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The Role of Thermal Alteration in Lithic Reduction Strategies at the Leftwich Site in Middle Tennessee

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Recommended Citation

Grubb, Audrey L., "The Role of Thermal Alteration in Lithic Reduction Strategies at the Leftwich Site in Middle Tennessee. " Master's Thesis, University of Tennessee, 1986.
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I am submitting herewith a thesis written by Audrey L. Grubb entitled "The Role of Thermal Alteration in Lithic Reduction Strategies at the Leftwich Site in Middle Tennessee." I have examined the final electronic 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.

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THE ROLE OF THERMAL ALTERATION IN LITHIC REDUCTION STRATEGIES AT THE LEFTWICH SITE IN MIDDLE TENNESSEE

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

Audrey L. Grubb
March 1986

ACKNOWLEDGEMENTS

Research at the Leftwich site was conducted as part of the Columbia Archaeological Project. Dr. Walter E. Klippel served as Principle Investigator and Project Director of the Columbia Archaeological Project. I am particularly indebted to Dr. Klippel who served as the chairman of my thesis committee and to committee members, Drs. Richard L. Jantz and Charles H. Faulkner for their encouragement, critical input and patience. Dr. Jantz provided statistical expertise. Dr. Faulkner sparked my interest in Southeastern Archaeology and directed my early years in Archaeology.

Numerous individuals have contributed to the successful completion of this thesis. Neil Robison and Bill Turner served as co-field directors during the summer of 1978, supervising excavation and surface survey collection, respectively. Backhoe trenching was accomplished by Cecil Fowler in 1980 and Charlie Hines in 1981. Numerous people have been involved in the field and laboratory processing of Leftwich site material. Crew members who assisted in collecting Leftwich material include Joe Barton, Joe Bartolini, Margie Block, Danny Boring, Anna Dixon, Chuck Faulkner, Nina Fitzgerald, Ingrid Ginsler, Howard Haygood, Will Hines, Pat Hofman, Steve Johnston, Jan Jones, Harley Lanham, Alicia Lafever,

Lee Loftus, Bill Love, Bruce Manzano, Kay Moneyhun, Darcy Morey, Patrice Newman, Connie O´Hare, Mike Posey, Anne Prados, Charlie Prose, Veryl Riddle, Chris Senior, Cheryl Smith, Mark Smith, Lee Tippitt and Deborah Turner.

G.R. Brakenridge furnished stratigraphic profile maps of Leftwich Trench G. Lee Ferguson performed thermal alteration experiments on chert samples from the proposed Columbia Reservoir. Dan Amick assisted in the analysis of Leftwich Area A artifacts. Discussion with archaeologists Chuck Bentz, Bob Entorf, Lee Ferguson, Charlie Hall, Jack Hofman and Gerry Kline have contributed substantially to the successful completion of this thesis. Terry Faulkner and Don Rosenbaum cheerfully prepared final draft figures. Editing assistance was recieved from Robert Entorf, Charles Faulkner, Sheila Grubb, Richard Jantz and Walter Klippel. Special thanks is extended to Bob Entorf and my parents Ralph and Sheila Grubb, who have provided invaluable support over a number of years and have always been there when it mattered most.

The University of Tennessee, Knoxville has supported this work through the Department of Anthropology, Photographic Services and the Computing Center. Figure reduction was accomplished by Knoxville Blueprint.

ABSTRACT

Research in 1978, 1980 and 1981 at the Leftwich site (40MU262), located on the Duck River in Maury County, Tennessee revealed stratigraphically separated buried Archaic cultural strata. Radiocarbon dates of 6160 and 4190 to 4130 years before present were associated with Benton and Ledbetter projectile points, respectively. A functional analysis of artifacts from a controlled surface collection and two buried Archaic components at Leftwich is undertaken. Buried Benton and Ledbetter components were stratigraphically separated based on vertical density peaks of lithic artifacts and debitage, as well as pebbles larger than 6 mm in size.

The relationship of thermal alteration to lithic resource location, lithic implement manufacturing processes and settlement is investigated. Intentional thermal alteration of lithic artifacts is indicated by: (1) an overall low incidence of overheating and (2) an association between thermal alteration and small biface thinning flakes and late stage bifaces in the surface, Benton and Ledbetter assemblages. Intentional thermal alteration is also significantly correlated with cores and large biface thinning flakes. Thermal alteration analysis can yield information regarding when and where lithic reduction took place.

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CHAPTER I

INTRODUCTION

The Leftwich site (40MU262) is located on the Duck River in Maury County, Tennessee. During the summers of 1980 and 1981 a systematic trenching program was conducted along the Duck River in Marshall and Maury counties, Tennessee as part of the Columbia Archaeological Project (Mahaffy 1980). Three backhoe trenches were excavated perpendicular to the Duck River at Leftwich. Three alluvial surfaces or terraces were visible in each of the trench profiles: T2, T1 and T0, in order of descending elevation above the Duck River (Brakenridge 1982, 1984). Hand trowling of the Leftwich trench profiles revealed stratigraphic contact between buried Archaic cultural strata. Ledbetter cluster projectile points occur in the upper 50 cm of the Leftwich formation (T1b) and were associated with radiocarbon dates of ca. 4130±130 and 4190±260 years B.P. (A-2553 and A-2366, respectively). Benton Stemmed and White Springs-Sykes cluster projectile points located in the lower 70 cm of the Leftwich formation were associated with a radiocarbon date of ca. 6160±330 years B.P. (A-2365).

Surface indications at the Leftwich site extend for nearly 1000 m parallel to and 200 m back from the Duck River. Prior to excavation, the Leftwich area was laid out in 50 x 50 m grid units and intensively surface collected. This surface collection contains the artifact and assemblage data employed in the final analysis.

In June 1981, six 1 x 1 m units were manually excavated adjacent to the initial Leftwich trench and designated Area A. This stratified sample contains the artifact and assemblage data employed in the subsequent analysis.

Research in this thesis is directed toward understanding hunter-gatherer settlement systems. In the discussion which follows I will delineate the underlying theoretical basis of my research, present the research questions to be addressed and define the units of analysis to be employed.

Relating archaeological facts to cultural dynamics poses special analytical problems for archaeologists. Especially valuable to this research will be organizational principles regarding hunter-gatherer procurement, settlement and technology developed by Binford (1976, 1979, 1980, 1982). Understanding the cultural processes responsible for human behavior can best be accomplished through combining knowledge gathered from ethnography, history, sociology, economics and archaeology (Thomas 1979).

Research will be directed toward understanding hunter-gatherer settlement organization. In order to realize this goal several research questions will be addressed. A functional analysis of artifacts from Leftwich artifact assemblages will be undertaken. Tool function is inferred from technological and morphological attributes. Observations on experimentally heated and unaltered chert specimens from the Middle Duck River Valley will be discussed. To assess intrasite thermal alteration variability, statistical tests such as chi-square and categorical regression will be employed. Intrasite assemblage variability is expected to contribute to knowledge about past settlement organization. Several interrelated problems relevant to interpreting the Leftwich site assemblages are investigated, including:

1. What activities are represented by the Leftwich surface and excavated Benton and Ledbetter lithic assemblages?

2. Are thermally altered lithic artifacts and debris from Middle Tennessee recognizable?

3. Were lithic artifacts accidentally or intentionally thermally altered?

4. If thermal alteration was intentional, is there a recognizable pattern?

5. Does a consideration of thermal alteration add to prehistoric behavior recognition?

CHAPTER II

ENVIRONMENTAL SETTING

A. PHYSIOGRAPHY

Due to its length, the state of Tennessee transects five major physiographic provinces. From east to west these are: 1) Blue Ridge, 2) Ridge and Valley, 3) Cumberland section of the Appalachian Plateau, 4) Interior Low Plateau and 5) Coastal Plain (Fenneman 1938; Shimer 1972). The Interior Low Plateau is composed of the Nashville Basin, surrounded by an area of relatively greater relief known as the Highland Rim in Tennessee. The Basin is an eroded structural dome that has developed into a depression through the widening of stream valleys (Fenneman 1938:431-434). The northern half of the Nashville Basin is drained to the northwest by the Cumberland River and its tributaries, the Stones and Harpeth rivers, while the southern half is drained to the west and south by the Duck and Elk rivers, respectively (DeSelm 1959:67).

The Nashville Basin has been divided into inner and outer portions based on physiographic, geologic, floristic and historic variability. The Inner Basin is underlain by massive argillaceous limestones and shales, whereas the outer portion contains high-grade, phosphate-rich, limestones (Harmon et al. 1959). Topographically the Inner Basin is rolling and hilly with numerous glade areas where the underlying limestone is exposed or is shallowly covered with soil (Braun 1950; DeSelm 1959; Edwards et al. 1974). The most distinctive feature of the Nashville Basin is the cedar glades, open to dense stands of cedar, which occur on Lebanon limestone (Braun 1950:131). Hardwood glades occur on Ridley limestone (Fenneman 1938:433). According to Quarterman (1950:251) cedar glades have probably existed in Middle Tennessee long before settlement by Euro-Americans. Earliest botanical description of the Nashville Basin mention a glade flora (Quarterman 1950:251).

The deeply dissected Outer Basin consists of steep slopes between narrow rolling ridge tops and narrow valley floors, as well as smoother undulating to hilly sections adjacent to the Inner Basin. Many steep to very steep areas of the Outer Basin are under cutover deciduous forest while hilly to steep areas are in permanent pasture and undulating to strongly rolling areas are cultivated or in pasture.

Flood plains are narrow along creeks in the Outer Basin whereas; flood plains in the Inner Basin are broader. Topographic criteria do not adequately distinguish local history of flood plain sedimentation and terrace formation since each younger fill laps up over the next older fill and covers at least the lower portion of its surface. Buried terraces are the rule rather than the exception in the middle Duck River Valley (Brakenridge 1982, 1984).

B. GEOLOGIC HISTORY

Geological doming began during the Paleozoic and continued into the Pliocene (Fenneman 1938:434). The Nashville dome was an island throughout most of its sedimentary history (Theis 1936:26-27). Streams not only maintained their courses across the rising dome but also widened their valleys. During pauses in doming activity valley floors expanded significantly (Fenneman 1938:434). Many of the formations, from Ordovician to Mississippian, were deposited in elongated embayments (Theis 1936:26-27). Ordovician, Silurian and Mississippian System formations were deposited in Middle Tennessee. Ordovician System formations include Murfreesboro, Pierce, Ridley, Lebanon, Carters, Hermitage, Bigby Cannon and Leipers-Catheys. Brassfield is the only Silurian System formation while Fort Payne and St. Louis-Warsaw comprise the Mississippian System formation deposited in Middle Tennessee.

The Nashville Basin is composed of a series of Ordovician limestone facies with the oldest rocks exposed at the center of the basin, and successively younger and higher strata forming roughly concentric rings around the center point. Ordovician, Missippian and Quaternary System formations are exposed in the vicinity of Leftwich.

Ridley

Ridley limestone, the lowest formation of the Ordovician System, is also the most widely exposed formation in the locality. Ridley is mostly limestone with shale and chert (Wilson 1949:36). Shale partings occur between thin layers of Ridley limestone due to the presence of muddy sediment during its formation (Wilson 1949:335). Residual Ridley chert may be present wherever Ridley bedrock underlies the soil or is exposed. Most fine-grained Ridley cobbles are found in the Duck River alluvial gravels or adhering to limestone matrix in bedrock outcrops such as bluffs and caves.

Lebanon

Lebanon limestone, also of the Ordovician System, forms an irregular belt around the outcrop areas of Ridley limestone. In addition, extensive exposures occur along the Duck River drainage basin and its banks.

Lebanon limestone has been characterized as locally non-cherty (Amick 1981), but Wilson (1949:41) suggests that chert stringers and nodules do occur. Lithologically Lebanon consists of thin beds of relatively pure limestone, averaging two to three inches, separated by thin partings of gray calcareous shale that weathers to a yellowish-gray color. The limestone is blue to gray in color which weathers gray except for layers at or near the top of the formation which develop a peripheral pinkish zone as a result of pre-Carters weathering (Wilson 1949). Physiographically, the outcrop of Lebanon forms a gently rolling belt between the almost flat surface developed on Ridley limestone to the base of the steeper slopes formed by the overlying Carters (Wilson 1949:44). Successive stages in the development of cedar glades range from bare outcrops of Lebanon limestone through: openings of grasses, herbs and shrubs in cedar-hackberry-elm glades, cedar hardwood forest, and ultimately into Mesophytic forest (Quarterman 1950) where soils develop to sufficient depths.

Carters

Carters limestone, also of the Ordovician System, overlies Lebanon limestone and is mostly composed of limestone with coquina, dolomitic fucoidal casts and mottlings, silt, clay, lenses and nodules of white to dark-gray chert. Within the Inner Basin, Carters commonly forms relatively steep slopes connecting the lower Lebanon limestone and the higher Hermitage formation which often cap extensive flat interstream divides. Carters limestone occurs as surface residual on steep slopes and bluffs, at interstream divides and talus deposits. Carters chert also occurs in formation outcrops, as well as in alluvial gravels within the central Duck River Valley.

Hermitage

The Hermitage formation, also of the Ordovician System, ranges from a shaly nodular limestone to a pink siliceous limestone which is distinct from contiguous formations. When weathered, it frequently has the appearance of a sandstone. The base of the Hermitage formation marks the line of separation between the inner and outer portions of the Nashville Basin (Harmon et al. 1959:2; Wilson 1949:106).

Bigby Cannon

Bigby Cannon limestone occurs directly upon various members of the Hermitage formation. Also of the Ordovician System, this formation is predominately limestone and contains phosphate, fossils, calcite, silt, clay, black shale and chert (Wilson 1949:115-116, 122, 127). Water worn cobbles from strath terraces appear to contain significantly greater amounts of Bigby Cannon chert than recent Duck River gravels (Amick 1981). This probably reflects the earlier erosional period of the Central Basin during which upper Ordovician strata covered a much greater portion of the present Inner Basin.

Leipers-Catheys

Leipers-Catheys is the uppermost exposed Ordovician formation found throughout Middle Tennessee. The Leipers-Catheys formation is primarily limestone with silt, clay, fossils, shale, and poor quality chert.

Brassfield

Brassfield occurs in thin outcrops along the boundary of the Western Highland Rim and the Nashville Basin. The Brassfield formation contains lenses, beds and small nodules of light-gray to black mottled chert.

Fort Payne

Bassler (1932:155) has described Fort Payne of the Nashville Basin as a massive argillaceous limestone which weathers into a solid, brittle, blocky chert and siliceous shale. The lowest formation of the Mississippian System, Fort Payne, is more resistant to weathering than the underlying layers of shale. Fort

Payne cherty rocks are responsible for the knobs that have been isolated by erosion in the Nashville Basin, as well as the steep break between the Highland Rim and the Basin (Harmon et al. 1959:1).

St. Louis

St. Louis-Warsaw limestone, also of the Mississippian System, is the uppermost formation capping the Highland Rim. This formation generally consists of a fine-grained to compact gray limestone. Chert derived from the St. Louis-Warsaw formation is typically porous and large pieces are likely to contain crinoid stems (Theis 1936:61-62).

C. QUATERNARY

The Quaternary System is represented in Middle Tennessee by alluvial deposits in the stream valleys. An alluvial mantle generally caps the terrace remnants, at various heights above the rivers, throughout the area. Bottom lands occupy a belt of nearly level land adjacent to the Duck River and creek channels which are periodically flooded. Occupying smooth strips above the bottom lands, low stream terraces have undulating to rolling relief. High stream terraces, above the present stream overflow, have gently sloping to moderately steep relief (Harmon et al. 1959:3). The older alluvium varies in composition from silt to gravel and is generally poorly sorted.

Exposures obtained by backhoe and bulldozer trenching of the Duck River Valley alluvium have formed the basis for a local alluvial lithostratigraphy (Brakenridge 1982,1984). Classified as an ingrown meandering river, the Duck has steep bedrock slopes on the outside of river bends which prohibit rapid channel migration characteristic of freely meandering rivers. Along the Duck River, flood plain sedimentation occurs through "suspended-load deposition during high-river stages on the higher portions of in-channel bars, on vegetated river banks, on level flood-plain surfaces, and also on low terrace scarps and treads" (Brakenridge 1984:24).

Four major flood plain sedimentary formations occur along the Duck River. In order of decreasing age, these formations are Cheek Bend, Cannon Bend, Leftwich and Sowell Mill Bridge. Terrace formation occurred in the middle Duck River Valley as a result of bedrock erosion and a lowered channel-floor position or lateral migration of the channel, during which each younger fill lapped up over the next older fill and covered at least the lower portion of its surface. A simple one-to-one relationship between geomorphic terrace surfaces and the age or lithostratigraphy of the underlying alluvium formations does not exist in the Duck River Valley. The highest terrace mapped, T2, is underlain by the Cheek Bend formation which overlies the higher late Pleistocene Valley floor. Expressed throughout the Duck River Valley, the Tl terrace is underlain by two Holocene formations: Cannon Bend (Tla) and Leftwich (Tlb). During the Holocene, Tl surfaces which contain a paleosol represent a period of flood plain stability when soil formation occurred. Periods of flood plain stability were preceded and followed by periods of sediment deposition, along with channel migration and cutbank erosion. The age of Tl surfaces varies over space and time throughout the middle Duck River Valley. The Tl terraces are each composed of fine sandy-silt and clayey-silt which indicates one primary flood plain accumulation occurred. The Sowell Mill Bridge formation, which veneers the Tl surface, occurs as narrow discontinuous berms along the Duck River, as well as within-channel longitudinal islands.

D. FLORA

The Nashville Basin is within the Carolinian Biotic province and the Western Mesophytic Forest Region (Braun 1950:122; Dice 1943). The major vegetation types form a complex mosaic which has resulted from both present and past influences. Floral records for the past 40,000 years have been compiled by Delcourt and Delcourt (1979, 1981) from radiocarbon dated pollen samples from 100 localities across eastern Canada and the eastern United States, as well as modern pollen samples from a wide geographic array (Table 2.1). Earliest floral records indicate Middle Tennessee was an Oak-Hickory-Southern Pine Forest at 40,000 years B.P. (Delcourt and Delcourt 1981). By 25,000 years B.P. an Oak-Hickory Forest dominated Middle Tennessee with a Jack Pine-Spruce Forest slightly east (Delcourt and Delcourt 1981). During the glaciation peak, about 18,000 years B.P., the Jack Pine Forest, with spruce and fir subdominates, prevailed in the Interior Low Plateau (Delcourt and Delcourt 1979, 1981; Klippel and Parmalee 1982). About 14,000 years B.P., during the late glacial, the Spruce-Jack Pine Forest expanded eastward into Kentucky and Middle Tennessee at the expense of the Jack-Pine dominated forest (Delcourt and Delcourt 1981; Klippel and Parmalee 1982). A Mixed Mesophytic Forest replaced the Jack Pine (glacial vegetation) by 10,000 years B.P. during the early Holocene (Delcourt and Delcourt 1981; Klippel and Parmalee 1982; Wright 1976). The Mid-Holocene general warming and drying trend known

TABLE 2.1. GEOLOGIC, CLIMATIC AND VEGETATION RECORD FOR THE NASHVILLE BASIN.

Years B.P	Geologic Time	Climate[1]	Vegetation[1]	Culture
200 1000 2500 4000	Late Holocene Interval	Cooling trend: increased precipitation	Deciduous Forests: Oak-Hickory	Mississippian Woodland Late Archaic
6000 8000	Mid-Holocene Interval	Hypsithermal: increased warmth and aridity	Xeric: Oak-Hickory	Middle Archaic
10000 12500	Early Holocene Interval	Cool and moist	Mixed Hardwoods	Early Archaic Paleoindian
16000	Woodfordian Subage	Late-glacial Interval: warming	Boreal Forests: Spruce-Jack Pine	
18000 23000		Glacial Peak	Jack Pine-Spruce	
25000 28000	Farmdalian Subage	Full Glacial Interval: mild warming	Deciduous Forests: Oak-Hickory	
40000	Altonian Subage	Full Glacial	Mixed Conifer-Northern Hardwoods Forest	

[1] from Delcourt and Delcourt (1979, 1981)

as the hypsithermal interval had widespread effects upon the floral composition by expanding grassland and diminishing forest size (Klippel and Parmalee 1982). The hypsithermal interval lasted from ca. 8,000 to 4,000 years B.P. (Deevey and Flint 1957; Delcourt and Delcourt 1979, 1981). From about 5,000 years B.P. to the present, an Oak Hickory forest has dominated Middle Tennessee (Delcourt and Delcourt 1979; Wright 1976).

E. CLIMATE

According to climatic data gathered at the United States Weather Bureau Station in Ashwood, Tennessee, the present climate of Middle Tennessee can be characterized as humid and temperate. Maury County averages 192 frost-free days from early April until late October. Rainfall is fairly well distributed, but short droughts occur in the summer and fall and excessive wet periods are common during winter and spring (Harmon et al. 1959). The prevailing wind direction throughout the year in Middle Tennessee is from the south (Conway 1963:137).

F. SOILS

The characteristics and formation of a soil are determined by the interaction of five factors: climate, vegetation, parent material, relief, and time. The temperature and rainfall of Maury County favor fairly intense leaching of minerals and bases. Thus, although climatic conditions hasten decomposition of organic matter, only small amounts accumulate in the soils. Small local differences in climate caused by variation in slope and exposure affect the formation of soil. Although the climate in Maury County does not differ enough to have caused the broad differences in the soils, it has been and is a powerful indirect influence on soil morphology (Harmon et al. 1959:66).

CHAPTER III

THE LEFTWICH SITE

A. THE SITE LOCATION

The Leftwich site (40MU262) is located in Maury County, Tennessee in the proposed Columbia Reservoir. The site takes its name from the small community of Leftwich located immediately northeast of the site identified on the USGS Verona, Tennessee Quadrangle Map, 7.5′ Series (Figure 3.1). The Leftwich site is situated on a high terrace above the present stream overflow, maximum elevation 192 m AMSL, on the left bank of the Duck River. In this area the Duck is a shallow, swiftly flowing river which has deeply incised into solid Ridley limestone bedrock.

Surface indications of the site include chipped and ground stone artifacts and debitage which extend for nearly 1000 meters parallel to the river and 200 m away from the river. Surface material is evident on the T1, T2 and T3 terraces and will be discussed in Chapter VI. Two stratigraphically separated assemblages occur within the buried Leftwich formation (T1b1): Late Archaic Ledbetter and Middle Archaic Benton. The buried alluvial lithic assemblages will be discussed in Chapter V. Subsequent late Holocene and Quaternary alluviation has

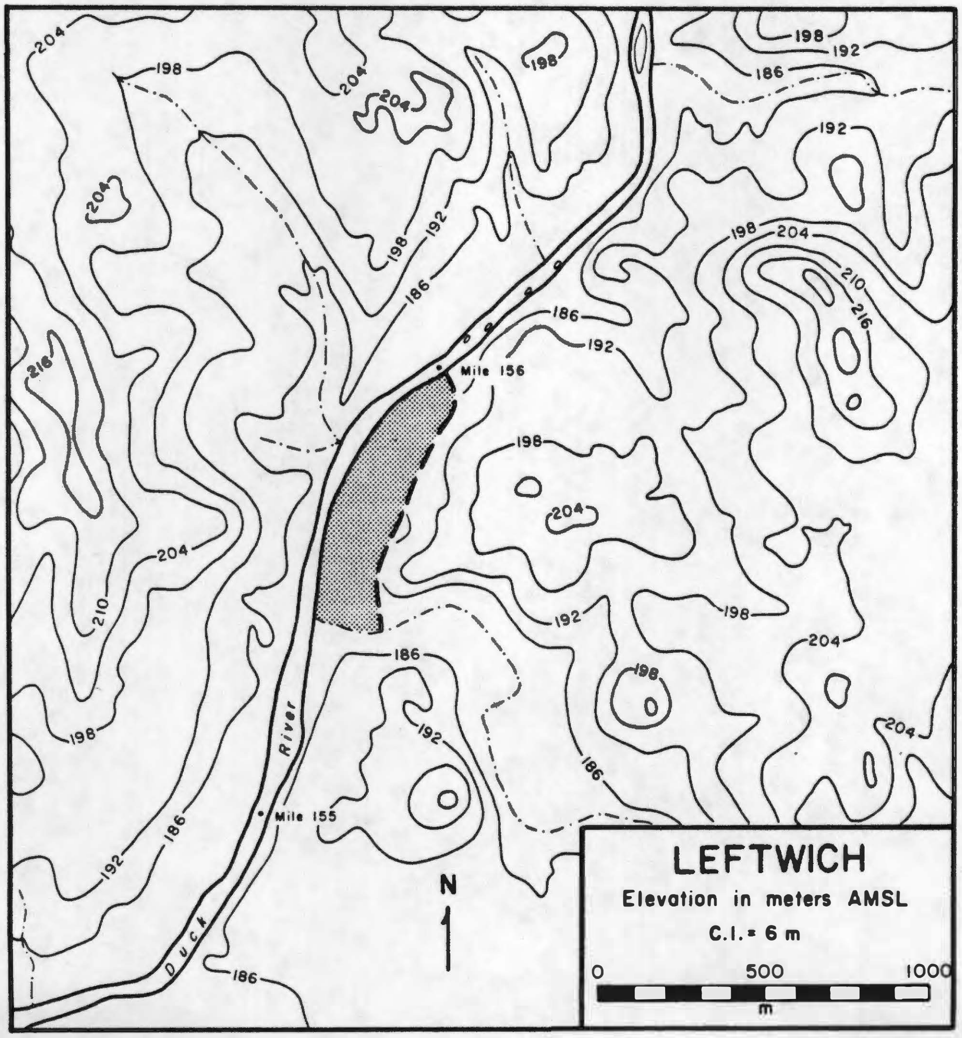

Figure 3.1. Leftwich Site Location.

covered these occupational surfaces and sealed them below the plowzone.

B. HISTORY OF INVESTIGATION

To facilitate description of investigations at the Leftwich site, five areas are identified and their locations are briefly described below. Area A contains a 2 x 3 m area which was located adjacent to Trench G in the woods (Figure 3.2). A row of four 2 x 2 m units were hand excavated on the undisturbed Pleistocene terrace and designated Area B (Figure 3.2). Area C contains six 2 x 2 m hand excavated units which were located around Feature 1A within the panned area (Figure 3.2). A surface survey was conducted in the southern portion of the Leftwich site and was designated Area D (Figure 3.3). The area panned for the new Leftwich Bridge fill dirt was designated Area E (Figure 3.2).

South Section

Area D. Dickson´s 1972-1973 survey in the Leftwich area located the Clifford site (40MU101) between Sowell Mill Pike and the intersection of Cedar Creek and the Duck River (Dickson 1976). Archaeological survey was initiated under Walter E. Klippel´s direction in May 1978 as part of the Columbia Archaeological Project. The datum

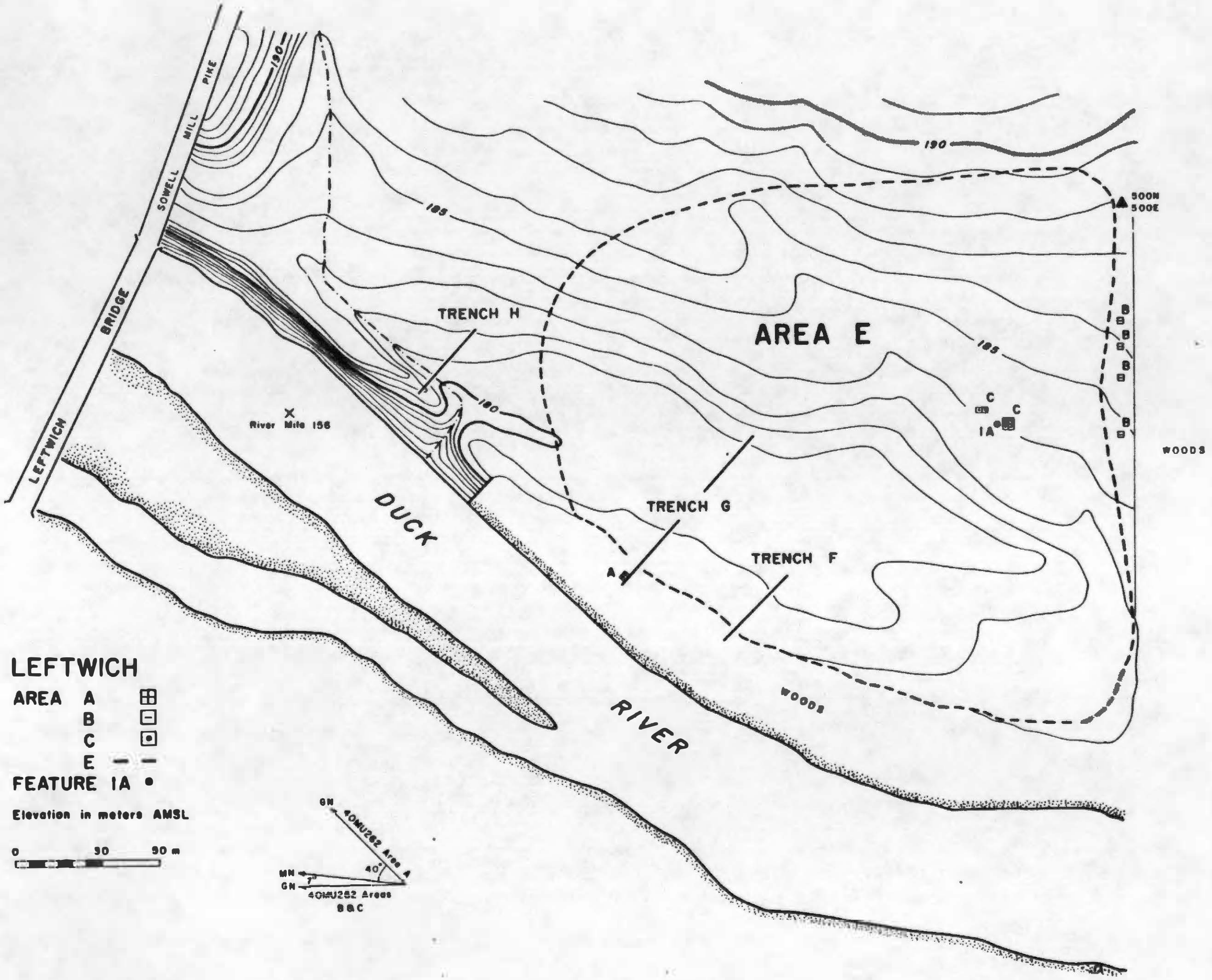

Figure 3.2. Leftwich North Areas and Trenches.

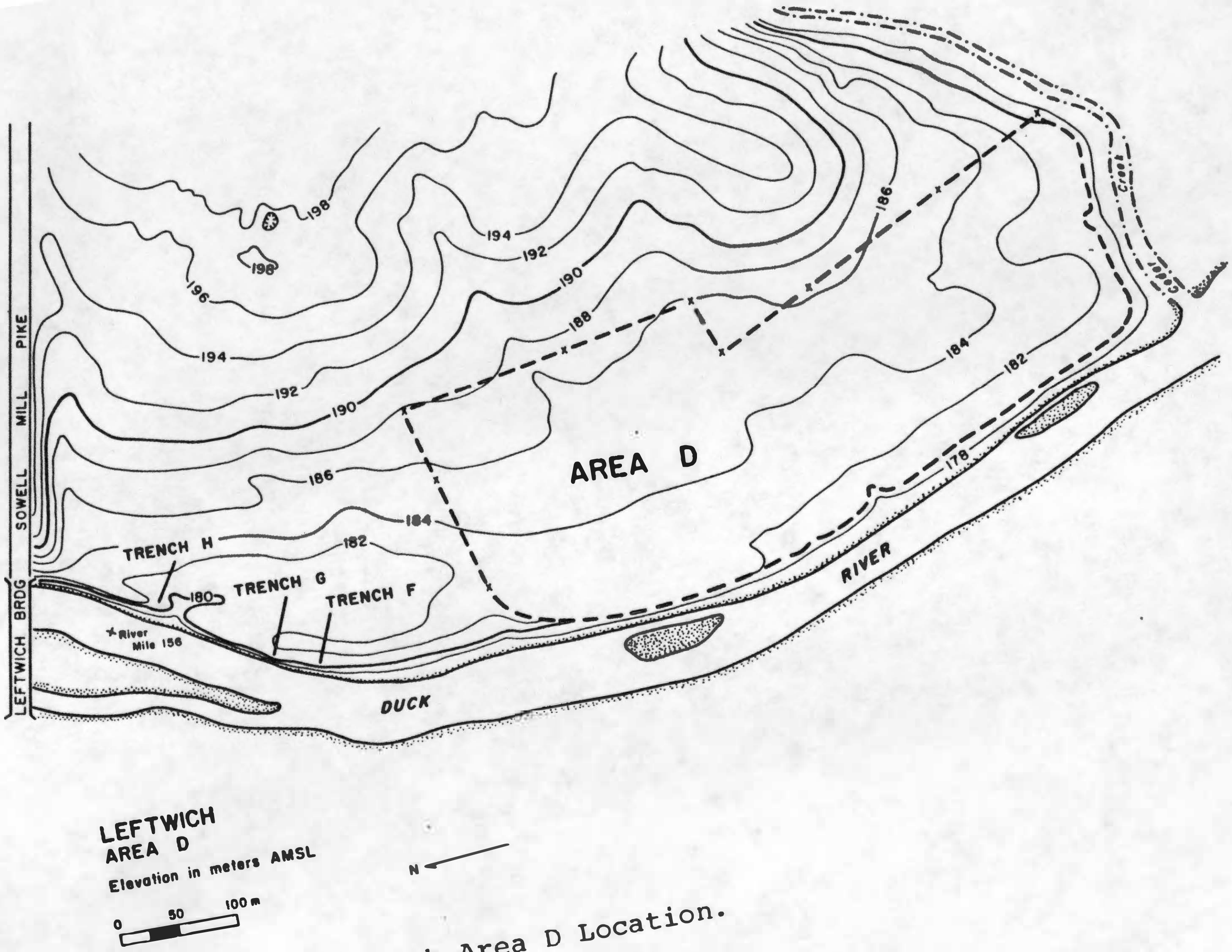

Figure 3.3. Leftwich Area D Location.

for Area D is located on the east-west fenceline 50 m west of the northeastern field edge. The actual elevation of the datum was determined to be 186.660 m AMSL from bench marks around the New Leftwich Bridge (Bentz 1984). The initial north-south transect line was established from the datum south to the fence corner approximately 250 m away. Grid north is 7° west of magnetic north. Units were distinguished by numbers from 1 to 67. Units were expediently, although not too accurately, established by means of a hand held Brunton compass and 1 m paces. The actual size of the gridded units varied from 34-54 m east to west and 40-50 m north to south (Figure 3.4).

Each unit was collected by walking between planted rows of soybeans. Surface visibility was greater than 90% due to limited ground cover and adequate rainfall (Turner 1980) since the field had been disked. Materials collected from each unit were bagged and labeled separately. In addition, concentrations within units were collected separately from the surrounding scatter. Several lithic scatters were located in Leftwich Area D (Figure 3.4). Although concentrations were given separate site numbers (40MU101, 40MU262 and 40MU278), this study considers all three sites to be part of the same site cluster since the lithic scatter is

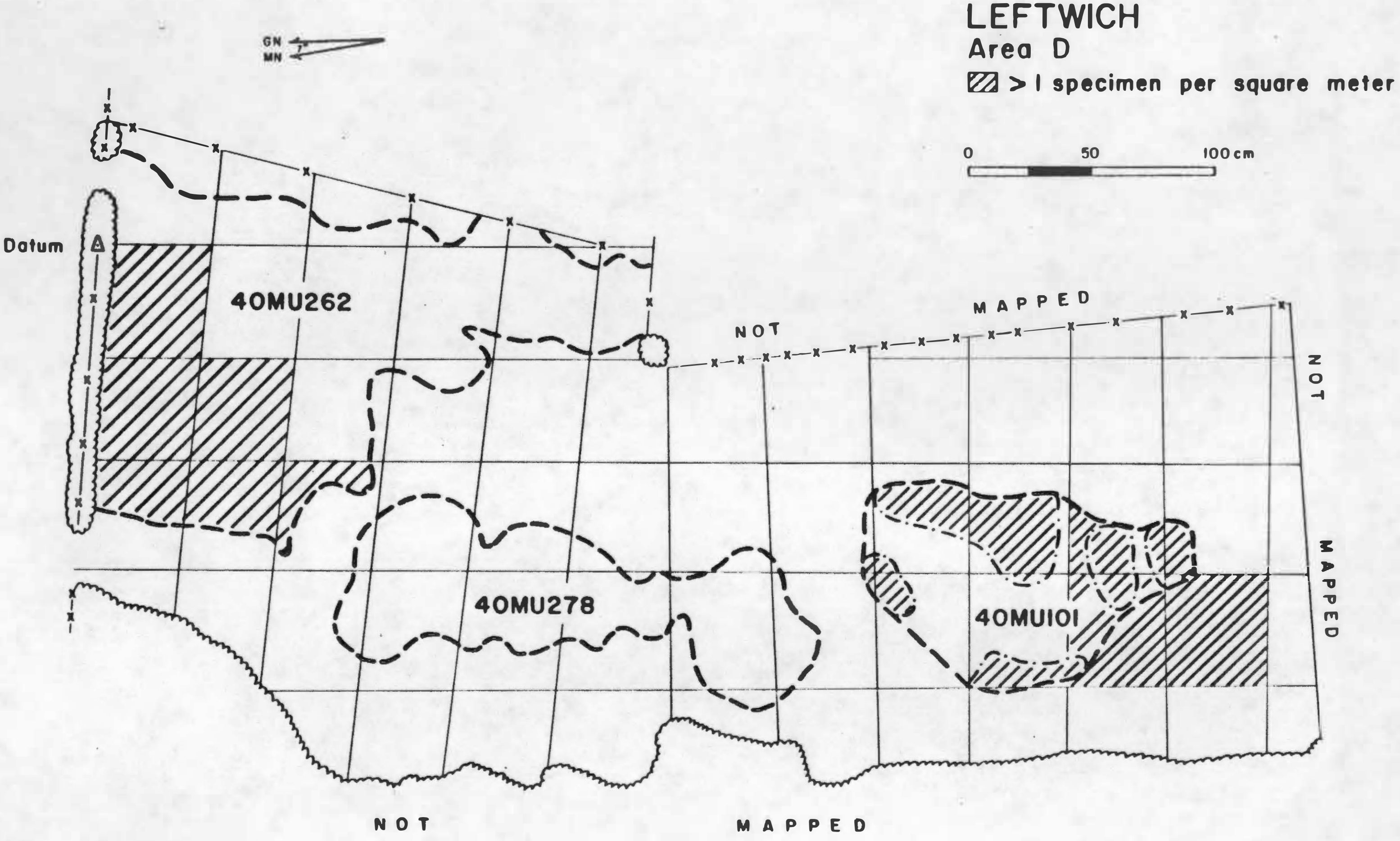

Figure 3.4. Leftwich Area D Surface Collection Grid and Density Distribution.

continuous (Figure 3.4). Cultural material collected includes chipped and ground stone tools, flake and stone debitage, burned limestone and limestone tempered sherds.

Since unit size varied considerably, artifact density was calculated for each square meter. Surface density at Leftwich varied from more than one artifact per square meter to less than one artifact per eight square meters. Figure 3.4 illustrates the distribution of 50 m^2 units or concentrations within units which contained one or more pieces per square meter. Two concentrations of material are evident. These both occur on the initial slope and crest of the Pleistocene terrace and are associated with sites 40MU101 and 40MU262. This surface collection contains the artifact and asemblage analytical units employed in the final analysis.

North Section

Area E. The Leftwich site (40MU262) was first located in 1978 by TVA archaeologist Major C.R. McCollough when a large portion of the site was removed during construction of the new Leftwich Bridge (Figure 3.2). General surface collections were made immediately below the plowzone and during stripping after sod removal. Panning operations continued to a maximum depth of 3 m below the original ground surface (Figure 3.5). The dense scatter of lithic material collected from the borrow area was recognized to be from a buried Late Archaic Ledbetter component. Cultural material from Area E includes chipped and ground stone tools, as well as flake and stone debris.

Feature 1A. A large heavily fired hearth (designated as Feature 1A) was exposed during panning operations on the Pleistocene terrace slope (Figure 3.2, page 22). Feature 1A measured 100 cm in diameter and 20-30 cm in depth. The hearth contained stone debris including burned limestone, flake debris, chipped stone tools and charcoal (Table 3.1). Stone debris was the largest artifact category, representing 60.23% (n=150) of the assemblage. The next most common artifact category was flake debitage comprising 35.34% (n=88) of the assemblage. Chipped stone tools represented 4.42% (n=11) of the lithic assemblage. Only two projectile points, one Pickwick and one Benton were diagnostic. Four other projectile points were too reworked or fragmentary to be identified. Feature 1A was probably a Late Archaic cooking hearth.

Feature 1A is similar morphologically to Late Archaic Ledbetter features from the Normandy Reservoir on the upper Duck River. Shallow circular basins (features

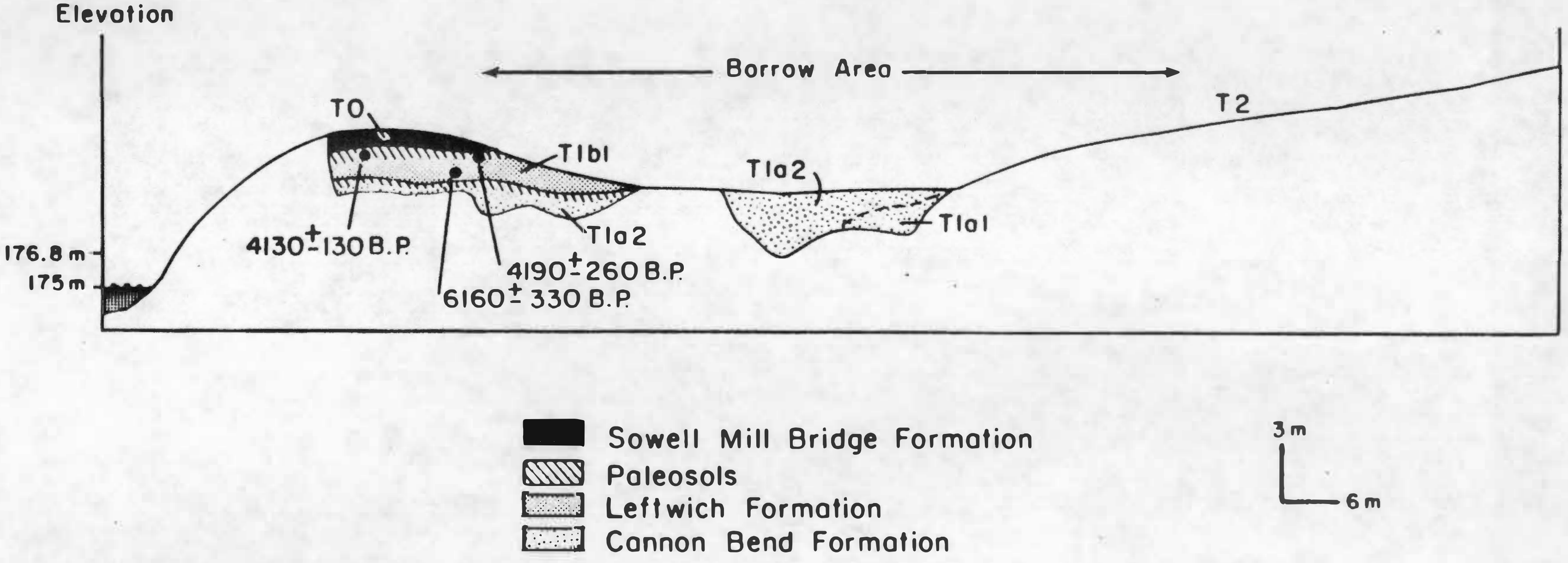

Figure 3.5. Stratigraphic Profile of Terraces at Leftwich based on Trench G (from Brakenridge 1982).

TABLE 3.1. FEATURE 1A LITHIC INVENTORY.

Artifact	N	Assemblage %
Bifaces	5	2.01
Projectile Points	6	2.41
Decortication flakes	16	6.43
Tertiary Flakes	19	7.63
Small BTF	3	1.20
Large BTF	14	5.62
Broken Flakes	36	14.46
Tested Cobbles	3	1.20
Blocky Debris	17	6.83
Hammerstones	2	0.80
Fire Cracked Rock	36	14.46
Burned Limestone	51	20.48
Unmodified Pebbles	21	8.43
Unmodified Cobbles	1	0.40
Broken Pebbles	19	7.63
Total	249	100%

69 and 83) occur at the Wiser-Stephen I site, 40CF81 (Davis 1978:334). In addition, seven basin-shaped features from the Eoff I site, 40CF32 are considered Late Archaic Ledbetter features (Faulkner and McCollough 1977). Feature 1A is also similar morphologically to Terminal Archaic basin-shaped roasting pit features from the Higgs site, 40LO45 (McCollough and Faulkner 1973) and from the Icehouse Bottom site, 40MR23 (Chapman 1973:31) in the Ridge and Valley Province.

Area C. A datum for Areas B and C was established in the southeastern corner on the east-west fenceline (Figure 3.2, page 22). It was arbitrarily assigned coordinates of 500 N 500 E. The original east-west transect line was established parallel to the fenceline. Grid north is 7° west of magnetic north. Six 2 x 2 m units were excavated around the hearth to a depth of 20 to 30 cm (Figure 3.2, page 22). Cultural material from Area C includes stone debris, flake debris, chipped stone tools, charcoal and daub.

Area B. Near the east-west fenceline, four 2 x 2 m units were excavated on the undisturbed Pleistocene terrace to a depth that varied between 80 and 110 cm (Figure 3.2, page 22). Cultural material from Area B includes chipped stone tools, flake and stone debris, charred botanical remains, daub and limestone tempered cord-marked pottery sherds.

Backhoe Trenches. During the summers of 1980 and 1981 three backhoe trenches were excavated approximately perpendicular to the Duck River at Leftwich (Figure 3.2, page 22). The initial trench location was determined by high frequency of subsurface remains exposed on the first terrace by Leftwich Bridge borrowing activities (Figure 3.2, page 22). Trench G extends from the crest of the Duck River bank to the Pleistocene T2 terrace. Two additional trenches were excavated as part of a systematic trenching program conducted during 1980 and 1981 (Mahaffy 1980). Trench F and H are located approximately 45.7 m south and 97.2 m north, respectively, of the initial trench (Figure 3.2, page 22).

Stratigraphy

Figure 3.5 illustrates the local geomorphology sequence at the Leftwich site. There were three alluvial surfaces or terraces visible in the profiles: T2, T1 and T0 in order of descending elevation above the Duck River. Clastic artifacts including daub, fauna, flora, limestone, lithic artifacts, pebbles and shale were individually marked with different colored flagging tape to facilitate mapping (Turner et al. 1982). Lithic remains from both walls of Trench G were mapped and collected during the summer and fall of 1980. A total of 205 lithic chipped stone artifacts and debris was collected. This includes 61 flakes, 136 stone debris (94 non-flaked stone debris) and eight chipped stone tools. Three of the eight tools were diagnostic projectile points (i.e. Ledbetter, Morrow Mountain and White Springs-Sykes).

A Late Archaic component was present at Leftwich which contained Ledbetter cluster projectile points and fragments. These occurred in the upper 50 cm of the Leftwich formation (Tlb) between 100 and 150 cm below ground surface.

Two Middle Archaic components were buried at Leftwich. One Middle Archaic component occurred in the lower 70 cm of the Leftwich formation (150-220 cm below ground surface) and contained Benton Stemmed and White Springs-Sykes projectile points.

In addition, a Middle Archaic Eva-Morrow Mountain component was present at Leftwich. This occupation occurred in the Cannon Bend formation paleosol (Tla). Hand excavations at Leftwich Area A did not extend to the Eva-Morrow Mountain component buried 230 to 270 cm below the ground surface.

Radiocarbon Dates

Three carbonized wood charcoal and nut shell samples from Trench G were submitted for radiocarbon dating. One of these was from the contact of the Tlbl and the Tlbl paleosol. The second sample was obtained within the upper Tlbl stratum. The third sample was collected from within the lower Tlbl stratum (Figure 3.6). Radiocarbon dates are uncorrected and referenced to A.D. 1950.

Sample A-2366: 4190±260 B.P. was collected directly from the south wall of Trench G, 1 m south and 7.3 m west of where test Area A was later excavated. The Tlbl soil and Tlbl contact area collected was 110 cm in length by 30 cm in width. The sample consisted of wood charcoal.

Sample A-2553: 4130±130 B.P. consists of charred hickory nut shell from the north wall of Trench G, within the upper Tlbl.

Sample A-2365: 6160±330 B.P.consisted of wood charcoal from the south wall of Trench G, 1 m south and 5 m west of Area A. The area collected was 207 cm in length and 30 cm in width within the base of the Tlbl.

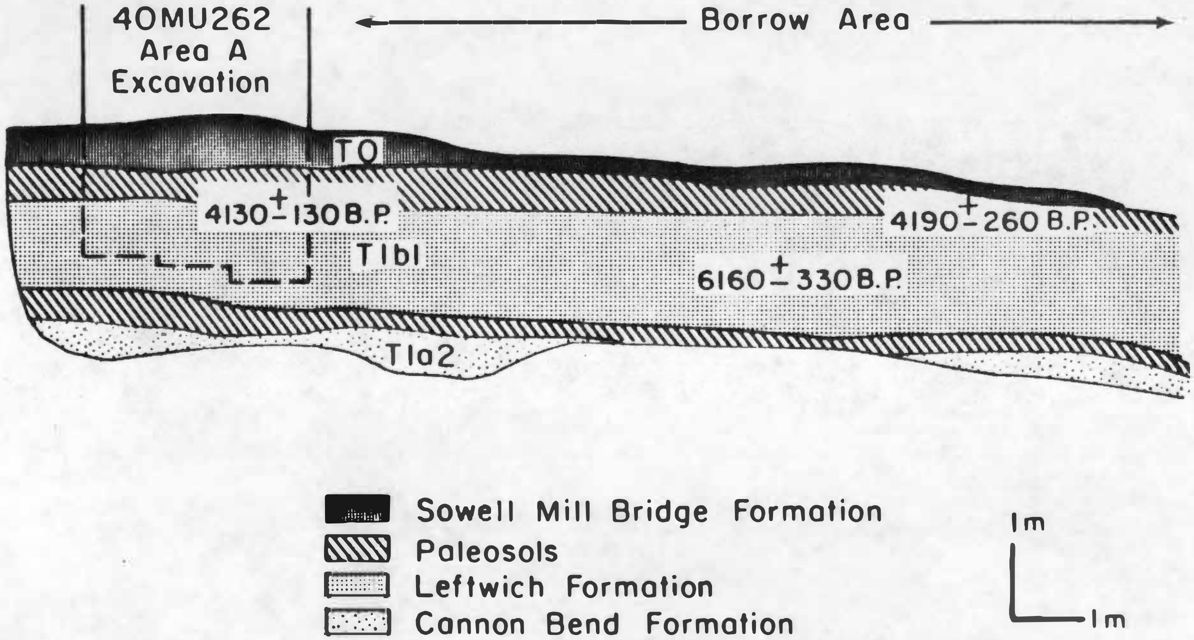

Figure 3.6. Stratigraphic North Profile of Trench G with Area A Excavation.

Methodology

Area A. In June 1981, six 1 x 1 m units were manually excavated adjacent to Leftwich Trench G (Figure 3.6). The datum for Area A is located on the northwestern corner of Trench G. It was arbitrarily assigned coordinates of 1 N 1 E. Grid north is 40° east of magnetic north. Elevations are referenced to the original ground surface. A small hackberry tree was conveniently growing adjacent to the northwest corner of unit 2 N 2 E. A nail inserted into the tree at ground level was used along with string, a line level and a 2 m folding ruler to determine unit elevations.

Before excavation began, Area A´s profile in Trench G was again collected and mapped. Seventeen lithic chipped stone tools and pieces of debris were recovered: four from the upper Tlb Ledbetter component, three from the lower Tlb Benton/White Springs-Sykes component and ten from the Tla Eva-Morrow Mountain component.

The Historic Alluvium or Sowell Mill Bridge formation (TO) was manually excavated in three 20 cm levels. A 100 liter floatation sample was retained from the northern half of square 2 N 4 E in each of the three 20 cm levels (Figure 3.7). A two liter soil sample was retained from the northeastern quadrangle of square 2 N 3

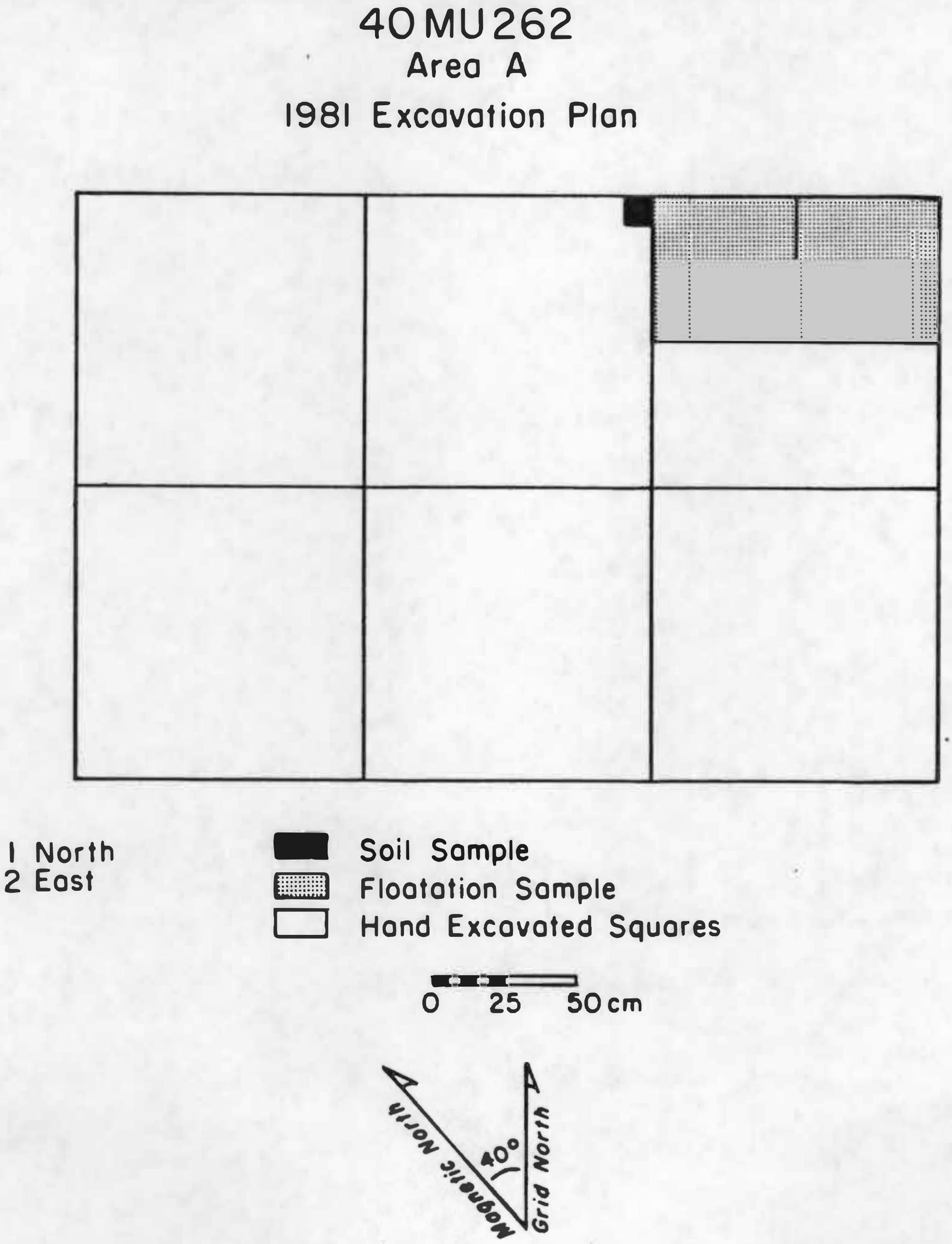

Figure 3.7. Leftwich Area A Excavation Plan View.

E in each of the three 20 cm levels (Figure 3.7). The remaining 1098 liters were waterscreened through 1.59 mm hardware mesh.

After the Sowell Mill Bridge formation was removed, the six units from Area A were manually excavated in 10 cm levels. Each 1 m^2 was subdivided into four equal squares and labeled Quads A through D starting with the southwestern quad. Two 25 liter floatation samples were obtained from the northern half of square 2 N 4 E (one each from Quads B and C) in each 10 cm level. A one liter soil sample was retained from the northeastern corner of square 2 N 3 E (Quad C) in each 10 cm level. Distributions of cultural material remains from Leftwich Area A levels 1-18 are summarized in Table 3.2. This stratified sample contains the artifact and assemblage analytical units employed in the subsequent analysis (e.g. Chapter V).

Within the Leftwich formation (Tlbl) faunal remains were noted as being present between 140 and 170 cm below ground surface. Since preservation was extremely poor, recovery of identifiable elements was not possible from either the Middle Archaic or Late Archaic occupations. Childe (1956:11) has noted that bone buried in acid soil may be completely dissolved in 50 years unless it has been previously calcined. Two terrestrial

TABLE 3.2. LEFTWICH AREA A CULTURAL MATERIAL INVENTORY BY LEVEL.

Cultural Material	Level																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Ceramic		X	X															
Daub								X		X	X	X	X	X	X			
Fauna		X										X	X	X				
Flora	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hemitite		X																
Limestone	X	X			X													
Lithic	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pebble	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

gastropods were recovered in level 2 (20 to 40 cm below ground surface) within the historic alluvium (T0).

Although no shale was recovered from the excavation, a large piece of shale (8 cm in length) was retrieved from Trench G within the upper T1b Late Archaic component. Shale occurs in several geologic formations in Middle Tennessee including Bigby Cannon, Carters, Fort Payne, Lebanon, Leipers-Catheys and Ridley (e.g. Chapter II).

CHAPTER IV

THERMAL ALTERATION STUDIES

In recent years it has been established that some prehistoric populations intentionally heated lithic materials (Ahler 1983; Anderson 1979; Crabtree and Butler 1964; Mandeville 1973; Purdy 1974; Schindler et al. 1982). Although physical and chemical effects of this phenomenon are well documented, its behavioral implications are not well understood. The occurrence of thermally altered chert and the circumstances under which intentional alteration might occur is examined with an emphasis on material recovered from the Southeast. In the discussion which follows a summary will be given of ethnographic accounts of thermal alteration, heat treatment experiments, properties of thermally altered as opposed to unaltered chert, and temporal distribution of thermal alteration. The terms heat treatment, thermal pretreatment, intentional thermal alteration, ITA and annealing are used interchangeably in reference to the process and archaeological occurrence.

A. HISTORIC PERSPECTIVE

Anthropologists have long recognized that thermal alteration was at least occasionally used in conjunction with quarrying or stone working (Holmes 1894:9, 1897:23, 1919:364-365). Apparently, very few ethnohistoric accounts were based on actual observations (Mandeville 1973; Purdy 1978). Many reports, such as Robinson`s (1938:224) account of heat treating a river cobble as <u>told</u> by a Nyasland boy, are based on a verbal account or memoir. Ethnohistoric references to the use of heat in shaping stone are numerous, but most accounts lack specific details. Intentional pretreatment of chert by Indian tribes such as the Harney Valley Paiute of Oregon (Whiting 1950:99), the Northern Paiute of Nevada (Stewart 1941:383), and the Wiyot of California (Squier 1953:17) is briefly mentioned but details are not disclosed.

More detailed accounts of the intentional thermal alteration of chert occur. Intentional pretreatment of chert by burial under a hearth has been reported by Steward (1941:337) for the Shoshoni along the Snake River of eastern Idaho. Steward (1942:264) has reported that the Shirwits, a southern Paiute group from northwestern Arizona, roasted flint in barrel cactus before it was flaked. The Reese River Shoshoni of central Nevada placed flint intended for flaking under fire ashes for five nights (Steward 1941:289). Accounts of heating chert directly `in the fire´ prior to cooling and flaking are quite common and include the Andaman Islanders (Man

1883:380), the Tubatulabal of California (Voegelin 1938:28), the Viard of California (Powers 1877:104), the Western Shasta, Foothill Niseman and Valley Maidu (Voegelin 1942:77), and the Yurok of California (Schumacher 1877).

Numerous ethnohistoric reports mention that flint arrowheads were made by the systematic application of fire and water (Eames 1915:65; Frazer 1908:68; Nagel 1914:140; Wallace and Hoebel 1952:104-105). Pond (1930:25) states that

> Some writers mention that artifacts were made by heating flint and dextrously dropping water upon it so that flakes were removed. Others say that the heated flint was cooled slowly and shaped. The process is never described in any detail and in no case is the technique given from reliable, first-hand observation.

Discussion of the process, intentional thermal alteration, and its advantages did not appear until the early 1960s when Crabtree and Butler (1964) first reported their thermal experiments. To improve the working quality of chert, and to counteract the tendency of chert to crack and spall when subjected to rapid temperature change, Crabtree and Butler (1964) suggest that the material to be heat treated was buried in the ground beneath a fire to allow slow and even heat distribution. Shippee (1963:271) found a prehistoric cache of artifacts buried under a hearth which appears to confirm Crabtree and Butler´s hypothesis.

B. HEAT TREATMENT EXPERIMENTS

Thermal Pretreatment

Pretreatment refers to the intentional exposure of chert to heat in preparation for further flaking. Numerous thermal alteration experiments have occurred on local lithic materials. In North America thermal alteration experiments have been conducted and reported on chert from 19 states within the U.S., as well as Canada and Nova Scotia (Table 4.1). In addition, thermal alteration experiments have been reported from several European countries including France, the Netherlands and Sweden. Experimental heating of chert has been accomplished with a variety of heat sources including ceramic kiln, gas range, furnace, as well as direct or indirect contact with an open fire, its ashes or coals. Table 4.1 lists experimentally heat altered chert samples gleaned from the literature. Chert samples are identified by name or geologic formation, in addition to their city, county, state, or country of location. Researchers have generally agreed that to successfully alter lithic material it must (1) be heated slowly to avoid crazing (Purdy 1974:40-41), (2) reach a critical

TABLE 4.1. LITHIC SAMPLES AND THERMAL ALTERATION METHOD USED FROM LITERATURE.

State	Lithic Sample	Range or Kiln	Buried or in Fire	Boiled	TL	References
AL	Bangor	X				Bond 1981
	Fort Payne	X				
	Tuscalloosa	X				
AR	Crowby´s Ridge		X			House & Smith 1975
	Knapp	X				Anderson 1979
	Novaculite	X				Flenniken & Garrison 1975
	Novaculite	X				Purdy & Brooks 1971
FL	Marion Co.				X	Maurer & Purdy 1983
	Obsidian	X				Purdy 1974
	Ocala	X				
	Silicified Coral	X				
	Misc. chert	X				Purdy & Brooks 1971
IL	Burlington	X			X	Rowlett et al. 1974
	Burlington	X	X			Rick 1978
	Chouteau	X	X			
	Keokuk	X	X			
MS	Fort Payne	X				Morrow 1981
MO	Burlington	X	X			Mandeville 1973
	Burlington	X			X	Rowlett et al. 1974
NE	Nehawka		X			Mandeville & Flenniken 1974
NY	Quartzite		X	X		McDowell-Loudan 1983
	Sandstone		X	X		
	Granite		X	X		
ND	Knife River	X				Ahler 1983
OH	Flint Ridge	X	X			Pickenpauch & Collins 1978

TABLE 4.1. (Continued)

State	Lithic Sample	Range or Kiln	Buried or in Fire	Boiled	TL	References
PA	Bald Eagle Jasper	X				Schindler et al. 1982
SC	Allendale Quarry	X				Anderson 1979
	Theriault Quarry	X				
TN	Agate	X				Hood & McCollough 1976
	Bigby Cannon	X				Hood & McCollough 1976
	Bigby Cannon	X				Robison & Hood 1976
	Carters	X				Robison & Hood 1976
	Chalcedony	X				Hood & McCollough 1976
	Chalcedony	X				Robison & Hood 1976
	Fort Payne	X				Hood & McCollough 1976
	Fort Payne	X				Robison & Hood 1976
	Knox Black					Purdy 1975a
	Knox Black					Chapman 1975
	Knox Black		X			Whyte 1984
	Quartz	X				Robison & Hood 1976
	Ridley	X				Robison & Hood 1976
	St. Louis	X				Hood & McCollough 1976
	St. Louis	X				Robison & Hood 1976
TX	Edwards Pluteau					Nelson 1968
	Fayette Co.	X				Patterson 1979
	Fine Grained					Sollberber & Hester 1973
WI	Hixton	X				Behm & Faulkner 1974
	Quartzite	X				Behm & Faulkner 1974
	Netherlands	X	X			Price et al. 1982
	Sweden	X				Olausson & Larsson 1982

temperature which varies with different varieties of silica material but is usually between 300-400° C (Mandeville 1973:188-189; Purdy and Brooks 1971), (3) remain at its critical temperature for several hours and (4) slow cooling is also essential to avoid thermal shock (Purdy and Brooks 1971:324).

Accidental Thermal Alteration

Accidental thermal alteration refers to unintentional exposure of chert to heat or unsuccessful thermal pretreatment. These specimens often exhibit heat fractures such as crazing, crenation or pot lids, as well as calcination and color change. Crazing can occur when chert is exposed to high temperatures, or if heated chert is not allowed to cool but immediately plunged into cold water (e.g., Purdy 1975b:138-139, Plate 6a, 6b). Large rather than small flakes are more likely to become permeated with minute surface cracks which cause the surface to be weakened (Crabtree 1972:56). Crenation is a distinctive half-moon shaped fracture that occurs rather than the expected flake when subsequent pressure or percussion is attempted on overheated siliceous material (e.g., Purdy 1975b:137, Plate 4a, 4b). Pot lids, varying widely in size, are detached from the main body of stone by rapid heating (Crabtree and Gould 1970:191; Purdy 1975b:136, Plate 3a, 3b). Since they always occur during the heating rather than the cooling process, pot lids are thought to be the result of expansion. Pot lids are plano-convex flakes that leave a concave scar but lack "compression rings of force lines" usually associated with flake manufacture (Crabtree 1972:84).

Accidental thermal alteration of archaeological artifacts is a new area of research currently being investigated in anthropology. Man-induced fire which could potentially affect archaeological site artifacts include accidental and prescribed forest fire, brush fire and human settlement features (i.e. campfire, hearths, burning structures and cremations (Bankoff and Winter 1979; Coles 1973; Hofman 1983; Johnston 1970; Kelly 1984; Komarek 1967; Lagercrantz 1954; Vogl 1974; Whyte 1983). Fire can be caused by a number of natural causes including lightening, volcanoes and chemical action (Barden and Woods 1974; Daubenmire 1947; Johnston 1970; Komarek 1967; Oakley 1961; Stewart 1954; Vogl 1974). Research on fire temperature at ground surface and subsurface indicates chert buried 2.54 cm or more would be protected from the deleterious effects of a forest fire (Table 4.2).

TABLE 4.2. SOIL TEMPERATURES ASSOCIATED WITH ACCIDENTAL AND PRESCRIBED FIRE.

		Maximum Temperature C				
Vegetation	Location	Surface	Soil	Depth cm	N	References
Long Leaf Pine	*	*	134.4	0.32	50	Heyward 1938
		*	134.4	0.64		
		*	90.6	1.27		
			No Change	2.54		
			No Change	1.27	15	
Grass	Sierra Nevada	121.1	65.6	0.76	4	Bentley & Fenner 1958
		121.1	93.3	0.76	7	
		121.1	121.1	0.76	3	
Brush	Sierra Nevada	176.7	121.1	0.76	10	
Pine	SE U.S.	150	No Change	1.00	1	Braun 1974
Jack Pine	MN	800	300	5.08	1	Algreen 1974
		800	300	7.62		
Douglas Fir	NW U.S.	1005	320	2.54	1	Isaac & Hopkins 1937
Heath	*	500	28	1.00	1	Whittaker 1961
Grassland	Japan	187	35	1.00	8	Iwanami 1969
			20	4.00		

TABLE 4.2. (Continued)

		Maximum Temperature C				
Vegetation	Location	Surface	Soil	Depth cm	N	References
Eucalyptus	Australia	213	67	2.54	1	Beadle 1940
		250	122	2.54	1	
			59	7.62		
			35	15.24		
			15	22.86		
			12	30.48		
			11	38.10		
		250	180	2.54	1	
			105	7.62		
			67	15.24		
			40	22.86		
			22	30.48		
			13	38.10		
		250	250	2.54	1	
			233	7.62		
			90	15.24		
			59	22.86		
			50	30.48		

* Missing Data

C. PHYSICAL PROPERTIES OF THERMALLY ALTERED CHERT

In an effort to understand the effects and significance of thermal alteration, detailed technical investigations were initiated in the early 1970s that emphasized the physical, chemical and mechanical consequences of thermal alteration. Properties of chert which are altered due to thermal pretreatment include color, gloss and grain size.

Color

The original color of flint is determined during the process of formation by the color and grain size of the original sediments, in addition to their cementing materials and the degree to which they have been weathered (Winkler 1975:8-10). Color can be absorbed by stone secondarily from one or more minerals carried in solution by soil or water; these minerals include hematite, iron salts, iron oxides, iron sulfides, limonite and manganese oxides (Honea 1964; Hurst and Kelly 1961; Melcher and Zimmerman 1977:1359; Shepherd 1972:122). Secondary staining can affect either the cortex or the chert interior and can be _any_ color (Shepherd 1972:122). Investigators have found that the presence of even minute amounts of iron in the chert itself lead to color change upon thermal treatment (Behm and Faulkner 1974:273; Hood and McCollough 1976:214; Olausson and Larsson 1982; Purdy 1974; Purdy and Brooks 1971:323; Weymouth and Williamson 1951:587).

The relationship between thermal alteration and weathering is not fully understood. All chert with unstable impurities are susceptible to patination. The rate of patination varies with texture and permeability of the chert, the distribution, proportion and kinds of impurities, as well as environmental factors such as temperature and soil chemistry (Hurst and Kelly 1961:255).

Research by Purdy and Clark (1979) indicates thermally altered chert is affected by more extensive and localized weathering than unheated chert. They suggest that more deeply weathered artifacts may have been accidentally or intentionally subjected to heat. On the other hand, Collins and Fenwick (1974:136) have evidence to suggest that heat treating may interfere with patination. On Texas sites Paleoindian projectile points were heated before final flaking yet lack patination while Early Archaic points are patinated but lack thermal alteration. Environment may be a factor in patination with arid environment retarding and humid environment accelerating patination (Purdy and Clark 1979). Anderson

(1979:222) and Rowlett et al. (1974:42) believe weathering itself may produce a reddish color in chert.

A striking difference in color frequently occurs in chert which has been thermally altered. On the other hand, color change often does not accompany thermal alteration (Anderson 1979:233; Collins and Fenwick 1974:137; Rowlett et al. 1974:42). Recognition of color change due to thermal treatment depends largely on the researcher´s´s familiarity with the normal range of colors of raw material (Behm and Faulkner 1974:275; Collins and Fenwick 1974:135; Melcher and Zimmerman 1977:1359; Shepherd 1972:122).

Gloss

The heating of stone prior to flaking relieves internal stresses and strains and makes the material more vitreous or glassy than in its raw state (Crabtree and Gould 1970:194). Therefore, flakes removed after heating leave lustrous scars. Presence of gloss is often a better indication that thermal alteration occurred than color change (Johnson and Morrow 1981). Change to waxy or greasy luster apparently is not linked to a narrow critical temperature range (Ahler 1983:4). For example, Knife River flint exhibits luster when flaked subsequent to heating between 150^{o} and 325^{o} C (Ahler 1983:4). Fine-grained glassy chert samples suffer thermal shock at a comparatively lower temperature than coarse-grained chert samples (Mandeville 1973). Melcher and Zimmerman (1977:1359) point out that the appearance of vitreous luster is subjective and can result from nonthermal effects such as use. Use-wear normally occurs on tool margins and would therefore be easily separable from glossy flake scars located medially.

Structure

At a certain critical temperature, heated chert recrystallizes producing a finer grained material (Crabtree and Butler 1964). Altered chert has an increased homogeneity and elasticity over unaltered chert with a greater tendency to fracture like glass (Purdy and Brooks 1971). The reduction-manufacturing process is facilitated due to the increased homogeneity and reduced point tensile strength of altered cherts (Collins 1973; Crabtree and Gould 1970; Purdy and Brooks 1971). Altered chert is more readily flaked than unaltered chert. That is, altered chert flakes are easier to detach and control (Crabtree and Gould 1970; Flenniken and Garrison 1975; Hood and McCollough 1976; Patterson 1979); flakes usually have feather rather than step or hinge termination (Flenniken and Garrison 1975; Mandeville and Flenniken 1974; Purdy and Brooks 1971); and pressure flakes tend to be longer, thinner, larger and wider (Crabtree and Butler

1971; Mandeville and Flenniken 1974; Patterson 1979). Crabtree and Gould (1970:194) note that heating alters the structure of certain materials (such as chert), making them easier to pressure flake and produce more controlled results than was possible on unaltered material.

D. THERMAL ALTERATION RECOGNIZED ARCHAEOLOGICALLY

Distribution

Descriptions of thermally altered lithic artifacts have become more common partly as a consequence of technical investigations and experiments. Thermal alteration is widely distributed both geographically and culturally (Anderson 1979:221; Collins and Fenwick 1974:135; Mandeville 1973: Figure 1). In North America thermal alteration has been reported for a variety of lithic artifacts and for all prehistoric cultural periods (Paleoindian through Mississippian). Thermal alteration was practiced by Paleoindians at the Debert site, Nova Scotia on flakes (Healy 1966). There is evidence Paleoindians thermally altered preforms at one of four Holcombe Beach sites, Michigan (Fitting et al. 1966) and at the Shoop site in Pennsylvania (Schindler et al. 1982). Cores were heated during the Early, Middle and Late Archaic at 55 Nine Mile Creek sites, Kansas (Johnson et al. 1972:311-312). At Rose Island, Tennessee, the Early Archaic inhabitants did not alter flakes or tools, only stone debris (J.Chapman 1975; Purdy 1975a). During the Early and Middle Archaic at Senator Edwards Chipped Stone Workshop in Florida a portion of flakes and tools were heated (Purdy 1975c:182). At the Crump site, Alabama Early and Middle Archaic late-stage bifaces and flake debris was thermally altered (DeJarnette et al. 1975a:18). During the Terminal Archaic at Palm Court site, Florida microlith blade cores and debris were thermally altered (Morse and Tesar 1974:95-97).

Along the Duck River in the Normandy Reservoir, Tennessee, thermal alteration has been reported on diagnostic Early, Middle, Late and Terminal Archaic, as well as Early, Middle and Late Woodland bifaces (Faulkner and McCollough 1973:87-155). Cores were heated during the Middle Woodland at nine Lawrence Gay Hopewell Mound sites in Illinois (Perino 1971). During the Middle Woodland in Illinois, thermal alteration was utilized on projectile points, scrapers and blades made of local material (Struever 1973:61). At Sister Grove Creek site, Texas an overall high incidence of thermal alteration has been reported for the late prehistoric period (A.D. 1000-1600) (Lynott 1975:61). Pressure flaked bifacial implements were thermally altered during the protohistoric period (A.D. 1680-1780) at a Hidatsa site in North Dakota (Ahler 1983).

Thermal alteration research initially focused on recognition and description of the process through technical investigation and experimentation. Reported information on thermally altered chert is frequently difficult to decipher because the number of thermally altered chert artifacts is rarely quantified by count or relative frequency. Some exceptions have occurred. These include DeJarnette and others (1975b:108) account of Stucks Bluff, Alabama. During the Middle Archaic through Late Woodland occupations 99% of the flake debris was thermally altered while 90% of the core tools and debris was not. At Wells Creek Crater, Tennessee 90% of the preform fragments had been thermally altered (Dragoo 1973:14-17). Paleoindian through Early Woodland inhabitants at Silver Springs, Florida thermally altered 15-30% of the flake debris to enhance flaking quality of raw material (Hemmings 1975:151).

Emphasis has shifted from recognition and description of ITA to assessing the role of thermal pretreatment in the reduction-manufacturing process for specific cultural periods. Paleoindians at the Parkhill site in Ontario, Canada incorporated thermal alteration in their fluted point technology (Pavlish and Sheppard

1983). Thermal alteration was practiced as a step in the manufacture of chipped stone tools during the Middle Archaic and Early Woodland while a different stone working technology with little or no thermal alteration was used during the Early and Late Archaic in Missouri (C.Chapman 1975:227). At 12 Kentucky sites Collins and Fenwick (1974:140-143) note a higher incidence of ITA on bifacial preforms and flakes from unheated cores than any other artifact category. They report relative frequencies for heated tools and debris. Thermal alteration was rare during the Early Archaic, increased during the Early Woodland and continued through the Mississippian occupation at the Collins site, Missouri (Klippel 1972:46-55). At Laugerie Haute, France the Solutrean occupation heated less than 1% of the total flake debris and implements with heating followed by pressure flaking, as well as both hard and soft hammer percussion (Collins 1973:466). Accidental exposure is believed to be cause of heat alteration at six Mesolithic sites at Havelte, Netherlands (Price et al. 1982:483-484).

Thermal pretreatment has been associated with both core reduction and biface manufacture on a number of sites. This review is not intended to be comprehensive, instead it mentions some of the circumstances under which intentional thermal alteration has occurred.

CHAPTER V

LITHICS FROM LEFTWICH EXCAVATION

A. INTRODUCTION

The majority of cultural remains recovered from 40MU262, Area A were lithic artifacts and their manufacturing debris. Table A.1 (Appendix A) lists all lithic remains excavated from Area A by level. Tables A.2, A.3, A.4 and A.5 (Appendix A) list flake debris, stone debris, chipped stone tools and ground stone tools, respectively. A total of 2,641 lithic artifacts and debris greater than 6 mm was recovered from the 1981 Area A excavation at Leftwich. The 2,364 waterscreened lithic artifacts and debris were catalogued and coded during the fall of 1981. Two hundred and seventy-seven lithic items greater than 6 mm were dry screened from the floatation sample's heavy fraction and coded later. Lithic artifacts and debris were coded using categories from Hofman and Turner (1979) and definitions from Faulkner and McCollough (1973), Hofman and Turner (1979), Wheat (1979) and White (1963).

Flake debitage was the largest artifact category, representing 76.30% (n=2,015) of the assemblage. The next most common artifact category was stone debris comprising 21.05% (n=556) of the assemblage. Chipped stone tools represent 2.31% (n=61) of the assemblage. Ground stone tools represent 0.34% (n=9) of the assemblage.

Chert Types

Lithic chert types were identified to parent geologic formation by visually comparing artifacts to collected samples. Middle Tennessee chert types, as well as chert identification procedures have been well described by Amick (1984:41-67). Chert from eight different geologic formations was recognized from Leftwich Area A specimens. These include Bigby Cannon, Brassfield, Carters, Fort Payne, Hermitage, Murfreesboro, Ridley and St. Louis. Ridley is the dominate chert category occurring in 54.27% of all specimens: 53.91% flake debris, 57.39% stone debris and 47.46% chipped stone tools. Fort Payne chert occurs in 39.42% of all specimens: 40.41% flake debris, 35.60% stone debris and 45.76% chipped stone tools. Bigby Cannon, Brassfield, Carters, Murfreesboro, St. Louis, miscellaneous chert and miscellaneous rock represent less than 5% of the chert specimen categories. A brief geologic depositional history of each chert type can be found in Ecological Setting, Chapter II.

Cortex

Cortex refers to the natural outer weathered surface, or rind on a chert cobble or nodule (Crabtree 1972:56). Four cortex categories are used. These include: (1) no cortex present, (2) incipient fracture planes, (3) matrix cortex and (4) water-worn cobble cortex. Incipient fracture planes are smooth flat surfaces with a thin mottled mineral veneer deposited over the fracture plane. Matrix cortex ranges from white to yellow in color, is rough, soft and thick. Cobble cortex ranges from white to brown in color, is smooth, hard and thin. Its sharp edges have been dulled and rounded by alluvial tumbling. Water-worn cobble cortex is quite distinct and easily recognizable.

Cortex values were recorded for their technological information. Incipient fracture planes are most common on material derived from matrix or residual deposits rather than alluvial sources. These planes are often internal rather than the outer weathered covering of a piece of chert. Presence of matrix cortex implies procurement by digging or collecting bedrock outcrops (e.g., bluffs, caves), as well as exposed ground surfaces. A non-alluvial origin is suggested. Presence of cobble cortex suggests procurement from alluvial sources such as: stream beds, old terraces and natural outcrops. Cortex must be removed from chert in order to produce chipped stone artifacts. Presence or absence of cortex on a specimen indicates the stage of lithic reduction, as well as distance from the chert source. Cortex is absent on 70.54% of all the artifacts; 80% flake debris, 45% stone debris, 81% chipped stone tools and 100% ground stone tools. Matrix cortex is present on 6% of the flake debris, 18% of the stone debris and 3% of the chipped stone tools. Cobble cortex is present on 14% of the flake debris, 38% of the stone debris and 15% of the chipped stone tools.

Texture

Texture values were recorded for their technological information. The five texture values defined by Amick (1982:13) are: (1) vitreous or homogeneous, (2) fine, (3) medium or sandy, (4) coarse and (5) desilicified. Fine textured specimens comprise 86% of the flake debris, 66% of the stone debris and 68% of the chipped stone tools.

Thermal Alteration

Thermal alteration studies have been conducted on lithic samples from a variety of locations in the Middle South by a number of researchers (Ferguson, personal communication 1981; Hood and McCollough 1976; Robison and

Hood 1976). A comparative collection of unaltered and pretreated specimens from documented formation exposures is housed at the Department of Anthropology, The University of Tennessee, Knoxville. Six thermal alteration categories defined by Ferguson (personal communication 1981) were used in coding Leftwich material. These include (1) no evidence of heating, (2) possibly heated, (3) definitely heated, (4) definitely heated after final modification, (5) definitely heated before final modification and (6) definitely heated before and after final modification.

Category 1. No evidence of heating. These specimens have no heat fractures: crazing, crenation or pot lids. If color change, luster or rippling occur, they are within the range of natural chert variability. Thermal alteration is not always detectible. Therefore, some specimens which apparently have not been altered, may have been heated. Specimens with no evidence of heating represent 46-89% of the flake debris, 50-100% of the stone debris (except for fire cracked rock and pot lids), 12-33% of the bifacially flaked tools and 80% of the unifacially flaked tools.

Category 2. Possibly heated. Many of these specimens were recognized by localized partial color change. Partial color change suggests unintentional low heat firing of these pieces. Luster with or without rippling is indicative of thermal alteration, but some chert is naturally lustrous. Therefore, specimens which may have been thermally altered are classified as possibly heated since definite presence or absence of heating cannot be determined. Possibly heated specimens comprise 8% of the flake debris, 5% of the stone debris and 15% of the chipped stone tools.

Category 3. Definitely heated. Definitely heated specimens are recognized by pot lids on dorsal flake surfaces and/or dull color change. Luster, rippling and other heat fractures may also be present on definitely heated pieces. This category reflects an inability to determine during what part of the lithic reduction stage thermal alteration occurred. In addition, the purpose of this alteration is indeterminate. Definitely heated specimens comprise 4-11% of the flake debris, 0-100% of the stone debris and 8-22% of the chipped stone tools.

Category 4. Definitely heated after final modification. Final modification refers to flake removal or breakage which occurred before heating took place. The best criteria for distinguishing these specimens is increased luster and discoloration on fractured surfaces. In addition, heat fractures on ventral or broken flake surfaces, especially pot lids, are also considered diagnostic. Color change is frequently evident on the dorsal and ventral surface of broken flakes which does not penetrate the center.

These pieces are suspected to be unintentionally altered and probably represent tools and debris which were fortuitously fired. Some specimens in this category may have been heated before and after final modification. The effects of heating often obscures the distinction between specimens heated after final modification and those heated before and after final modification. Consequently this category is larger than category 6. Specimens definitely heated after final modification comprise 1-4% of the flake debris, 1% of the stone debris and 12% of the projectile points.

Category 5. Definitely heated before final modification. Final modification in this instance refers to post alteration flaking or utilization. These specimens represent intentional thermal alteration to improve the chert´s flakability. The most diagnostic criterion for this category is contrasting luster, especially islands of relic luster on ventral flake surfaces. Color change, rippling and chipping after heat fractures occurred were also considered diagnostic.

Specimens definitely heated before final modification comprise 1-23% of the flake debris, 6-33% of the stone debris and 44-53% of the chipped stone tools.

Category 6. Definitely heated before and after final modification. This category is difficult to recognize because post flaking alteration, tends to erase the effects of heating before modification. Specimens in this category usually exhibit luster, color change and rippling with crazing, pot lids and/or crenated fractures. Category 6 contains two specimens which represent 33% of the chipped stone tools. Since this category is so small, for statistical comparisons these specimens will be combined with Category 4.

Biface Failure

Biface failures refer to possible reasons bifaces were discarded after or during manufacture. These have been discussed extensively by other authors (Amick 1982:19-21,33-34; Crabtree 1972; Johnson 1979, 1981a, 1981b; Purdy 1975b; Roper 1979; Tsirk 1979) and include hinge, reverse, perverse, transverse hinge, lateral snap, incipient fracture plane, crenated fracture, pot-lidding, expansion fracture, haft snap, edge collapse, plow damage, impact/use fracture and combinations. Many times an individual biface specimen will exhibit more than one biface failure. Therefore, the number of biface failures represented in a single category may be more than the number of individual specimens in that category.

Component Differentiation

A Late Archaic Ledbetter component and a Middle Archaic Benton component occur at Leftwich in a stratigraphically separated context. The Area A Ledbetter occupation is easily discernable from the vertical distribution of lithic chipped stone specimens greater than 6 mm (Figure 5.1). A definite peak occurs in level 11.

The Benton occupation peak is less dramatic. Vertical density distribution of lithic chipped stone specimens by individual squares allows the Middle Archaic component to be revealed (Figure 5.2). A small increase of lithics occurs in Area A level 13 squares 1 N 2 E and 1 N 3 E, level 14 square 1 N 4 E, as well as, level 15 squares 2 N 2 E and 2 N 4 E.

Hofman (1984:89) has noted that a minimum number of depositional surfaces can be recognized within buried strata by vertically plotting pebble density. Two distinctive peaks are evident in the Leftwich pebble distribution (Figure 5.3). The peaks in levels 11 and 15 correspond with the diagnostic Ledbetter and Benton implements recovered from levels 10 to 11 and 14

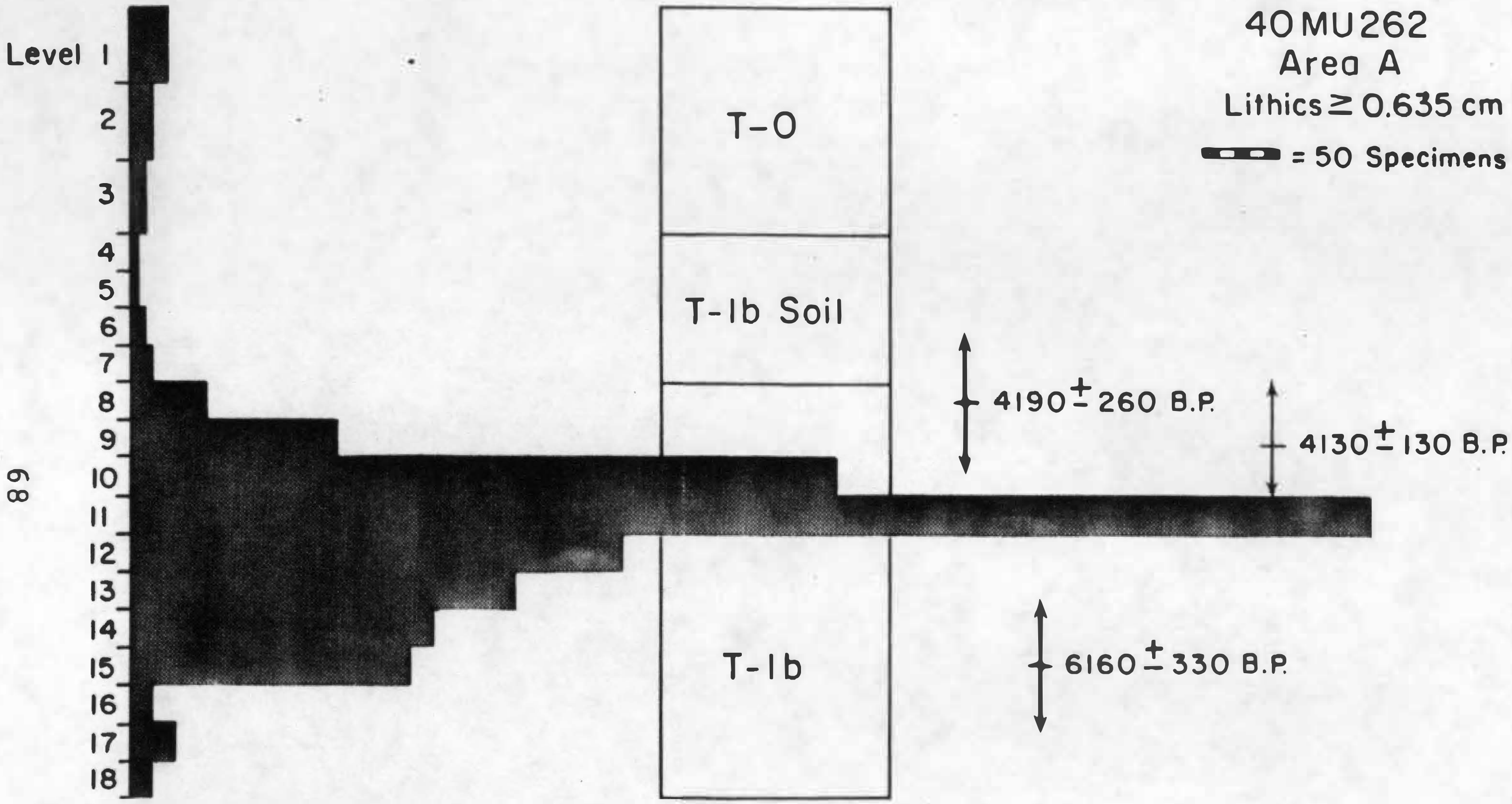

Figure 5.1. Vertical Density Distribution of Lithic Chipped Stone Specimens from Leftwich Area A by Level.

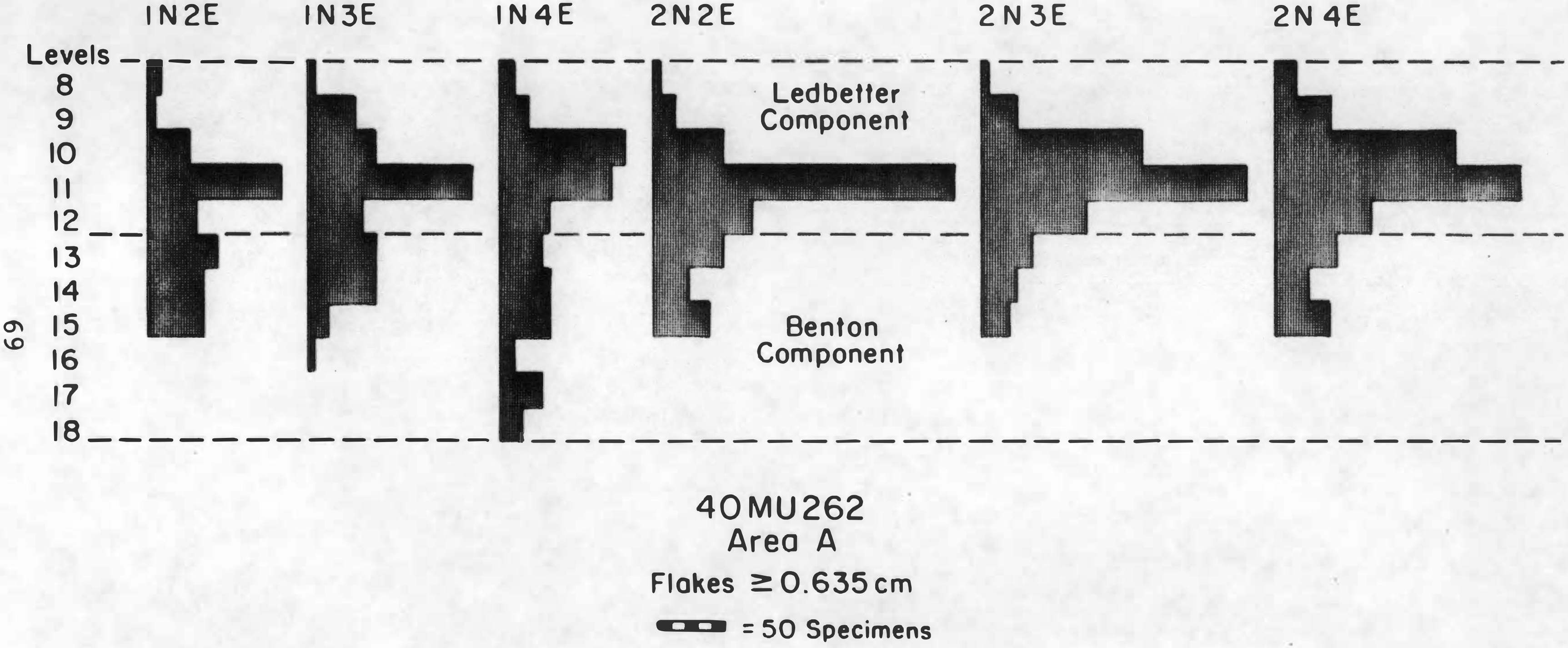

Figure 5.2. Vertical Density Distribution of Lithic Chipped Stone Specimens from Leftwich Area A by Unit and Level.

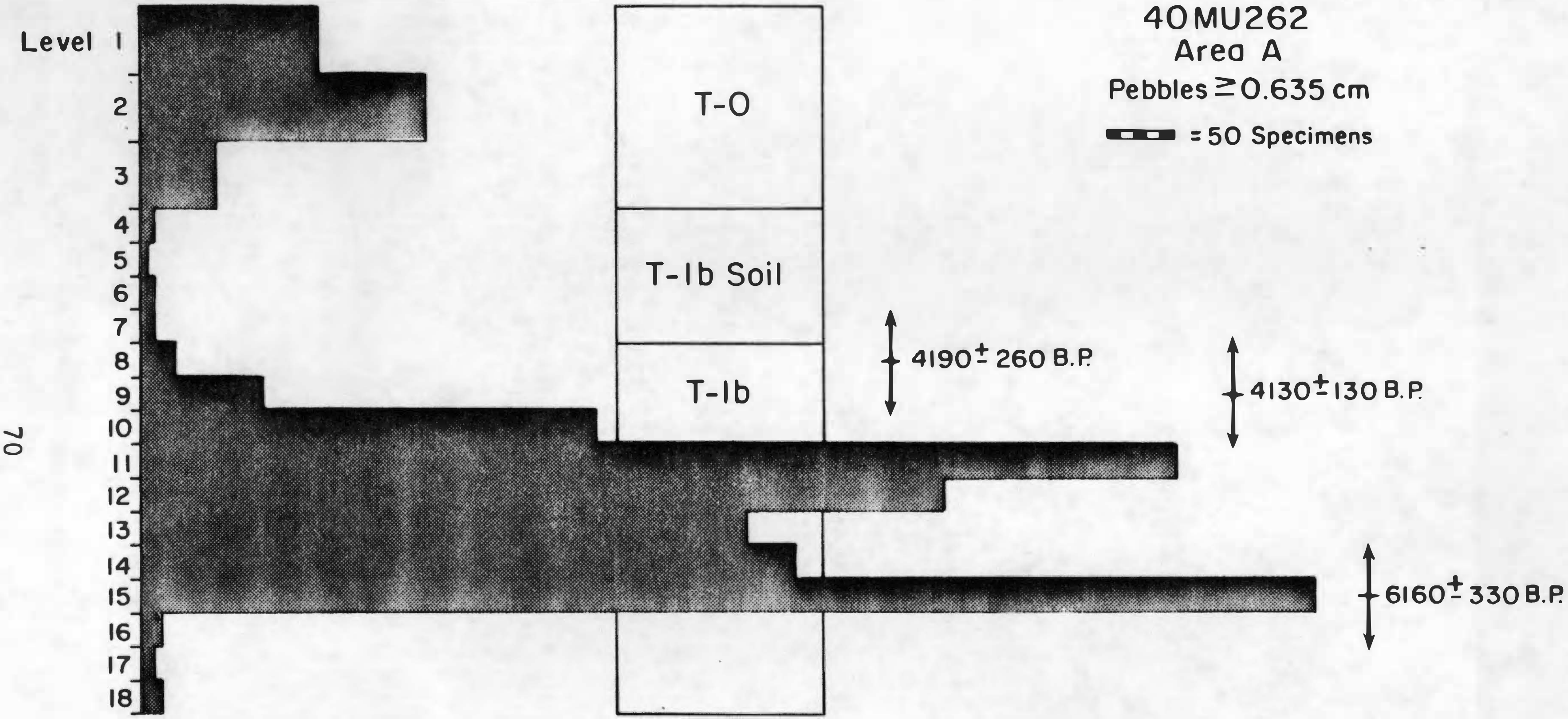

Figure 5.3. Vertical Distribution of Pebble Density from Leftwich Area A by Level.

respectively. The cultural division within the Tlbl at Leftwich is supported by the vertical density distribution of pebbles greater than 1 cm.

The Leftwich Late Archaic sample is derived from all excavated lithic specimens from Area A levels 8 through 12 (100 to 150 cm depth) greater than 6 mm. The Leftwich Middle Archaic sample is composed of all excavated lithic specimens greater than 6 mm from Area A levels 13 through 18 (150 to 210 cm depth). Diagnostic projectile points recovered during profile mapping of Trench G are also discussed. Table 5.1 shows the breakdown of the broad lithic categories collected from 40MU262 Area A by Archaic component.

B. CHIPPED STONE TOOLS

The projectile point categories include triangular, stemmed and notched artifacts, and reworked pieces. No attempt was made to separate the functional categories of projectile point and knife. Terms used to describe each projectile point´s base, blade, cross section, distal end, shoulder and stem shape are from Cambron and Hulse (1975). Measurements taken follow Benfer and Benfer (1981:393). The 63 chipped stone tools discussed below include unifacial and bifacial implements recovered from the mapping of Trench G and the excavation

TABLE 5.1. LITHIC CATEGORIES FROM LEFTWICH AREA A BY COMPONENT.

Component		Flake Debris	Stone Debris	Chipped Stone Tools	Ground Stone Tools	Total
Ledbetter	N	1433	372	40	4	1849
	%	77.50%	20.12%	2.16%	0.22%	100.00%
Benton	N	537	142	20	5	704
	%	76.28%	20.17%	2.84%	0.71%	100.00%

of Area A. These artifacts have been divided into 15 categories.

Ledbetter Cluster (n=15) (Figure 5.4)

Description. Basal edges are straight with two basal edges beveled. Stems are mostly straight to slightly expanded, with one stem contracted. Cross sections are biconvex or plano-convex. Blade side edges are straight or excurvate while two blade edges are slightly serrated. Asymmetrical shoulders are horizontal, inversely tapered or expanded.

Two of the 15 Ledbetter projectile points were later refitted. Texture ranges from six vitreous, six fine and one medium-grained. Six points are made of Fort Payne chert, four are Ridley, one is St. Louis and one is Brassfield. No cortex was present on nine of the points, one has matrix cortex and three have cobble cortex. Thermal alteration was not evident on one specimen, three were possibly heated, one was definitely heated and eight were heated before they were flaked. Numerous biface failures are present and include 12 lateral snaps, 1 hinge, 1 edge collapse, 1 pot lid and 1 crenated heat fracture.

Comment. Type named for the Ledbetter Landing site in Benton County, Tennessee in the Western Tennessee

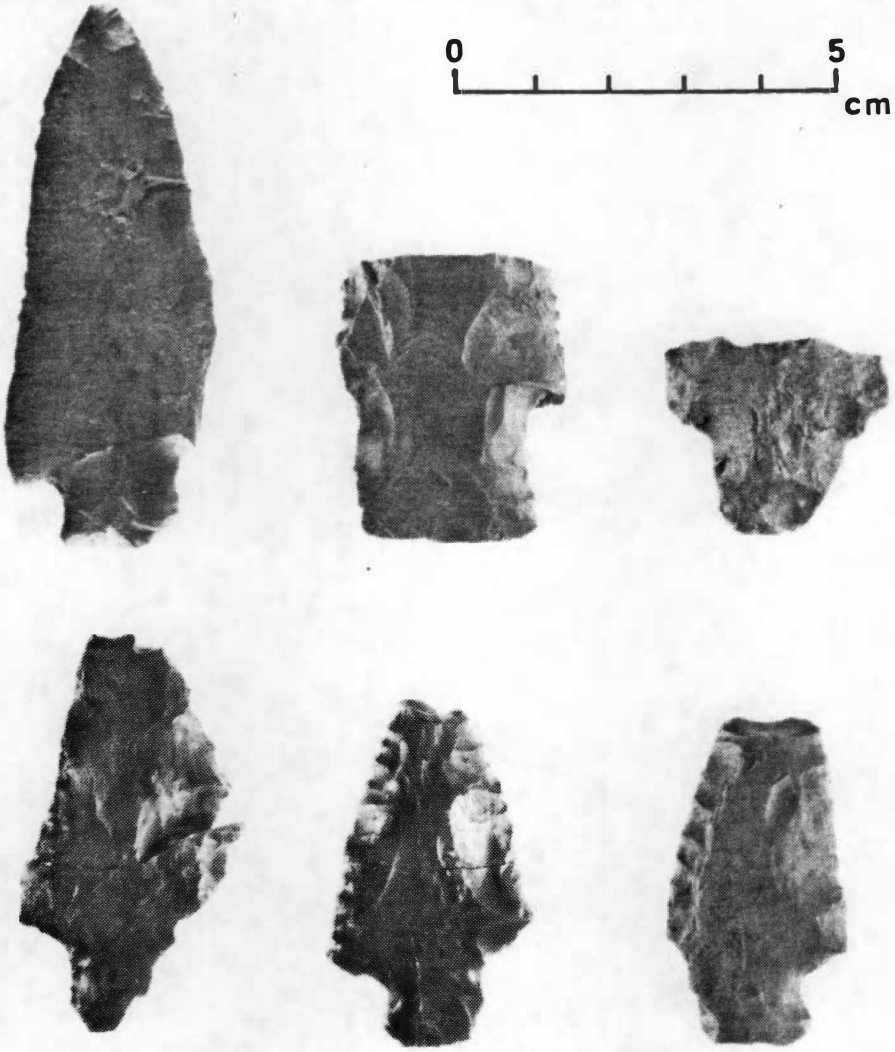

Figure 5.4. Leftwich Area A Late Archaic Ledbetter Cluster Projectile Points.

Valley. Ledbetter cluster points were recovered from the upper cultural stratum within the Tlb Leftwich formation. Their vertical location corresponds to levels 10 and 11. A C-14 date of 4130±130 B.P. (A-2553) was obtained from charred hickory nut shell associated with three excavated 10 cm levels: 8 through 10 (100-130 cm depth). An additional C-14 date of 4190±260 B.P. (A-2366) was obtained from wood charcoal associated with three excavated 10 cm levels: 7 through 9 (90-120 cm depth). These C-14 dates correspond well with other Ledbetter dates from the Southeast (Table 5.2). Based on the associated C-14 dates, the Ledbetter occupation at the Leftwich site is within the Late Archaic period (see Radiocarbon Dates, Chapter 3). Ledbetter cluster points have also been found in the Normandy Reservoir area (Faulkner and McCollough 1973), Western Tennessee River Valley (Lewis and Kneberg 1959), Cedar Creek (Futato 1983), Alabama (Cambron and Hulse 1975) and Yellow Creek (Thorne et al. 1981).

Attributes used to distinguish Late Archaic projectile point types appear to be variations resulting from different stages in manufacturing process. For example, Pickwicks have expanded barbed shoulders, while others lack the barb. Thorne and others (1981:264) found that there is a great deal of variation in the

TABLE 5.2. LATE ARCHAIC LEDBETTER RADIOCARBON DATES FROM THE SOUTHEAST.

Site	Material	Sample #	B.P. Date	B.C. Date	S.D.	References
40MU262	Charcoal	A-2366	4190	2240	260	Brakenridge 1982, 1984
	Hickory nuts	A-2553	4130	2180	130	Hall et al. 1985
40MU430	Hickory nuts	Gx-8732	4185	2235	165	Hall 1983
	Hickory nuts	Gx-8731	3205	1255	150	Hall et al. 1985
40MU347	Wood & nuts	UGa-3350	3215	1265	125	Amick 1983 Hall et al. 1985
40ML139		Gx-9080	4270	2320	155	Klippel & Turner 1983 Hall et. 1985
40MU261		UGa-2775	4655	2705	75	Klippel & Turner 1983 Hall et al. 1985
40CF111	Charcoal	UGa-719	4033	2080	260	Faulkner & McCollough 1974
	Charcoal	UGa-725	2850	900	870	Cobb 1978
40CF32	Charcoal	UGa-685	5055	3105	105	Faulkner & McCollough 1977
	Charcoal	Uga-686	5385	3435	205	
1LU25	Antler	C-755/756	4764	2814	250	Libby 1952
40HY13	Shell	M-109	4050	2100	300	Lewis & Kneberg 1959
	Antler	M-356	3580	1630	300	

illustrated stem and blade shapes and that the same authors do not agree from site to site. Futato (1983) combines Ledbetter and Pickwick points while Faulkner and McCollough (1973) group Ledbetter, Pickwick and Cotaco Creek together. Evidence from several sites suggests Pickwick, Ledbetter and Mulberry Creek ppk´s should be combined under one name (Thorne et al. 1981). Thorne and others (1981:266-270) suggest the name Pickwick Stemmed while Faulkner and McCollough (1973) suggest the name Ledbetter cluster.

<u>Measurements.</u> Maximum length 52-75.5 mm, mean=63.3 mm (n=5); maximum width 26-34 mm, mean=30.88 mm (n=8); distance from point to tang 45-66 mm, mean=54 mm (n=5); stem length 9-17 mm, mean=11.61 mm (n=9); mid-stem width 13-23 mm, mean=17.22 (n=9); blade length 44-64 mm, mean=53 mm (n=6); mid-blade width 21-29 mm, mean=25.8 mm (n=5); blade thickness 7-12 mm, mean=9.88 (n=8); stem thickness 5-9 mm, mean=7 mm (n=9); notchpoint-stem corner angle $8\text{-}20^{\circ}$,mean=11° (n=8); midstem-stem corner angle $35\text{-}50^{\circ}$, mean=40.9° (n=9).

<u>Benton Stemmed</u> (n=3) (Figure 5.5a)

<u>Description.</u> Bases are straight and incurvate with both edges beveled. The short stems are straight and incurvate with beveling on the incurvate edge. Cross

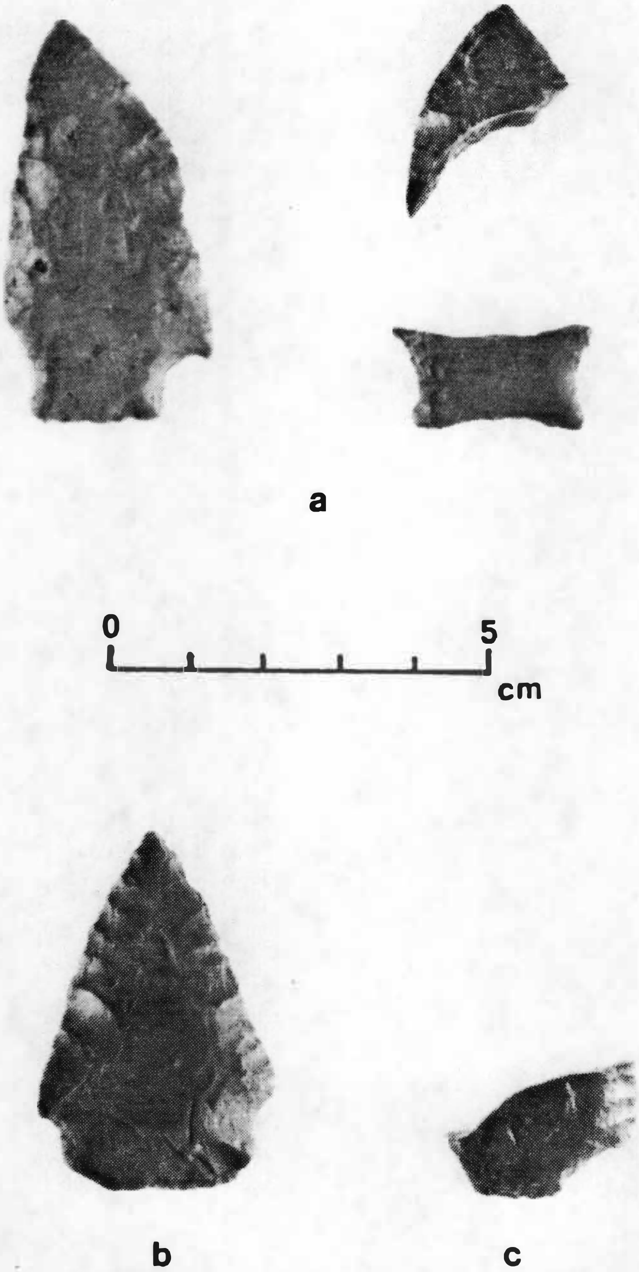

Figure 5.5. Leftwich Area A Diagnostic Bifaces: a) Benton, b) White Springs/Sykes and c) Eva/Morrow Mountain.

sections are biconvex. The distal ends are acute. Blade edges are excurvate. Shoulders are inversely tapered.

Texture present on each point ranges from vitreous, fine to medium-grained. Two points are Fort Payne and one is Ridley chert. No cortex was present on any of the specimens. Thermal alteration occurred on two points before flaking and one was heated after flaking. Biface failures include one reverse fracture, one pot lid and two crenated heat fractures.

Comment. Type named after Benton County, Tennessee in the Western Tennessee Valley. Benton stemmed points were recovered from the lower cultural stratum within the Tlb Leftwich formation. Their vertical location is in level 14. A C-14 date of 6160±330 B.P. (A-2365) was obtained from wood charcoal associated with three excavated 10 cm levels: 14-16 (160-190 cm depth). This C-14 date corresponds well with others from the southeast associated with Benton Stemmed points (Table 5.3). Benton Stemmed points have also been found in the Normandy Reservoir (Faulkner and McCollough 1973); in Alabama (Cambron and Hulse 1975); in the Columbia Reservoir (Amick and Hofman 1981).

Measurements. Maximum length 52 mm (n=1); maximum width N.A.; distance from point to tang 48 mm (n=1); stem

TABLE 5.3. MIDDLE ARCHAIC BENTON AND WHITE SPRINGS/SYKES RADIOCARBON DATES.

Site	Diagnostic Points	Sample #	B.P. Date	B.C. Date	S.D.	References
40MU262	Benton & White Springs/Sykes	A-2365	6160	4210	330	Brakenridge 1982, 1984 Hall et al. 1985
40MU174	Benton & White Springs/Sykes	Gx-9954	6160	4210	175	Hofman 1984
		Gx-8918	6115	4165	205	Hall et al. 1985
		Gx-8917	5765	3815	200	
	Benton	Gx-9954	6160	4210	175	
		Gx-8918	6115	4165	205	
40MU347	White Springs/ Sykes	A-2367	6240	4290	500	Brakenridge 1982,1984 Amick 1983 Hall et al. 1985
40ML139	Benton	Gx-9315	5245	3295	230	Klippel and Turner 1983
	White Springs/ Sykes	Gx-9081	5870	3920	165	Hall et al. 1985
40MU430	Benton	Gx-8733	5115	3165	185	Hall 1983
	Benton & White Springs/Sykes	Gx-8734	5370	3420	190	Hall et al. 1985
40MU432	White Springs/ Sykes & Eva/ Morrow Mtn.	Gx-8822	6375	4425	215	Amick 1984 Hall et al. 1985
22AL521	Benton	UGa-3872	5550	3600	85	American Antiquity 48(4)
22MO819	Benton	UGa-2633	5525	3575	75	American Antiquity 48(1):185
	Benton	UGa-2634	5645	3695	100	

length 7-9 mm, mean=8 (n=2); mid-stem width 17-21 mm, mean=19 (n=2); blade length 45 mm (n=1); mid-blade width 23-24 mm, mean=23.5 (n=2); blade thickness 7-9 mm, mean=8 mm (n=2); stem thickness 6-7 mm, mean=6.5 mm (n=2); notch point-stem corner angle 5° (n=1); midstem-stem corner angle 54° (n=1).

White Springs-Sykes Cluster (n=1) (Figure 5.5b)

Description. Basal edge is thinned and straight. Short, broad stem is straight. Cross section is flattened at base and biconvex at blade. Both blade edges are beveled. Shoulders are horizontal and narrow. This fine textured Fort Payne point has no cortex. Thermal alteration occurred before final flaking took place. No biface failure is apparent.

Comment. Type from the Quad site named after White Springs, Alabama in Limestone County (DeJarnette et al. 1962:70). Although not recovered within Area A, this projectile point from the North Wall of Trench G, at the base of the Leftwich formation (Tlb), resembles White Springs-Sykes (Cambron and Hulse 1975:116; DeJarnette et al. 1962:70). Its vertical location corresponds to Leftwich Area A level 18.

Materials from many northern Alabama sites suggest a typological relationship between White Springs, Benton Stemmed and Buzzard Roost Creek points. Cambron and Hulse (1975:116) suggest Benton Stemmed projectile points were used later than White Springs-Sykes. Radiocarbon dates associated with both Benton Stemmed and White Springs-Sykes points overlap 1300 years; however, C-14 dates associated only with Benton Stemmed or White Springs-Sykes points overlap only 260 years (Table 5.3).

White Springs have been found in the Western Tennessee River Valley associated with Sykes from the Eva site (Lewis and Kneberg 1961); in Alabama associated with Morrow Mountain from Stanfield-Worley Bluff Shelter (DeJarnette et at. 1962); and in the Normandy Reservoir (Faulkner and McCollough 1973).

Measurements. Maximum length 47 mm; maximum width 32 mm; distance from point to tang 40 mm; stem length 9 mm; mid-stem width 26 mm; blade length 38 mm; mid-blade width 23 mm; blade thickness 11 mm; stem thickness 7 mm; notchpoint-stem corner angle 10°; mid-stem-stem corner angle 50°.

Eva-Morrow Mountain Cluster (n=1) (Figure 5.5c)

Description. Base is excurvate. Stem and shoulders are rounded. Cross section is biconvex. This point is of fine textured Fort Payne chert with no cortex. Biface failure is a crenated heat fracture which spans the blade. Thermal alteration occurred after the final flaking.

Comment. Type named for Eva site in Benton County, Tennessee in the Western Tennessee Valley. The Eva-Morrow Mountain projectile point was located in the Cannon Bend paleosol (Tla) in the North Wall of Trench G. Its vertical location corresponds to level 22 from Leftwich Area A. Eva points have been found throughout the middle and western Tennessee region (Alexander 1982; Faulkner and McCollough 1973; Hofman 1982,1983,1984; Joerschke 1983; Lewis and Kneberg 1961; Lindstrom 1981; Morse and Morse 1964).

Measurements. Maximum length 46 mm; maximum width 31 mm; distance from point to tang 39 mm; stem length 6 mm; mid-stem width 12 mm; blade length 40 mm; mid-blade width 27 mm; blade thickness 9 mm; stem thickness 6 mm; notchpoint-stemcorner angle -10°; midstem-stemcorner angle 45°.

Miscellaneous Point Tips (n=2) (Figure 5.6a)

Description. Blade shapes are straight. Distal ends are acute. Cross sections are biconvex and flattened. Both point tips are fine-grained Ridley chert with no cortex. Thermal alteration may have occurred on

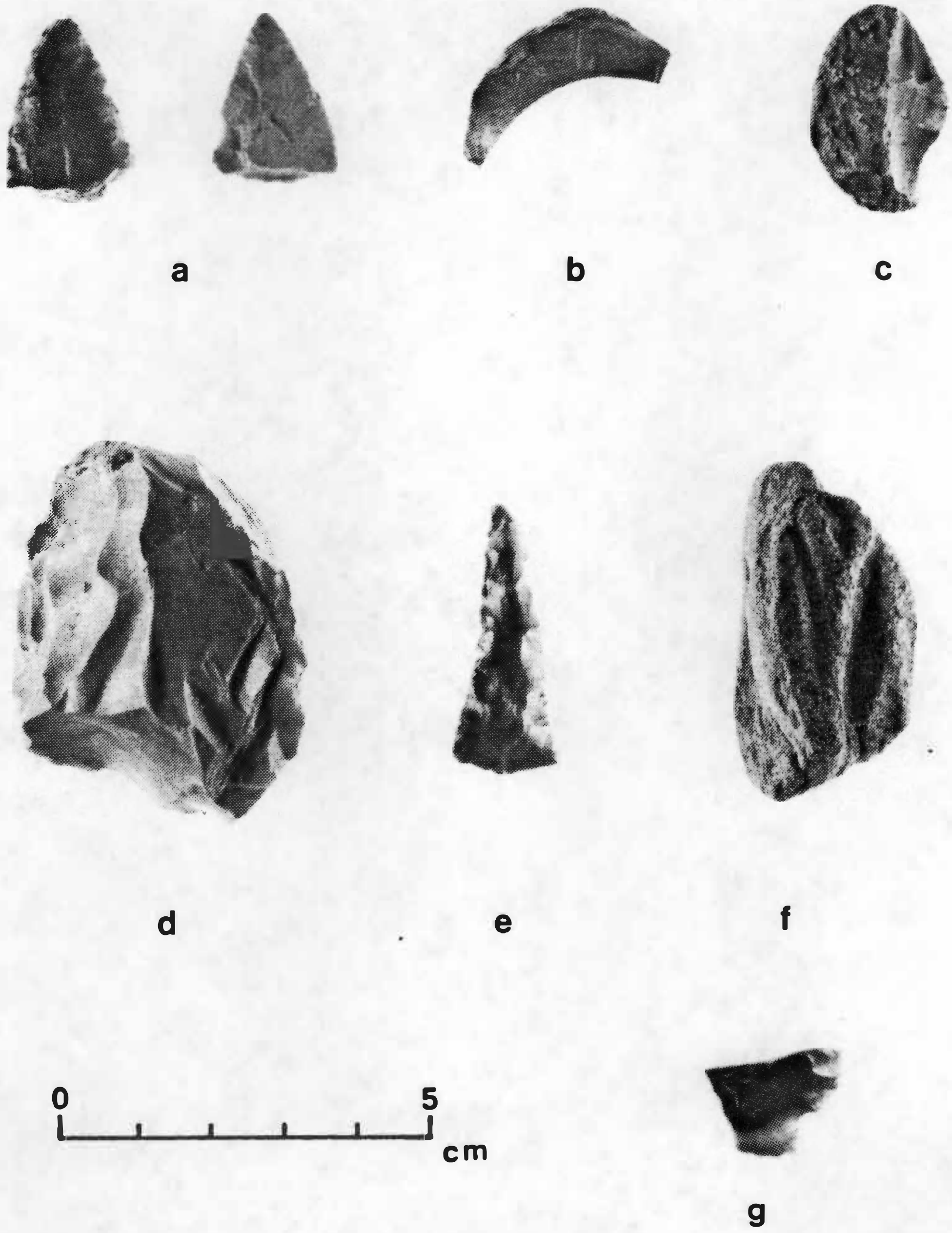

Figure 5.6. Leftwich Area A Miscellaneous Chipped and Ground Stone Tools: a) Miscellaneous Point Tip Fragments, b) Intermediate Biface, c) Unifacial Tool, d) Initial Biface, e) Drill, f) Abrader and g) Miscellaneous Point Base Fragment.

one specimen while one was heated before flaking. Biface failures present include one lateral snap and one pot lid heat fracture.

Comment. Both of these specimens occur within the Late Archaic component. Their vertical locations are levels 10 and 11.

Measurements. Blade thickness 5-8 mm, mean=6.5 mm (n=2).

Miscellaneous Point Base Fragments (n=5) (Figure 5.6g)

Description. Textures range from three fine-grained to two coarse specimens. Two base fragments are Fort Payne while three are Ridley chert. No cortex was present on any of the specimens. Thermal alteration possibly occurred on one base fragment, two were definitely heated and two were heated before flaking. Biface failures include two reverse fractures, one incipient fracture plane, two pot lids, and two crenated heat fracture.

Measurements. N.A.

Miscellaneous Point Edge Fragments (n=11)

Description. Textures range from one vitreous, eight fine-grained and two medium. The seven Fort Payne and four Ridley edge fragments all lack cortex. There is no evidence of thermal alteration on three specimens, four were heated before flaking, three were heated after flaking and one was heated before and after flaking. Biface failures include two reverse, four lateral snaps, one hinge, one perverse, five pot lids and two crenated heat fractures.

Measurements. Blade thickness 5-9 mm, mean=6.75 mm (n=4).

Initial Stage Bifaces (n=1) (Figure 5.6d)

Description. Bifaces are artifacts flaked on both sides, not assignable to a projectile point category. The initial stage of biface reduction includes bifaces in early stages of thinning and fragments of amorphous pieces (Faulkner and McCollough 1973:83). Blade shape is excurvate. Cross section is plano-convex. This fine-grained Ridley chert biface has tan cobble cortex. Thermal alteration possibly occurred. Biface failure is edge collapse.

Measurements. Maximum length 53 mm; maximum width 41 mm; blade thickness 20 mm.

Intermediate Stage Bifaces (n=1) (Figure 5.6 b)

Description. Bifaces in the intermediate stage have been partially thinned or edge-retouched. Lanceolate bifaces and fragments are both included in the intermediate stage (Faulkner and McCollough 1973:83). Neither the biface shape or size can be determined from the single fragment recovered. Cross section is biconvex. The fine-grained Ridley chert biface has no cortex. Thermal alteration occurred before and after flaking took place. Biface failures include pot lid and crenated heat fractures.

Measurements. Blade thickness 9 mm.

Miscellaneous Biface Fragments (n=9)

Bifaces and biface fragments which do not fit into any other biface category are classified as miscellaneous bifaces. Two biface midsections, one tip and six edges were recovered. Textures range from one vitreous, six fine-grained, one medium and one coarse specimen. Five biface fragments are Fort Payne while four are Ridley chert. No cortex is present on eight specimens and one has brown cobble cortex. Thermal alteration is not present on one biface fragment, possibly occurred on two, two were definitely heated and four were heated before flaking. Biface failures include two incipient fracture planes, seven lateral snaps, three perverse, one edge collapse, one pot lid and one crenated heat fracture.

Drills (n=4) (Figure 5.6e)

Description. A biface with a long rod-like blade, narrow and thick, diamond-quadrilaterial in cross section is known as a drill. Often the entire blade section tapers uniformly to a blunt distal point and the blade is shaped by means of bifacial removals (Faulkner and McCollough 1973:86). Drills are further classified on the basis of presence or absence of hafting preparation.

Drill morphology is present on four bifaces which all lack hafting preparation. One drill is complete, two are midsections and one is a blade edge. Cross sections are median ridged. There are two drills each of Fort Payne and Ridley chert. One drill has no evidence of thermal alteration, one was possibly heated and two were definitely heated before they were flaked. All four drills lack heat fractures and cortex. Biface failures include five lateral snaps, one step fracture and one perverse fracture.

Measurements. Blade thickness 7-8 mm, mean=7.67 mm (n=3).

Gravers (n=1)

Description. Gravers have one or more tiny pointed projections, formed by localized retouch, sometimes alternate (Faulkner and McCollough 1973:82, 87; Hofman and Turner 1979). The graver is on a piece of fine textured, Ridley blocky debris with matrix cortex. There is no evidence of thermal alteration.

Comment. The graver is associated with the Late Archaic component.

Utilized Light-duty Scraper (n=4)

A thin (less than 4 mm) utilized edge with attritional scarring is present on two tertiary flakes, one large biface thinning flake and one broken flake. Texture is vitreous on one flake and fine on three. Two flakes are Fort Payne while one each are Ridley and St. Louis chert. Cortex is not present on three specimens and one has cobble cortex. Thermal alteration is not evident on any of the scrapers. Scraping tools have an edge angle greater than 45°, usually more than 65° and exhibit unifacial use wear. Light-duty tools have polish and small feathered attritional scars, as well as smaller and less numerous nibbling scars. Possible functions of light-duty tools include use on meat, skin and fibers.

Utilized Heavy-duty Scraper (n=1)

This secondary flake is on vitreous Ridley chert with cobble cortex and no evidence of thermal alteration. Heavy-duty tools have a thick edge (usually more than 4 mm), short step fractures on functional edge with rounding or smoothing of projections. Possible functions of heavy-duty tools include use on bone, wood and antler.

Retouched Heavy-duty Scraper (n=1)

This retouched secondary flake with intentional scarring is on fine-grained Ridley chert with an incipient fracture plane and no evidence of thermal alteration.

Retouched Light-duty Scraper (n=1)

This broken flake is on fine-grained Ridley chert which lacks cortex and may have been heated.

Retouched Light-duty Cutting Tool (n=1)

This broken flake is on fine-grained Bigby Cannon chert which lacks cortex and has no evidence of thermal alteration. Cutting tools have an edge less than 65°, usually 45° and bifacial use wear.

Utilized Light-duty Cutting Tool (n=1)

This utilized broken flake is on vitreous St. Louis chert with cobble cortex and has no evidence of thermal alteration.

C. GROUND STONE TOOLS

Abraders (n=9) (Figure 5.6f, page 84)

Abraders are used in flint-knapping to abrade the edge of a workpiece, to strengthen it for flaking or to abrade the basal edges (Faulkner and McCollough 1973:158; Wheat 1979:131). All nine abraders are sandy textured, Hermitage sandstone, with no cortex or evidence of thermal alteration.

D. FLAKE DEBITAGE

Raw materials used to produce chipped stone include quarried flint blocks and nodules, in addition to water-worn cobbles and pebbles. The manufacture of chipped stone tools typically produces a large quantity of waste debris. Lithic debitage includes flake and non-flake debris. Categories within the class `flake debitage´ were identified and accounted for 76% of the total lithic assemblage at the Leftwich site. The flake classifications represent discrete stages in the lithic reduction sequence, and are so discussed.

Primary Decortication Flakes (n=18)

Decortication flakes

> are struck from a natural irregularity of a nodule or from a pebble and are detached transversely from one of the narrow ends....cortex covers the entire outer face of these flakes. Since they are detached first, they are called primary decortication flakes (White 1963:5).

Primary decortication flakes have full dorsal cortex, a broad thick platform and a flake angle about 90°. They were probably removed by hard hammer percussion and represent the initial mode of core reduction. At less than 1% of the total assemblage frequency, as well as, the total flake debitage category; primary flakes are not abundant at the Leftwich site.

Secondary Decortication Flakes (n=442)

When the cortex covers only a part of the outer face, the flakes are called secondary decortication flakes. The main difference between primary and secondary decortication flakes is that while primary flakes were usually discarded, secondary flakes were often used as a naturally backed knife (White 1963:5).

A substantial quantitative increase in secondary over primary decortication flakes is to be expected in virtually any lithic reduction sequence. Kline (1979) has argued that the frequency of decortication flakes provides a measure of proximity between site and raw material source, with a high frequency indicating close proximity between site and source and a low frequency indicating distant removal of site and source. The ratio of decortication flakes to cores at Leftwich is 468:31 or 15:1. This is a high decortication flake to core ratio indicating chert sources are located in close proximity to Leftwich.

A large variety of chert types and depositional situations exist in the Columbia Reservoir. Primary *in situ* outcrops of chert, such as Fort Payne could be quarried from Elk Ridge approximately 28 km south of the Duck River. In addition to primary *in situ* outcrops of chert, redeposited cherts are also locally available in the Duck River Basin. For example, residual Ridley and Carters chert can be found in upland and valley slope areas as the surface debris remaining after its limestone matrix has erroded. A high proportion of Bigby-Cannon chert occurs in upland and valley slope areas as remnants of old river gravel deposits or strath terraces. Recent river gravel deposits also constitute a readily available source for anyone within walking distance of the Duck River and its tributaries.

Tertiary Flakes (n=313)

Tertiary flakes are detached from a chert core, cobble or nodule from which all or nearly all cortex has been removed. In addition to lack of cortex on the dorsal surface, tertiary flakes exhibit wide, thick striking platforms with flake angles close to 90°.

Bifacial Thinning Flakes (n=340)

Biface thinning flakes (BTF) usually exhibit the negative impression of previously removed flakes on their dorsal surface. The striking platform is normally quite small and often lipped on the ventral platform margin. In addition, the platform may have signs of crushing or abrading which result from preparing the striking surface (Crabtree 1972). It is generally assumed that these flakes were produced by direct percussion with a soft hammer baton fabricator, as evidenced by the acute flake angle typically found on BTF´s.

The number of BTF´s to bifacial implements is moderately low for Leftwich, with 340 BTF´s to 50 bifacial implements yielding a ratio of 7:1. Several factors could account for the small number of BTF´s recovered. In all probability, many BTF´s were too fragmentary to be identified and were classified as broken flakes.

Wide platform. (n=150) BTF`s with a broad platform and a wide diffuse bulb of percussion are indicative of soft hammer direct percussion. The lateral edges vary from straight or slightly curved to very irregular, and normally terminate in a feather edge. The distal end frequently terminates in a snap break or hinge fracture but sometimes feathers out. The dorsal face frequently shows the removal of tiny platform preparation flakes just below and along the platform edge, while the face itself usually displays several prior flake removals. Total flake size is usually greater than 2 cm long or wide and greater than 2 mm thick.

Small platform. Small platform BTF´s normally result from thinning large bifaces by direct soft hammer percussion. The dorsal surface exhibits the negative impression of previously removed flakes. The striking platform is often lipped on the ventral margin and usually is ground or crushed from platform preparation. Total flake size is usually less than 2 cm long or wide, less than 3 mm thick and has no cortex.

Petaloid. (n=13) Shapes of petaloid flakes vary from triangular or oblong to parallel-sided. They are pressure flakes with small platforms, resulting from the manufacture of bifacial implements. One or more edges may be irregular in outline, but normally terminate in a feathered edge. The dorsal face of the flake normally shows the negative impression of previously removed flakes, leaving an interflake ridge slightly off-center. On the ventral face the bulb of percussion usually expands laterally to the edges and downward in a smooth curve, often with a very slight compression lip. Total flake size is usually less than 2 mm long or wide and less than 2 mm thick, with a small platform less than 3 mm wide (Wheat 1979:114).

Retouch flakes. (n=25) "This class of debitage was presumably produced during final shaping or resharpening of artifacts" (Amick 1982:16). Considered to be produced by pressure retouch, these flakes are typically small and thin in size and ovoid in shape. Retouch flakes usually retain remnants of the working edge of the piece and the triangular facet between adjacent flake scars.

Broken Flakes (n=849)

Broken flakes generally comprise a high percentage of the total debitage collection from any site. The most abundant flake category for Leftwich is broken flakes. Defined as those flakes not sufficiently complete to be identified to a specific technological category; specifically, broken flakes lack cortex and a platform (Hofman and Turner 1979). Flakes from all flake categories except primary decortication probably comprise the class broken flakes.

Core Rejuvenation Flakes (n=8)

Flakes removed from a core by percussion in order to prepare the core surface for removal of useable flakes, tend to be thick, elongated flakes with remnants of the former core platform edge (Amick 1982:16; Wheat 1979:117-118).

E. STONE DEBRIS

Non-flake stone debitage includes percussors used to manufacture flakes and also the spent chert nucleus left from producing flakes.

Hammerstones (n=2)

A spherical or subspherical mass with wear attributable to battering is classified as a hammerstone (Faulkner and McCollough 1973).

> This non-chipped stone debris category represents percussors used in stone implement manufacturing processes. Battering and crushing along prominent ridges and margins is typical of hammerstone morphology (Amick 1982:15).

Core (n=21)

The term core refers to a block, nodule, water-worn cobble or pebble from which flakes have been detached. Cores are generally of isotrophic material and bear two or more negative flake scars. The intentional production of flakes rather than a core differentiates cores from bifaces.

Blocky Debris (n=278)

Angular blocky debris can be defined as chipped stone material that has definite evidence of flaking, such as negative flake scars; however, it is not assignable to a definite flake or stone debris category. Many items classified as blocky debris are undoubtedly the nucleus of a core, i.e. a waste or worn-out core from which no more flakes can be struck (Hofman and Turner 1979; Whitthoft 1952).

Tested Cobbles (n=10)

These specimens usually show only a few flake removals and minimal decortication with 80% or more cortex present (Amick 1982:15; Hofman and Turner 1979).

Fire Cracked Rock (n=197)

House and Smith (1975:80) have described fire cracked rock (FCR) as one of several kinds of non-descript prehistoric lithic debris which are difficult to distinguish and relate to specific kinds of cultural behavior. FCR shows evidence of having been fired and broken by heat; it is characterized by 1) discoloration, usually red or black but sometimes white or grey, 2) jagged irregular fractures such as pot lids, fire spalls, crazing, or crenation and 3) no evidence of conchoidal fracture features such as a platform or bulb of percussion (Conwall 1958:67; House 1975:68; McDowell-Loudan 1983:26; Purdy 1975b:137-139, Plates 4a, 4b, 6a, 6b, 7a, 7b; Purdy and Brooks 1971). Not all FCR specimens exhibit all characteristics described above, but the presence of any of these strongly suggests they were fired. Most recognized FCR have probably had repetitive exposure to heat and water (Conwall 1958:67; McDowell-Loudan 1983:26).

FCR could be confused with flake debris, stone debris (i.e. as cores or blocky debris), as well as broken and/or unmodified cobbles and pebbles. Sometimes chert and quartzite will crack into spalls with no jaggedness or irregularity which resemble flake or stone debris (House 1975:68; House and Smith 1975:78). Cobbles and pebbles classified as unmodified or broken could be FCR with exposure to low or short duration heat.

The presence of FCR in quantity is generally considered to reflect cooking practices involving heating of rocks and their subsequent use in earth ovens or for stone boiling (House and Smith 1975:75). Cooking with "hot rocks" has been documented ethnographically in North America (Driver and Massey 1957:233) and elsewhere in the world, and is still considered a traditiional outdoor cooking method occasionally used in our own society. FCR is probably the result of "hot rocks" being used for cooking in earth ovens, for stone boiling, or recycling of quarry waste and broken cobble tools in cooking practice (House 1975:68).

FCR occurs in a wide variety of archaeological contexts in North America. Although all prehistoric cultural systems produced at least small quantities, large quantities of FCR were produced during Middle Archaic and later occupations in the southeastern United States (Chapman 1973; House and Smith 1975).

Pot lids (n=6)

Varying widely in size, pot lids are generally round, lenticular pieces of chert detached from the main body of stone by rapid heating (e.g. Purdy 1975b:Plate 3a, 3b). Since potlids always occur during the heating process rather than the cooling process, they are thought to be the result of expansion (Purdy 1975b:136). Crabtree and Gould (1970:191) point out that potlids are often identified as "human made artifacts."

Leftwich Area A texture, chert types, cortex and thermal alteration categories for Benton and Ledbetter lithic debitage are presented in Tables A.6, A.7, A.8 and A.9 (Appendix A), respectively. The 15 lithic debitage categories represented from Leftwich Area A are listed below.

1. Primary Decortication Flakes
2. Secondary Decortication Flakes
3. Tertiary Flakes
4. Large Biface Thinning Flakes
5. Small Biface Thinning Flakes
6. Petaloid Flakes
7. Retouch Flakes
8. Broken Flakes
10. Core Rejuvenation Flakes
11. Hammerstones
13. Cores
14. Blocky Debris
15. Tested Cobbles
16. Fire Cracked Rock
17. Pot Lids

CHAPTER VI

LITHICS FROM LEFTWICH SURFACE COLLECTION

A total of 25,500 lithic artifacts and debris greater than 6 mm was collected in 1978 from Leftwich Area D and comprises the Leftwich surface collection. The largest artifact category, flake debitage, represents 69.09% (n=17,617) of the assemblage. The next most common artifact category is stone debris representing 26.00% (n=6,630) of the assemblage. Chipped stone tools comprise 4.84% (n=1,235) while ground stone tools comprise 0.07% (n=18) of the assemblage. Artifact categories previously defined in Chapter V will not be repeated.

A. CHIPPED STONE TOOLS

A total of 583 projectile point/knives is discussed below which comprise 47.21% of the chipped stone tools. Only 71 points were believed to be diagnostic while 33 did not fit a named type. Point fragments (n=467) comprise 80.10% of the ppk´s and 37.81% of the chipped stone tools. Initial and intermediate stemmed bifaces (n=12) comprise the remainder of the ppk category. Whenever possible stemmed bifaces have been identified to point clusters following Faulkner and

McCollough (1973). Diagnostic points are discussed culturally from Woodland to Early Archaic, followed by undiagnostic points and fragments.

Jack´s Reef Corner Notched (n=1)

This small thin corner notched point with barbed shoulders resembles the type Jack´s Reef Corner Notched (Ritchie 1961). Morphologically it is similar to types which occur on Middle-Late Woodland sites in the Middle South (Faulkner and McCollough 1973:105-106). This basal section is vitreous St. Louis, without cortex which was heated before final flaking.

Hamilton Cluster (n=1)

This small triangular, thin straight blade point resembles the type Madison (Scully 1951). Morphologically similar points have been recovered in Late Woodland and Mississippian Period cultural context in the upper Duck Valley (Faulkner and McCollough 1973:143-144) and Collins River Valley (Kline 1979:105). This complete point is fine-grained Fort Payne without cortex which was possibly heated.

Lanceolate Expanded Stemmed Cluster (n=3)

These specimens resemble the type Bakers Creek associated with Middle Woodland assemblages (Cambron and Hulse 1975:8). In the upper Tennessee Valley they are considered to span the Middle and Late Woodland periods (Faulkner and McCollough 1973:145-146). One point is complete while the other two are basal sections. All three are fine-grained Fort Payne which were heated before final flaking. Cortex is absent on two specimens while one has incipient fracture planes.

Lanceolate Spike Cluster (n=1)

This specimen resembles the type Bradley Spike common on Owl Hollow phase sites in the upper Elk and Duck Valleys (Faulkner and McCollough 1973:98-99, 144-145). This complete point is vitreous Ridley chert which lacks cortex and was heated before final flaking.

McFarland Cluster (n=8)

These medium size triangular points are associated with early Middle Woodland assemblages in the upper Duck Valley (Faulkner and McCollough 1973:146-148). Two specimens are complete while six are basal sections. Texture ranges from three vitreous to five fine-grained. Chert types present include six Fort Payne and one each Ridley and Bigby Cannon. No cortex is present on any of the Copena points. Thermal alteration possibly occurred in one specimen, one was heated after final flaking, five were heated before flaking and one was heated before and after flaking.

Rounded Base Cluster (n=3)

These points are similar to the type Gary included in the Rounded Base Cluster (Faulkner and McCollough 1973:113-117). They have a relatively long, broad and rounded stem. These points have been found in a Late Archaic context in the the Tennessee Valley and are suggested to occur in Early Woodland as well (Faulkner and McCollough 1973:150-151). Two points are nearly complete while one is a basal section. Texture includes one vitreous and two fine-grained. Chert types present include two Fort Payne and one Bigby Cannon. Two lack cortex while one has cobble cortex. Thermal alteration possibly occurred in one specimen while two were heated before final flaking.

Motley (n=2)

These long expanded stemmed points resemble the type Motley associated with Poverty Point phase assemblages in the lower Mississippi Valley (Cambron and Hulse 1975:92). These complete and nearly complete points are fine-grained Fort Payne with no cortex which were heated before final flaking.

Wade Cluster (n=3)

These points are distinguished from the Ledbetter Cluster by prominent shoulder barbs and resemble the type

Wade which are considered Terminal Archaic/Early Woodland artifacts in the upper Duck Valley (Faulkner and McCollough 1973:149). These basal point sections are fine-grained, lack cortex and were heated before final flaking. Chert types present include two Ridley and one Fort Payne.

Ledbetter Cluster (n=18)

These points closely resemble the types Cotaco Creek, Ledbetter and Pickwick. Ten points are complete while 11 are basal sections. Texture ranges from 1 vitreous, 21 fine-grained to 2 medium. Chert types present include 12 Fort Payne and 8 Ridley. Cortex is absent on 22 specimens while 2 have cobble cortex. Thermal alteration is not evident on 6 specimens, 4 were possibly heated, 10 were heated before final flaking and 4 were heated after final flaking.

Benton Stemmed (n=8)

These three complete points and five basal sections all lack cortex. Texture ranges from one vitreous to seven fine-grained specimens. Chert types present include four Fort Payne and two each Bigby Cannon and Ridley. Thermal alteration possibly occurred on three specimens while five were heated before final flaking.

White Springs-Sykes Cluster (n=2)

These basal point sections are Fort Payne chert, lack cortex and were heated before final flaking. Texture ranges from one vitreous to one fine grained specimen.

Eva-Morrow Mountain Cluster (n=8)

Two points are complete, one is a midsection with shoulders and five are basal sections. Texture ranges from one vitreous to seven fine-grained. Chert types present include six Fort Payne and two Ridley. Cortex is absent on all eight points. Thermal alteration possibily occurred on three specimens, one was definitely heated, three were heated before final flaking and one was heated before and after flaking.

Kirk Cluster (n=2)

These corner notched points resemble the type Decatur (Cambron and Hulse 1975:41) which are included in the Kirk Cluster and considered to be Early Archaic artifacts (Hofman and Turner 1979). These two complete points are Fort Payne chert and lack cortex. Texture ranges from one vitreous to one fine-grained specimen. Thermal alteration possibly occurred on one specimen while one was heated before final flaking.

Big Sandy Cluster (n=5)

These large side notched points resemble Big Sandy types (Cambron and Hulse 1975:14-17) and are grouped in one cluster (Hofman and Turner 1979). Three points are complete and two are midsections with shoulders. Texture ranges from one vitreous to four fine-grained. Chert types present include three Fort Payne and one each Bigby Cannon and Ridley. Cortex is absent on all five points. Thermal alteration is not evident on one specimen, two were possibly heated, one was definitely heated and one was heated before final flaking.

No Category Points (n=33)

These complete and nearly complete points do not fit into any recognizable type category. Texture ranges from 4 vitreous, 14 fine-grained to 1 medium specimen. Chert types present include 14 Fort Payne, 2 Ridley, 2 Bigby Cannon and 1 St. Louis. Cortex is absent on 17 specimens while 2 have cobble cortex. Thermal alteration is not evident on 6 specimens, 6 were possibly heated, 3 were definitely heated and 18 were heated before final flaking.

Initial Stemmed Biface (n=6)

The four base and two midsection initial stemmed bifaces are all fine-grained. Five specimens are Fort Payne while one is Ridley chert. Cortex is absent on five specimens while one has cobble cortex. Two specimens have no evidence of thermal alteration, one was possibly heated and three were heated before final flaking.

Intermediate Stemmed Biface (n=6)

The one vitreous and five fine-grained Fort Payne chert all lack cortex. One specimen has no evidence of thermal alteration, three were possibly heated and two were heated before final flaking. Three specimens are basal sections, one is complete and two are nearly complete.

Projectile Point Tip Fragment (n=125)

Cortex is absent on 124 specimens while 1 has cobble cortex. Chert types present include 69 Fort Payne, 43 Ridley, 10 Bigby Cannon, 1 each Brassfield, Chalcedony and Quartzite. Texture ranges from 24 vitreous, 94 fine and 7 medium-grained. Fourteen specimens have no evidence of thermal alteration, 30 were possibly heated, 2 were definitely heated, 7 were heated after flaking, 70 were heated before final flaking and 2 were heated before and after flaking.

Projectile Point Midsection Fragment (n=101)

Cortex is not present on 98 point midsections, 1 has incipient fracture planes and 2 have cobble cortex. Chert types present include 68 Fort Payne, 27 Ridley and 6 Bigby Cannon. Texture ranges from 22 vitreous, 74 fine, 4 medium and 1 coarse-grained. Thermal alteration is not evident on 13 specimens, 16 were possibly heated, 1 was definitely heated, 8 were flaked before heating, 50 were heated after final flaking and 13 were heated before and after flaking.

Projectile Point Edge Fragment (n=44)

Cortex is not present on 43 point edge fragments while 1 has cobble cortex. Chert types present include 24 Fort Payne, 18 Ridley and 2 Bigby Cannon. Texture ranges from 8 vitreous to 36 fine-grained. Thermal alteration is not evident on 4 specimens, 6 were possibly heated, 8 were heated after flaking, 23 were heated before final flaking and 3 were heated before and after flaking.

Projectile Point Base Fragment (n=197)

Cortex is not present on 193 base fragments, 1 has incipient fracture planes and 3 have cobble cortex.

Chert types present include 130 Fort Payne, 51 Ridley, 11 Bigby Cannon and 5 St. Louis. Texture ranges from 35 vitreous, 155 fine, 6 medium to 1 coarse-grained specimen. Thermal alteration is not evident on 24 specimens, 60 were possibly heated, 6 were definitely heated, 8 were heated after flaking, 88 were heated before final flaking and 11 were heated before and after flaking.

Chopping Tool (n=1)

Cores or nucleiform pieces which exhibit (1) bifacial large-flake removals on a segment of their perimeter, (2) an exposed sharp cutting edge with an angle of 30-45 degrees between flake scars on the two surfaces and (3) evidence of heavy wear or battering on the cutting edge are called chopping tools (Faulkner and McCollough 1973:84). Chopping tools were probably used for a variety activities such as butchering, wood working and hide working (House 1975:62). The one chopping tool is of fine-grained Ridley chert, with cobble cortex and no evidence of thermal alteration.

Combination Tools (n=1)

Combination tools have two well defined morphological implement types on one chipped stone artifact. The only combination tool from Leftwich is a scraper/graver on a reworked Benton projectile point. The specimen is fine-grained Fort Payne heated before final flaking with no cortex.

Core Scraper (n=4)

All of these artifacts are cores which exhibit bifacial edge damage along the margin of flake scar intersection. Core scrapers have been interpreted as useful for a variety of activities including butchering, hide working and wood working (Faulkner and McCollough 1973). Texture ranges from two each vitreous and fine-grained. Two specimens are Fort Payne and Ridley chert. No cortex is present on one specimen while three have cobble cortex. Thermal alteration is absent on three core scrapers while one was possibly heated.

Drills (n=23)

Drill morphology is present on 5 reworked projectile points, as well as 18 bifaces with no hafting preparation. Texture ranges from 3 vitreous to 20 fine-grained specimens. Drill chert types include 11 Fort Payne, 9 Ridley and 3 Bigby Cannon. All specimens lack cortex. Thermal alteration is not evident on five specimens, eight were possibly heated, one was definitely heated and nine were heated before final flaking.

End Scrapers (n=15)

An end scraper is recognized by the presence of a regular, steeply retouched working edge at one or both ends of the longitudinal axis. The function of the artifact is not affected whether the artifacts are flakes, bifaces or ppk´s. End scrapers are expected to occur in butchering and hide working tool kits (House 1975:62). Fourteen projectile points have been reworked as end scrapers while one bifacial end scraper has no haft modification. Texture ranges from eight vitreous to seven fine-grained specimens. Chert types present include 12 Fort Payne and 3 Ridley. No cortex is present on 12 end scrapers, 1 has matrix cortex and 2 have cobble cortex. Thermal alteration is not evident in four specimens, seven were possibly heated and four were heated before final flaking.

Gravers (n=5)

Four of the gravers are on flakes while one is on a piece of blocky debris. Texture ranges from four fine-grained to one medium specimens. Chert types present include four Ridley and one Fort Payne. Cortex is absent on two specimens, one has matrix cortex and two have cobble cortex. Thermal alteration is not evident on two specimens, two were heated before flaking and one was heated before and after final flaking.

Side Scrapers (n=3)

Marginally retouched lithic artifacts with the functional edge convex and parallel to the longitudinal axis are known as side scrapers. The longitudinal working edge is usually modified in a rough and irregular fashion; few specimens were prepared by fine lamellar retouching (Faulkner and McCollough 1973:85). Two bifaces and one piece of blocky debris are represented in the side scraper category. Traditionally, side scrapers have been interpreted as butchering, hide working and wood working implements (House 1975:63). All three specimens are fine-grained, have cobble cortex and no evidence of thermal alteration. Chert types present include one Ridley and two Fort Payne specimens.

Initial Stage Bifaces (n=101)

Texture ranges from 6 vitreous, 80 fine-grained and 15 medium specimens. Chert types present include 69 Fort Payne, 27 Ridley and 5 Bigby Cannon specimens. No cortex is present on 84 initial bifaces, 1 has matrix cortex and 16 have cobble cortex. Thermal alteration is not evident on 34 specimens, 31 were possibly heated, 10 were definitely heated, 1 was heated after flaking and 25 were heated before final flaking.

Intermediate Stage Bifaces (n=246)

Texture range from 24 vitreous, 203 fine-grained and 19 medium specimens. Chert types present include 174 Fort Payne, 50 Ridley, 19 Bigby Cannon, 1 each Carters, Quartzite and St. Louis. No cortex is present on 225 intermediate bifaces, 3 have matrix cortex and 18 have cobble cortex. Thermal alteration is not evident on 40 specimens, 73 were possibly heated, 15 were definitely heated, 14 were heated after flaking, 100 were heated before flaking and 4 were heated before and after final flaking.

Late Stage Bifaces (n=126)

Fully thinned and edge-retouched lanceolate bifaces and fragments comprise the late stage. Whole bifaces in this category could be converted to a ppk type by stemming or notching, and fragments probably include many examples which were stemmed or notched ppk´s when unbroken (Faulkner and McCollough 1973:83).

Texture ranges from 28 vitreous, 90 fine, 6 medium and 2 coarse-grained specimens. Chert types present include 79 Fort Payne, 36 Ridley, 10 Bigby Cannon and 1 St. Louis. No cortex is present on 122 final bifaces while 4 have cobble cortex. Thermal alteration is not evident on 8 specimens, 31 were possibly heated, 6 were definitely heated, 7 were heated after flaking, 71 were heated before flaking and 3 were heated before and after final flaking.

Bifacial Blanks (n=4)

Bifacial blanks are symmetrical bifaces, broken or discarded in advanced process of thinning, lacking notches or use-wear. Texture ranges from one vitreous to three fine-grained specimens. Chert types present include three Fort Payne and one Ridley. No cortex is present on three specimens while one has cobble cortex. Thermal alteration possibly occurred on two blanks while two were heated before final flaking.

Miscellaneous Biface Fragments (n=64)

Texture ranges from 11 vitreous, 51 fine-grained and 2 medium specimens. Chert types present include 43 Fort Payne, 14 Ridley, 6 Bigby Cannon and 1 St. Louis. No cortex is present on 60 biface fragments while 4 have cobble cortex. Thermal alteration is not evident on 7 specimens, 14 were possibly heated, 1 was definitely heated, 8 were heated before flaking, 32 were heated after flaking and 2 were heated before and after final flaking.

Adzes (n=3)

Thick elongated bifaces with a utilized straight to convex working edge at one end of the long axis, formed by bifacial removals, are classified as adzes. Such pieces have facial symmetry near the working edge, but are seldom completely bifacially worked. Attrition from wear may be found on the working edge, as well as "opal sheen" or "silica gloss" on one face (Faulkner and McCollough 1973:85). Adzes are assumed to be associated with wood working (House 1975:61). Texture ranges includes one fine and two medium-grained specimens. All three adzes are of Fort Payne chert. Cortex is absent on one specimen while two have cobble cortex. Thermal alteration is not evident on one specimen, one was definitely heated and one was heated before final flaking.

Perforators (n=1)

A lithic artifact with a short, often asymmetrical, narrowed and pointed projection formed by lines of unidirectional marginal retouch on both sides of the projection, converging to a point is known as a perforator (Faulkner and McCollough 1973:82, 86; White 1963:40). Light-duty perforators have a thin edge (usually less than 4 mm), polish and attrition scars. Perforators have generally been interpreted as hide working implements useful for light-duty drilling and reaming (House 1975:64). This light-duty perforator is on vitreous Ridley which has been heated before final flaking and lacks cortex.

Flake Tools (n=55)

Flake tools have been divided into nine categories based on edge angle, edge thickness and intentional or attritional scarring: 1 Utilized Light-duty Scraper, 4 Utilized Heavy-duty Scrapers, 12 Retouched Heavy-duty Scrapers, 2 Retouched Light-duty Scrapers, 5 Retouched Light-duty Cutting Tools, 4 Retouched Heavy-duty Cutting Tools, 8 Utilized Light-duty Cutting Tools, 14 Retouched Intermediate Flake Tools and 8 Utilized Intermediate Flake Tools. Texture ranges from 6 viteous, 47 fine-grained and 2 medium specimens. Chert types present include 28 Fort Payne, 23 Ridley and 4 Bigby Cannon. No cortex is present on 30 flake tools, 2 have matrix cortex and 23 have cobble cortex. Thermal alteration is not evident on 19 specimens, 17 were possibly heated, 3 were definitely heated and 16 were heated before final flaking.

B. GROUND STONE TOOLS

Abraders (n=6) (Figure 6.1a)

All six abraders are medium textured Hermitage sandstone. No cortex is present on four specimens while two have matrix cortex. Thermal alteration is not

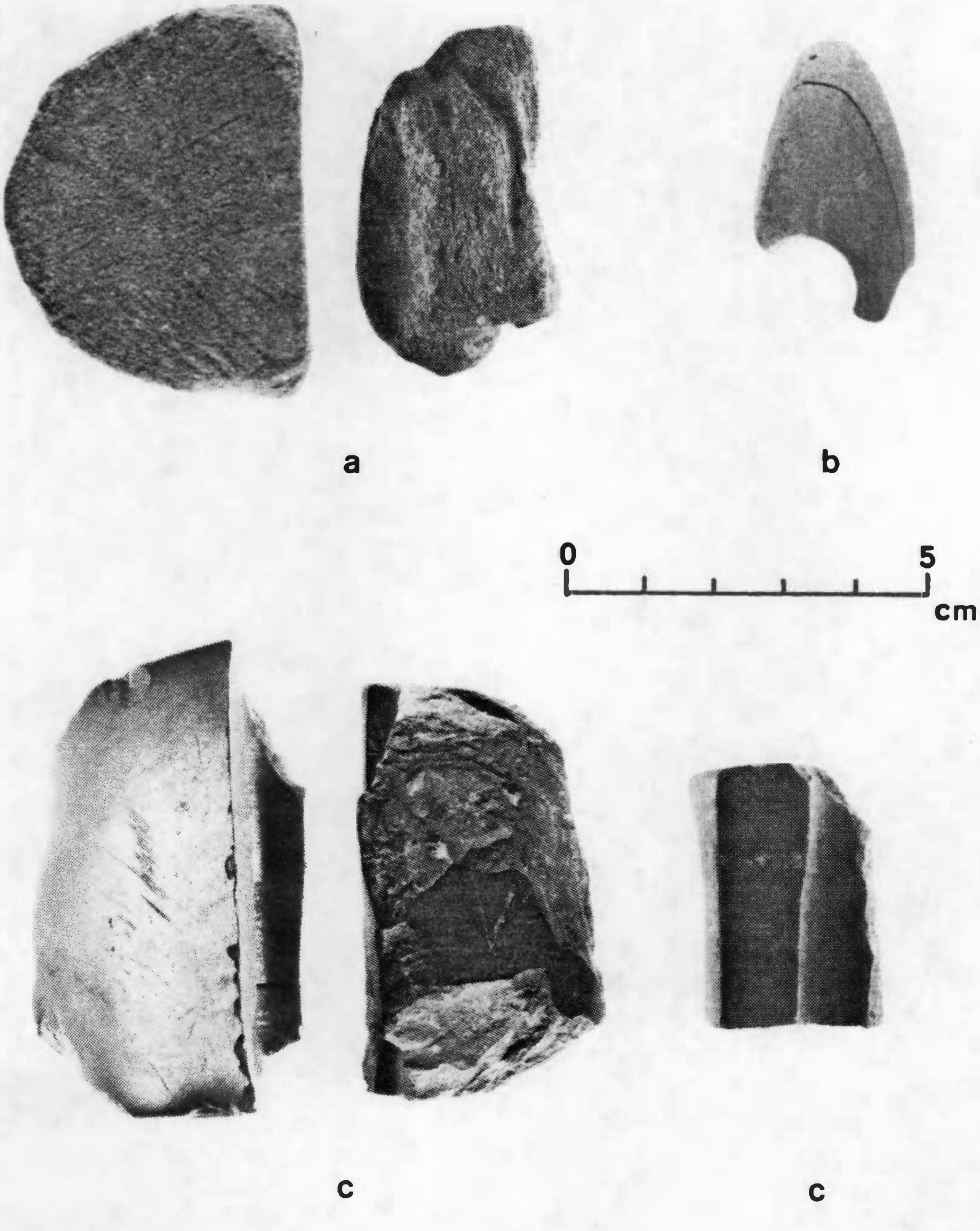

Figure 6.1. Leftwich Area D Ground Stone Tools: a) Abraders, b) Gorget and c) Bannerstones.

evident on one specimen, four were possibly heated and one was definitely heated. Four abraders are smooth while two are deeply grooved.

Bannerstones (n=2) (Figure 6.1c)

The name bannerstone was first applied by Dr C.C. Abbott to the highly polished stones which seem to have been "shaped and drilled for mounting upon handles so as to be carried during ceremonies as standards or banners" (Baer 1921:445).

Since these highly polished stones have frequently been found with spear throwers or atlatls, their function with spear throwers has been open to speculation. The attachment of objects to the shaft of spears has been thought to add greater force, thus increasing velocity and distance (Cole 1972:4). Archaeological experiments with weighted spear throwers have yielded inconclusive and contradictory results (Hill 1948:41-42; Mau 1963:11; Paulter 1976:502; Peets 1960:109). Cole (1972:1) and Paulter (1976:502) found that distance was directly proportional to the weight of the attached stone; therefore, the additional weight was a hindrance rather than a benefit! Rigid spear throwers with polished stone artifacts are known only archaeologically and only within the continental United States and southern Canada; however, flexible shaft spear throwers are not unique to North America (Paulter 1976:501, 508).

Any stone capable of taking on a high polish and reflecting brilliant or pleasing colors could be used for a bannerstone. Materials used prehistorically for bannerstones include diabase, granite, jasper, quartz (especially crystallized and rose), quartzite, water-worn pebbles, serpentine, shale, shell, slate (especially green and banded or ribbon) and steatite (Baer 1921:447). The most common bannerstone form is a perforated winged object having long, thin, tapering, symmetrical wings, diverging from a mid-rib, through which a cylindrical hole has been longitudinally drilled (Baer 1921:445). Baer (1921:445) notes that bannerstones are

> usually of too soft a material and of too delicate workmanship to be weapons, tools or implements of practical use. The carefully selected material, the elegant and symmetrical shape, and the high polish of these relics have led many to believe that their use was of a ceremonial nature.

The two recovered bannerstones are described separately. One bannerstone is fine-grained Fort Payne with no cortex and was heated after it was shaped. The non-cryptocrystalline greenstone bannerstone has cobble cortex and no evidence of heating.

Celts (n=2) (Figure 6.2)

Celts are pecked into shape and are either thick or flattened with a ground and polished bit (Faulkner and McCollough 1973:158-159; Morris 1969:216; Walthall 1973:409). Materials used prehistorically for celts are similar to those used for bannerstones. These medium-grained Lebanon limestone celts both lack cortex and evidence of thermal alteration.

Gorget (n=1) (Figure 6.1b)

Gorgets have been interpreted as stone ornaments of rank or authority worn at the breast by suspension from the neck. They are usually rectangular, flat, of slate or stone relatively easy to polish and drill. With one hole the length hangs vertically as a pendant while a gorget with two holes would hang horizontally (Brennan 1973:165). This fine-grained greenstone gorget fragment has no cortex or evidence of thermal alteration.

Pestle (n=2) (Figure 6.3)

Pestles are club-shaped, hand held tools used for grinding substances (Faulkner and McCollough 1973:157; Morris 1969:980; Walthall 1973:409). Two conical or bell-shaped grinding stones were possibly used as pestles. These quartzite pestles both have cobble cortex, while one is fine-grained and possibly heated and

Figure 6.2. Leftwich Area D Celts.

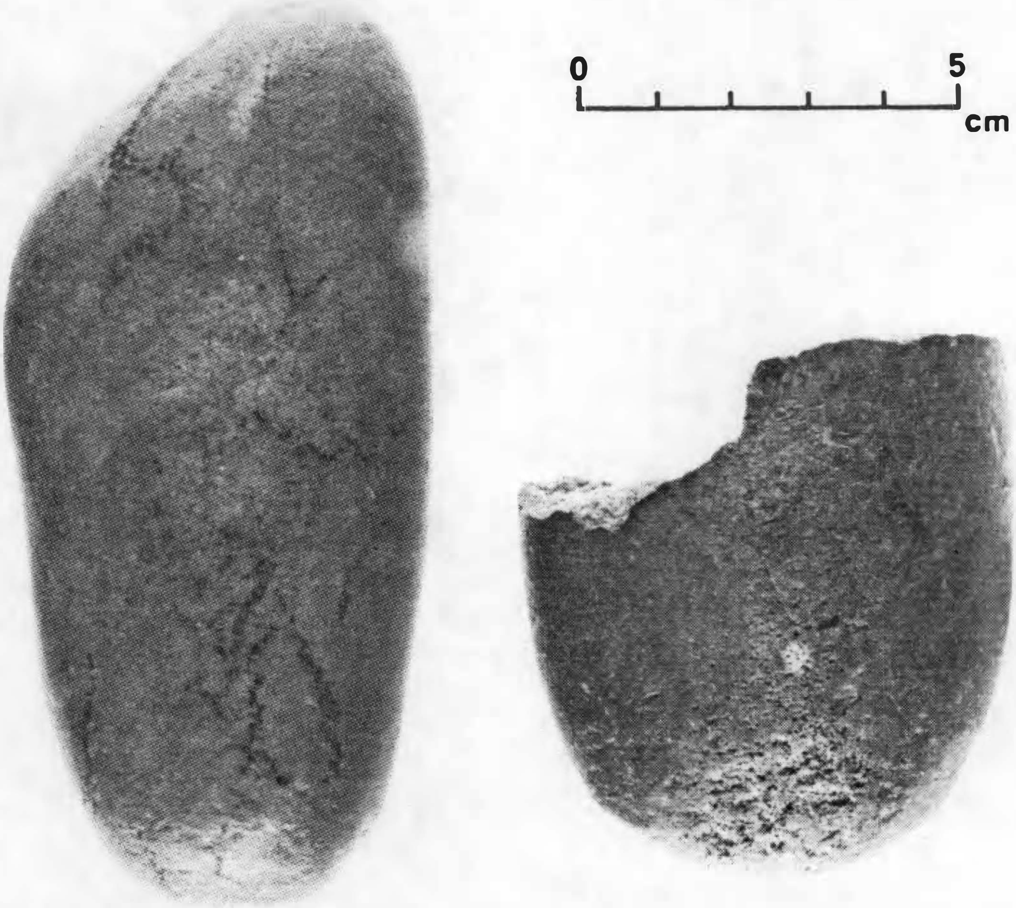

Figure 6.3. Leftwich Area D Grinding Stones.

the other is coarse-grained with no evidence of thermal alteration.

<u>Hammerstone/Grinding Stone</u> (n=4) (Figure 6.4)

Fist-size cobbles with one or more pecked and ground surfaces are suggested to have been utilized as hammers. Medium texture is present on two specimens while two are coarse-grained. One hammerstone/grinding stone is siltstone while three are quartzite. No cortex is present on one specimen, one has matrix cortex and two have cobble cortex. Thermal alteration is not evident on three specimens while one was possibly heated.

<u>Stone Vessel Sherd</u> (n=1)

The stone vessel sherd fragment is fine-grained steatite with no cortex which was possibly heated.

C. LITHIC DEBITAGE

Leftwich Area D lithic debitage texture, chert types, cortex and thermal alteration categories are presented in Tables B.1, B.2, B.3 and B.4 (Appendix B), respectively. The 17 lithic debitage categories from Leftwich Area D are listed below.

1. Primary Decortication Flakes
2. Secondary Decortication Flakes
3. Tertiary Flakes

Figure 6.4. Leftwich Area D Hammerstone/Grinding Stones.

4. Large Biface Thinning Flakes
5. Small Biface Thinning Flakes
6. Petaloid Flakes
7. Retouch Flakes
8. Broken Flakes
9. Shatter
10. Core Rejuvenation Flakes
11. Hammerstones
12. Pecking Stones
13. Cores
14. Blocky Debris
15. Tested Cobbles
16. Fire Cracked Rocks
17. Pot Lids

CHAPTER VII

DISCUSSION AND SUMMARY

The purpose of this section is to develop a model for hunter-gatherer settlement systems in the middle Duck River Valley. Emphasis is placed on general assemblage characteristics, as well as specific lithic manufacturing and reduction systems. Intentional thermal alteration is incorporated with lithic resources and lithic technology in the arguments presented below.

A. DESIGN OF A MODEL

Thermal Alteration

Several factors are necessary for chert artifacts or nodules to be thermally altered. These include tangible items such as fuel and chert, as well as, the necessary skill, knowledge or experience. An additional factor is time. Successful alteration of lithic material may be accomplished by (1) slow heating, (2) maintaining a critical temperature for several hours and (3) slow cooling which is essential (Purdy and Brooks 1971:324). Thermal pretreatment is a reflection of patterned behavior; it can be related to local raw material quality or perceived functional-manufacturing objectives. Most hunter-gatherers thermally alter chert in either the core or biface stage (e.g. Chapter IV).

Lithic Resources

Lithic resources located in the inner and outer portions of the Central Basin and the Highland Rim vary in distribution, quality and size. Detailed observations of chert resources in the middle Duck River Valley have been discussed by Amick (1981, 1984), Faulkner and McCollough (1973), McCluskey (1974,1976), Penny (1974) and Penny and McCollough (1976).

Ordovician Ridley and Carters chert are widely available within the Inner Basin but are of poor quality. Small nodules of high quality Fort Payne and Bigby Cannon chert occur in gravel deposits within the Inner Basin. Larger nodules of Fort Payne occur in the Outer Basin, as well as moderate size Brassfield chert nodules. High quality Fort Payne and St. Louis chert sources are abundant on the Highland Rim.

"It has long been recognized that sources for lithic materials in a site . . . reveal something of the territory and movements of prehistoric peoples" (Reher and Frison 1980:142-143). The investigation of chert variability in archaeological context has important implications about group mobility patterns (Amick

1984:102; Gramly 1980:823; Reher and Frison 1980:121-135).

Lithic Technology

Lithic implement manufacture is a subtractive technology which is suitable for activity analysis. Since debitage is generally discarded at the manufacturing site, it indicates general and specific reduction activities. Hunter-gatherer lithic technology varies between expedient tool manufacture and abandonment-discard and the curation of tools which reflect specific lithic resources being exploited. Amick (1984:157-158) has suggested that technological expediency may be determined by high frequency of initial reduction debris, locally available chert and cortex presence while curated technology may be determined by high frequency of cortex absence, late stage manufacture debris and non-local chert.

Settlement Organization

Hunter-gatherers have developed settlement strategies to cope with spatial distributed resources (Binford 1980:10). Collecting and foraging can be thought of as two alternative hunter-gatherer organizational systems on a continuum. Foraging strategies are characterized by variable group size and mobility:

consumers move to resources. Archaeological sites generated by foragers include residential bases and locations. Collecting strategies are characterized by: food storage at least part of the year with resources moved to consumers through special task groups. Archaeological sites generated by collectors include field camps, stations, caches, as well as residential bases and locations.

The recognition of thermally altered specimens was considered to be important to understanding lithic manufacturing processes at Leftwich. Thermal alteration has been recognized as an important part of both core and biface reduction strategies (e.g. Chapter IV). The relationship of thermal alteration, lithic resource locations, general lithic reduction, manufacturing technology and settlement organization are considered. If lithic sources reflect group mobility, the inclusion of thermal alteration should yield additional information regarding when and where lithic reduction took place. The correlation of thermal alteration, cortex presence or absence and stage of reduction should indicate when thermal alteration took place in the manufacturing stage. The association of thermal alteration, chert type and stage of reduction should indicate which artifacts were intentionally altered at Leftwich.

Tests of statistical independence are determined by the chi-square distribution. Confidence levels are set at 95% (p .05) for each test. Lithic material from Leftwich Areas A and D are utilized in the model. They have been described in Chapters V and VI, respectively. Several subgroups of lithic specimens will be examined. These include (1) total assemblage, (2) flake debitage, (3) flaked stone debris and (4) chipped stone tools. The intentional use of thermal alteration in the surface and excavated lithic assemblages is investigated below.

B. ANALYSIS OF LEFTWICH SURFACE COLLECTION

Assessment of differential technological organization and implications of group mobility are particularly important in analyzing the Leftwich assemblages. The proportion of heat altered lithic chipped stone tools and debris from Leftwich will be examined. Thermal alteration categories utilized in this analysis have been described in Chapter VI. For this study three categories of thermal alteration are utilized: unaltered, successfully altered and overheated. Unaltered specimens have no evidence of heat alteration (category 1). Successfully altered (categories 2 and 5) specimens have color change and luster. Overheated specimens exhibit heat fractures (categories

3, 4 and 6). Initially, general thermal alteration at Leftwich Area D will be examined. A closer examination of specific artifact categories for Area D follows the general discussion.

Investigation of Accidental Thermal Alteration

Before hypothesis tests are undertaken, the possibility thermal alteration occurred accidentially will be investigated. Price et al. (1982) suggest accidentally thermal alteration at archaeological sites can be determined by: (1) an overall high occurrence of thermal overheating (pot lids, crazing and calcination), (2) no association between color change and specific artifact categories and (3) absence of association between heat alteration and heat source. If some artifact categories contain unusually high or low incidence of heat altered specimens, then intentional alteration is suggested and can be investigated.

Heat alteration is crosstabulated by broad lithic categories in Table 7.1. A definite pattern of thermal use is evident with 44.44% of the ground stone tools, 47.56% of the flake debris and 71.35% of the chipped stone tools successfully altered while 43.56% of the stone debris are overheated. There is a relationship between heat alteration and lithic categories from the Leftwich surface collection. The huge chi-square value

TABLE 7.1. CROSSTABULATION OF LEFTWICH AREA D LITHIC AND THERMAL ALTERATION CATEGORIES.

Lithic Categories		Thermal Alteration			
		Unaltered	Successfully Altered	Overheated	Total
Flake Debris	o	6214	8317	3086	17617
	e	5656.78	7725.23	4234.99	
	X*2	54.89	45.33	311.73	
	%	35.27	47.21	17.52	
Stone Debris	o	1768	1974	2888	6630
	e	2128.88	2907.32	1593.8	
	X*2	61.18	299.62	1050.92	
	%	26.67	29.77	43.56	
Chipped Stone Tools	o	198	883	154	1235
	e	396.56	541.56	296.88	
	X*2	99.42	215.27	68.76	
	%	16.03	71.5	12.47	
Ground Stone Tools	o	8	8	2	18
	e	5.78	7.89	4.33	
	X*2	0.85	0	1.25	
	%	44.44	44.44	11.11	
Total		8188	11182	6130	25500

Chi Square = 2209.22 df = 6

is primarily associated with overheated stone debris which includes fire cracked rock and pot lids (26% of category). Table 7.2 contains broad lithic categories and thermal alteration with FCR and pot lids removed from the stone debris category. The significant chi-square value is associated with chipped stone tools in Table 7.2. Although some accidentally thermal alteration undoubtedly occurred, it comprises a minority of the Leftwich surface collection.

Test Results

Cortex. Cortex is the weathered outer layer of chert. Generally cortex is removed in order to make chipped stone artifacts. The observation of cortex on lithic specimens yields important clues regarding technological and procurement systems. Presence of cortex includes specimens with matrix, residual and cobble cortex while absence of cortex includes specimens with no cortex and those with incipient fracture planes.

There are statistically significant differences between cortex and thermal alteration categories. Tables 7.3, 7.4, 7.5 and 7.6 present the test results for the total assemblage, flake debris, flaked stone debris and chipped stone tools, respectively. Specimens with cortex present exhibit a higher frequency with lack of thermal

TABLE 7.2. THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D LITHIC CATEGORIES WITH FIRE CRACKED ROCK AND POT LIDS EXCLUDED.

		Thermal Alteration			
Lithic Types		Unaltered	Successfully Altered	Overheated	Total
Flake Debris	o	6214	8317	3086	17617
	e	6066.96	8268.34	3281.70	
	X*2	3.56	0.29	12.26	
	%	35.73	47.21	17.52	
Stone Debris	o	1768	1951	1187	4906
	e	1689.53	2302.58	913.89	
	X*2	3.65	53.68	81.62	
	%	36.04	39.77	24.19	
Chipped Stone Tools	o	198	883	154	1235
	e	425.31	579.63	230.06	
	X*2	121.49	158.78	25.15	
	%	16.03	71.5	12.47	
Ground Stone Tools	o	8	8	2	18
	e	6.20	8.45	3.35	
	X*2	0.52	0.02	0.54	
	%	44.44	44.44	11.11	
Total		8188	11159	4429	23776

Chi Square = 461.56 df = 6

TABLE 7.3. TOTAL ASSEMBLAGE CORTEX AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

Cortex Types		Thermal Alteration Unaltered	Successfully Altered	Overheated	Total
Cortex Absent	o	4827	8170	4055	17052
	e	5475.36	7477.47	4099.17	
	X*2	76.77	64.14	0.48	
	%	28.31	47.91	23.78	
Cortex Present	o	3361	3012	2075	8448
	e	2712.64	3704.53	2030.83	
	X*2	154.97	129.46	0.96	
	%	39.78	35.65	24.56	
Total		8188	11182	6130	25500

Chi Square = 426.78 df = 2

TABLE 7.4. FLAKED STONE DEBRIS CORTEX AND THERMAL ALTERATION VARIABILITY FROM LEFTWICH AREA D.

Cortex Types		Thermal Alteration Unaltered	Successfully Altered	Overheated	Total
Cortex Absent	o	303	729	555	1587
	e	564.90	635.92	386.18	
	X*2	121.42	13.62	73.80	
	%	19.09	45.94	34.97	
Cortex Present	o	1407	1196	614	3217
	e	1145.10	1289.08	782.82	
	X*2	59.90	6.72	36.43	
	%	43.87	37.18	19.09	
Total		1710	1925	1169	4804

Chi Square = 311.89 df = 2

TABLE 7.5. FLAKE DEBITAGE CORTEX AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

		Thermal Alteration			
Cortex Types		Unaltered	Successfully Altered	Overheated	Total
Cortex Absent	o	4345	6602	2522	13469
	e	4750.89	6358.73	2359.39	
	X*2	34.68	9.31	11.21	
	%	32.26	49.02	18.72	
Cortex Present	o	1869	1715	564	4148
	e	1463.11	1958.27	726.61	
	X*2	112.60	30.22	36.39	
	%	45.06	41.35	13.60	
Total		6214	8317	3086	17617

Chi Square = 234.41 df = 2

TABLE 7.6. CHIPPED STONE TOOL CORTEX AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

		Thermal Alteration			
Cortex Types		Unaltered	Successfully Altered	Overheated	Total
Cortex Absent	o	173	815	147	1135
	e	181.97	811.50	141.53	
	X*2	0.44	0.02	10.2	
	%	15.24	71.81	12.95	
Cortex Present	o	25	68	7	100
	e	16.03	71.50	12.47	
	X*2	5.02	0.17	02.4	
	%	25.00	68.00	7.00	
Total		198	883	154	1235

Chi Square = 8.26 df = 2

alteration and lower frequency with both successful alteration and overheating. Cortex absence, on the other hand, shows a high relative frequency with both successful alteration and overheating and a low relative frequency with lack of thermal alteration.

Chert. Ridley and Fort Payne chert represent 90% of the chert present in the total surface assemblage. A total of 11 chert classifications comprise the remaining 10%. These include Bigby Cannon, Brassfield, Carters, Greenstone, Lebannon, Quartzite, Steatite, St. Louis, miscellaneous chert and miscellaneous rock. For statistical purposes, only raw counts of Ridley and Fort Payne chert were utilized in the analysis.

There are statistically significant differences between thermal alteration categories: successfully altered and overheated with chert type. Tables 7.7, 7.8, 7.9 and 7.10 present the test results for the total assemblage, flake debris, flaked stone debris and chipped stone tools. Ridley chert shows higher relative frequency with thermal overheating and lower relative frequency with successful alteration. It is interesting to note that Ridley chert comprises 64.62% of the identified fire cracked rock and pot lids combined. Fort Payne chert, on the other hand, shows a higher relative frequency with successful alteration and lower relative

TABLE 7.7. TOTAL ASSEMBLAGE RIDLEY AND FORT PAYNE CHERT THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

		Thermal Alteration			
Chert Types		Unaltered	Successfully Altered	Overheated	Total
Ridley	o	3323	3579	3553	10455
	e	3465.94	4467.68	2521.38	
	X*2	5.90	176.77	422.09	
	%	31.78	34.23	33.98	
Fort Payne	o	4313	6264	2002	12579
	e	4170.06	5375.32	3033.62	
	X*2	4.90	146.92	350.82	
	%	34.29	49.80	15.92	
Total		7636	9843	5555	23034

Chi Square = 1107.4 df = 2

TABLE 7.8. RIDLEY AND FORT PAYNE CHERT FLAKE VARIABILITY BY THERMAL ALTERATION.

Chert Types		Thermal Alteration Unaltered	Successfully Altered	Overheated	Total
Ridley	o	2227	2420	1492	6139
	e	2239.41	2833.30	1066.29	
	X*2	0.07	60.29	169.96	
	%	36.28	39.42	24.30	
Fort Payne	o	3580	4927	1273	9780
	e	3567.59	4513.70	1698.71	
	X*2	0.04	37.84	106.69	
	%	36.61	50.38	13.02	
Total		5807	7347	2765	15919

Chi Square = 374.89 df = 2

TABLE 7.9. FLAKED STONE DEBRIS CHERT AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

Chert Types		Thermal Alteration			
		Unaltered	Successfully Altered	Overheated	Total
Ridley	o	1034	943	867	2844
	e	1045.59	1084.80	713.69	
	X*2	0.13	18.54	32.97	
	%	36.36	33.16	30.49	
Fort Payne	o	566	717	225	1508
	e	554.41	575.20	378.39	
	X*2	0.24	34.96	62.18	
	%	37.53	47.55	14.92	
Total		1600	1660	1092	4352

Chi Square = 149.02 df = 2

TABLE 7.10. CHIPPED STONE TOOL CHERT AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

		Thermal Alteration			
Chert Types		Unaltered	Successfully Altered	Overheated	Total
Ridley	o	52	203	79	334
	e	56.31	236.13	41.57	
	X*2	0.33	4.65	33.70	
	%	15.57	60.78	23.65	
Fort Payne	o	139	598	62	799
	e	134.69	564.87	99.43	
	X*2	40.1	1.94	14.09	
	%	17.40	74.84	7.76	
Total		191	801	141	1133
Chi Square = 54.85		df = 2			

frequency with thermal overheating. Unaltered Ridley and Fort Payne chert specimens are both distributed as expected.

Texture. The five texture categories described in Chapter V have been condensed to fine (category 1 and 2) and coarse (category 3, 4 and 5). There are statistically significant differences between texture and thermal alteration categories. Tables 7.11, 7.12, 7.13 and 7.14 present the test results for the total assemblage, flake debris, flaked stone debris and chipped stone tools. As expected, fine texture consistently has a higher relative frequency with successfully altered specimens and a lower relative frequency with those overheated. Coarse texture consistently has a higher relative frequency with overheated specimens and a lower relative frequency with those successfully altered. Unaltered fine and coarse textured chipped stone tools are randomly distributed. Unaltered fine textured flake debitage has a lower relative frequency while coarse textured flakes have a higher relative frequency. Unaltered fine textured flaked stone debris has higher relative frequency while coarse textured stone debris shows a lower relative frequency.

TABLE 7.11. TOTAL ASSEMBLAGE TEXTURE AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

Texture Types		Thermal Alteration Unaltered	 Successfully Altered	 Overheated	Total
Fine	o	7377	10541	4315	22233
	e	7138.97	9749.39	5344.64	
	X*2	7.94	64.28	198.36	
	%	33.18	47.41	19.41	
Coarse	o	811	641	1815	3267
	e	1049.03	1432.12	785.36	
	X*2	54.01	437.02	9.90134	
	%	24.82	19.62	55.56	
Total		8188	11182	6130	25500

Chi Square = 2111.51   df = 2

TABLE 7.12. FLAKE DEBITAGE TEXTURE AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

Texture Types		Thermal Alteration Unaltered	 Successfully Altered	 Overheated	Total
Fine	o	5623	7942	2499	16064
	e	5666.21	7583.83	2813.96	
	X*2	0.33	16.92	35.25	
	%	35.00	49.44	15.56	
Coarse	o	591	375	587	1553
	e	547.79	733.17	272.04	
	X*2	3.41	174.97	364.65	
	%	38.06	24.15	37.80	
Total		6214	8317	3086	17617

Chi Square = 595.53 df = 2

TABLE 7.13. FLAKED STONE DEBRIS TEXTURE AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

		Thermal Alteration			
Texture Types		Unaltered	Successfully Altered	Overheated	Total
Fine	o	1540	1710	776	4026
	e	1433.07	1613.25	979.68	
	X*2	7.98	5.80	42.35	
	%	38.25	42.47	19.27	
Coarse	o	170	215	393	778
	e	276.93	311.75	189.32	
	X*2	41.29	30.03	219.13	
	%	21.85	27.63	50.51	
Total		1710	1925	1169	4804

Chi Square = 346.58 df = 2

TABLE 7.14. CHIPPED STONE TOOL TEXTURE AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

Texture Types		Thermal Alteration Unaltered	Successfully Altered	Overheated	Total
Fine	o	184	854	126	1164
	e	186.62	832.24	145.15	
	X*2	40.0	0.57	2.53	
	%	15.81	73.37	10.82	
Coarse	o	14	29	28	71
	e	11.38	50.76	8.85	
	X*2	0.60	9.33	41.44	
	%	19.72	40.85	39.44	
Total		198	883	154	1235

Chi Square = 54.51 df = 2

Reduction stage. Flake debitage has been divided into four categories and crosstabulated with thermal alteration (Table 7.15). Flake debitage categories are: (1) Decortication flakes which include primary, secondary and core rejuvenation flakes, (2) Tertiary flakes, (3) Large BTF´s and (4) Small BTF´s which also include retouch and petaloid flakes. Broken flakes were excluded from this analysis. Initial reduction and biface reduction flakes follow opposite thermal alteration patterns. Decortication and Tertiary flakes have a higher relative frequency of unalteration and a lower relative frequency with successful alteration. Large and small BTF´s have a higher relative frequency with successful alteration and a lower relative frequency with lack of alteration. All overheated flakes exhibit a random distribution.

All flaked stone debris categories deviate from expectation (Table 7.16). Tested cobbles have a higher relative frequency of unalteration and a lower relative frequency with both successful alteration and overheating. Cores show a high relative frequency with unalteration, as well as successful alteration and a low relative frequency with overheating. Blocky debris exhibits a higher relative frequency with overheating while unaltered blocky debris has a lower relative

TABLE 7.15. FLAKE REDUCTION STAGE DEBRIS AND THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

Flake Types		Thermal Alteration Unaltered	 Successfully Altered	 Overheated	Total
Decortication Flakes	o	1700	1491	510	3701
	e	1481.99	1690.41	528.59	
	X*2	32.07	23.52	0.65	
	%	45.93	40.29	13.78	
Tertiary Flakes	o	980	927	329	2236
	e	895.36	1021.28	319.36	
	X*2	8.00	8.71	0.29	
	%	43.83	41.46	14.71	
Large Biface Thinning Flakes	o	752	1122	322	2196
	e	879.34	1003.01	313.64	
	X*2	18.44	14.12	0.22	
	%	34.24	51.09	14.66	
Small Biface Thinning Flakes	o	109	499	102	710
	e	284.31	324.29	101.41	
	X*2	108.10	94.12	0	
	%	15.35	70.28	14.37	
Total		3541	4039	1263	8843
Chi Square = 308.24		df = 6			

TABLE 7.16. FLAKED STONE DEBRIS THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

Lithic Debris		Thermal Alteration Unaltered	Successfully Altered	Overheated	Total
Blocky Debris	o	1087	1310	984	3381
	e	1203.48	1354.79	822.73	
	X*2	11.27	1.48	31.61	
	%	32.15	38.75	29.10	
Tested Cobbles	o	172	81	22	275
	e	97.89	110.19	66.92	
	X*2	56.11	7.73	30.15	
	%	62.55	29.45	8.00	
Cores	o	451	534	163	1148
	e	408.63	460.01	279.35	
	X*2	2.15	11.90	48.46	
	%	39.29	46.52	14.20	
Total		1710	1925	1169	4804

Chi Square = 200.86 df = 2

frequency, and successfully altered blocky debris is randomly distributed. There is a relationship between the amount of cortex present and thermal alteration. Lack of cortex is correlated with successful alteration while cortex presence is associated with no heat treatment.

Biface manufacture appears to have been an important aspect of aboriginal behavior at Leftwich. In all, over 1,100 bifaces were recovered from the controlled surface collection of 40MU262. Initial and late stage bifaces follow opposite thermal alteration patterns (Table 7.17). Initial bifaces have a higher relative frequency with lack of alteration and a lower relative frequency for successful alteration. Late stage bifaces, on the other hand, show a high relative frequency with successful alteration and a low relative frequency of unalteration. Overheated initial and late stage bifaces are both randomly distributed. Intermediate bifaces are randomly distributed in all thermal alteration categories.

Chipped Stone Tools. Based on diagnostic projectile point/knives, the Leftwich area has been occupied continuously, seasonally or sporadically from Early Archaic to Late Woodland times. The artifacts and debitage potentially represent a ca. 9,000 year

TABLE 7.17. BIFACE STAGE THERMAL ALTERATION VARIABILITY FOR LEFTWICH AREA D.

		Thermal Alteration			
Bifaces		Unaltered	Successfully Altered	Overheated	Total
Initial Biface	o	34	56	11	101
	e	17.36	70.93	12.70	
	X*2	15.95	3.14	0.23	
	%	33.66	55.45	10.89	
Intermediate Biface	o	40	173	33	246
	e	42.29	172.77	30.94	
	X*2	0.12	0	0.14	
	%	16.26	70.33	13.41	
Late Biface	o	8	106	16	130
	e	22.35	91.30	16.35	
	X*2	9.21	2.37	0.01	
	%	6.15	81.54	12.31	
Total		82	335	60	477

Chi Square = 31.17 df = 4

accumulation (Amick et al. 1985: Table 2.1). Table 7.18 presents thermal alteration categories by cultural periods. Due to low cell frequencies, chi-square tests were not conducted.

C. INTRASITE COMPONENT ANALYSIS

Assessment of differential technological organization and implications of group mobility are particularly important in comparing the two Leftwich Archaic components. A general examination of thermal alteration at Leftwich Area A will be conducted initially. A closer examination of specific artifact categories for both components follows the general discussion. Before analysis is undertaken, the possibility thermal alteration occurred accidentially will be investigated.

Investigation of Accidental Thermal Alteration

Thermal alteration variability is crosstabulated by broad lithic categories in Tables 7.19 and 7.20 for excavated Benton and Ledbetter components, respectively. Fire cracked rock and pot lids are excluded while abraders are included with "stone debris" in Tables 7.19 and 7.20. Between 26% and 32% of the total assemblages show characteristics of thermal alteration. The incidence of successful alteration is smaller than the

TABLE 7.18. DIAGNOSTIC PROJECTILE POINTS AND THERMAL ALTERATION VARIABILITY FROM LEFTWICH AREA D.

	Thermal Alteration			
Diagnostic Projectile Points	Unaltered	Successfully Altered	Overheated	Total
Jack´s Reef Corner Notched		1		1
Hamilton Cluster		1		1
Lanceolate Expanded Stemmed		3		3
Lanceolate Spike		1		1
McFarland Cluster		6	2	8
Rounded Base Cluster		3		3
Motley		1	1	2
Wade		2	1	3
Ledbetter Cluster	6	14	4	24
Benton		8		8
White Springs/Sykes		2		2
Eva/Morrow Mountain		6	2	8
Kirk Cluster		2		2
Big Sandy Cluster	1	3	1	5
Total	7	59	5	71
%	9.86	83.10	7.04	100.00

TABLE 7.19. CROSSTABULATION OF LEFTWICH AREA A BENTON COMPONENT LITHIC AND THERMAL ALTERATION VARIABILITY.

		Thermal Alteration			
Lithic Artifacts		Unaltered	Successfully Altered	Overheated	Total
Flake Debitage	o	391	79	67	537
	e	351.64	80.86	104.50	
	X*2	4.41	0.04	13.46	
	%	72.81	14.71	12.48	
Stone Debris	o	59	21	62	142
	e	92.98	21.38	27.63	
	X*2	12.42	0.01	42.75	
	%	41.55	14.79	43.66	
Chipped and Ground Stone Tools	o	11	6	8	25
	e	16.37	3.76	4.87	
	X*2	1.76	1.33	2.01	
	%	44	24	32	
Total		461	106	137	704

Chi Square = 78.19 df = 4

TABLE 7.20. CROSSTABULATION OF LEFTWICH AREA A LEDBETTER COMPONENT LITHIC AND THERMAL ALTERATION VARIABILITY.

		Thermal Alteration			
Lithic Types		Unaltered	Successfully Altered	Overheated	Total
Flake Debitage	o	1125	145	163	1433
	e	962.57	151.13	319.31	
	X*2	27.41	0.25	76.52	
	%	78.51	10.12	11.37	
Stone Debris	o	104	27	241	372
	e	249.88	39.23	82.89	
	X*2	85.16	3.81	301.59	
	%	27.96	7.26	64.78	
Chipped and Ground Stone Tools	o	13	23	8	44
	e	29.56	4.64	9.80	
	X*2	9.28	72.65	0.33	
	%	29.55	52.57	18.18	
Total		1242	195	412	1849
Chi Square =	577	df = 4			

occurrance of overheating in both components. The Benton assemblage has the greatest overall amount of heat alteration (31.80%), as well as the highest proportion of successful alteration (15.53%), while the Ledbetter assemblage has a lower proportion of successful alteration (11.54%) and overheating (14.23%).

The occurrance of overheating at Leftwich corresponds closely with that reported from Mesolithic sites in the Netherlands (Price et al: 1982: Table 5). Price et al: (1982:475) conclude

> The high incidence of overheating phenomena in those assemblages is indicative of accidental exposure to heat. The proportion of overheated pieces is much greater than would be expected from a few accidental misfirings during the process of intentional thermal pretreatment. The abundance of overheated pieces suggests that accidental exposure to heat sources during the occupation and/or brush fires after the abandonment of the site is responsible. The incidence of overheating is directly correlated with the size of the assemblages at each site and suggests that the proportion of heat alteration may be a function of the duration, intensity, or season of occupation. More heat sources would be expected to occur at a settlement inhabited during the colder months of the year.

At Leftwich there is a relationship between heat alteration categories and Archaic components. In the Benton assemblage flake debitage has a higher relative frequency with lack of alteration (Table 7.19) while the Ledbetter assemblage flake debitage has a lower relative frequency with unalteration (Table 7.20). In both assemblages flake debitage has a lower relative frequency with overheating and a random distribution with successful alteration. Stone debris and ground stone tools have a higher relative frequency with overheating, a lower relative frequency with unalteration and a random distribution with successful alteration. Both component´s chipped stone tools have a higher relative frequency with successful alteration, as well as overheating and a lower relative frequency with lack of alteration. Large chi-square values in the Benton component occur in stone debris with overheating, in chipped stone tools with overheating, as well as unalteration, and in flake debitage with overheating. Large chi-square values in the Ledbetter component occur in chipped stone tools with successful alteration, as well as lack of alteration in stone debris with both overheating and unalteration and flake debitage with overheating. Accidental thermal alteration undoubtly occurred at Leftwich, but chi-square tests indicate lithics from the Benton and Ledbetter components differ significantly in the amount of successfully altered lithic artifacts. This difference is investigated below.

Cortex

Total lithic assemblage. Tables 7.21 and 7.22 present the chi-square test results for the total lithic assemblages in the Benton and Ledbetter components, respectively. Unaltered Ledbetter lithic specimens have a higher relative frequency without cortex and a lower relative frequency with cortex. Successfully altered Ledbetter lithic specimens show a high relative frequency without cortex and a low relative frequency with cortex. In both components overheating exhibits a higher relative frequency with cortex presence and a lower relative frequency without cortex. Unaltered and successfully altered specimens are randomly distributed in the Benton component.

Flake debitage. Flake debris cortex and thermal alteration test results are presented in Tables 7.23 and 7.24 for Benton and Ledbetter components, respectively. All unaltered, successfully altered and overheated flake debitage are distributed as expected whether cortex is present or not.

Flaked stone debris. Test results of flaked stone debris for Benton and Ledbetter components are presented in Tables 7.25 and 7.26, respectively. Unaltered, successfully altered and overheated flaked

TABLE 7.21. TOTAL ASSEMBLAGE CORTEX AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Cortex		Unaltered	Successfully Altered	Overheated	Total
Cortex Absence	o	372	90	93	555
	e	365.01	84.35	105.64	
	X*2	0.13	0.38	1.51	
	%	67.03	16.22	16.76	
Cortex Present	o	91	17	41	149
	e	97.99	22.65	28.36	
	X*2	0.50	1.41	5.63	
	%	61.07	11.41	27.52	
Total		463	107	134	704
Chi Square = 9.56		df = 2			

TABLE 7.22. TOTAL ASSEMBLAGE CORTEX AND THERMAL ALTERATION VARIATILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Cortex		Unaltered	Successfully Altered	Overheated	Total
Cortex Absence	o	935	149	231	1315
	e	892.55	132.28	290.17	
	X*2	2.02	2.11	12.07	
	%	71.10	11.33	17.57	
Cortex Present	o	320	37	177	534
	e	362.45	53.72	117.83	
	X*2	4.97	05.2	29.71	
	%	59.93	6.93	33.15	
Total		1255	186	408	1849
Chi Square = 56.08		df = 2			

TABLE 7.23. FLAKE DEBITAGE CORTEX AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Cortex		Unaltered	Successfully Altered	Overheated	Total
Cortex Absence	o	329	68	56	453
	e	329.84	66.64	56.52	
	X*2	0	0.03	0	
	%	72.63	15.01	12.36	
Cortex Present	o	62	11	11	84
	e	61.16	12.36	10.48	
	X*2	10.0	50.1	30.0	
	%	73.81	13.10	13.10	
Total		391	79	67	537

Chi Square = 0.22 df = 2

TABLE 7.24. FLAKE DEBITAGE CORTEX AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

Cortex		Thermal Alteration Unaltered	Successfully Altered	Overheated	Total
Cortex Absence	o	881	122	120	1123
	e	881.63	113.63	127.74	
	X*2	0	0.62	0.47	
	%	78.45	10.86	10.69	
Cortex Present	o	244	23	43	310
	e	243.37	31.37	35.26	
	X*2	0	2.23	1.70	
	%	78.71	7.42	13.87	
Total		1125	145	163	1433
Chi Square =	5.02	df = 2			

TABLE 7.25. FLAKED STONE DEBRIS CORTEX AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Cortex		Unaltered	Successfully Altered	Overheated	Total
Cortex Absence	o	37	14	22	73
	e	39.26	12.27	21.47	
	X*2	0.13	0.24	10.0	
	%	50.68	19.18	30.14	
Cortex Present	o	27	6	13	146
	e	24.74	7.73	13.53	
	X*2	0.21	0.39	0.02	
	%	58.70	13.04	28.26	
Total		64	20	35	119

Chi Square = 1.0 df = 2

TABLE 7.26. FLAKED STONE DEBRIS CORTEX AND THERMAL ALTERATION VARIABILITY FROM LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Cortex		Unaltered	Successfully Altered	Overheated	Total
Cortex Absent	o	31	12	33	76
	e	40.12	10.03	25.85	
	X*2	2.07	0.39	1.98	
	%	40.79	15.79	43.42	
Cortex Present	o	73	14	34	121
	e	63.88	15.97	41.52	
	X*2	1.30	0.24	1.36	
	%	60.33	11.57	28.10	
Total		104	26	67	197

Chi Square = 7.34 df = 2

stone debris are randomly distributed whether cortex is present or not.

Lithic Resources

Total lithic assemblages.

Chi-square test results of the total lithic assemblages are presented for Benton and Ledbetter components, in Tables 7.27 and 7.28 respectively. Unaltered Ridley and Fort Payne specimens are randomly distributed in both components. Ledbetter Ridley chert specimens show a high relative frequency with successful alteration while Fort Payne specimens have a low relative frequency with successful alteration. Benton Ridley chert has a high relative frequency with overheating. Overheated Ledbetter specimens and successfully altered Benton specimens are randomly distributed for both chert types.

Flake debitage.

Tables 7.29 and 7.30 present the chi-square test results of the flake debitage for Benton and Ledbetter components, respectively. Benton and Ledbetter components do not have the same response probabilities for thermally altered chert. Benton Ridley chert shows a high frequency with overheating, while Fort Payne chert has a low frequency with overheating. On the other hand, Ledbetter Ridley chert shows a high relative frequency with successful alteration, while Fort Payne

TABLE 7.27. TOTAL ASSEMBLAGE RIDLEY AND FORT PAYNE CHERT THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Chert Type		Unaltered	Successfully Altered	Overheated	Total
Ridley	o	256	60	84	400
	e	264.22	61.77	74.01	
	X*2	0.26	0.05	1.35	
	%	64	15	21	
Fort Payne	o	176	41	37	254
	e	167.78	39.23	46.99	
	X*2	0.40	0.08	2.12	
	%	69.29	16.14	14.57	
Total		432	101	121	654

Chi Square = 4.26 df = 2

TABLE 7.28. TOTAL ASSEMBLAGE RIDLEY AND FORT PAYNE CHERT THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Chert Type		Unaltered	Successfully Altered	Overheated	Total
Ridley	o	635	133	213	981
	e	662.27	98.72	220.01	
	X*2	1.12	11.90	0.22	
	%	64.73	13.56	21.71	
Fort Payne	o	539	42	177	758
	e	511.73	76.28	169.99	
	X*2	1.45	15.41	0.29	
	%	71.11	5.54	23.35	
Total		1174	175	390	1739
Chi Square = 30.39		df = 2			

TABLE 7.29. RIDLEY AND FORT PAYNE CHERT FLAKE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Chert Type		Unaltered	Successfully Altered	Overheated	Total
Ridley	o	218	45	49	312
	e	226.80	45.97	39.23	
	X*2	0.34	0.02	2.43	
	%	69.87	14.42	15.71	
Fort Payne	o	152	30	15	197
	e	143.20	29.03	24.77	
	X*2	0.54	0.03	3.85	
	%	77.16	15.23	7.61	
Total		370	75	64	509

Chi Square = 7.21 df = 2

TABLE 7.30. RIDLEY AND FORT PAYNE CHERT FLAKE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Chert Type		Unaltered	Successfully Altered	Overheated	Total
Ridley	o	570	100	80	750
	e	587.10	75.06	87.84	
	X*2	0.50	8.29	0.70	
	%	76	13.33	10.67	
Fort Payne	o	468	35	78	599
	e	468.90	59.94	70.16	
	X*2	0.62	10.38	0.88	
	%	81.14	5.84	13.02	
Total		1056	135	158	1349

Chi Square = 21.37 df = 2

chert has a low relative frequency with successful alteration. Unaltered chert specimens are distributed randomly for both components. Successfully altered specimens are distributed as expected in the Benton component, while overheated specimens are randomly distributed in the Ledbetter component.

Flaked stone debris. Flaked stone debris test results are presented in Tables 7.31 and 7.32 for Benton and Ledbetter components, respectively. Successfully altered Ledbetter Ridley stone debris has a higher relative frequency, while successfully altered Fort Payne stone debris shows a lower relative frequency. Ledbetter unaltered and overheated Ridley and Fort Payne flaked stone debris are randomly distributed. Benton unaltered, successfully altered and overheated Ridley and Fort Payne flaked stone debris are all randomly distributed.

Texture

Total lithic assemblage. Test results of the total lithic assemblages for Benton and Ledbetter components are presented in Tables 7.33 and 7.34, respectively. Successfully altered fine and coarse specimens are distributed randomly in both components. In addition, Benton fine textured specimens are randomly distributed. Benton coarse specimens show a high

TABLE 7.31. FLAKED STONE DEBRIS CHERT AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Chert Type		Unaltered	Successfully Altered	Overheated	Total
Ridley	o	35	9	22	66
	e	33.93	11.10	20.97	
	X*2	0.03	0.40	0.05	
	%	53.03	13.64	33.33	
Fort Payne	o	20	9	12	41
	e	21.07	6.90	13.03	
	X*2	0.05	0.64	0.08	
	%	48.78	21.95	29.27	
Total		55	18	34	107

Chi Square = 1.25 df = 2

TABLE 7.32. FLAKED STONE DEBRIS CHERT AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Chert Type		Unaltered	Successfully Altered	Overheated	Total
Ridley	o	59	26	33	118
	e	61.21	17.04	39.75	
	X*2	0.08	4.71	1.15	
	%	50	22.03	27.97	
Fort Payne	o	38	1	30	69
	e	35.79	9.96	23.25	
	X*2	0.14	8.06	1.96	
	%	55.07	1.45	43.48	
Total		97	27	63	187

Chi Square = 16.1 df = 2

TABLE 7.33. TOTAL ASSEMBLAGE TEXTURE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Texture		Unaltered	Successfully Altered	Overheated	Total
Fine	o	422	96	103	621
	e	408.41	94.38	118.20	
	X*2	0.45	0.03	1.95	
	%	67.95	15.46	16.59	
Coarse	o	41	11	31	83
	e	54.89	12.62	15.80	
	X*2	3.51	0.21	14.62	
	%	49.40	13.25	37.35	
Total		463	107	134	704
Chi Square = 20.77		df = 2			

TABLE 7.34. TOTAL ASSEMBLAGE TEXTURE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Texture		Unaltered	Successfully Altered	Overheated	Total
Fine	o	1078	151	293	1522
	e	1033.05	153.11	335.84	
	X*2	1.96	0.03	5.46	
	%	70.83	9.92	19.25	
Coarse	o	177	35	115	327
	e	221.95	32.89	72.16	
	X*2	9.10	0.14	25.43	
	%	54.13	10.70	35.17	
Total		1255	186	408	1849

Chi Square = 42.12 df = 2

relative frequency with overheating and a low relative frequency for lack of alteration. Ledbetter fine-grained specimens exhibit a high relative frequency with lack of alteration and a low relative frequency for overheating. Ledbetter coarse-grained specimens, on the other hand, show a higher relative frequency with overheating and a lower relative frequency with lack of thermal alteration.

Flake debitage. Flake debitage test results are presented in Tables 7.35 and 7.36 for Benton and Ledbetter components, respectively. Benton flake debitage texture categories are randomly distributed whether thermal alteration occurred or not. Ledbetter flake debitage texture categories follow the pattern described above for the total Ledbetter assemblage.

Flaked stone debris. Chi-square test results of texture and thermal alteration for the Benton and Ledbetter components flaked stone debris, are presented in Tables 7.37 and 7.38 respectively. Ledbetter stone debris texture categories follow the same pattern described for the total Ledbetter assemblage. Although Benton stone debris texture categories follow the pattern described above for the total Benton assemblage,

TABLE 7.35. FLAKE DEBITAGE TEXTURE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Texture		Unaltered	Successfully Altered	Overheated	Total
Fine	o	358	72	57	487
	e	354.59	71.64	60.76	
	X*2	30.0	0	0.23	
	%	73.51	14.78	11.70	
Coarse	o	33	7	10	50
	e	36.41	7.36	6.24	
	X*2	0.32	0.02	2.27	
	%	66	14	20	
Total		391	79	67	537

Chi Square = 2.87 df = 2

TABLE 7.36. FLAKE DEBITAGE TEXTURE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Texture		Unaltered	Successfully Altered	Overheated	Total
Fine	o	989	119	133	1241
	e	967.52	124.70	148.78	
	X*2	0.48	0.26	1.67	
	%	79.69	9.59	10.72	
Coarse	o	136	26	40	202
	e	157.48	20.30	24.22	
	X*2	2.93	1.60	10.28	
	%	67.33	12.87	19.80	
Total		1125	145	173	1443

Chi Square = 17.22 df = 2

TABLE 7.37. FLAKED STONE DEBRIS TEXTURE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Texture		Unaltered	Successfully Altered	Overheated	Total
Fine	o	56	16	23	95
	e	51.09	15.97	27.94	
	X*2	0.47	0	0.87	
	%	58.95	16.84	24.21	
Coarse	o	8	4	12	24
	e	12.91	4.03	7.06	
	X*2	1.87	0	3.46	
	%	33.33	16.67	50	
Total		64	20	35	119

Chi Square = 6.67 df = 2

TABLE 7.38. FLAKED STONE DEBRIS TEXTURE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Texture		Unaltered	Successfully Altered	Overheated	Total
Fine	o	67	17	53	137
	e	72.32	18.08	46.59	
	X*2	0.39	0.06	0.88	
	%	48.91	12.41	38.69	
Coarse	o	37	9	14	60
	e	31.68	7.92	20.41	
	X*2	0.89	0.15	2.01	
	%	61.67	15	23.33	
Total		104	26	67	197

Chi Square = 4.38 df = 2

significance is probably due to small sample size and should be considered ambiguous.

Reduction Stage

<u>Flake reduction stage.</u> Tables 7.39 and 7.40 present the chi-square test results of flake debitage and thermal alteration variability for the Benton and Ledbetter components, respectively. Benton and Ledbetter components do not have the same response probabilities for thermal alteration and flake stage. In the Benton component large BTF´s have a higher relative frequency with overheating and decortication flakes are randomly distributed. Large BTF´s in the Ledbetter component have a low relative frequency with overheating and decortication flakes show a high relative frequency with overheating. In both components small BTF´s show a high relative frequency with successful alteration and tertiary flakes have a low relative frequency with successful alteration.

<u>Biface thinning flake size.</u> Test results of biface flake stage from Benton and Ledbetter components are presented in Tables 7.41 and 7.42, respectively. Large and small BTF´s follow the same patterns discussed above but are not significant.

TABLE 7.39. FLAKE REDUCTION STAGE DEBRIS AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Flake Stage		Unaltered	Successfully Altered	Overheated	Total
Decortication Flakes	o	96	13	11	120
	e	91.28	14.36	14.36	
	X*2	0.24	0.13	0.79	
	%	80	10.83	9.17	
Tertiary Flakes	o	45	3	7	55
	e	41.84	6.58	6.58	
	X*2	0.24	1.95	0.03	
	%	81.82	5.54	12.73	
Large Biface Thinning Flakes	o	25	6	9	40
	e	30.43	4.79	4.79	
	X*2	0.97	0.31	3.70	
	%	6.25	15	2.25	
Small Biface Thinning Flakes	o	12	6	1	19
	e	14.45	2.27	2.27	
	X*2	0.42	6.13	0.71	
	%	63.16	31.58	5.26	
Total		178	28	28	234
Chi Square = 15.62		df = 6			

TABLE 7.40. FLAKE REDUCTION STAGE DEBRIS AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Flake Stage		Unaltered	Successfully Altered	Overheated	Total
Decortication Flakes	o	269	28	43	340
	e	276.18	31.72	32.10	
	X*2	0.19	0.44	3.70	
	%	79.12	8.24	12.65	
Tertiary Flakes	o	216	17	25	258
	e	209.57	24.07	24.36	
	X*2	0.20	2.08	0.02	
	%	83.72	6.59	9.69	
Large Biface Thinning Flake	o	94	13	3	110
	e	89.35	10.26	10.39	
	X*2	0.24	0.73	5.26	
	%	85.45	11.82	2.73	
Small Biface Thinning Flake	o	135	24	12	171
	e	138.90	15.95	16.15	
	X*2	0.11	4.06	1.07	
	%	78.95	14.04	7.02	
Total		714	82	83	879
Chi Square = 18.1		df = 6			

TABLE 7.41. BIFACE FLAKE REDUCTION STAGE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Flake Stage		Unaltered	Successfully Altered	Overheated	Total
Large Biface	o	25	6	9	40
Thinning	e	25.08	8.14	6.78	
Flakes	X*2	0	0.56	0.73	
	%	6.25	15	2.25	
Small Biface	o	12	6	1	19
Thinning	e	11.92	3.86	3.22	
Flakes	X*2	0	1.19	1.53	
	%	63.16	31.58	5.26	
Total		37	12	10	59
Chi Square = 4.01		df = 2			

TABLE 7.42. BIFACE FLAKE REDUCTION STAGE AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Flake Stage		Unaltered	Successfully Altered	Overheated	Total
Large Biface Thinning Flakes	o	94	13	3	110
	e	89.64	14.48	5.87	
	X*2	0.21	0.15	1.40	
	%	85.45	11.82	2.73	
Small Biface Thinning Flakes	o	135	24	12	171
	e	139.36	22.52	9.13	
	X*2	0.14	0.10	0.90	
	%	78.95	14.04	7.02	
Total		229	37	15	281

Chi Square = 2.9 df = 2

Cores and bifaces. Chi-square test results of expedient and chipped stone artifacts are presented in Tables 7.43 and 7.44 for Benton and Ledbetter components, respectively. Successfully altered Ledbetter bifaces have a high relative frequency, while successfully altered cores show a low relative frequency. Unaltered Ledbetter Bifaces have a lower relative frequency than expected. Unaltered and overheated Ledbetter cores are randomly distributed. Benton cores are distributed randomly regardless of thermal alteration. Unaltered Benton bifaces show a low relative frequency, while successfully altered, as well as overheated bifaces have a high relative frequency.

D. INTERSITE COMPONENT ANALYSIS

Flake Reduction

Chi-square test results of flake reduction stage by Benton and Ledbetter components are presented in Table 7.45. Benton assemblage decortication and large BTF´s have a high relative frequency while small BTF´s have a low relative frequency and tertiary flakes are randomly distributed. Ledbetter assemblage small BTF´s show a high relative frequency, decortication flakes have a low relative frequency while tertiary, as well as large BTF´s are randomly distributed. Lithic flake reduction

TABLE 7.43. CROSSTABULATION OF CORES, BIFACES AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A BENTON COMPONENT.

		Thermal Alteration			
Artifact Type		Unaltered	Successfully Altered	Overheated	Total
Cores	o	58	20	35	113
	e	53.43	21.90	37.67	
	X*2	0.39	0.16	0.19	
	%	51.33	17.70	30.97	
Bifaces	o	3	5	8	16
	e	7.57	3.10	5.33	
	X*2	2.76	1.16	1.34	
	%	18.75	31.25	50	
Total		61	25	43	129
Chi Square = 6.0		df = 2			

TABLE 7.44. CROSSTABULATION OF CORES, BIFACES AND THERMAL ALTERATION VARIABILITY FROM THE LEFTWICH AREA A LEDBETTER COMPONENT.

		Thermal Alteration			
Artifact Type		Unaltered	Successfully Altered	Overheated	Total
Cores	o	103	26	67	196
	e	91.58	40.23	64.19	
	X*2	1.42	5.03	0.12	
	%	52.55	13.27	34.18	
Bifaces	o	4	21	8	33
	e	15.42	6.77	10.81	
	X*2	8.46	29.91	0.73	
	%	12.12	63.64	24.24	
Total		107	47	75	229

Chi Square = 45.67 df = 2

TABLE 7.45. CROSSTABULATION OF FLAKE REDUCTION STAGE DEBRIS BY LEFTWICH AREA A COMPONENTS.

Assemblage		Initial Reduction Flakes	Tertiary Flakes	Large Flakes	Small BTF	Total
Benton	o	120	55	40	19	234
	e	96.71	65.81	31.54	39.95	
	X*2	5.61	1.77	2.27	10.95	
	%	51.28	23.50	17.09	8.12	
Ledbetter	o	340	258	110	171	879
	e	363.29	247.19	118.46	150.05	
	X*2	1.49	0.47	0.60	2.92	
	%	38.68	29.35	12.51	19.45	
Total		460	313	150	190	1113

Chi Square = 26.1 df = 3

debitage indicates the Ledbetter component is more logistically oriented than the Benton component.

Chert and Biface Reduction

Table 7.46 presents tabular data of Ridley and Fort Payne chert projectile points/knives, whole and fragmentary bifaces, large BTF´s, small BTF´s, retouch and petaloid flakes combined and the ratio of BTF´s to bifacially flaked tools from the Leftwich surface assemblage and the Benton and Ledbetter assemblages.

Biface Failure

Biface failure refers to possible reasons bifaces were discarded after or during manufacture (e.g. Chapter 5). Technological studies of biface production have consistently considered breakage variability as an important source of information (Ahler 1983; Amick 1982; Johnson 1979, 1981a, 1981b). Patterns of breakage should be responsive to functional and organizational aspects of prehistoric hunter-gatherers which concern anthropological researchers. Biface failures were recorded for all bifacially flaked chipped stone artifacts. More projectile points/knives were heat fractured than any other chipped stone artifact. Less than 30% of the Ledbetter unstemmed bifaces have heat fractures while 0% of the Benton unstemmed bifaces have

TABLE 7.46. LEFTWICH RIDLEY AND FORT PAYNE CHERT BIFACE REDUCTION DEBRIS AND ARTIFACTS BY ASSEMBLAGE.

Assemblage	Chert	PPK´s	Bifaces	Large BTF	Small BTF	Retouch Flakes	Ratio
Benton	Ridley	9	0	26	8	1	4:1
	Fort Payne	3	4	13	7	3	3:1
Ledbetter	Ridley	7	5	59	44	14	10:1
	Fort Payne	17	6	47	92	19	7:1
Surface	Ridley	164	136	600	190	12	3:1
	Fort Payne	375	380	1453	445	24	3:1

heat fractures. Biface failures caused by heat fractures and non-thermal fractures are contrasted for projectile points/knives. There is a relationship between PPK failure type and Archaic component (Table 7.47). A greater frequency of Benton points are heat fractured than expected while Ledbetter points are not heat fractured. Seventeen points and point fragments associated with the Ledbetter assemblage have no heat fractures (77.27%). A majority of Ledbetter non-heat fractured PPK´s exhibit lateral snap (71%) with occasional reverse (18%), perverse (6%) and hinge (6%). Only four points and point fragments associated with the Benton assemblage lack heat fractures (40%). A majority of Benton non-heat fractured PPK´s exhibit reverse (50%), as well as, an equal amount of lateral snap and hinge (25%).

Although both Fort Payne and Ridley are heat fractured, Ridley dominates both assemblages with 100% of the Benton Ridley PP/K´s heat fractured and 30% of the Ledbetter Ridley PP/K´s heat fractured. Fort Payne heat fractured PP/K´s comprise 42% of the Benton Fort Payne PP/k´s and 11% of the Ledbetter Fort Payne PP/K´s.

TABLE 7.47. LEFTWICH PROJECTILE POINTS AND BIFACE FRACTURE TYPE BY ASSEMBLAGE.

Assemblage		Non-heat Fractured Points	Heat Fractured Points	Total
Benton	o	4	6	10
	e	6.57	3.44	
	X*2	1.01	1.91	
	%	40	60	
Ledbetter	o	17	5	22
	e	14.44	7.56	
	X*2	0.45	0.87	
	%	77.27	22.73	
Total		21	11	32
Chi Square =	4.24	df = 1		

E. INTERSITE COMPONENT COMPARISONS: FUNCAT STATISTIC

In order to compare multiple variables within two Archaic components, an analysis of variance procedure, known as Funcat, is utilized to produce a linear regression model from nominal data. Funcat was run using the Statistic Analysis System (SAS), a computer software system for data analysis (Ray 1982). Nominal or categorical variables have "a small number of discrete levels where levels are treated as names rather than as representatives of some ordered scale" (Ray 1982:245). Funcat models functions of categorical responses as a linear model. Raw data utilized in the Funcat procedure can be found in Appendix C. Funcat specializes in homogeneity tests for single response, multiple sample problems. According to Grizzle et al. (1969) this procedure uses weighted least squares to produce minimum chi-square estimates. Funcat assumes that units are chosen randomly from a background population about which you want to generalize. The background population is assumed to be infinite, so sampling with or without replacement is not relevant. The response is categorical since what is measured are the frequency counts for each sample. Counts are assumed to follow a multinomial distribution. Each cell count must be 0.5 or larger but 15 or more is recommended. In order to avoid trouble with empty cells, some researchers recommend adding small values to each cell; however, increasing cell counts to the model may seriously bias variance estimates in problems with a large number of cells but a small total frequency. In this analysis categories were collapsed when necessary to avoid zero cells.

Funcat requires responses to be distinguished from design effect factors. The Funcat model consists of response and design effects (response = A B A*B). The two possible components: Benton and Ledbetter, have been designated as the response variable. Five design factors are investigated (1) cortex, (2) texture, (3) chert, (4) thermal alteration and (5) reduction stage. Each possible combination of response variable with design effect variables yields the number of samples produced in the model. The statistical options specified in the model statement (after a slash) include FREQ, PROB, ONEWAY and COV.

The question one seeks to answer is: are component probabilities the same in each sample? If response probabilities are not the same, there are several possible reasons. Differences may be due to (1) design effect A alone, (2) design effect B alone, (3) design effect A and B additively or (4) design effect A and B with interaction. When the residual term is zero, an additive model with design effects and their interaction fits the data adequately.

Cortex

Total lithic assemblages.

Significant differences between cortex presence or absence and all thermal alteration categories occurs in the total lithic assemblage for both components. Data collected on each component´s assemblage have been tabulated into six samples corresponding to three thermal alteration and two chert groups (Table C.1, Appendix C). Both heat and cortex are significant at less than the .05 level (Table 7.48). The interaction of heat and cortex is not significant. An additive model of mean, thermal alteration, cortex and the interaction of thermal alteration and cortex fits the data adequately. Benton and Ledbetter components do not have the same response probabilities for thermal alteration and cortex presence or absence.

Flake debitage.

Data collected on each component´s flake debitage have been tabulated into six samples (Table C.2, Appendix C). With all flakes combined, Benton and Ledbetter components have the same response probabilities (Table 7.49).

TABLE 7.48. FUNCAT STATISTIC FOR LEFTWICH AREA A TOTAL ASSEMBLAGE CORTEX AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	204.17	0.0001
Thermal Alteration	2	8.38	0.0152
Cortex	1	8.10	0.0044
Heat*Cortex	2	0.88	0.6444
Residual	0	-0.00	1.0000

TABLE 7.49. FUNCAT STATISTIC FOR LEFTWICH AREA A FLAKE DEBITAGE CORTEX AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	104.55	0.0001
Thermal Alteration	2	5.92	0.0517
Cortex	1	4.03	0.0447
Heat*Cortex	2	0.67	0.7136
Residual	0	-0.00	1.0000

Flaked stone debris. Data collected on each component´s stone debris have been tabulated into six samples (Table C.3, Appendix C). Cortex is significant at less than the .05 level (Table 7.50). Both thermal alteration and the interaction of heat and cortex have no significant effects. An additive model of mean, thermal alteration, cortex and the interaction of heat and cortex fits the data adequately. Benton and Ledbetter components do not have the same response probabilities for cortex and thermally altered stone debris.

Lithic Resources

Total lithic assemblages. Data collected on each component´s total lithic assemblage, have been tabulated into six samples corresponding to three thermal alteration groups: unaltered, successfully altered and overheated and two chert groups: Ridley and Fort Payne (Table C.4, Appendix C). Both heat and the interaction of thermal alteration and chert are significant at less than the .05 level (Table 7.51). There are no significant chert effects. An additive model of mean thermal alteration, chert and the interaction of thermal alteration and chert fits the data adequately. Benton and Ledbetter components do not have the same response probabilities for thermally altered chert.

TABLE 7.50. FUNCAT STATISTIC FOR LEFTWICH AREA A FLAKED STONE DEBRIS CORTEX AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	13.2	0.0003
Thermal Alteration	2	0.99	0.6099
Cortex	1	9.98	0.0016
Heat*Cortex	2	0.89	0.6422
Residual	0	0.00	1.0000

TABLE 7.51. FUNCAT STATISTIC FOR LEFTWICH AREA A TOTAL ASSEMBLAGE CHERT AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	212.01	0.0001
Thermal Alteration	2	24.13	0.0001
Chert	1	0.04	0.8410
Heat*Chert	2	16.77	0.0002
Residual	0	0.00	1.0000

Flake debitage. Data collected on each component´s flake debitage have been tabulated into samples (Table C.5, Appendix C). Heat, chert and the interaction of heat and chert are all significant at less than the .05 level (Table 7.52). An additive model of mean, thermal alteration, chert and the interaction of heat and chert fits the data adequately. Benton and Ledbetter component´s flake debitage do not have the same response probabilities for thermally altered chert.

Flaked stone debris. Data collected on each component´s stone debris have been tabulated into six samples (Table C.6, Appendix C). Heat, chert and the interaction of heat and chert are all significant at the .05 level (Table 7.53). An additive model of mean, thermal alteration, chert and the interaction of heat and chert fits the data adequately. Benton and Ledbetter component´s flaked stone debris do not have the same response probabilities for thermally altered chert.

Texture

Total lithic assemblage. Data collected on each component´s total assemblage have been tabulated into six populations (Table C.7, Appendix C). Texture is significant at less than the .05 level (Table 7.54). Thermal alteration and the interaction of heat and

TABLE 7.52. FUNCAT STATISTIC FOR LEFTWICH AREA A FLAKE DEBITAGE CHERT AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	122.78	0.0001
Thermal Alteration	2	12.81	0.0017
Chert	1	2.31	0.1286
Heat*Chert	2	15.75	0.0004
Residual	0	0.00	1.0000

TABLE 7.53. FUNCAT STATISTIC FOR LEFTWICH AREA A FLAKED STONE DEBRIS CHERT AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	1.16	0.2822
Thermal Alteration	2	4.26	0.1191
Chert	1	4.38	0.0363
Heat*Chert	2	9.82	0.0074
Residual	0	-0.00	1.0000

TABLE 7.54. FUNCAT STATISTIC FOR LEFTWICH AREA A TOTAL ASSEMBLAGE TEXTURE AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	181.04	0.0001
Thermal Alteration	2	3.83	0.1476
Texture	1	9.98	0.0016
Heat*Texture	2	1.26	0.5318
Residual	0	-0.00	1.0000

texture are not significant. An additive model of mean, thermal alteration, texture and the interaction of heat and texture fits the data adequately.

Flake debitage. Data collected on each component´s flake debitage have been tabulated into six samples (Table C.8, Appendix C). Texture is the only variable significant at less than the .05 level (Table 7.55). Both thermal alteration, as well as the interaction of heat and texture have no significant effects. Benton and Ledbetter component´s flake debitage do not have the same response probabilities for thermal alteration and texture.

Flaked stone debris. Data collected on each component´s stone debris have been tabulated into six samples (Table C.9, Appendix C). Thermal alteration, texture and the interaction of heat and texture are all significant for flaked stone debris (Table 7.56). Benton and Ledbetter component´s flaked stone debris do not have the same response probabilities for thermal alteration and texture.

Complete Model

A complete model would include all design and response variables: cortex, thermal alteration, chert, texture and component. Since several zero cells would be

TABLE 7.55. FUNCAT STATISTIC FOR LEFTWICH AREA A FLAKE DEBITAGE TEXTURE AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	95.05	0.0001
Thermal Alteration	2	2.31	0.3146
Texture	1	5.29	0.0214
Heat*Texture	2	0.93	0.6277
Residual	0	0.00	1.0000

TABLE 7.56. FUNCAT STATISTIC FOR LEFTWICH AREA A FLAKED STONE DEBRIS TEXTURE AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	15.31	0.0001
Thermal Alteration	2	2.25	0.3242
Texture	1	2.64	0.1045
Heat*Texture	2	11.55	0.0031
Residual	0	-0.00	1.0000

created, two models were computed for the total assemblage. Design variables: cortex and texture each contributed to zero cells, so were separated into two models.

Data collected on each component´s total assemblage have been tabulated into 12 samples (Table C.10, Appendix C). Thermal alteration, the interaction of cortex and chert and the interaction of heat and chert are all significant at less than the .05 level (Table 7.57). Cortex, chert and the interaction of heat and chert are not significant. An additive model of mean, thermal alteration, cortex, chert and all possible interactions fits the data adequately. Benton and Ledbetter components do not have the same response probabilities for thermal alteration, cortex, chert and all possible interactions.

Data collected on each component´s total assemblage have been tabulated into 12 samples (Table C.11, Appendix C). Texture and the interaction of thermal alteration and chert are all significant at less than the .05 level (Table 7.58). Thermal alteration, chert, the interaction of texture and chert and the interaction of heat and texture have no significant effects. An additive model of mean, thermal alteration, texture, chert and all possible interactions fits the data

TABLE 7.57. FUNCAT STATISTIC FOR LEFTWICH AREA A TOTAL ASSEMBLAGE CORTEX, CHERT AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	148.27	0.0001
Thermal Alteration	2	18.07	0.0001
Cortex	1	3.16	0.0757
Chert	1	3.63	0.0566
Cortex*Heat	2	2.18	0.3357
Cortex*Chert	1	17.51	0.0001
Heat*Chert	2	18.16	0.0001
Residual	0	0.21	0.9018

TABLE 7.58. FUNCAT STATISTIC FOR LEFTWICH AREA A TOTAL ASSEMBLAGE TEXTURE, CHERT AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	134.00	0.0001
Thermal Alteration	2	2.23	0.3284
Texture	1	18.74	0.0001
Chert	1	0.20	0.6532
Texture*Chert	1	1.28	0.2573
Heat*Texture	2	3.32	0.1898
Heat*Chert	2	16.62	0.0002
Residual	2	0.78	0.6777

adequately. Benton and Ledbetter components do not have the same response probabilities for thermal alteration, texture, chert and interactions.

Reduction Stage

Flake reduction stage.

Data collected on each component´s flake reduction stage have been tabulated into 12 samples (Table C.12, Appendix C). Initial flake reduction includes primary and secondary flake debitage. Small biface thinning flakes, retouch and petaloid flakes are included with small BTF´s. The interaction of thermal alteration and flake reduction stage is significant at less than the .05 level (Table 7.59). Separately the variables heat and stage have no significant effects. An additive model of mean, thermal alteration, flake stage and the interaction of heat and stage fits the data adequately. Benton and Ledbetter components do not have the same response probabilities for thermally altered flake debitage.

Biface thinning flake size.

Biface thinning flakes have been divided into two size groups: large and small where small BTF´s include petaloid and retouch flakes. Data collected on each component´s biface flake size have been tabulated into six samples (Table C.13, Appendix C). Both thermal alteration and biface flakes

TABLE 7.59. FUNCAT STATISTIC FOR LEFTWICH AREA A FLAKE REDUCTION STAGE AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	76.19	0.0001
Thermal Alteration	2	4.61	0.0996
Flake Stage	3	16.38	0.0009
Heat*Flake Stage	6	14.61	0.0235
Residual	0	-0.00	1.0000

are significant at less than the .05 level (Table 7.60). The interaction of heat and biface flake size has no significant effect. An additive model of mean, thermal alteration, biface flake size and the interaction of heat and biface flake size fits the data adequately. Benton and Ledbetter components do not have the same response probabilities for thermally altered biface flake size.

Cores and biface. Due to sample size, reduction stone debris: cores, tested cobbles and blocky debris have been grouped together and referred to as "cores." Data collected on each component´s chipped stone artifacts: cores and bifaces have been tabulated into six samples (Table C.14, Appendix C). The interaction of thermal alteration and artifact type is significant at less than the .05 level when each degree of freedom is individually inspected. The variables thermal alteration and artifact type are not significant alone (Table 7.61). An additive model of mean, thermal alteration, artifact type and the interaction of heat and artifact type fits the data adequately. Benton and Ledbetter components do not have the same response probabilities for thermally altered artifacts.

TABLE 7.60. FUNCAT STATISTIC FOR LEFTWICH AREA A BIFACE THINNING FLAKE SIZE AND THERMAL ALTERATION VARIABILITY.

Source	DF	Chi Square	Probability
Intercept	1	25.06	0.0001
Thermal Alteration	2	6.63	0.0362
Biface Flake Size	1	13.21	0.0003
Heat*Flake Size	2	4.53	0.1036
Residual	0	0.00	1.0000

TABLE 7.61. FUNCAT STATISTIC FOR LEFTWICH AREA A BIFACE, CORE AND THERMAL ALTERATION VARIABILITY.

Effect	DF	Chi Square	Probability
Intercept	1	8.30	0.0040
Thermal Alteration	1	0.13	0.7223
	1	1.58	0.2090
Core/Biface	1	0.05	0.8316
Heat*Core/Biface	1	0.39	0.5315
	1	4.79	0.0286
Residual	0	0.00	1.0000

F. SUMMARY

Variation in an archaeological assemblage is assumed to be directly related to the human activities performed at that location. Therefore, assemblages should vary with respect to the age and sex of the group, in addition to the specific activities performed. Since lithic reduction is accomplished in recognizable discrete stages, lithic analysis should lead to the identification of different activities among assemblages.

The thermal alteration of lithic artifacts has sparked the attention and imagination of archaeologists for a number of years. Although many archaeologists have reported thermal alteration variability, few have integrated it into general or specific lithic variability studies. As a result, a confusing pattern of thermal alteration has emerged in North America associated with both flake and biface production for virtually every temporal period. This thesis has utilized statistical tests of chi-square and categorical regression analysis to determine significant patterns in the lithic artifacts recovered from the surface and excavated assemblages of the Leftwich site. These differences may be useful in explaining behavioral differences between assemblages. In order to effectively evaluate the success of this approach, there are three questions to consider. First, were lithic artifacts accidentally or intentionally thermally altered? Second, if there is a reconizable pattern of thermal alteration, what is it? And, the third area of interest is whether or not the inclusion of thermal alteration analysis results in any significant improvements in prehistoric behavior recognition. A discussion of activities represented by the lithic assemblages is addressed before the above questions are considered.

Activities Represented by Leftwich Lithic Assemblages

The excavated Benton and Ledbetter components of the Leftwich site are represented by a limited variety of artifacts and consist primarily of discarded projectile points/knives and biface fragments. In addition, a few flake tools and drills occur in both Archaic components. Lithic material recovered indicates activities represented include hunting, butchering, hide working, bone working, tool maintenance, heating and cooking based on implied lithic function (Faulkner and McCollough 1973; Hofman and Turner 1979; House 1975). Charred botanical remains indicate plant food processing possibly occurred. The Leftwich Benton and Ledbetter assemblages represent short-term occupations which probably occurred repeatedly.

Activities that occurred during the 9,000 year lithic record reflected in the Leftwich surface collection include: hunting, butchering, wood working, hide working, bone working, biface production, tool maintenance, plant food processing, stone bowl processing, heating and cooking based on implied lithic function (Faulkner and McCollough 1973; Hofman and Turner 1979; House 1975). The Leftwich surface assemblage reflects a diverse range of activities; however, hunting is the dominate activity indicated since projectile point/knives comprise the majority of the chipped stone tool category.

Intentional Thermal Alteration of Lithic Artifacts

Intentional thermal alteration of lithic specimens is indicated by: (1) an overall low incidence of thermal overheating and (2) an association between thermal alteration and specific lithic artifact categories for the surface and excavated assemblages.

Recognizable Patterns of Thermal Alteration

Chi-square tests (discussed earlier) indicate a significant pattern of thermal alteration exists for the surface and excavated assemblages. Lack of alteration is significantly correlated with cortex absence in the Ledbetter assemblage and cortex presence in the surface assemblage. A significant number of unaltered decortication flakes, tertiary flakes, tested cobbles and initial stage bifaces occur in the surface assemblage. Lack of thermal alteration is associated with fine-grained specimens in the Ledbetter assemblage.

Intentional thermal alteration is significantly correlated with small biface thinning flakes in the surface and both excavated assemblages, cores and large BTF´s in the surface assemblage and late stage bifaces in the surface and Ledbetter assemblages. A significant number of successfully altered Fort Payne chert specimens occur in the surface assemblage while successfully altered Ridley chert dominates the Ledbetter assemblage. Cortex absence is correlated with successful alteration in the surface and Ledbetter assemblages. Successful alteration is significantly correlated with all fine-grained specimens in the surface assemblage.

Overheating is significantly correlated with Ridley chert specimens in the surface and Benton assemblages. Cortex presence is significantly associated with overheating in the Benton and Ledbetter assemblages. A significant portion of the overheated specimens are coarse-grained in the surface, Benton and Ledbetter assemblages. Excluding fire cracked rock and pot lids, artifacts significantly associated with overheating include blocky debris from the surface assemblage, large BTF´s and bifacial tools from the Benton assemblage and decortication flakes from the Ledbetter assemblage.

Thermal Alteration adds to Prehistoric Behavior Recognition

The analysis of thermal alteration variability tends to reflect the direct relationship of hunter-gatherer cultural systems to their physical environment via lithic resources. Amick (1984) has noted a trend in the Inner Nashville Basin for Middle Archaic groups to primarily utilize local chert (i.e. Ridley) while Late Archaic groups focus on non-local lithic resource (i.e. Fort Payne). The Leftwich site follows this pattern. The Leftwich Ledbetter assemblage can be viewed as more logistically oriented than the Benton assemblage based on lithic resources.

Thermal alteration occurs with both biface and flake production in the surface and both excavated assemblages at the Leftwich site. Successful thermal alteration is significant with biface manufacture in all assemblages while successful alteration has a high relative frequency with flake production only in the surface assemblage. Bifaces of both Ridley and Fort Payne chert were manufactured at the Leftwich site. Fort Payne small BTF´s dominate the Ledbetter and surface assemblages while Ridley large BTF´s dominate the Benton and Ledbetter assemblages and Fort Payne large BTF´s dominate the surface assemblage. The Ledbetter assemblage has a significant number of late stage reduction flakes, Fort Payne flake debitage and Fort Payne chipped stone tools. A significant number of early reduction flakes, Ridley flake debitage and Ridley stone debris occurs in the Benton assemblage.

The number of Ridley Benton projectile points/knives heat fractured is significant. Although some Benton bifaces were successfully heated before small BTF´s were removed a significant number were overheated. Thermal fractures could be the result of unsuccessful heat treatment since a significant number of large BTF´s are overheated and PPK´s heat fractured.

A significant number of Fort Payne PP/K´s and bifaces were successfully altered after large BTF´s were removed and before small BTF´s were removed for the surface and Ledbetter assemblages. During the Ledbetter occupation Fort Payne chert bifaces were brought to Leftwich and retooled. Thermal alteration of Fort Payne bifaces took place before they were retooled and incorporated into the Leftwich assemblage: either at Leftwich or another location. During the ca. 9,000 year accumulation of artifacts and debitage represented in the

Leftwich surface collection, Fort Payne chert was brought to Leftwich and both initial shaping and retouching was accomplished. Thermal alteration of Fort Payne bifaces took place before they were retooled and incorporated into the Leftwich surface assemblage.

It should be possible to infer the kind of sites where intentional thermal alteration would occur. The effort required to thermally alter chert suggests that the process will occur only in certain areas or on certain site types. If thermal alteration occurred at a site, evidence would be represented by extensive quantities of fire cracked rock, as well as altered reduction and manufacturing debris (Purdy 1971). The time and care required to successfully alter chert suggests that evidence for the process will occur at relatively stable sites (i.e., base camps) rather than at temporary extraction stations (Anderson 1979:231). Thermally altered artifacts and flake debitage are likely to be found on temporary sites from loss or discard, as well as biface reworking or resharpening. The process of thermal alteration is not likely to have been practiced on temporary sites.

Aspects of settlement systems are highly interrelated and complex variables to decipher. Lithic technological parameters provide a useful measure of settlement system organizational strategy. A general trend of reduced residential mobility has been recognized for Eastern North America through the Archaic period (Walthall 1980). A shift in settlement system appears to occur during the Archaic period. Based on lithic resources and technology Amick (1984) has suggested the settlement system change occurs between Middle and Late Archaic periods. Research from Leftwich implies task group organization and labor differentiation began during the Middle Archaic period. Site function and and sample sizes are similar for both excavated Leftwich assemblages. Both Archaic components have long trajectory assemblages, procurement of local and non-local chert, and thermal alteration associated with biface manufacture.

Site interpretations can be enhanced through consideration of thermal alteration variability. This study illustrates the potential of pursuing thermal alteration variability as an additional tool in measuring behavioral variability reflected in different lithic assemblages.

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APPENDICES

APPENDIX A

LEFTWICH EXCAVATION LITHIC DATA

TABLE A.1. AN INVENTORY OF ALL LITHICS EXCAVATED FROM LEFTWICH AREA A BY LEVEL.

	Level	Centimeters Below Surface	N	Relative Frequency
	1	20	23	0.87%
	2	40	16	0.61%
	3	60	11	0.42%
	4	70	6	0.23%
	5	80	5	0.19%
	6	90	10	0.38%
	7	100	17	0.64%
	8	110	49	1.86%
	9	120	136	5.15%
	10	130	483	18.29%
	11	140	865	32.75%
	12	150	316	11.97%
	13	160	256	9.69%
	14	170	202	7.65%
	15	180	186	7.04%
	16	190	13	0.49%
	17	200	31	1.17%
	18	210	16	0.61%
Total			2641	100.00%

TABLE A.2. LIST OF FLAKE DEBITAGE FROM LEFTWICH AREA A BY LEVEL.

Level	Centimeters Below Surface	N	Relative Frequency
1	20	13	0.65%
2	40	5	0.25%
3	60	5	0.25%
4	70	3	0.15%
5	80	1	0.05%
6	90	6	0.30%
7	100	12	0.60%
8	110	28	1.39%
9	120	85	4.22%
10	130	385	19.11%
11	140	713	35.38%
12	150	222	11.02%
13	160	210	10.42%
14	170	157	7.79%
15	180	120	5.96%
16	190	11	0.55%
17	200	25	1.24%
18	210	14	0.69%
Total		2015	100.00%

TABLE A.3. LIST OF STONE DEBRIS FROM LEFTWICH AREA A BY LEVEL.

	Level	Centimeters Below Surface	N	Relative Frequency
	1	20	10	1.80%
	2	40	11	1.98%
	3	60	6	1.08%
	4	70	3	0.54%
	5	80	3	0.54%
	6	90	4	0.72%
	7	100	5	0.90%
	8	110	21	3.78%
	9	120	50	8.99%
	10	130	91	16.37%
	11	140	122	21.94%
	12	150	88	15.83%
	13	160	41	7.37%
	14	170	36	6.47%
	15	180	59	10.61%
	16	190	1	0.18%
	17	200	4	0.72%
	18	210	1	0.18%
Total			556	100.00%

TABLE A.4. CHIPPED STONE TOOLS FROM LEFTWICH AREA A BY LEVEL.

	Level	Centimeters Below Surface	N	Relative Frequency
	1	20		
	2	40		
	3	60		
	4	70		
	5	80	1	1.64%
	6	90		
	7	100		
	8	110		
	9	120	1	1.64%
	10	130	6	9.84%
	11	140	27	44.26%
	12	150	6	9.84%
	13	160	5	8.20%
	14	170	7	11.48%
	15	180	6	9.84%
	16	190	1	1.64%
	17	200		
	18	210	1	1.64%
Total			61	100.00%

TABLE A.5. GROUND STONE TOOLS FROM LEFTWICH AREA A BY LEVEL.

Level	Centimeters Below Surface	N	Relative Frequency
1	20		
2	40		
3	60		
4	70		
5	80		
6	90		
7	100		
8	110		
9	120		
10	130	1	11.11%
11	140	3	33.33%
12	150		
13	160		
14	170	2	22.22%
15	180	1	11.11%
16	190		
17	200	2	22.22%
18	210		
Total		9	99.99%

TABLE A.6. LEFTWICH AREA A FLAKE AND STONE DEBRIS TEXTURE CATEGORIES BY COMPONENT.

Assemblage Component	Artifact Category	Texture					
		Vitreous	Fine	Medium	Coarse	Desilified	Total
Benton	1		3				3
	2		104	12	1		117
	3		45	9	1		55
	4		37	3			40
	5		14	1			15
	6		4				4
	8	11	269	22	1		303
	11		1				1
	13	1	7	2			10
	14	3	81	15	1		100
	15		3		8		3
	16		14	3	6		24
	17	3	1				4
Ledbetter	1		7	8			15
	2	2	242	67	13	1	325
	3		217	39	2		258
	4	7	99	4			110
	5	3	131	3			137
	6		9				9
	7		25				25
	8	19	473	52	2		546
	10		7		1		8
	11			1			1
	13	1	7		3		11
	14	7	112	41	14	4	178
	15		5	1	1		7
	16		104	51	14	4	173
	17		2				2
Total		57	2023	334	68	9	2484

TABLE A.7. LEFTWICH AREA A FLAKE DEBITAGE, STONE DEBRIS AND CHERT CATEGORIES BY COMPONENT.

		Chert								
Assemblage Component	Artifact Category	Obc	Sbr	Oc	Mfp	Ord	Msw	Misc. Chert	Misc. Rock	Total
Benton	1				2	1				3
	2	12			52	53				117
	3	5			19	31				55
	4				13	26		1		40
	5				7	8				15
	6				3	1				4
	8	8			101	192	1	1		303
	11					1				1
	13	1			5	4				10
	14	4			33	61		1	1	100
	15				3					3
	16				8	7		3	6	24
	17					4				4
Ledbetter	1	1			4	10				15
	2	29			100	190		5	1	325
	3	17	1		92	147			1	258
	4	3		1	47	59				110
	5		1		92	44				137
	6				2	7				9
	7	1			17	7				25
	8	18		1	241	283	2	1		546
	10				4	4				8
	11					1				1
	13				4	7				11
	14	3	2		60	107		3	3	178
	15				5	2				7
	16	1			65	100		2	5	173
	17					1		1		2
Total		103	4	2	979	1358	3	18	17	2484

TABLE A.8. LEFTWICH AREA A FLAKE DEBITAGE, STONE DEBRIS AND CORTEX CATEGORIES.

Assemblage Component	Artifact Category	Cortex Absent	Incipient Fracture Planes	Matrix Cortex	Cobble Cortex	Total
Benton	1				3	3
	2		40	7	70	117
	3	52			3	55
	4	39			1	40
	5	15				15
	6	4				4
	8	303				303
	11	1				1
	13	4			6	10
	14	63		8	29	100
	15				3	3
	16	8		3	13	24
	17	3			1	4
Ledbetter	1		4	5	6	15
	2		74	109	142	325
	3	224		4	30	258
	4	101		1	8	110
	5	135			2	137
	6	9				9
	7	25				25
	8	546				546
	10	6		1	1	8
	11				1	1
	13	5		2	4	11
	14	71		40	67	178
	15			1	6	7
	16	74		36	63	173
	17	1			1	2
Total		1689	118	217	460	2484

TABLE A.9. LEFTWICH AREA A FLAKE DEBITAGE, STONE DEBRIS AND THERMAL ALTERATION CATEGORIES BY COMPONENT.

Assemblage Component	Artifact Category	Thermal Alteration 1	2	3	4 & 6	5	Total
Benton	1	3					3
	2	93	8	11		5	117
	3	45	2	7		1	55
	4	25	4	9		2	40
	5	10	1	1		3	15
	6	2	1			1	4
	8	213	28	39		23	303
	11	1					1
	13	5	3			2	10
	14	51	5	35		9	100
	15	2				1	3
	16			24			24
	17			1	2	1	4
Ledbetter	1	13		2			15
	2	256	26	37	4	2	325
	3	216	15	19	6	2	258
	4	94	8	3		5	110
	5	109	16	8	1	3	137
	6	4	2	1		2	9
	7	22	1	1	1		25
	8	405	54	42	37	8	546
	10	6	1	1			8
	11	1					1
	13	8		2		1	11
	14	88	18	62	3	7	178
	15	7					7
	16			173			173
	17			1		1	2
Total		1679	193	479	54	79	2484

APPENDIX B

LEFTWICH SURFACE LITHIC DATA

TABLE B.1. LEFTWICH AREA D FLAKE AND STONE DEBRIS TEXTURE CATEGORIES.

Artifact Category	Texture					
	Vitreous	Fine	Medium	Coarse	Unknown	Total
1		13	7	1		21
2	352	2780	449	50		3631
3	181	1750	280	25		2236
4	254	1821	119	1	1	2196
5	138	517	16	1		672
6	6	28				34
7	4					4
8	1034	7143	590	4		8771
9	1	1	1			3
10	9	32	6	2		49
11	2	36	26	26	8	98
12		3	1			4
13	82	881	142	43		1148
14	182	2662	510	27		3381
15	11	208	44	12		275
16	12	717	543	196	7	1475
17	39	166	26	18		249
Total	2307	18758	2760	406	16	24247

TABLE B.2. LEFTWICH AREA D FLAKE DEBITAGE AND STONE DEBRIS CHERT CATEGORIES.

	Chert									
Artifact Category	Obc	Sbr	Oc	Mfp	Quartz	Ord	Msw	Misc. Chert	Misc. Rock	Total
1	3			10		8				21
2	526	2	3	1575	3	1507	15			3631
3	228		4	1034		968	2			2236
4	139	1		1453	1	600	2			2196
5	35			445		190	2			672
6	2			23		9				34
7				1		3				4
8	700	9	3	5217	1	2833	8			8771
9				2		1				3
10	9			20		20				49
11	12			57	8	11		8	2	98
12				1		3				4
13	226		2	462		457			1	1148
14	202			930	1	2246	2			3381
15	17			116		141		1		275
16	91			341		1000		20	23	1475
17	23			93		124		9		249
Total	2213	12	12	11780	14	10121	31	38	26	24247

TABLE B.3. LEFTWICH AREA D FLAKE AND STONE DEBRIS CORTEX CATEGORIES.

	Cortex				
Artifact Category	Cortex Absent	Incipient Fracture Planes	Matrix	Cobble	Total
1			1	20	21
2		388	158	3085	3631
3	1926	41	1	268	2236
4	2049	25	2	120	2196
5	669			3	672
6	6	28			34
7	4				4
8	8771				8771
9	2			1	3
10	15	4	3	27	49
11	3	1	2	92	98
12		2		2	4
13	359		25	764	1148
14	1228	470	107	1576	3381
15		1	8	266	275
16	473	175	102	725	1475
17	200	3		46	249
Total	15705	1138	409	6995	24247

TABLE B.4. LEFTWICH AREA D FLAKE AND STONE DEBRIS THERMAL ALTERATION CATEGORIES.

	Thermal Alteration					
Artifact Category	No Evidence of Heating	Possibly Heated	Definitely Heated	Heated Before and After Final Modification	Heated After Final Modification	Total
1	14	2	3		2	21
2	1667	741	451	45	727	3631
3	980	519	294	35	408	2236
4	752	512	240	82	610	2196
5	107	164	74	27	300	672
6	2	14	1	17		34
7				4		4
8	2672	1652	1044	778	2625	8771
9	1		1	1		3
10	19	9	10	1	10	49
11	55	15	17	1	10	98
12	3	1				4
13	451	233	123	40	301	1148
14	1087	776	727	257	534	3381
15	172	60	22		21	275
16			1472	3		1475
17			72	154	23	249
Total	7982	4698	4551	1445	5571	24247

APPENDIX C

CATEGORICAL REGRESSION DATA

TABLE C.1. LEFTWICH AREA A TOTAL ASSEMBLAGE CORTEX AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Cortex	Benton Component	Ledbetter Component	Total
1	Unaltered	Absent	372	935	1307
2	Unaltered	Present	91	320	411
3	Success	Absent	90	149	239
4	Success	Present	17	37	54
5	Overheated	Absent	93	231	324
6	Overheated	Present	41	177	218
Total			704	1849	2553

TABLE C.2. LEFTWICH AREA A FLAKE DEBITAGE CORTEX AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Cortex	Benton Component	Ledbetter Component	Total
1	Unaltered	Absent	329	881	1210
2	Unaltered	Present	62	244	306
3	Success	Absent	68	122	190
4	Success	Present	11	23	34
5	Overheated	Absent	56	120	176
6	Overheated	Present	11	43	54
Total			537	1433	1970

TABLE C.3. LEFTWICH AREA A FLAKED STONE DEBRIS CORTEX AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Cortex	Benton Component	Ledbetter Component	Total
1	Unaltered	Absent	37	35	72
2	Unaltered	Present	27	73	100
3	Success	Absent	14	12	26
4	Success	Present	6	14	20
5	Overheated	Absent	22	33	55
6	Overheated	Present	13	34	47
Total			119	201	320

TABLE C.4. LEFTWICH AREA A TOTAL ASSEMBLAGE CHERT AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Chert	Benton Component	Ledbetter Component	Total
1	Unaltered	Ridley	256	635	891
2	Unaltered	Fort Payne	176	539	715
3	Success	Ridley	60	133	193
4	Success	Fort Payne	41	42	83
5	Overheated	Ridley	84	213	297
6	Overheated	Fort Payne	37	177	214
Total			654	1739	2393

TABLE C.5. LEFTWICH AREA A FLAKE DEBITAGE CHERT AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Chert	Benton Component	Ledbetter Component	Total
1	Unaltered	Ridley	218	570	788
2	Unaltered	Fort Payne	152	486	638
3	Success	Ridley	45	100	145
4	Success	Fort Payne	30	35	65
5	Overheated	Ridley	49	80	129
6	Overheated	Fort Payne	15	78	93
Total			509	1349	1858

TABLE C.6. LEFTWICH AREA A FLAKED STONE DEBRIS CHERT AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Chert	Benton Component	Ledbetter Component	Total
1	Unaltered	Ridley	35	59	94
2	Unaltered	Fort Payne	20	38	58
3	Success	Ridley	9	26	35
4	Success	Fort Payne	9	1	10
5	Overheated	Ridley	22	33	55
6	Overheated	Fort Payne	12	30	42
Total			107	187	294

TABLE C.7. LEFTWICH AREA A TOTAL ASSEMBLAGE TEXTURE AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Texture	Benton Component	Ledbetter Component	Total
1	Unaltered	Fine	422	1078	1500
2	Unaltered	Coarse	41	177	218
3	Success	Fine	96	151	247
4	Success	Coarse	11	35	46
5	Overheated	Fine	103	293	396
6	Overheated	Coarse	31	115	146
Total			704	1849	2553

TABLE C.8. LEFTWICH AREA A FLAKE DEBITAGE TEXTURE AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Texture	Benton Component	Ledbetter Component	Total
1	Unaltered	Fine	358	989	1347
2	Unaltered	Coarse	33	136	169
3	Success	Fine	72	119	191
4	Success	Coarse	7	26	33
5	Overheated	Fine	57	133	190
6	Overheated	Coarse	10	30	40
Total			537	1433	1970

TABLE C.9. LEFTWICH AREA A FLAKED STONE DEBRIS TEXTURE AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Texture	Benton Component	Ledbetter Component	Total
1	Unaltered	Fine	56	67	123
2	Unaltered	Coarse	8	41	49
3	Success	Fine	16	17	33
4	Success	Coarse	4	9	13
5	Overheated	Fine	23	53	76
6	Overheated	Coarse	12	14	26
Total			119	201	320

TABLE C.10. LEFTWICH AREA A TOTAL ASSEMBLAGE CORTEX, CHERT AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables			Response Frequency		
Sample	Thermal Alteration	Cortex	Chert	Benton Component	Ledbetter Component	Total
1	Unaltered	Absent	Ridley	215	456	671
2	Unaltered	Absent	Fort Payne	132	433	565
3	Unaltered	Present	Ridley	41	179	220
4	Unaltered	Present	Fort Payne	44	106	150
5	Success	Absent	Ridley	52	105	157
6	Success	Absent	Fort Payne	35	38	73
7	Success	Present	Ridley	8	28	36
8	Success	Present	Fort Payne	6	4	10
9	Overheated	Absent	Ridley	69	135	204
10	Overheated	Absent	Fort Payne	20	87	107
11	Overheated	Present	Ridley	15	78	93
12	Overheated	Present	Fort Payne	17	90	107
Total				654	1739	2393

TABLE C.11. LEFTWICH AREA A TOTAL ASSEMBLAGE TEXTURE, CHERT AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables			Response Frequency		
Sample	Thermal Alteration	Texture	Chert	Benton Component	Ledbetter Component	Total
1	Unaltered	Fine	Ridley	238	510	748
2	Unaltered	Coarse	Fort Payne	168	499	667
3	Unaltered	Fine	Ridley	18	125	143
4	Unaltered	Coarse	Fort Payne	8	40	48
5	Success	Fine	Ridley	57	105	162
6	Success	Coarse	Fort Payne	39	36	75
7	Success	Fine	Ridley	3	28	31
8	Success	Coarse	Fort Payne	2	6	8
9	Overheated	Fine	Ridley	68	152	220
10	Overheated	Coarse	Fort Payne	31	133	164
11	Overheated	Fine	Ridley	16	61	77
12	Overheated	Coarse	Fort Payne	6	44	50
Total				654	1739	2393

TABLE C.12. LEFTWICH AREA A FLAKE REDUCTION STAGE AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Flake Stage	Benton Component	Ledbetter Component	Total
1	Unaltered	Decortication	96	269	365
2	Unaltered	Tertiary	45	216	261
3	Unaltered	Large BTF	25	94	119
4	Unaltered	Small BTF	12	135	147
5	Success	Decortication	13	28	41
6	Success	Tertiary	3	17	20
7	Success	Large BTF	6	13	19
8	Success	Small BTF	6	24	30
9	Overheated	Decortication	11	43	54
10	Overheated	Tertiary	7	25	32
11	Overheated	Large BTF	9	3	12
12	Overheated	Small BTF	1	12	13
Total			234	879	1113

TABLE C.13. LEFTWICH AREA A BIFACE THINNING FLAKE SIZE AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Flake Stage	Benton Component	Ledbetter Component	Total
1	Unaltered	Large BTF	25	94	119
2	Unaltered	Small BTF	12	135	147
3	Success	Large BTF	6	13	19
4	Success	Small BTF	6	24	30
5	Overheated	Large BTF	9	3	12
6	Overheated	Small BTF	1	12	13
Total			59	281	340

TABLE C.14. LEFTWICH AREA A BIFACE, CORE AND THERMAL ALTERATION FREQUENCY DISTRIBUTION.

	Design Variables		Response Frequency		
Sample	Thermal Alteration	Artifact	Benton Component	Ledbetter Component	Total
1	Unaltered	Biface	3	4	7
2	Unaltered	Core	58	103	161
3	Success	Biface	5	21	26
4	Success	Core	20	26	46
5	Overheated	Biface	8	8	16
6	Overheated	Core	35	67	102
Total			129	229	358

VITA

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