determine their relative resistance to fracture. A report of this experiment was included in a paper presented at the Southeastern Archaeological Conference (Whyte 1983a).

Materials and Methods

The first phase of the experiment involved the generation of burned chert specimens. To achieve this, 110 Knox Black chert flakes between 1 and 6 cm in size were placed on the ground and a wood fire built above them. The fire burned at approximately 700°C for two hours, then gradually died. When cool, the flakes were carefully removed from the ashes. One hundred and fifty-two flakes and flake fragments greater than 0.3 cm were recovered. Fourteen or more of the original 110 had exploded into several fragments, while seven showed no changes. The rest of the specimens showed varying degrees of potlidding, crazing and tonal value increase (from black to light grey).

A sample of 50 burned flakes between 1 and 4 cm was drawn from the group. These and 50 whole, unburned flakes of the same material and size range were placed on the ground surface of a flat sandy field. Flakes of each sample were paired on the ground with their ventral (concave) faces up. Then, wearing soft-soled shoes, the author walked across the field, stepping once on each pair while attempting to maintain a constant pace and pressure. Flakes and flake fragments were then gathered and observed for damages.

Results

Through fragmentation, the sample of unburned artifacts increased from 50 to only 58 (by 16%), whereas the sample of burned artifacts increased from 50 to 70 (by 40%). Fractures produced by trampling are straight and perpendicular to the flake plane (Figure 18). They occurred on thin extremities--usually toward the distal end--and show a faint S-shape in cross-section (Figure 18). A slight hinge or negative of a hinge is evident where the fracture meets the dorsal flake surface, indicating that the fracture emanated from the ventral side. Gross fracture morphology is similar for burned and unburned flakes, although the fracture surfaces of burned flakes show a grainy or sugary texture.

Interpretations

The experiment shows that trampling can cause chert artifact breakage, and that burned chert artifacts break more readily than unburned ones. It is stressed that these flakes were only stepped on once by a 77 kg human; surficial artifacts on a site trodden

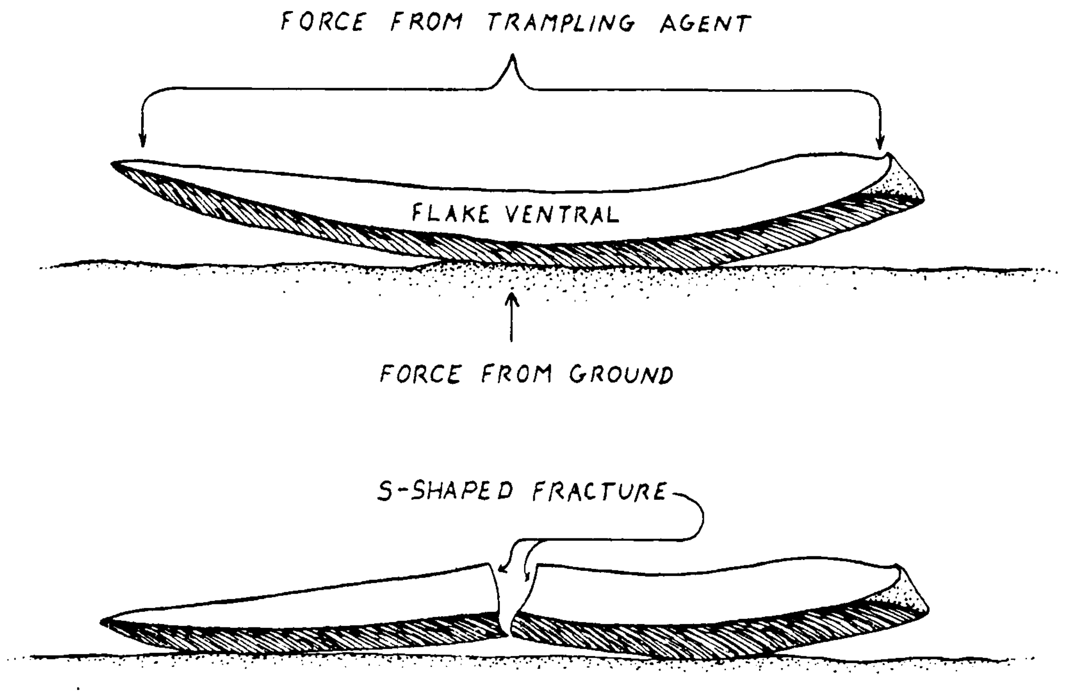

Figure 18. Fracture dynamics of trampling.

by several humans for several days may have been subjected to repeated trampling. The subsequent influences of forest fires and the hooves of large animals may have been exponential. Forest fires cause artifacts to break and become more susceptible to further breakage by trampling.

APPENDIX C

FREEZE-THAW EXPERIMENT

The natural freeze-thaw cycle is a major weathering process acting in the mechanical breakdown of rocks (Winkler 1973). Freezing water trapped in cracks in flint may exert a pressure of one ton per square inch, causing severe damage (Shepherd 1972). This experiment tests the effects of freezing on burned and unburned flakes.

Materials and Methods

A nodule of grey chert from the Monteagle Formation in East Tennessee was reduced to flakes. One hundred of these were placed within a tray of sand, and a fire built above them. The fire was fueled with a mixture of hard and soft woods and burned for approximately two hours. After cooling, the flakes were recovered for inspection. All of the flakes had become crazed and lighter in tonal value (Figure 19), but none had broken.

Fifty of these and fifty unburned flakes between 1 and 6 cm long were soaked in water for 18 hrs. These were then placed in a 6 cm deep tray of moist sand--25 of each on the surface and 25 of each at a depth of 3 cm. The tray was placed in a freeze-thaw chest used in civil engineering to test concrete samples. The tray underwent approximately 112 freeze-thaw cycles between -18°C and 4.5°C over a period of 14 days.

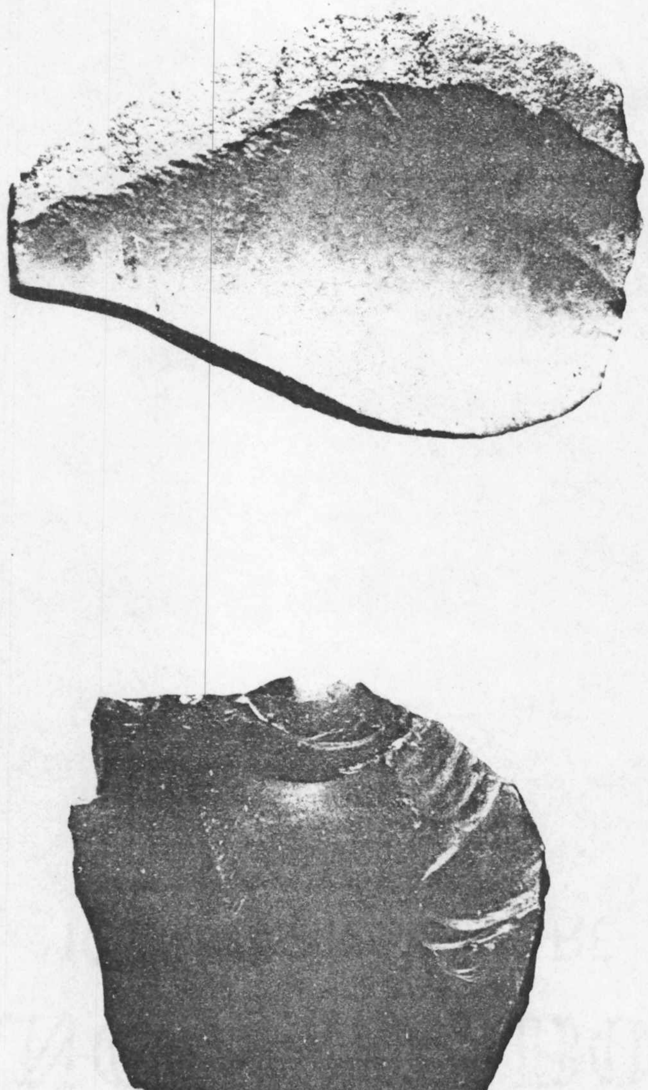

Figure 19. Comparison of burned and unburned Monteagle Grey chert flakes.

Results

After careful recovery and inspection of the flakes, it was noted that only one burned flake was broken (Figure 20). The flake had fractured along incipient potlid cracks. The resulting spall is megascopically indistinguishable from those commonly produced by burning.

Interpretations

The experiment shows that moist, burned artifacts of chert can fracture as a result of freezing. The fact that no unburned flakes fractured may be a reflection of the small sample of flakes tested, the small sample of freeze-thaw cycles, or the amount of water absorbed prior to freezing. Shepherd (1972), however, states that only cracked flint such as that crazed by burning, will break from freezing.

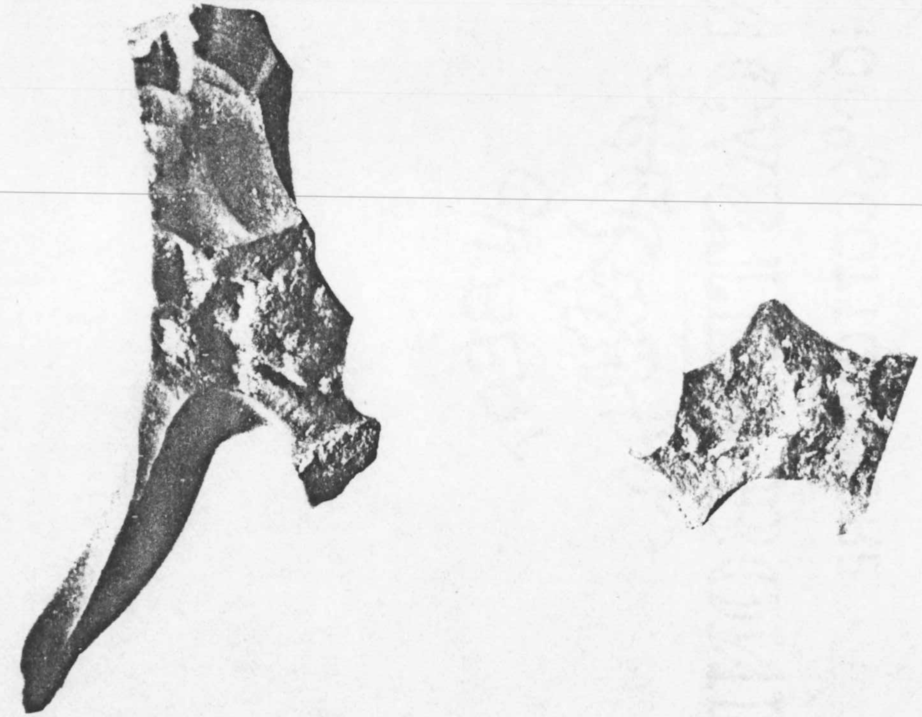

Figure 20. Fragments of burned flake broken by freezing.

VITA

Thomas R. Whyte was born in Washington, D.C. on May 26, 1955. His childhood was spent in McLean, Virginia where he graduated from McLean High School in 1973. That same year he entered James Madison University in Harrisonburg, Virginia to study art. In 1977 he received a B.F.A. degree and was awarded for outstanding achievement in art. That year he was exposed to archeology and became involved in several archeological projects through James Madison University.

Unsatisfied with his knowledge of anthropology, he left James Madison to attend graduate school at The University of Tennessee, Knoxville, where he has participated on many projects and served as an instructor in 1982 and 1983. In August, 1984 he was awarded the Master of Arts degree in Anthropology, and is presently seeking a Ph.D. at The University of Tennessee, Knoxville.

Tom is a harmonica and baritone uke player in an old-time country string band. He is also a certified pilot and scuba diver. His goal is to return to Virginia to conduct archeological research and grow old.