REMOTE SENSING AND CORE DRILLING OF FIVE MOUNDS AT THE MOUNDVILLE SITE

by

Matthew D. Gage
and
V. Stephen Jones

Submitted to
Alabama Historical Commission
468 South Perry Street
Montgomery, Alabama 36130-0900
AHC Contract No. PT98-DM072

Performed by
The University of Alabama
University of Alabama Museums
Office of Archaeological Services
13075 Moundville Archaeological Park
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As a result of this project, the University of Alabama held the *Southeastern Remote Sensing and Core Sampling Seminar* on June 5, 1999. The idea for the seminar was prompted by Jim Knight who also served as a discussant and a source of valuable information about previous and ongoing investigations at Moundville. The seminar brought together numerous researchers conducting investigations of mound sites with the use of remote sensing technology and continuous core sampling. Each of the participants offered their expertise in their particular area of interest and opened the eyes of many to the possibilities of these types of studies.

Field work would not have been possible without the help of Jen Keeling, Donald Brown, Jeff Sherard, James Wilkins, Scott Meeks, and Hunter Johnson.

At the *Southeastern Remote Sensing and Core Sampling Seminar* Jim Knight expressed a well founded warning, "...don't let the technology guide the research. Let the research guide the technology." Somewhere in these investigations, we think we have found a happy medium.

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CHAPTER 1

INTRODUCTION

Mound complexes are a relatively common features on the landscape of the southeastern United States. Their presence, now understood to be much older than previously considered, reveals a continuous trend towards social complexity, political administration, and labor control. Mississippian mounds in particular, represent the remains of complex social entities that dominated the area both physically and culturally, prior to European intercession. This project represents an attempt to gain a further understanding of the factors involved in the development of the Mississippian culture by interpreting the sequence of construction within earthen mounds. Five mounds, A, E, L, Q, and Y, at the Moundville Site (1Tu500) serve as the focus of this study (Figures 1 and 2).

The Moundville Site and Its Environment

The Moundville site occupies approximately 75 hectares of the east bank of the Black Warrior River between mile markers 303 and 304 (Figure 1). At this point, the river is a winding twisting channel, cutting through the alluvial valley. Adjacent to Moundville, the river forms a large southerly dip known as Hemphill Bend. Numerous meander scars and oxbow lakes exist to the north, evidence of the changing course of the main channel. Moundville was built on a high Pliocene-Pleistocene terrace at an average elevation of 150 feet AMSL, well above the limits of the 100 years flood level.

The Alluvial-deltaic Plain of the Black Warrior River forms a large, rich, floodplain cutting through the Fall Line Hills of Alabama (Sapp and Emplaincourt 1975). The soils of the alluvial valley consist predominantly of silty loams laid down during thousands of flooding episodes. In contrast, the soils of the level terrace on which Moundville is located and the surrounding sloping to steep topography is formed of marine sediments deposited as stratified sands, silts, and clays (Johnson 1981). According to the Tuscaloosa County soil survey (Johnson 1981) Moundville is occupied by Choccolocco silt loam, a deep well-drained soil found on high stream terraces above escarpment banks of the Black Warrior River. Included in the map unit are convex areas with a sandy surface layer and soils that have a yellowish brown subsoil (Johnson 1981:17).

Mound A is situated near the southern head of a large, deep, erosional ravine which today extends south of the southernmost portion of the Mounds B and R (Figure 2). Northwest of the mound, this ravine cuts more than 12.2 m (40 ft) into the terrace exposing portions of the underlying Coker and/or Gordo formations (W. Gary Hooks personal communications 1999).

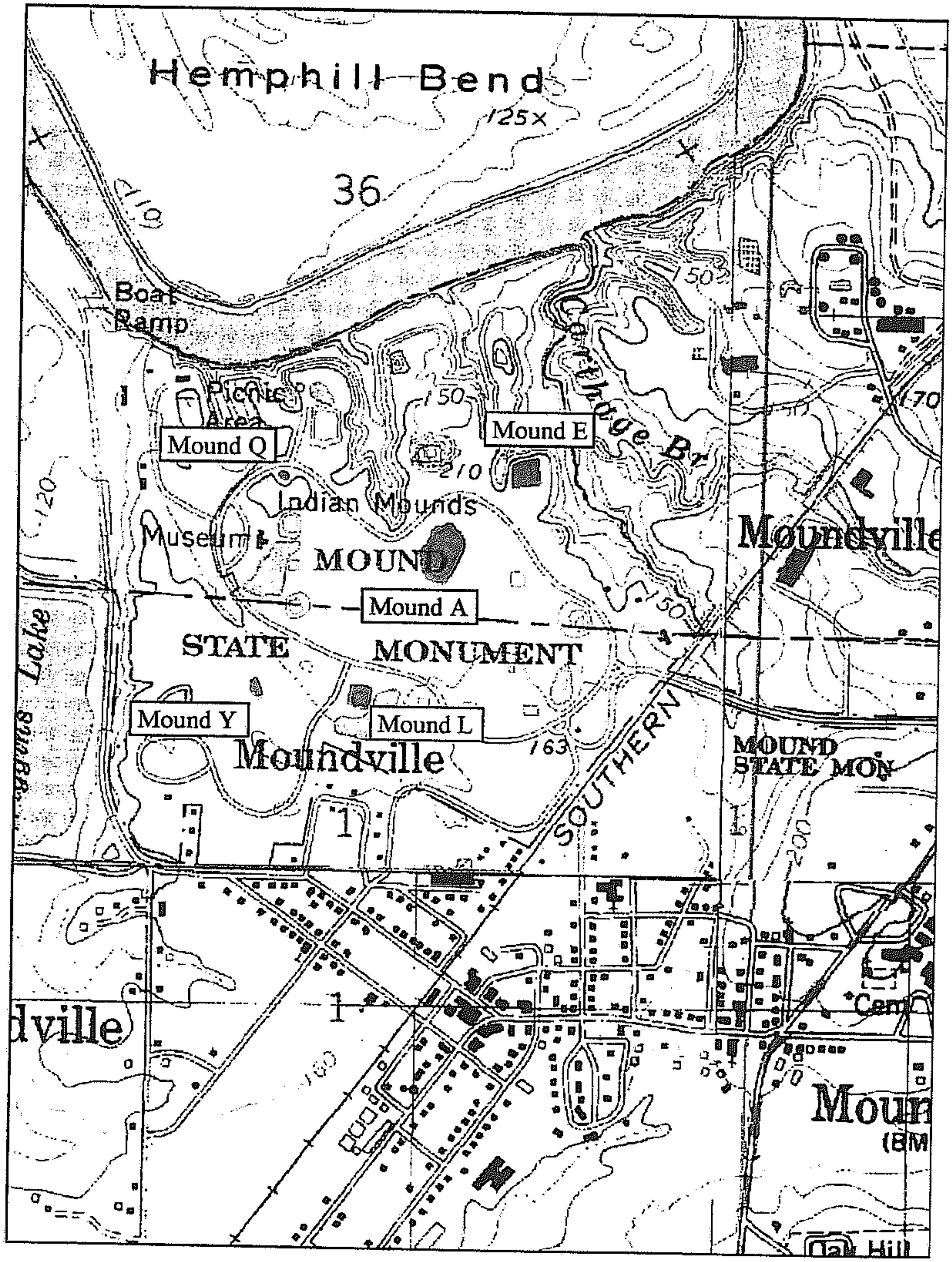

Figure 1. Project Area.

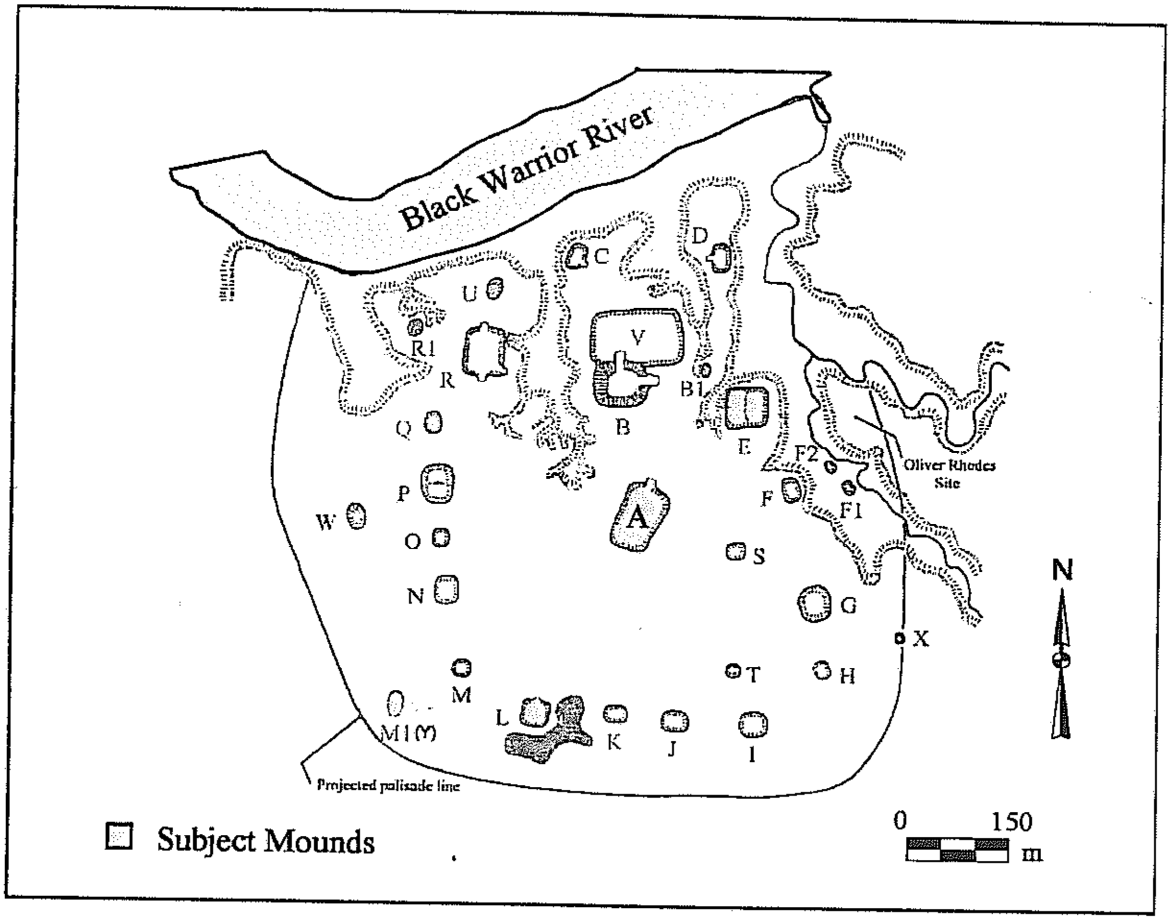

Figure 2. Mounds selected for remote sensing and core drilling.

Within the ravine itself, areas of erosion provide evidence for the source of much of the bright clays found within the fill of the mounds. Stratified deposits dominated by clay and overlain by gravelly sand form the foundation of the terrace. The intermittent channel which has formed the ravine is densely littered with quartzite pebbles averaging 15.2 mm in diameter (n=34). At the upper reaches of the ravine, where these pebbles erode directly from the overlying Pliocene-Pleistocene deposits, the pebbles lack discoloration. As the ravine is followed north to the river and etches deeper into the terrace deposits, the underlying red, brownish yellow, and gray clay, sandy clay, and very sandy clay strata begin to appear in the eroded stream bank.

Debate exists about the nature of the underlying materials within the area (e.g., Hooks personal communications, Conant 1967, Copeland 1968). Hemphill Bend of the Black Warrior River lies just north of the Tuscaloosa and Hale County border. The boundary between the Gordo and Coker Formations of the Upper Cretaceous age Tuscaloosa Group lies slightly to the south. The Coker Formation is the earliest part of the Tuscaloosa Group overlain by the Gordo Formation. The Eoline member of the Coker formation is marine in origin consisting predominantly of stratified and cross-stratified fine grained sand interbedded with carbonaceous and lignitic clays (Conant 1967). The unnamed upper member is highly variable with light colored micaceous sand as the dominant material and red-mottled gray clay common in the upper portion (Conant 1967:7). Meanwhile, the Gordo Formation consists of lenticular beds of massively bedded mottled clay, sand, and gravel (Copeland 1968:19). The Gordo formation is the main gravel-bearing part of the Tuscaloosa Group. However, the upper portion consists predominantly of lenticular beds of red or purple mottled gray clay, carbonaceous clay, and crossbedded sand (Conant 1967:8). Conant (1967:8) notes that the contact between the Gordo and Coker is the easiest of the sequence to recognize and map because of an ironstone layer commonly present at the base of the Gordo, and the fact that, in general, the clays of the Coker tend to be red stained while the Gordo tend to be purple stained. The Geologic maps used in both Jones (1967:53) and Copeland (1968: Plate 2) outline the generalized boundaries of the Coker and Gordo Formations throughout west–central Alabama. The maps place Moundville well within the confines of the Coker Formation. However, examination of the exposed east bank of the Black Warrior at Hemphill Bend reveals the dark purple mottled gray clay attributed to the Gordo formation at or near the average water level. Above these clays are crossbedded sands similar to those of the Coker formation but also attributed to the upper portion of the Gordo Formation. Thus, the area attributed to the Coker Formation may in fact be Gordo.

Within the ravine, downstream from where the clay deposits begin to appear, quartzite pebbles become discolored. The discoloration attests to the heavy mineral content in the clay, namely the oxide hematite (Fe_2O_3). The pebbles acquire a red to dark red coloration from the iron oxide staining. Even pottery sherds visible in portions of the drainage, downstream from the clay outcrop, display the discoloration caused by submersion in water containing high concentrations of iron oxides. A Bell Plain restricted bowl sherd with a beaded rim, a vessel type attributed to late Moundville II and Moundville III (Steponaitis 1983), showed extensive discoloration as did a thick Bell Plain basal sherd.

Within the mound fill, the deposits found in the upper portions of the terrace are dominant. Sand and sandy clay were excavated, transported, and deposited to form the massive earthen structure. Within the predominantly sandy fill, clays are also present. Some exhibit bright coloration, such as the red, gray, and purple clays found in the Coker and Gordo Formations. These were likely taken from locations within the ravines and along the adjacent river bank.

Early Archaeological Investigations of Moundville

Moundville is not only one of the largest Mississippian mound complexes in the Southeast, it is also one of the most extensively studied sites (Knight 1998; Steponaitis 1980). Beginning in the mid-nineteenth century, antiquarians became interested in "the mounds at Carthage," as the site was then known (Maxwell 1876).

In 1876 Thomas Maxwell published *Tuskaloosa: The Origin of Its Name, Its History, Etc.* Within the paper, originally presented to the Alabama Historical Society, Maxwell included a discussion of the Carthage Mounds[1] (1876:69).

> *It may be permitted, as being cognate to our subject, to give some account of the monuments left here by the race which preceded us. These are scattered all over the face of the country, in the shape of mounds, and some of them are in our immediate vicinity. Some are at Carthage, 17 miles south of us. These I visited for the first time 36 years ago. They were then about 15 in number. Since then some have been plowed down, so as to be scarcely visible. The larger ones are still there, and objects of great interest. The largest one is about 80 feet high on the side next to the Warrior river[2], and on its summit are some of the largest trees of the forest. In 1840 I measured some of the oaks upon it that were over 9 feet in circumference. At that time I spent several days digging into this mound, until the neighbors thought I was demented. I found a large mass of broken pottery, arrow-heads of flint, hatchets of flint, and burned clay mixed with pebbles and charcoal.*

Maxwell's work in 1840 marks the first documented excavations into the site. The largest mound at the site, and the one believed to have been excavated by Maxwell, is Mound B. Measuring 17.37 m (57 feet), the mound covers more than an acre at the base and is separated from Mound R by a deep ravine.

Although this investigation was the first documented, it is not the first to have occurred, for in the discussion of his 1840 excavation, the author mentions that as he was working at the mounds, a young woman presented him with a "beautiful vase" (1876: 70). Maxwell's work was followed by that of Nathaniel T. Lupton, a professor of chemistry from the Southern University in Greensboro, Alabama (Steponaitis 1983a; Weiss 1998) and his student Edward Parish. The investigations were intended to help provide answers as to the "race" of people responsible for the construction of the Carthage Mounds (Lupton 1869).

The next major investigations of the site, and some of the most extensive, were conducted by Clarence Bloomfield Moore (1852-1936), a wealthy philanthropist from Philadelphia. Moore arrived at Prince's Landing in the Spring of 1905 in the flat-bottomed, stern wheel, steamer the *Gopher of Philadelphia*. The steamer carried all of his supplies, thirteen trained excavators, and five supervisors, along with the captain J. S. Raybon, Dr. Milo G. Miller, and himself (Knight 1996; Moore 1905; Stoltman 1973; Wardle 1906). Moore's expeditions were conducted with the sponsorship of the Academy of Natural Sciences of Philadelphia. His finds were displayed in the

[1] For the majority of the nineteenth century, the location had been known as Carthage. It was not until 1891, that A. H. Griffin acquired land from O. T. Prince and laid out a grid plan of streets south of the mound complex. He named the community Moundville.

[2] C.B. Moore noted in his 1905 publication that the river running from Demopolis to Tuscaloosa, Alabama was referred to as the Warrior, while from Tuscaloosa upstream it was known as the Black Warrior. The name Black Warrior was ascribed to the entire river sometime near the turn of the century.

Academy's archaeological hall and published in the *Journal of the Academy of Natural Sciences of Philadelphia* at his own expense.

By 1905, Moore was working on his fifteenth field season and had already published several of these reports. It was during the off-season of 1904 that Raybon had traveled to Tuscaloosa and worked his way down the Black Warrior River stopping at each landing and investigating potential sites and the names of property owners. Permission to dig at Moundville was acquired prior to departure from Mobile Bay, on December 29, 1904. It was not until February 6, 1905 that the *Gopher* entered the lower Tombigbee River and began working its way north to Tuscaloosa, at the time the northernmost navigable port on the Black Warrior River.

On March 17, Moore and the crew of the *Gopher* arrived at Prince's Landing. They steamed slightly past the landing and tied up at Hemphill Bend, directly across the river from the site.

The following day after the *Gopher*'s arrival at Moundville, Moore and his crew began work excavating and mapping the site. The job of surveying the mounds and surrounding features fell to Miller whose normal role consisted of being the project's anatomist. Miller recorded twenty-two of the site's currently known, twenty-nine mounds. He mapped the site in great detail including several of the gullies and erosional washes that dissect the northern end of the site and the bluff overlooking the Black Warrior River. He also documented the location of trenches visible in several mounds which had been dug prior to the arrival of the *Gopher*.

As Miller mapped the site, Moore's crew began the task of excavating trial-holes, "averaging four feet square and four feet deep" (Moore 1905:139). The normal crew housed on the *Gopher* was supplemented with ten men from the surrounding community. Excavations into mounds and surrounding areas were back-filled following completion, a novel act compared to the excavations undertaken by prior investigators[3].

Moore's 1905 field season at Moundville consisted of the excavation of at least 378 trial-holes, numerous references to "extensively dug through" mounds, large-scale trenching, and numerous excavations of ground level areas surrounding the mounds. Thirty-five days of excavations by a crew of 23 men, five supervisors, Moore, and Miller resulted in the uncovering of hundreds of human burials and thousands of artifacts, the mapping of 22 of the 29 mounds at the site, and the promotion of Moundville as one of the preeminent archaeological sites in the Southeast.

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[3] Several of these un-filled excavations that predate Moore's work are believed to be those visible in Miller's map as trenches or gullies (Moore 1905:129).

The Moundville Site Chronology

The Moundville Site (1Tu500) is located on the east bank of the Black Warrior River in West-central Alabama. The site consists of 29 earthen mounds constructed and occupied by Mississippian peoples between approximately A.D. 900 and 1650 (Figure 2). The mounds are considered the result of organized social activities which included various techniques of construction and labor organization. The current understanding of the chronological sequence of occupation at Moundville was developed in the 1970s with more recent refinements (Knight and Steponaitis 1998; Steponaitis 1980, 1983b).

As it stands, the chronological sequence is broken into five ceramic phases and five, not necessarily synchronous, developmental stages (Knight and Steponaitis 1998:6-25). The first ceramic phase, dating to between A.D. 900 and 1050, is the West Jefferson. It represents a terminal Woodland manifestation defined from sites in the upper Warrior Basin and present throughout the Black Warrior Valley (Jenkins and Neilsen 1974).

Corresponding to the West Jefferson ceramic phase is a developmental stage involving, and thus referred to as, *Intensification of Local Production* (Knight and Steponaitis 1998:10-12). Its span of existence matches the dates given for the ceramic phase of the terminal Woodland. Survey data provided from the Tombigbee, Tennessee, Black Warrior, Alabama, and Coosa River Valleys suggest the terminal Woodland experienced a period of inter-areal conflict and resource stress which may have led to more permanent community oriented settlement patterns (Knight and Steponaitis 1998; Little 1999; Walthall 1980).

The presence of a Late Woodland occupation at Moundville is only tentatively known by the existence of grog-tempered West Jefferson phase pottery from the site (Astin 1996; Knight 1989a, 1992; Ryba 1997; Scarry 1995). However, in light of current evidence, it is more likely that the grog-tempered pottery commonly attributed to the West Jefferson phase was still being produced during the subsequent early Moundville I phase (Knight and Steponaitis 1998:12). Consequently, Vernon James Knight, Jr. and Vincas P. Steponaitis believe it is unlikely that Moundville was occupied prior to A.D. 1050.

The Mississippian occupation of the Moundville Site began with the Moundville I ceramic phase spanning the two hundred years between A.D. 1050 and 1250. The phase is broken into early and late subphases marked by the changing frequencies of types Bell Plain, Moundville Engraved, Moundville Incised, Warrior Plain, and Carthage Incised.

Early Moundville I roughly corresponds to the *Initial Centralization* developmental stage from about A.D. 1050 to 1200. It is during this time that the diagnostic characteristics of Mississippian culture become apparent. Mounds were built or at least begun, shell-tempered ceramics became dominant, and an increased dependence on maize-based horticulture occurred

(Knight and Steponaitis 1998; Scarry 1995, 1998; Schoeninger and Schurr 1998). The presence of grog-tempered ceramics, typical of the West Jefferson phase, points to either incorporation of local tradition (Ned J. Jenkins, personal communication) or contemporaneous occupation and interaction between the two cultures (Richard A. Krause, personal communication).

The *Regional Consolidation* developmental stage spans late Moundville I, from A.D. 1200, to early Moundville II, around A.D. 1300. The stage is dependent upon the idea that Moundville's basic form was a planned pattern. Construction of the majority of the mounds at least began during a time when political power was being consolidated among elite members of the community (Knight and Steponaitis 1998:14-15). It was also during this time that the palisade, surrounding much of the site, was first constructed (Scarry 1995) and maize replaced other resources as the dominant source of nutrients (Schoneinger and Schurr 1998).

The Regional Consolidation stage overlapped the Moundville I phase and extended into the early Moundville II phase at around A.D. 1250. During Moundville II, Carthage Incised and Moundville Engraved were the dominant pottery types. Moundville Incised waned in frequency and eventually disappeared and vessel form and decoration shifted. The Moundville II phase terminated around A.D. 1400.

The developmental stage subsequent to Regional Consolidation is referred to as the *Paramountcy Entrenched*. The stage began in late Moundville II, around A.D. 1300, and ended around A.D.1450 in the following ceramic phase. It was during this time that certain burials appeared with finery attributed to elite status. Copper earspools, gorgets, and hair ornaments, marine shell beads, and other non-local items are but a few of the grave goods attributed to elite burials. Midden deposits at the site became scarce, suggesting a decrease in population. Knight and Steponaitis (1998:18) attribute the decrease in middens and, possibly, populations to the abandonment of the site by commoners and limited occupation by only high status individuals. The number of burials, compared to midden deposits, also suggests that individuals living outside the site boundaries were brought to Moundville specifically for burial. In essence, Moundville had become established as a massive ceremonial center.

The Moundville III ceramic phase is marked by continued shift in forms from about A.D. 1400 to 1550. Moundville Engraved and Carthage Incised continued their predominance during the early Moundville III phase, but by the end, Moundville Engraved became virtually nonexistent.

At approximately A.D. 1450, Moundville again experienced a decline in population. Known as the stage of *Collapse and Reorganization*, only a limited number of mounds at the site appear to show evidence of modification during this time while the remainder were evidently abandoned. In particular, the northern side of the site shows continuation of occupation, while the majority of mounds forming the southern periphery were abandoned (Knight 1989a, 1992, 1998).

The Collapse and Reorganization stage continued through the final ceramic phase at Moundville. The Moundville IV phase is marked by the existence of urn burials and new pottery types including Alabama River Incised and Alabama River Appliqué. Evidence for occupation during the latter portion of the developmental stage includes occupations of Mounds B, P, and E. Maize dependence by the site's occupants was replaced by wild resources. By the end of the sixteenth century, only sparse occupation of Moundville existed. By the seventeenth century, the Black Warrior Valley had become a border zone between warring factions of Creek and Choctaw. The introduction of European settlers into the area was well established by the early 1800s.

The chronological period of occupation that concerns us here is the five hundred year span between A.D. 1050 and 1550. In particular, this includes the initial construction, period of modification and occupation, and final decline of use of Mound R. Between the mound's initial construction during the Moundville I phase, and eventual abandonment sometime near the end of Moundville III, a vast amount of change took place in the morphology of the earthen structure.

Purpose

Culturally modified landscapes both reflect and affect the way Mississippian peoples viewed themselves and their world at large. As such, the investigation of anthropogenically modified landscapes serves to aid in the development of an understanding of cultures and culture change (Dalan 1993, Gage 2000). The very nature of mound construction requires sediment to be removed from other areas and redeposited to a secondary mound context. Such activities reveal patterns in the amount of sediment utilized and the necessary labor expenditures employed.

This study is intended to identify the internal matrix of Mississippian mound structures by examining the stratigraphic zonation present within five mounds at the Moundville Site. The general size, location, and features of the mounds were considered in selecting the five to be tested. The capacity for imaging the internal structure of earthen mounds at Moundville was realized with the ground-penetrating radar and core sampling of Mound R (Gage 2000). The project focused on a single mound, producing 60 core sample sections and 780 m of transects imaged across the mound's summit.

Mound R experienced a series of at least six, and possibly as many as eight, episodes of construction. The exact number is in question because of the extent of historic modifications to all but the mound's edges resulting from extensive cultivation of the large platform mound's summit. It is believed that the five or possibly six episodes of construction recognized by Knight (1993:18-19) correspond to the three later stages (III, IV, and V) of construction recognized in the core samples. In addition, the 1993 excavations likely encountered two or three additional episodes on the edge of the mound removed from the central portion by cultivation and subsequent erosion.

The initial episode of construction, likely occurring during late Moundville I or early Moundville II phase, was the largest with each succeeding episode being much smaller in volume. The estimates of labor required for each episode of construction, although dictated by the population and available labor force, was likely limited to less than 21 days for any individual stage.

The distribution of features, including house floors, slopes, and midden deposits reveals a shift in the primacy of occupation areas and refuse disposal. While the earliest stages of the mound experienced construction efforts concentrated in the central and northern portion of the Mound R locale, the later post-Stage II episodes of construction involved a massive addition to the southern end of the mound. This, in turn, was followed by a shift in refuse disposal from concentration in the northeast portion of the mound during the first two stages (I and II), to random distribution around the mound's edges in subsequent stages (III-V).

Throughout Mound R's occupation, the northern end of the mound appears to have been preferred for summit architecture. Interestingly, this preference appears after the first stage of construction. Only during Stage I does a burned surface, suggestive of burned summit architecture, appear in the southern portion of the mound.

Mound R's patterns of occupation mirror the changes in social organization proposed for the site . With the changing population, successive episodes of decreased volumes of construction become apparent until probably the end of Moundville III or early Moundville IV when Mound R is abandoned.

Earthen mounds, specifically Mississippian platform mounds built throughout the Southeast are constructed in a common way. Sediment is piled to from a surface raised above the surrounding ground level. The uppermost surface of this structure may represent the first and only summit, or it may be one in a series of mound building episodes. Additions to mounds are not only common, but the norm (DeJarnette and Wimberly 1941; Knight 1995; Lewis and Kneberg 1993; Schnell et al. 1981). David J. Hally (1996:110-112) has made a study of the likely duration between Mississippian mound-construction stages. His findings come from both ethnographic and ethnohistoric evidence derived from the Natchez as well as possibly from the Taensa and Timucua which suggest that the frequency with which mounds were provided additional stages requires an event of similar frequency. The phenomenon Hally identifies as the only "event having sufficient community interest and occurring with sufficient frequency and regularity to have served as the stimulus for most rebuilding" was the succession of a chief (Hally 1996:95). As such, he believes that the duration of a stage's use-life was between fifteen and twenty-five years (Hally 1996:110).

Knight (1986, 1989b) supports a slightly different, although relatively compatible, cosmological foundation for monumental architecture and its "burial." Falling within his "triad of iconic families" Mississippian platform mounds were symbolic objects of sacred display (Knight 1986:678). The mound is an icon representative of earth, modified by periodic burial as a means of its purification and renewal (Knight 1986:678, 1989b:282). It is a sacred element representative of ceremonial and religious beliefs, such as a metaphor for the "earth island," as a means of appeasing or honoring ancestral spirits, or associated with mountains or other elevated surfaces (Knight 1989b). The addition of stages symbolizes renewal, purification, and possibly fertility, not unlike the Muskogee "green corn dance."

For whatever reason, successive episodes of construction over years, decades, or centuries was undertaken by groups of laborers in an effort to modify the existing communal landscape. The commonality of building techniques and methods leads to a similarity, notable in almost all such earthen structures. Basketload upon basketload was excavated from secondary locations, transported to a common locale, and deposited to form mounded earthen structures. As a result, profiles of these structures reveal individual piles of sediment as well as summit surfaces buried by subsequent additions of mound fill.

Anthropogenic modifications to the landscape require labor above and beyond the basic needs for human survival. The impetus behind the coordinated efforts of several individuals required for the development of a mound can only be speculated upon. Moundville's political organization as a stratified, chiefdom level society provides some semblance, if again speculative, of reason behind mound construction. Justification by elite individuals for corporate labor expenditure might be found in what Earle has called "... an ideology that strengthens the legitimate position of leaders..."(1991:6). He outlines a series of ten political strategies designed to potentially answer the question of elite control. These include:

(1.) *giving (inflicting debt), feasting, and prestations;*
(2.) *improving infrastructure of subsistence production;*
(3.) *encouraging circumscription;*
(4.) *outright force applied internally;*
(5.) *forging external ties;*
(6.) *expanding the size of the dependent population;*
(7.) *seizing control of existing principles of legitimacy (the past, supernatural, and natural);*
(8.) *creating or appropriating new principles of legitimacy;*
(9.) *seizing control of internal wealth production and distribution;*
(10.) *seizing control of external wealth procurement* (Earle 1991:5).

By comparing these strategies to Moundville's archaeological record, it is possible to at least suggest exclusion of those that may not apply. Strategies (1) and (2) require leaders to harness the economic power resulting from controlling the means of production. This is certainly a viable option given the resources available for craft production within the influence sphere of the civic ceremonial center (Welch 1991, 1996,). The clays which outcrop along the Black Warrior River near or below current artificial pool levels provide an excellent source for pottery production. In fact, much of the pottery found at the site and attributed to non-local sources, has instead been found to have been made from Moundville-area clays (Welch 1996:84). Resources within the Fall Line Hills and subject to Moundville's political control may have also included sandstone (Sherard 1999), Tuscaloosa gravel, and any number of perishable and non-perishable materials (Scarry 1995; Welch 1991, 1996). Although any assertion that Moundville was the controlling center for craft specialization during Mississippian times is tentative at best, some evidence does exist for craft production at the Moundville site and not at other adjacent sites within its sphere of influence (Muller 1997; Scarry 1995; Steponaitis 1991; Welch 1991, 1996).

Strategies (3) through (6) are tied directly to forced conscription and/or warfare. While we know that the preceding Late Woodland witnessed large scale areal conflict (Steponaitis 1983, 1991), the Moundville I phase and the subsequent Moundville II and III phases saw a decrease in conflict. The number of traumatic injuries noted in burials from the site are few and far between (Powell 1988, 1991, 1992, 1998). This lack of evidence for traumatic injuries or death caused by combat does not support the idea that the occupants of Moundville were involved with extensive warfare. However, the presence of the palisade wall surrounding Moundville from the Moundville I phase to possibly the middle of the Moundville II phase implies the desire for some type of protection (Scarry 1998; Vogel and Allan 1985).

The remaining strategies, (7) through (10), emphasize the need for leaders to portray themselves as necessary to maintaining the order of the world (Earle 1991:6-7). This may come in the form of controlling non-domestic goods and their exchange. The artifact assemblage from Moundville shows a differentiation between elite and non-elite burials in regard to the presence or absence of trade goods and/or exotic materials (Peebles 1971, 1974). This differentiation may, as suggested elsewhere (see, e.g., Scarry 1995; Steponaitis 1991; Welch 1991, 1996) represent a situation in which foreign exchange was dominated by the Moundville elite. None of the exotic looking pottery, originally believed to have been non-local and only recently attributed to production at Moundville, appears at the known outlying sites. Other non-local materials include obsidian projectile points, elk antlers, Mill Creek and Dover chert hoes, and an Amethyst bead (Peebles 1979; Welch 1996). Their access to these goods might then afford them privilege in the form of subservient behavior by non-elite individuals, namely labor expenditure. The connection between the presence of these items, in potentially elite burials, and the construction of monumental architecture by Mississippian peoples is undoubtedly conjectural. But, whatever the cause, the building of 29 earthen mounds within a confined area the size of Moundville required both communal planning (Knight 1998) and extensive labor organization.

The application of the term "chiefdom" to Moundville's social organization follows the definition provided by Service (1962) and Sahlins and Service (1995). This establishes Mississippian culture within the general categories of sociocultural complexity in the evolution of human society (Blitz 1993). It is also intended as a cross-cultural comparison (Knight 1995; Earle 1989) relying on the recognition of the existence of a hierarchical social order, craft specialization, and differential access to resources. The result is a theoretical understanding of Moundville's occupants as reliant upon a stratified social structure dominated by elite individuals. Evidence of this can be interpreted from the construction of monumental architecture at the site, the establishment of which required technical systems of labor organization and work force implementation.

The impetus behind this project has been to gain a stronger understanding of the factors which led to the existence of what is recognized as the second largest Mississippian community in eastern North America (Peebles 1974,1979; Scarry 1986, 1995; Steponaitis 1983b). Factors involved with the organization of labor, to the extent implied by the monumental architecture present at the Moundville site, have led to the need for investigation of the driving forces behind mound building (Knight 1995; Pauketat 1994). By understanding the amount of effort required for each successive level of mound construction, implications related to social organization at Moundville can be examined.

Interpretations related to the organization of labor and the skills required by elite proponents of these efforts, suggests the existence of political power manipulation at Moundville. In this instance, power can be understood as the capacity to achieve results through the manipulation of others (Smith 1992). Through some force of social cohesion, the elite at Moundville were able to persuade others to assist in the construction of large earthen structures. Understanding the implications of these actions requires examination of each of the resulting developments, in this instance, each of the successive layers from mound building episodes.

Investigation of the rise of the Moundville chiefdom depends on uncovering archaeological data related to specific contributions of individual temporal points within the sequence of occupation as they correspond to the overall development of the site (Knight 1995). As a result of more than a century of archaeological inquiry, many of these points are relatively well understood. Ceramic chronologies for the site have been established (DeJarnette and Wimberly 1941; Steponaitis 1980, 1983b), as have discussions of tribute (Welch 1991, 1996; Pauketat 1994), and resource exploitation (Peebles 1974; Scarry 1986; Blitz 1993; Astin 1996). Nevertheless, gaps exist within the archaeological data which must be addressed. These include what Knight (1995:5-6) has referred to as the lack of detailed history of corporate labor investment in public works and the chronological sequence of mound construction. This not only includes initial construction, but additions and general maintenance. These are vital elements necessary for developing our understanding of elite control over labor and cultural change throughout the period of chiefdom level organization. To examine the social implications of chiefdom level society we must acquire an understanding of the observable results of such societies, namely the modification to the natural or existing landscape.

Understanding of the overall morphology of prehistoric modified landscapes has been promoted by several recent studies of anthropogenically altered areas (e.g., Dalan 1993; Gage 2000; Hoffman 1993; Smith 1992). These studies have followed a trend in the investigation of artificially modified landscapes: the interpretation of built environments (Dalan 1993) and the dynamic aspects of these modified environments' relationship with human beings. Ranita Dalan's work at Cahokia has revealed extensive evidence of soil borrowing and its relative time sequencing for construction activities. In addition, Bruce D. Smith's (1992) work on Cahokia's woodhenges represents a potential interpretation of Mississippian site development as it relates to hierarchical social organization.

Recent works by archaeologists at Moundville (see, e.g., Knight 1995; Ryba 1997) have focused on architectural styles of structures built atop mound summits and the relationship of these structures to social organization. Yet, these investigations have been dependent upon the most commonly employed techniques available, namely excavation. Most of the data currently available have been the result of excavations begun by Knight in 1989 (Knight 1992, 1995; Knight and Steponaitis 1998). These excavations have looked at both the flanks of several of the mounds, as well as summit architecture of Mounds E and Q. They have included stratigraphic discussions for each mound; however, their focus has not included examination of individual building episodes and labor expenditures.

While this study is by no means unprecedented (see, e.g., Gage 2000; Hoffman 1993; Price et al. 1964; Reed et al. 1968; Stein 1986, 1991), it is one of the first attempts at combining relatively non-invasive investigative techniques with the intent of recognizing mound construction stages. It is by no means intended as a replacement for the predominant archaeological techniques; rather, it is considered to be a guide for future research. By establishing a model of the internal morphology of the mounds, we are, in essence, creating a blueprint for future investigations.

CHAPTER 2

BACKGROUND OF THE MOUNDVILLE REMOTE SENSING AND CORE DRILLING PROJECT

The lack of available data related to stage volumes, labor expenditures, and internal mound structure is understandable under the current circumstances. Most of the investigations have relied upon common techniques of archaeological inquiry, namely excavation. Following these techniques, it would require an exorbitant expenditure of money, time, and labor to examine portions of the mounds' matrices located in deeply buried deposits. As is unavoidable with archaeological excavations, the matrices examined are inevitably destroyed. This might not be seen as a problem unless we consider the potential for future developments of more efficient and conclusive investigative methods.

Various options that avoid this extensive destruction do exist. Relatively non-invasive techniques of investigation have been a part of archaeological inquiry for many years. The majority of studies involving core sampling of modified landscapes have either been focused on establishing source location for site materials (Dalan 1993), in establishing the location of submound deposits for pre-excavation tests (Dalan 1993; Knight 1995), or for predicting overall site layouts (Hoffman 1993). This research project is intended to avoid many of the destructive results of conventional techniques while obtaining stratigraphic information related to cultural activities occurring during the existence of the Moundville chiefdom.

Ground-Penetrating Radar

The goal behind the project was to assess the potential for relatively noninvasive investigation of earthen mounds. Since remote sensing has become a relatively common practice in archaeological inquiry, it was a primary factor (Gage and Jones 2000). Because the depths of deposits intended to be examined were greater than 5.0 m, the viability of the majority of remote sensing techniques, namely resistivity, gradiometry, and magnetometry, were considered limited. Given certain conditions, ground-penetrating radar (GPR) has the potential to image much deeper, up to 40.0 m below the surface. Because of these factors, GPR was decided as the technique with the greatest potential for providing the data required (Figure 3). The features intended for imaging included large scale differences within the mound matrix, such as large trenches, pits, fire hearths, prepared clay floors, and different stages of construction.

GPR requires a means of ground-truthing to provide adequate information for interpreting subsurface conditions. As such, it was necessary to perform limited invasive investigation. Core sampling offered an excellent option by providing a continuous profile of the stratified deposits at

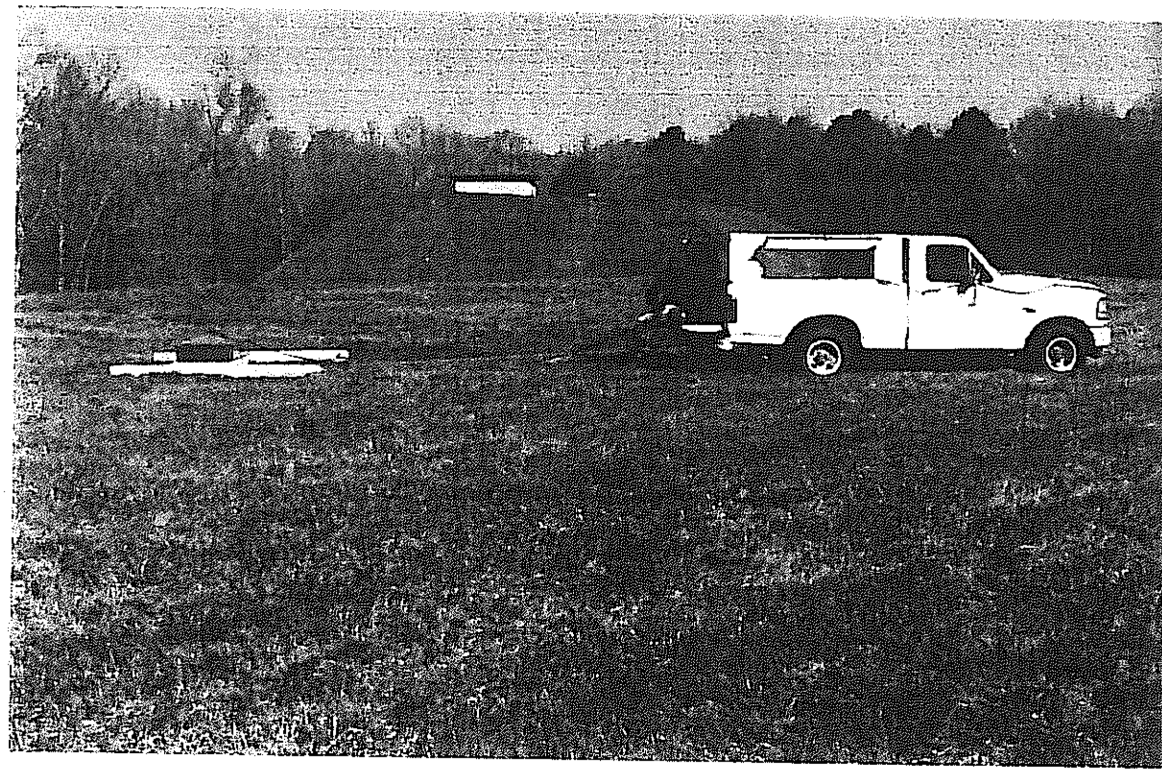

Figure 3. GPR survey of Mound A in progress.

a given location. It also offered the potential to result in the least amount of impact to the mound while providing the greatest amount of information concerning deeply buried deposits.

If the mounds were built in stages with the use of sediments and soils from the surrounding landscape capped by living surfaces, then strata marking the extinct summits exist within. Consequently, each episode of construction should be definable based on separation by these strata. Since GPR works by recognizing variations in subsurface materials, the radar data should show the variations in the vertical profiles. Finally, because the GPR survey capabilities are limited and ground-truthing is necessary, core samples taken from selected locations should not only provide continuous profiles of the mounds, evidencing the extinct summits, but also a unit of comparison for the GPR data and means of sampling GPR recognized anomalies. If the variations in the sediment were not enough to manipulate the wave energy propagation, then the GPR data should show none of these features, and instead, reveal a consistent subsurface profile of heterogeneous mound fill.

Ground-penetrating radar, also referred to as electromagnetic subsurface profiling or subsurface interface radar, involves the direction of a pulse or wave of electromagnetic energy into the ground. The return time of reflected energy is recorded in a similar manner to that employed in aircraft radar (Weymouth 1986; Conyers and Goodman 1997). As an investigative tool, GPR allows the archaeologist to cover a relatively large area while providing information about the location of buried features. Unfortunately, GPR is not a simple process applicable to every site. The ground in which the site exists must be conducive to radar survey. Its potential relies on soil and sediment type, ground moisture, vegetation, and topography (Bevan 1998; Conyers and Goodman 1997).

GPR is a non-invasive geophysical technique that creates a continuous profile of the subsurface. Unlike magnetic susceptibility, resistivity, or conductivity instruments, GPR is an interface detector specifically designed to recognize abrupt changes in soils or sediments (Bevan 1998). It is especially useful in detecting soil and sediment stratigraphy and large subsurface features which consist of material unlike the surrounding soil or sediment matrix.

A radar image is achieved by transmitting a low frequency electromagnetic energy pulse, usually in the 80 to 1000 Megahertz (MHz, millions of Hertz) range, into the ground with a transmit/receive antenna (Heimmer 1992; Vaughan 1986). The velocity of radiation in the ground is usually around 5-15 cm/nanosecond, or 37,500-150,000 km/second (Weymouth 1986). As the signal passes through the ground and encounters various soil horizons, sediment zones, or buried features, a reflection is produced. This reflection is detected by the antenna, converted from an electromagnetic signal to a digital or analog signal, and directed to the control unit. A typical radar reflection might include geologic formations, soil and/or sediment interfaces, natural disturbances such as animal burrows and stumps, as well as artificially developed features such as pipes, building foundations, water lines, burial shafts, abandoned wells, and so forth. The depth to which objects can be detected varies from site to site and is dependent upon the properties of the soils and/or sediments present.

The University of Alabama Museums, Office of Archaeological Services currently utilizes a SIR System-8, manufactured by Geophysical Survey Systems, Inc. The system consists of a control unit (mainframe and control module), a monitor with instantaneous display, a graphic recorder, an analog recorder, a power distribution unit, and various transducers (antennae ranging from 120 MHz to 500 MHz) mounted on sleds. The antenna is connected to the control unit by means of a 61 m long control cable. The system is powered through a distribution unit connected to a 12 volt automobile battery for field investigations. The Office of Archaeological Services' system can be operated by a single individual; however, another person makes the survey much easier. While one person pulls the antenna along set transects, a second person monitors the equipment and notes anomalies as they present themselves. GPR models now available include built-in battery packs and consist of a backpack unit, antennae, and a connected laptop computer with digital recording capabilities.

As with any type of archaeological inquiry, collecting the data is only a small fraction of the process. Radar images, recorded digitally or in an analog format, must be downloaded to a computer with software designed to filter, enhance, and display information. Various software packages exist with differing capabilities and user-friendliness. The Office of Archaeological Services utilizes a RADAN software package, also designed by Geophysical Survey Systems, Inc., specifically for use with their radar systems. The software allows for data download, storage, filtration, compression, varying display parameters, and manipulation. Although the software is not particularly user-friendly, it is excellent for enhancing and interpreting GPR data.

Ground-penetrating radar was originally designed to assist in locating buried utilities, cavities, fractures, and voids (Vickers et al. 1976:81). Always quick to take advantage of new technology, archaeologists recognized a potential for locating subsurface archaeological features. As early as 1974, GPR was utilized to locate and delineate buried features at Hungo Pavi, located within Chaco Canyon National Monument, New Mexico (Vickers et al. 1976). Interpretation of radar data and, later, excavation revealed that some of the anomalous reflections in the transect profiles had revealed the presence of buried masonry walls associated with a pithouse (Conyers and Cameron 1998; Conyers and Goodman 1997; Vickers et al. 1976).

Following the success at Chaco Canyon, a number of GPR surveys were applied to historical archaeology. These surveys were successful in locating a variety of subsurface features, such as foundations, cellars, and stone walls (Bevan 1998; Conyers and Cameron 1998; Conyers and Goodman 1997; Kenyon 1977). The archaeological applications of GPR rapidly became more widespread. At the Ceren site in El Salvador, GPR was utilized to investigate structures buried by volcanic ash (Sheets 1992). In Japan, sunken clay floors and buried soil horizons covered by up to two meters of volcanic pumice and loam were identified (Conyers and Goodman 1997).

Today, advances in technology have improved the capabilities and results of radar surveys. Computer technology now allows for the construction of subsurface maps in three dimensions. These maps outline areas which exhibit similar reflections and display areas of particularly high amplitudes. Whereas previous GPR surveys were limited to the production of radar profiles, these programs allow large areas and massive amounts of data to be compiled into site and individual feature maps (Conyers and Cameron 1998).

Core Sampling

Core sampling of archaeological sites has a long and varied history. Early coring, not unlike these investigations, involved attempts to determine the nature of archaeological sites and their geomorphological settings. At the Cahokia site, Monks Mound, the largest Mississippian mound, has been subject to numerous such investigations (Fowler 1989; Skele 1988). In 1916, A.R. Crook augered a 25 ft. sample from the fourth terrace in an effort to determine whether the earthen structure was a natural feature of the landscape or an artificial mound (Reed et al. 1968). Even after his work, Crook was not convinced that the deposits were "man-made." As a result, Morris M. Leighton followed suit by augering five holes in the fourth terrace. He determined that the stratified deposits were like those he had noted in other mounds and that at least the upper portion of the mound was artificial (Reed et al. 1968; Stein 1986). In 1939, under the direction of James A. Ford, Louisiana State University used coring to examine the extent of midden deposits at the Little Woods Area sites

(Ford and Quimby 1945). Ford was trying to determine why shell middens were located away from the shore of Lake Pontchartrain. He directed Preston Holder to conduct investigations to ascertain where the actual shore of the lake had been during the midden's development.

Ford's familiarity with core sampling arose from his ties to Louisiana State University's, Department of Geography and Anthropology. At the same time that Ford was doing his research on archaeological sites in the Mississippi Delta, Richard J. Russell was using core sampling to determine the extent of delta progradation and submergence. Ford, meanwhile, was working out the pottery sequence in the area. Fred B. Kniffen combined their data to check the methods used to date the delta. He collected pottery from the sites and used the assemblages to date changes in the Mississippi River's morphology (Stein 1986:506).

After testing the Little Woods Area sites, the same techniques were employed at the Big Oak Island Site in 1939 and the Tchefuncte Site in 1941 (Ford and Quimby 1945, Stein 1986). The technique Ford was using did not produce continuous solid cores, but rather allowed materials from great depths to be brought to the surface by means of an Archimedes screw auger (Rapp and Hill 1998).

By 1964, a different system was being used by archaeologists to core sites. The West Virginia Geological Survey was using an Acker "Hillbilly" Core Drill rig. The rig was employed to determine the nature of deeply buried archaeological deposits along the Kanawha River (Price et al. 1964). The rig was fitted with a sampling system that produced solid sediment cores by hammering 3 inch steel pipe casing and a split-tube sampler into the ground with a 300 lb. weight. The samples produced included intact profiles of the stratigraphy of the archaeological sites. The coring succeeded in determining the area of concentration, establishing the potential for intact deposits at the site, revealing the depth of deposits, and provided information about why the site was occupied (Price et al. 1964:221).

Inspired by Price, Hunter, and McMichael's success at coring stratified deposits, Nelson A. Reed, John W. Bennett, and James W. Porter returned to Monks Mound in 1967 with a truck mounted drilling rig (Fowler 1989; Reed et al.1968; Skele 1988; Stein 1986). The continuous sampling system employed had several bugs, and five of the 340 cores they drilled were lost (Reed et al. 1968:139-140). Nevertheless, they recovered a relatively intact series of profiles within the core samples. Prior to the completion of coring, it was decided that a 2 m by 7 m test trench would be excavated by standard methods to compare with the conclusions of the core sampling. The trench was carried to 6.03 m below the surface. The comparison of the cores to the trench excavation revealed several discrepancies including bands of sand and black clay interpreted in the core samples as possible laid floors. The excavation showed them to be basketloads within mound fill rather than buried summits (Reed et al. 1968:141). Nevertheless, the majority of their recognized stage contacts were present in the excavations as well. As a result of their efforts, fourteen individual "soil features" or stages of construction were recognized. Estimates of volume and labor expenditures were generated, carbon samples were recovered and dated, and the hypothesis that Monks Mound was an incomplete work was suggested (Reed et al. 1968:142-147).

Again, building upon their success, Richard W. Casteel conducted core sampling of a midden deposit to determine the feasibility of producing samples for microanalysis (Casteel 1970). Casteel found that a single person could auger, bag, and process by flotation a single core sample to 100 cm below the surface in less than one hour and 30 minutes. The same size sample, taken through standard techniques, would require the excavation of an entire test unit to the same depth (Casteel 1970:466).

In 1977, Julie Stein augered the Carlston Annis Mound, a shell midden, on the Green River in Kentucky. Using a one inch split spoon auger, she produced several 24 cm samples to depths between 1.5 m and 2 m (Stein 1978, 1982). She then produced a 0.25 m contour paleotopographic map of the deposits within the 4,000 year old mound, as well as estimates of the volume contained between bonded units, and an isopach map showing contour lines drawn according to deposits of like thickness (Stein 1978:15-17).

In a 1978 article, Bryan C. Gordon demonstrated the use of coring combined with chemical and pedological analysis of deeply buried archaeological sites under freezing conditions (Gordon 1978; Stein 1986). Klo-kut, a well stratified Vunta Kutchin Indian site on the Porcupine River in northern Yukon, Alaska, was sampled using a 1 5/8 inch diameter portable core drill. Gordon determined that the potential for recognizing the vertical and horizontal extent of archaeological sites was possible and that, although ultra-violet sensor tests were unsuccessful, chemical analysis of phosphorous was useful in determining areas of human occupation (Gordon 1978:337-338).

Probably one of the best summaries of the use of augering and core sampling was presented by Stein (1986; see also, Stein 1991; Canti and Meddens 1998; Hoffman 1993). In her article, she divides the use of augering and coring into two periods. Period I covers the methods and techniques used from 1935-1955. Period II covers those from 1964 to the present. She claims that the invention of radiocarbon dating in 1955 halted the need for relative dating of archaeological sites through core sampling (Stein 1986:509). Instead, she notes that the second period was more oriented towards site delineation, the development of stratigraphic data, and the viability of augering and coring in the reduction of investigative costs.

The use of coring and augering in archaeological investigation has continued as the usefulness of the techniques is obvious for site delineation, stratigraphic determination, and sediment, floral and faunal, pollen, and carbon sample recovery. More recent articles outline the use of portable mechanical coring devices (Canti and Meddens 1998) and the need for close-interval sampling to determine internal site structure (Hoffman 1993).

Stein, in particular has been a major proponent of coring and augering, even going so far as to say, "...a corer is potentially the most useful piece of equipment an archaeologist can have" (Stein 1991:138). It must be noted here that the majority of the coring Stein is referring to uses a relatively small diameter, 1 inch split spoon auger, 1.5 inch to 1.625 inch soil sampler, or a 4 inch bucket auger. The samples produced by the smaller diameter samplers, obviously, limit the width of the available profile produced, while the bucket auger often mixes the sediments as the cutting teeth penetrate the deposits. Nevertheless, many of the investigations which utilize these techniques are done with similar intentions to those outlined here.

CHAPTER 3

TERMINOLOGY, EXPERIMENTATION, AND METHODOLOGICAL EXPLANATION

This chapter explains many of the ideas behind the analysis of the GPR data and core samples and attempts to qualify the analysis process. The examination of the core samples reveals the presence of well stratified deposits. The stratigraphy is the result of sediment additions used to create the large earthen structures. Several terms will be used which must first be defined. They are commonly used words which may have more than one meaning and are here employed to discuss the various features seen within the core samples.

To begin, the deposits utilized to construct the mounds are made up of sediment. *Sediments* are the inorganic and organic particles accumulated by natural or human processes (Waters 1996). We are here concerned with sediments resulting from both, but especially those accumulated as a consequence of human activities. These are also known as archaeosediments (Waters 1996), anthropogenic sediments (Hassan 1978), and anthropic sediments or deposits (Gasche and Tunca 1983). *Anthropogenic* will be used in much of the following text. *Soils* are the weathering profiles developed by the physical and chemical alteration of preexisting sediments (Waters 1996). They are the result of *in situ* development, while sediment requires accumulation in a secondary context. Soils are present within the core samples, but predominantly only within the last sample sections recovered where submound deposits were encountered.

The sediment texture referred to within the text was determined based on samples taken during the bisection process. They were visually examined and manually tested for texture following guidelines established by the Alabama Soil Survey. In addition, a hand lens with 10x magnification and a stereoscopic microscope were used in conjunction with a grain size analysis card developed by American/Canadian Stratigraphic and designed to follow the Wentworth size classification scheme (see Boggs 1995:81). A Munsell color chart was used to provide color designations.

Anomalies are the basic units recognized in the GPR data. They consist of variations in amplitude signatures between the subject feature and surrounding matrix. These variations are caused by changes in the sediment within the mound. As radar energy passes through different sediments, the signal changes in accordance with the sediment's propensity to conduct it. These changes are recorded by the GPR unit as variations in amplitude frequency.

Each *core sample* represents a portion of the vertical profile of the mounds' deposits. The core samples are broken into 152 cm long by 10 cm diameter sections. The size of the sections is the result of the length of the core drilling *sampler*, a hollow cylinder with a narrowed tip which fits inside the drilling auger. The core samples are removed from *well locations* which are the positions on the mound chosen for drilling. The wells consist of 30 cm diameter holes produced by the drilling auger boring into the mound. The center 10 cm diameter core sample is recovered from each well.

Chronostratigraphy refers to the stratigraphic classification used to differentiate between surfaces buried at varying depths within the mound. Steno's principle of superposition simply states that the oldest deposits are at the bottom and the youngest at the top (Boggs 1995). Consequently, we can refer to the relative age of sediment deposits based on their position within the core samples. Within the samples, the basic chronostratigraphic units are *layers* or *strata*. These strata are the result of complete episodes of construction and occupation of the mound's sequence of summits as well as individual basket loads of sediment utilized to build the mound. They also include historic alterations to the mound's upper one meter. Layers and strata will be utilized synonymously to discuss the varying bands of sediment within the samples. The layer closest to the existing summit surface of the mound will be referred to in the text as the *modern humus* layer. This layer represents an O horizon or surface horizon consisting predominantly of organic material.

A *break* is used to explain a distinct vertical change in sediment appearance within the core samples. They are the contacts between different layers or strata. Breaks do not necessarily refer to the contact of separate episodes of construction. They are simply the places within the samples where sediments of different color, texture, or sorting contact one another.

A *stage* refers to an individual full episode of construction that either began by building upon sub-mound deposits or by adding to an existing summit. A stage is a planned initial construction or enlargement of the mound. It is composed of one or more layers and a buried summit. A *summit* refers to the horizontal uppermost surface of the mound which acted as a living surface or a break between episodes of construction. Buried summits are those which have experienced additional modification in the form of overlying sediment additions to the mound. Because the current summits of the mounds are the result of historic modification, the sediments involved in this last additions are not considered a stage.

An *episode* of construction refers to both the labor required to build each stage of the mound as well as the material utilized, such that Stage *a* is the end result of Episode *b* where *c* person-days were expended and *d* cubic meters of fill were deposited.

The *flank* of the mound refers to the slopes that exist between the summit or surface of any stage of construction and the natural ground surface surrounding the base of the mound or another underlying flank. These slopes have been altered both naturally and artificially as a result of mound building, weathering, and historic reconstruction activities. They are sometimes represented in the samples by sorted deposits where water activity has resulted in down slope sediment migration.

The recognition of each summit is based on a process of elimination. The contact of layers represents the differences of deposited material. Those contacts with dynamic breaks and no intermixing of upper and lower deposits appear different from those where a potential stable surface (summit) was not developed.

The most obvious markers between stages come from those areas where organic material was burned. The charcoal left behind forms a lens, usually less than 2 cm thick and underlain by material that includes fired clay. The heating of the summit sediment by the fire alters its appearance and structure. Conglomerations of sand, mud, and clay particles in gravel size fragments, similar to un-tempered pottery sherds, are formed and become evident in the underlying sediment. Included with this material is daub from structures which also becomes fired. The latter is difficult to distinguish from the fired clay of the summit in the core sample profile, except that it is often found intermixed within a lens of charcoal. Thanks to the effects of gravity and the sequence of building collapse on burned material, the daub of the upper portion of the structure falls atop the charcoal from the lower portion of the structure and, in turn, is covered by more charcoal.

In instances where organic material was not present in enough quantity to leave behind a lens of charcoal following burning, other means for determining buried summits is necessary. The stable summit of a mound would necessarily have had to have undergone some form of leveling process to develop a relatively flat surface. Whether this comes in the form of dumping basketlaods strategically between other loads or spreading and leveling basketloads, the result is a relatively flat surface. Compaction of this surface then begins, first by the builders and then by its occupants as they walk over the summit. Since episodes of construction consists of sediment from various sources, rather than a single location, the summit should appear as a relatively compact and somewhat mottled layer with the preceding layers being a series of homogeneous strata designating basketloads. In addition, the intermixing of the summit with overlying deposits should be relatively limited. Although the effects of pedoturbation are an undeniable factor, the contacts should remain relatively intact because of the summit's compact nature.

All of these factors were considered as potential indicators of buried summits. Their recognition was, and still is, considered relatively speculative and cannot be shown as fact without actual excavation or other, as yet undetermined, means.

Experimental Mound

In an effort to see to just what extent the various factors would have on sediments and how they would appear in a core sample, a simple experiment was designed to recreate mound deposits. A 68 L (18 gal) plastic tub was filled with 40 cm of various sediments and features, then a core sample was taken from the center and bisected. During the filling, each stage was measured and recorded. A lucite sheath was driven into the deposits and the sample was bisected, photographed, and profiled (Figure 4).

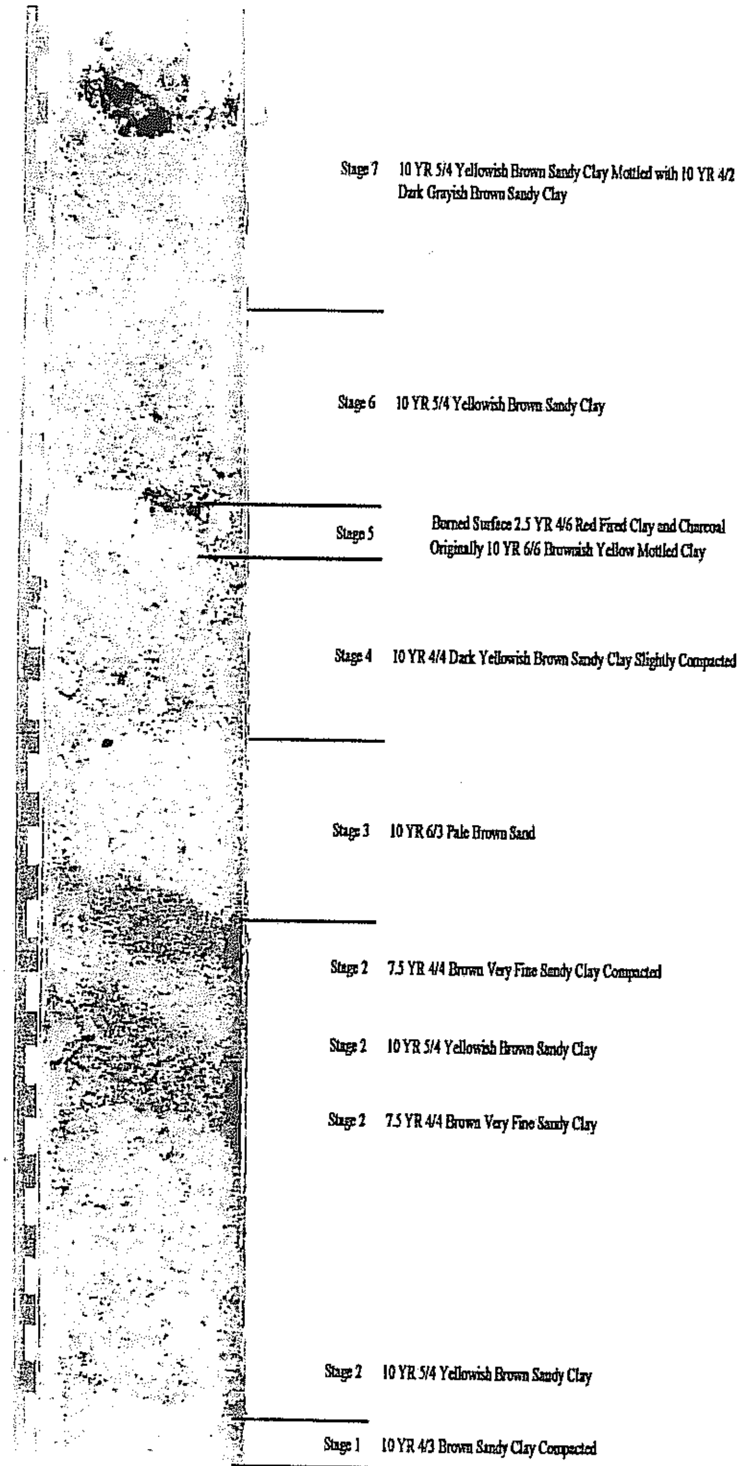
Stage 7 10 YR 5/4 Yellowish Brown Sandy Clay Mottled with 10 YR 4/2 Dark Grayish Brown Sandy Clay
Stage 6 10 YR 5/4 Yellowish Brown Sandy Clay
Stage 5 Burned Surface 2.5 YR 4/6 Red Fired Clay and Charcoal Originally 10 YR 6/6 Brownish Yellow Mottled Clay
Stage 4 10 YR 4/4 Dark Yellowish Brown Sandy Clay Slightly Compacted
Stage 3 10 YR 6/3 Pale Brown Sand
Stage 2 7.5 YR 4/4 Brown Very Fine Sandy Clay Compacted
Stage 2 10 YR 5/4 Yellowish Brown Sandy Clay
Stage 2 7.5 YR 4/4 Brown Very Fine Sandy Clay
Stage 2 10 YR 5/4 Yellowish Brown Sandy Clay
Stage 1 10 YR 4/3 Brown Sandy Clay Compacted

Figure 4.

The first stage consisted of 2 cm of 10 YR 4/3 brown sandy clay. The surface was dampened and compacted.

The second 15 cm thick stage consisted of: a layer of uncompacted, dry, 10 YR 5/4 yellowish-brown, sandy clay; a second layer of uncompacted, damp, 7.5 YR 4/4 brown, very fine sandy clay; a third layer of uncompacted, dry, 10 YR 5/4 yellowish-brown, sandy clay; and finally, a fourth layer of damp, 7.5 YR 4/4 brown, very fine sandy clay. The surface of this final layer was compacted.

The third stage consisted of 7 cm of dry 10 YR 6/3 pale brown sand. The sand was not compacted.

The fourth stage consisted of 10 YR 4/4 dark yellowish brown sandy clay. The sediment was dampened, leveled, and only slightly compacted.

The fifth stage consisted of 10 YR 6/6 brownish yellow-mottled clay. The clay was mixed with water to form a thick solution, poured atop the fourth stage, and compacted. The surface was allowed to dry before a fire was built to simulate a burned structure. The fire burned for 30 minutes and the coals allowed to cool before the next layer was added.

The sixth stage consisted of slightly damp, 10 YR 5/4 yellowish-brown, sandy clay. The surface was compacted forming a 4 cm layer.

The seventh, and final layer, consisted of 4 cm of more 10 YR 5/4 yellowish-brown sandy clay mottled with 10 YR 4/2 dark, grayish-brown, sandy clay. The surface was then saturated with water and allowed to sit for two days.

A clear lucite core sampling tube was then hammered into the deposits. The difference in the penetration technique in comparison to the core drilling rig is obvious, but it still only resulted in 2 cm of compaction or about five percent.

The core sample was removed by bisecting the entire plastic tub. The profile of the tub was examined and the core sample extracted. The lucite sheath was then cut open and the sediment sample bisected (Figure 4).

The results are as follows:

The first stage was easily discernable from the first layer of the second stage by both feel and color. The compaction of the first layer was evident both during the bisection process and by taking a trowel and scraping along the long axis of the sample.

The colors of the layers within the second stage were obvious and the fact that none were compacted caused some intermixing of the breaks between layers, less than 0.3 cm of downward movement.

The sand and pale color of the third layer were also obvious. Because of the texture difference and the compaction of the underlying deposits, intermixing was virtually nonexistent at the lower contact. However, the overlying, dark, yellowish-brown sandy clay did migrate into the upper contact of the sand deposit. Again, the difference in grain size was a factor.

The fifth stage, the simulated burned structure, was the only layer that changed in appearance. The color changed from a mottled 10 YR 6/6 brownish yellow to 2.5 YR 4/6 red. The layer, especially at the surface, became very hard and remnant charcoal flecks provided evidence of the fire. No intermixing of the overlying deposits occurred.

The sixth and seventh stages were virtually identical in color. The major difference was the compaction of the surface of the sixth layer. Again, the difference could be felt during the bisection process and by running a trowel over the surface, but little indication could be seen simply by examining the location of the known break. The major tell-tale marker was a crack which formed at the break during transport of the sample.

The experiment helped to allay several fears. First, those breaks which included similar color sediment could be differentiated based on compaction. This is, of course, assuming that the turbation of the deposits is limited and that they are virtually unchanged from their original deposition, a common factor in all of the core sample analysis. Second, those surfaces between deposits which were not compacted resulted in more intermixing of sediments than the compacted surfaces. Third, the heating of a mound summit results in color and texture change which is apparent in the core samples.

GPR Experimentation

In an effort to better understand the ability of the GPR to image subsurface features, a hole was bored into the south flank of Mound E. In an effort to avoid damage to undisturbed deposits, the hole was placed within the backfilled units excavated by Knights 1993 flank trenching project (Knight 1995). Although the deposits within the backfilled units are obviously disturbed, they are composed of the same sandy clay fill material used in the mounds construction and exhibited the same average dielectric constant. An auger with a barrel diameter of 10 cm and a rod length of two meters was used to punch a hole one meter below the mound summit into the side of the mound. The auger was left in the hole to serve as a target for the GPR. Both the 300 and 500 MHz antennae were dragged over the target location, both before and after the auger was set in place. The results varied. The 300 MHz antenna proved more effective in imaging the metal auger. The auger was then exchanged for two lawnmower blades. It was assumed that the added density would be more easily imaged by both antennae.

The relative dielectric permativity (RDP) of soil or sediment is determined by multiplying the speed of light by the result of the range setting on the GPR unit divided by the two way travel time. The result is then divided by the depth. Moisture in the mound can increase the RDP as can the strong ionic bound found within clays, both of which were present within Mound E at the time of the experiment. With the 300 MHz antenna, the minimum range setting at which the target appeared as a hyperbola was 28 nanoseconds. Moisture noted when the auger was bored into the side of Mound E suggested our RDP was slightly higher than actuality. We estimated the RDP to be roughly 5, and our images produced with the 300 MHz antenna were considered consistent with deposits roughly 2.5 m below the surface. However, our results were poor at best. The poor resolution was blamed on a relative high clay content within the Mound E sediments and the level of moisture present at the time of the experiment.

CHAPTER 4

FIELD INVESTIGATION AND ANALYTICAL TECHNIQUES

GPR Data Collection

The GPR study was conducted within a series of grids established on the summit of each mound (Figures 5-9). The grids were placed in a manner as to allow for the maximum coverage of the surface area of the mounds' summits. Data collection was then conducted within these grids using a variety of antennae depending on the characteristics of the individual mounds. With the exception of the direction in which the data was collected, all mounds were imaged using the same basic method. For example, data collection on Mound L was executed within a grid measuring 27 m by 27 m. The grid was divided into one meter transects with a north-south orientation. GPR profiling was conducted along the one meter transects beginning in the northeastern corner of the grid. All transects were profiled from east to west with horizontal location marks at one meter intervals. Given these guidelines, the final results of imaging at Mound L was a total of twenty-eight transects, numbered from 0 to 27, imaged from east to west beginning along the northern baseline (Transect 0) proceeding southward to the southern baseline (Transect 27). In general, this procedure was used on all of the mounds in the study although the direction in which the profiling was conducted was determined by accessability to the individual mounds.

The one exception to this model was Mound A (Figure 3). Mound A is a large flat-topped mound with a surface area of 0.279 ha (0.69 acres). The size and the height of the mound dictated that profiling be conducted within a series of interconnecting grids established on the summit (Figure 5). The data were collected within these grids and incorporated during analysis of the data.

Following the data collection, all data was returned to OAS for further analysis. All data on the tapes was then loaded into the Radan software package designed for GPR. The data from each grid was then edited into individual sections, each one representing a transect. As a result, each transect became accessible as an individual unit for analysis and comparison. All data was then filtered to remove static or high-frequency distortion.

Anomalies were selected, based on their image clarity and size, for coring. Their locations, previously marked by pin flags, were marked with blue flagging as locations to be sampled.

Core Sampling

The coring locations were selected based on two guiding principles: first, a good representative sample of the entire mound was necessary to be able to examine the internal construction sequences at the largest and most general level. This involved six samples intended to

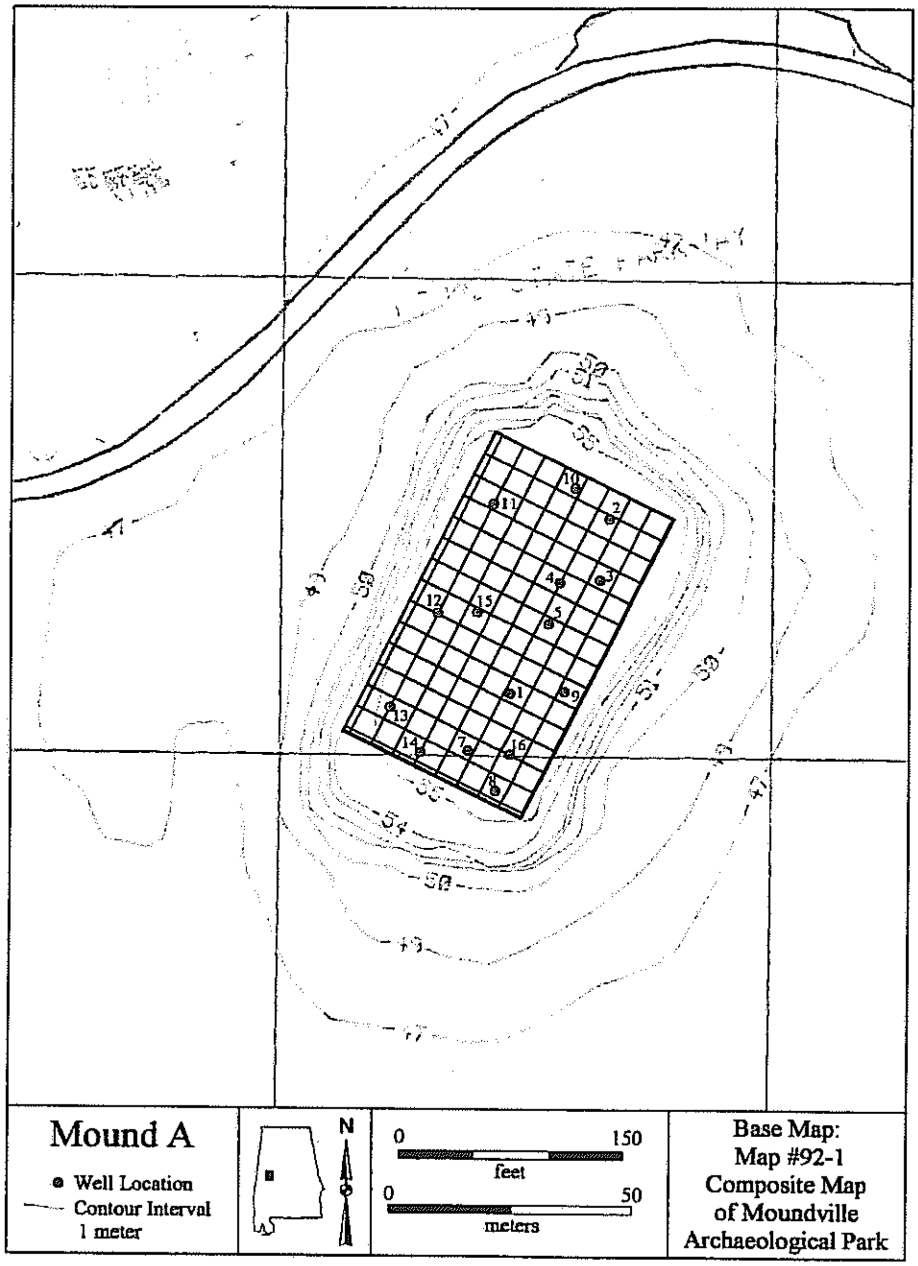

Figure 5. Mound A GPR grid and core sample locations.

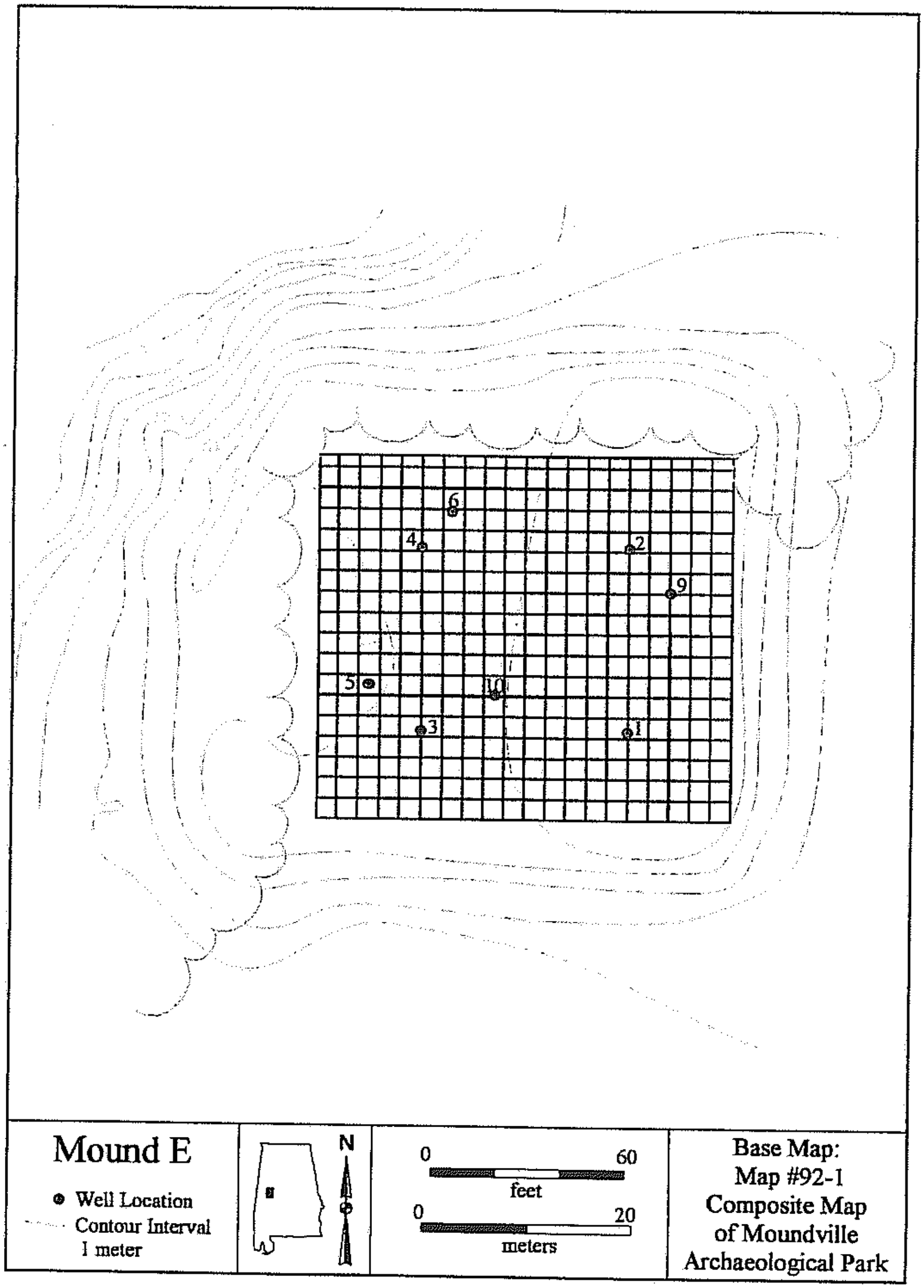

Figure 6. Mound E GPR grid and core sample locations.

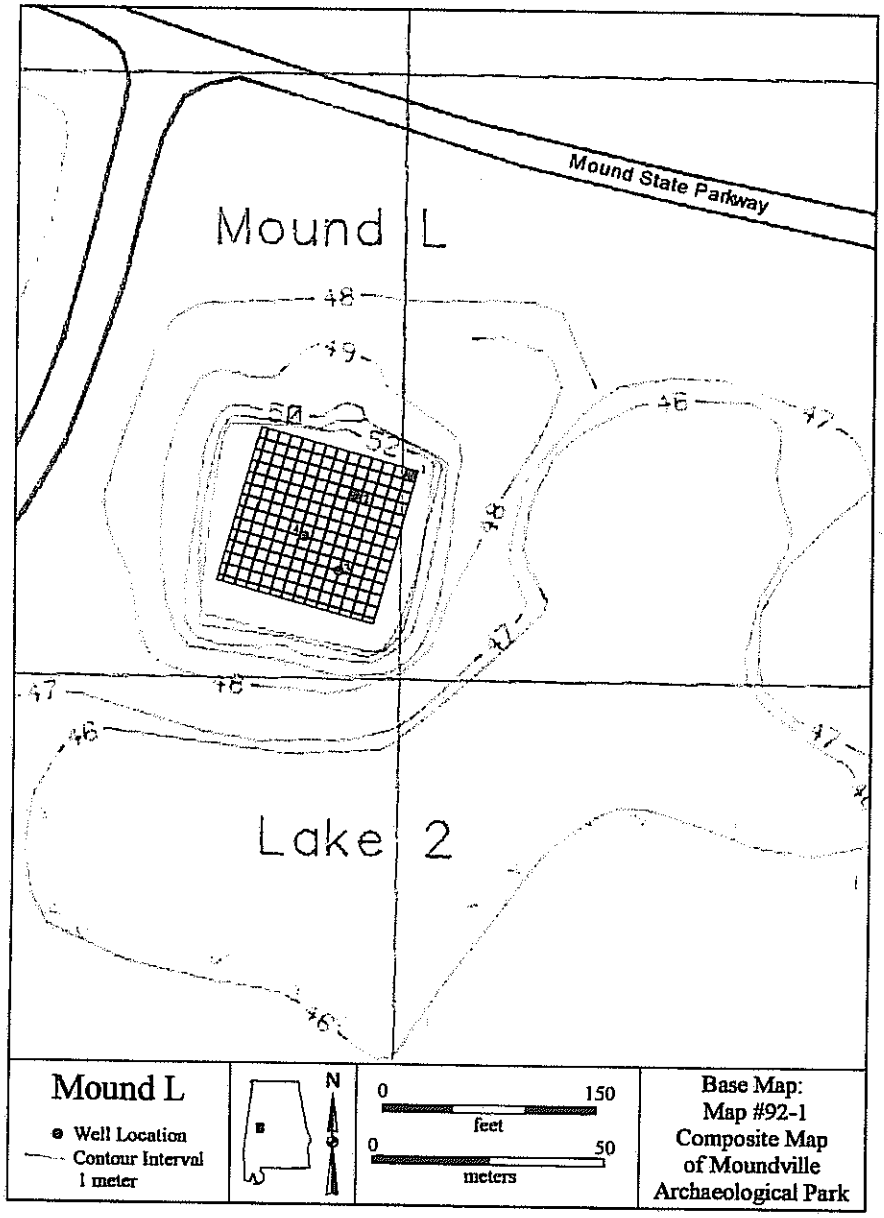

Figure 7. Mound L GPR grid and core sample locations.

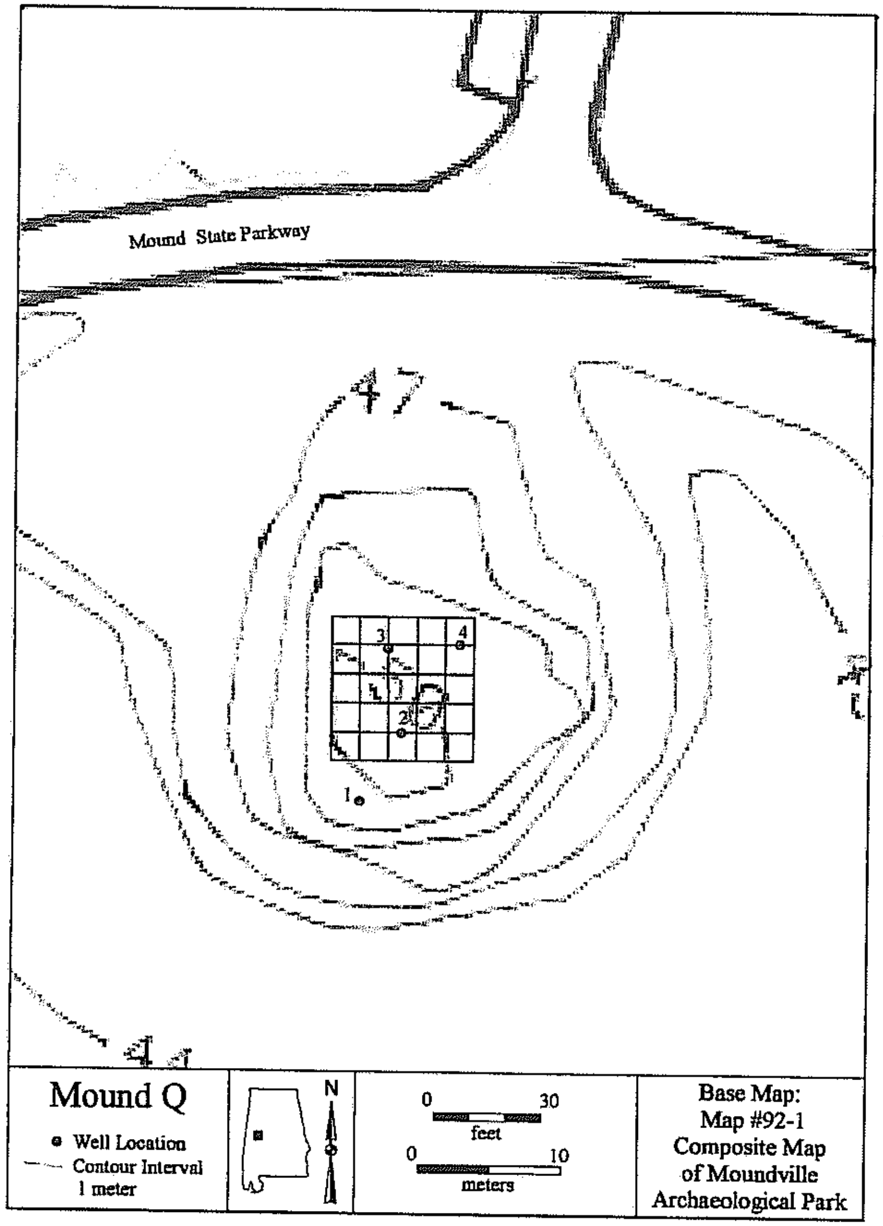

Figure 8. Mound Q GPR grid and core sample locations.

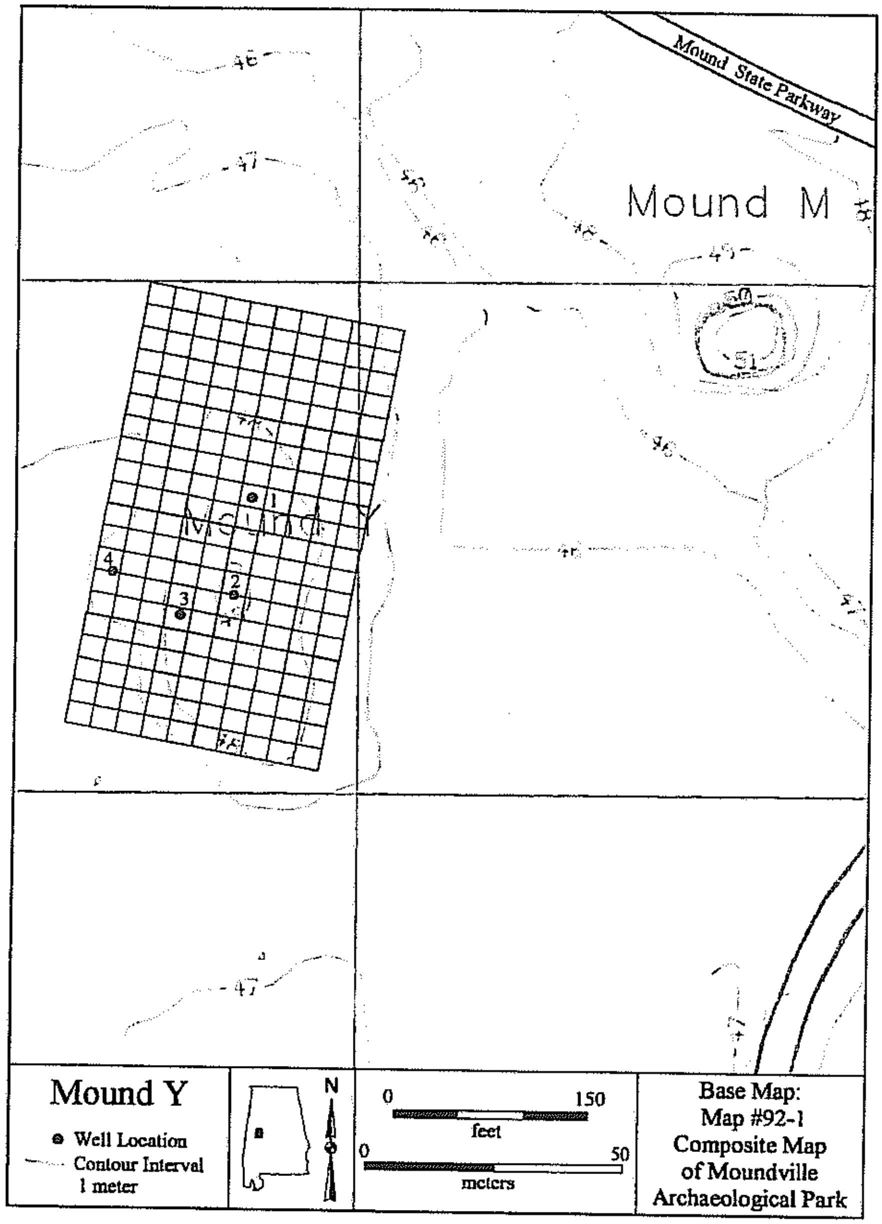

Figure 9. Mound Y GPR grid and core sample locations.

provide broad areal stratigraphic evidence of the mound. In addition, the anomalies located by the GPR provided locations for the remaining core samples, the underlying idea was that core sampling might provide insight into the nature of anomalies that appeared on the GPR generated grid and that might offer information about modifications to the internal matrices of the mounds.

Each of the coring locations was divided into one 122 cm by 10 cm with each subsequent sample section measuring 152.4 cm by 10 cm as was required by the auger mechanism of the drilling rig used for the core sampling. Coring was accomplished with the use of a large mobile drilling rig and crew provided by Technical Drilling Services, Inc. of Knoxville, Alabama. Preliminary examination of Mounds A, E, L, Q, and Y by Britette Lee, President of Technical Drilling Services, Inc., and Curtis Lee, Vice President and head of drilling operations, suggested that the use of the rig would not adversely affect the mounds.

The rig consists of a Central Mining Equipment (CME) 75 High Torque drilling unit mounted on a GMC Top Kick chasis with a tandem axle. The complete rig weighs approximately 43,000 lbs (Figures 10-11).

Once on the mounds' summit, the rig was positioned over the predetermined well locations and the auger was prepared. The auger consists of multiple parts: The lucite sampling tube, the sampler itself, and the actual auger sections. The five foot lucite sheaths, or sampling tubes, are placed within the hardened steel sampler, the threaded ends screwed on, and placed inside the auger. Then the entire contraption is attached to the drilling unit shaft (Figures 10-11).

The rig is fitted with a clutch control system, similar to a standard transmission in an automobile. This offers the drilling crew variable boring speeds depending on the type of soils/sediments encountered. The drilling went deep enough to ensure that we would achieve sterile sub-mound soils and have examples of the mounds' base in each sample.

Once the coring was completed and the wells were abandoned they were filled to within 1.5 m of the surface with a filtration media or white sand, to ensure recognition as historic modification by future investigations. The sand was then covered with bentonite pellets. The pellets swell when hydrated and act to seal the well. Finally, grout was poured in to fill the remainder and to ensure against direct water damage.

Following field investigations, the samples were returned to the David L. DeJarnette Archaeological Laboratory at Moundville for storage in preparation for analysis. Each core sample section was bisected along its long axis by first scoring the lucite sheath on a table saw, then cutting the sheath open with a knife, and finally splitting the sample into two halves with a knife. The sections of the bisected core samples and the GPR data comprised the materials analyzed for the purpose of this project. Each section was labeled with hyphenated numbers. The first number in the sequence denotes the core sample while the second is for the section. The sections are numbered

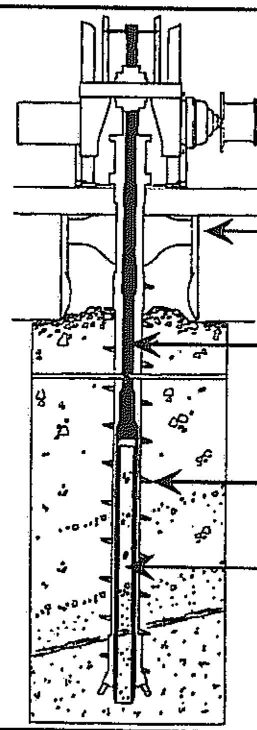

Figure 10. Schematic drawing of the core drilling rig.

from top (mound summit) to bottom (submound soil). For example, the section containing the uppermost deposits of Mound E in Core Sample 1 is listed as *Mound E CS 1-1.*

The profiles evident in each of the bisected samples appear as strata revealing separate instances of modification to the morphology of the mounds. These apparent modifications are the result of both human and natural processes acting upon the various mound summits and fill deposits which previously existed. Through macro- and microscopic examination of the matrix of the soils/sediments and comparisons of the strata of the core samples, the differences between sediments of natural and artificial modification were observed and recorded. The granular matrix of the sediments, modified within the context of the mounds by exposure to surface processes (such as living floor activities or summit exposure to natural elements) and various other human activities (including such factors as midden formation or house construction activities), were examined in an effort to differentiate them from those of the non-summit matrices. These non-summit variations are the result of the techniques employed in the construction of each mound, namely basketloads of fill. These variations were differentiated and recorded to establish strata which represent previous mound summits now buried below the current summit surface.

Recorded data of the stratigraphy from the mounds were then compared utilizing sediment variations to establish related summit features. These features were anticipated to appear in various

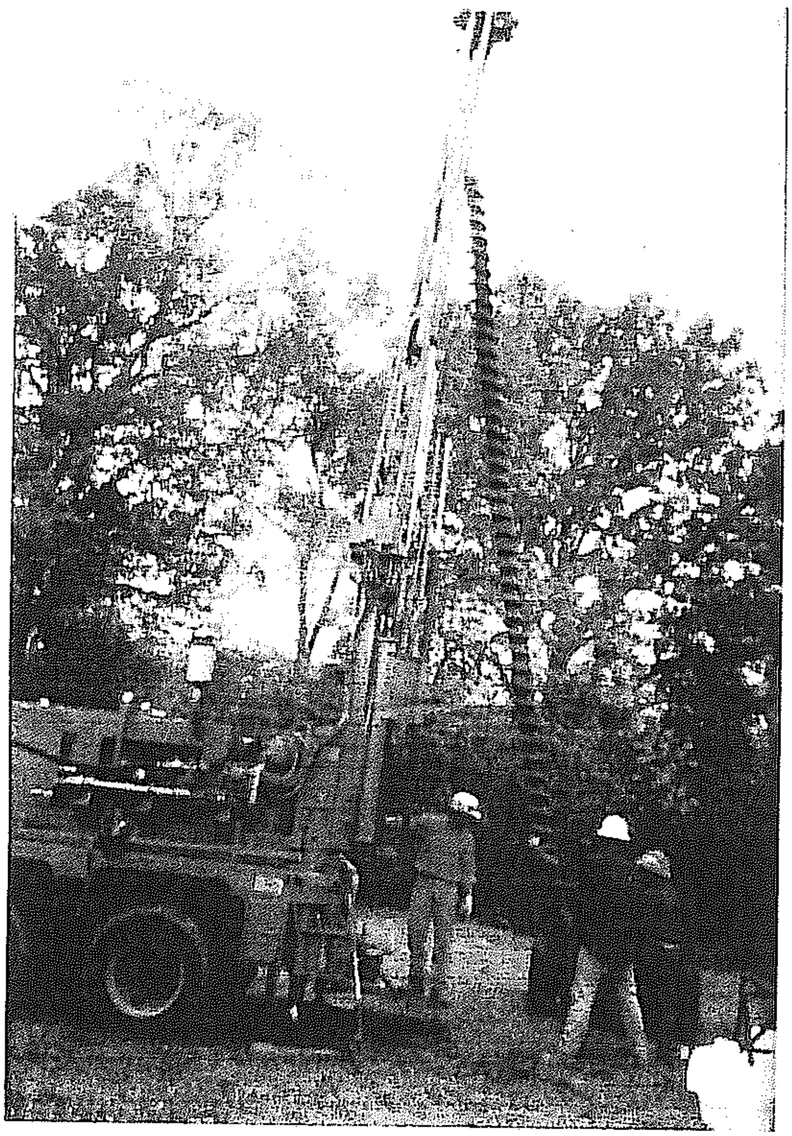

Figure 11. The auger extracted from a drilled well.

forms, including house floors, middens, and zones of incipient soil formation. Measurements recorded from the depth of the cores and depths taken from the coring locations across the mounds' summit acted as control factors for determining locations within the original context of the mounds. Similar stratigraphic zones related in both variety of sediments and depths were then linked to develop a picture of the internal matrices of the mounds' structure. If possible, this composite image was compared to unit profiles recorded during previous excavations (Knight 1995). These profiles represent the only other recorded stratigraphic evidence from the mounds and act as an additional control factor for establishing related depositional strata.

Undoubtedly, the nature of mound fill has offered obstacles during analysis as evident mixing and mottling of sediments from various episodes of mound building, basketloads of fill, house construction, day-to-day activities, and natural processes appear. Nevertheless, inspection of the core samples has revealed that distinct stratification does indeed exist and provides substantial evidence for separating individual episodes of construction separated by periods of summit occupation.

CHAPTER 5

RESULTS

Following are the results of the GPR data collection and core sampling. They include an introduction to the individual mounds, previous investigations and impacts to each, and a description of the well locations and why they were chosen.

Mound A

Mound A is situated centrally within the roughly rectangular arrangement of mounds at Moundville (Figures 1 and 12). Speculation concerning this arrangement has been discussed recently by Knight (1998:48). Mound A is the second largest mound in volume. The base covers more than an acre and the summit measures approximately 47 m by 82 m. Given the size of the mound, it is not surprising that prior to the 1930s it's summit was cultivated (Figure 13). Clarence B. Moore's investigations into the mound were limited. He wrote,

> *Mound A, the central one of the Moundville group, about 22 feet in height and irregularly oblong in horizontal section, has a summit plateau 155 by 271 feet. Thirty-three trial-holes were sunk in the plateau, showing yellow clay with a slight admixture of sand. One small arrowhead of Jasper alone rewarded our research* (Moore 1905).

In fact, Moore found more off the mound in the surrounding area than he did within the mound itself. During his initial visit in 1905, he directed his crew to the area west of Mound A where they uncovered, "a number of skeletons not associated with artifacts of any sort." In 1907, when he again visited the site, Moore's crew unearthed ten additional burials.

The lack of intensity of Moore's investigations seems relatively surprising considering the prominence of Mound A. The structure is massive and, in a sense, isolated in the center of the open plaza. The summit is broad and level and was subject to extensive cultivation. This may explain the limits of Moore's initial excavations. At the time of his first visit, Mound A was likely in cultivation (Moore 1905). His second visit focused on areas not completely investigated during his first, and those areas believed to hold burials and associated grave goods. These did not include Mound A.

The next recorded investigations are poorly documented and even more poorly understood. An excavation plan view and profile suggest the Alabama Museum of Natural History (AMNH) dug a 10 foot wide trench east to west across Mound A. The drawings reveal two mound stages and evidence of summit buildings (Knight 1992:3). The artifacts from this excavation were incorporated into a study intended to identify the sequence of Mound A's occupation. The majority of the sherds

Figure 12. Southern elevation of Mound A.

Figure 13. Mounds A and E circa 1933. The summits of Mound A (left) and Mound E (right center) are shown in cultivation.

examined in the study, Moundville Incised *var. Moundville* and *Carrollton*, fall well within the late Moundville I to early Moundville II phase. A much smaller percentage are attributed to a Moundville III phase occupation and serve as evidence of a later, minor component (Knight 1992:6).

The excavation of the 10 foot wide trench was likely related to the restoration project undertaken by the AMNH in the 1940s (Jones 1941). In places, more than a meter of yellowish-brown and mottled gray sandy clay fill was added to the summit of Mound A in an effort to "restore" it to a truncated platform mound. After years of cultivation, plowing and subsequent erosion, the mound, and summit in particular, had been subject to extensive deflation. One of the original estimates for restoration calls for 96 yards of fill to be added to the summit, 72 yards to be used to fill a five foot deep gully on the northeast corner, and an additional 18 yards to be used to fill a gully on the east flank. As was the case with several of the mounds subject to restoration, the efforts resulted in a protective layer of artifact sterile sediment overlying the summit and portions of the flanks of Mound A. The extent of modifications to the underlying deposits appear to have been relatively minimal. For our purposes, the fill placed atop the mound has acted as a marker, delineating the sediment matrix between historic fill and aboriginal deposits. In essence the fill has encapsulated the mound, protecting the summit and shielding the underlying deposits.

In 1996, Vernon James Knight, Jr. conducted a field school on the summit of Mound A. His excavations included a series of one by two meter units placed into the southeastern corner of the mound's summit. Portions were excavated to as much as 250 cm below the surface. Profiles and plan drawings of the excavations reveal at least three stages of construction and evidence of summit architecture.

The deposits revealed in the profiles indicate that the southern flank of the mound has migrated towards the south with each successive episode of mound building. The lowest stage includes yellowish-brown sandy deposits overlain by a dark yellowish-brown midden. Atop the midden is a layer of gray mottled clay with minimal sand content. Large lumps of clay were included in this layer, some measuring 33 cm in length. The upper break in the second stage includes a lens of charcoal with several intrusions from the overlying stage. The final recognizable stage consists of a yellowish-brown and gray sandy clay fill truncated by the historic plow zone.

GPR Data

Mound A is a large flat-topped mound with a surface area of 0.279 ha (0.69acres) located in the north central portion of the mound complex (Figure 1). The initial testing consisted of a series of transects imaged within a 40 by 70 m grid previously established at the summit of the mound. The initial testing was conducted in order to determine if the sediments were conducive to radar; and if so, what antenna configuration would be best suited for imaging the mound. During the preliminary testing we utilized three antennae as well as numerous range and gain settings. The antennae consisted of a 500, a 300, and a 120 MHz units. The 500 and 300 MHz antennae offer greater resolution of the sediments; however, these antennae are incapable of imaging to great depths. On the other hand, the 120 MHz antenna allows for deeper penetration of the radar signal while the resolution is somewhat compromised. Following this testing series, the analysis of the data indicated that, unlike the other mounds (Mounds E, L, Q, and Y), Mound A was conducive to imaging by radar. In fact, the data recovered using the 120 MHz antenna, with a range setting of 150 nanoseconds, revealed stratified sediments distributed horizontally across the mound (Figure 14). These sediments appeared in a manner possibly indicative of successive building episodes of the mounds.

Based on the results of this initial testing, we determined that the use of the 120 MHz antenna was advantageous, in that the data revealed what appears to be stratified episodes related to the construction of the mounds. In addition, the greater depth of penetration provided by the 120 MHz antenna, potentially allowed for imaging from the summit to the base of the mound. However, there were also disadvantages to the use of the MHz 120 antenna in this application. Due to its low frequency and broad band width, the antenna is very large and cumbersome to operate. This presents a specific set of problems given the confines of the original survey grid and the height of the mound. The size of the antenna dictated that it be mounted on a sled and pulled behind a vehicle (Figure 3). In order to alleviate this problem, the original grid was divided into a series of interconnecting grids located within the confines of the original grid. The data were then collected within these grids and later combined into a single unit for analysis. Following the establishment of the grid's system, a series of transects was imaged at one-meter intervals from east to west, beginning along the northern baseline, proceeding to the south. Following the data collection, all data were returned to OAS and downloaded into the Radan software package designed for GPR. Each transect was then individually analyzed and compared to the others. Following the analysis of the data, the core-drilling well locations were chosen in order to correlate the core samples with the analysis of the GPR profiles. In addition, a series of amplitude-slice maps were also produced. The following is a description of the core drilling locations based on the analysis of the data.

Well 1: Transect 45 at 15 m. Well 1 was set to penetrate the central portion of the mound in an area recognized as exhibiting "onlapping" or sloped deposits (Figure 15). The locations was drilled during a demonstration at the *Remote Sensing and Core Sampling Seminar* held on June 5, 1999.

Well 2: Location: Transect 6 at 12 m. Well 2 was set to penetrate a sloped profile that originates on the eastern side of the mound. This layer of stratigraphy appears to taper downward from east to west, and is probably associated with the linear anomaly represented in the cores drilled on the east side of the mound (Figure 16).

Well 3: Transect 18 at 8 m. Well 3 also indicates an east to west slant and is directly associated with Core Sample 2.

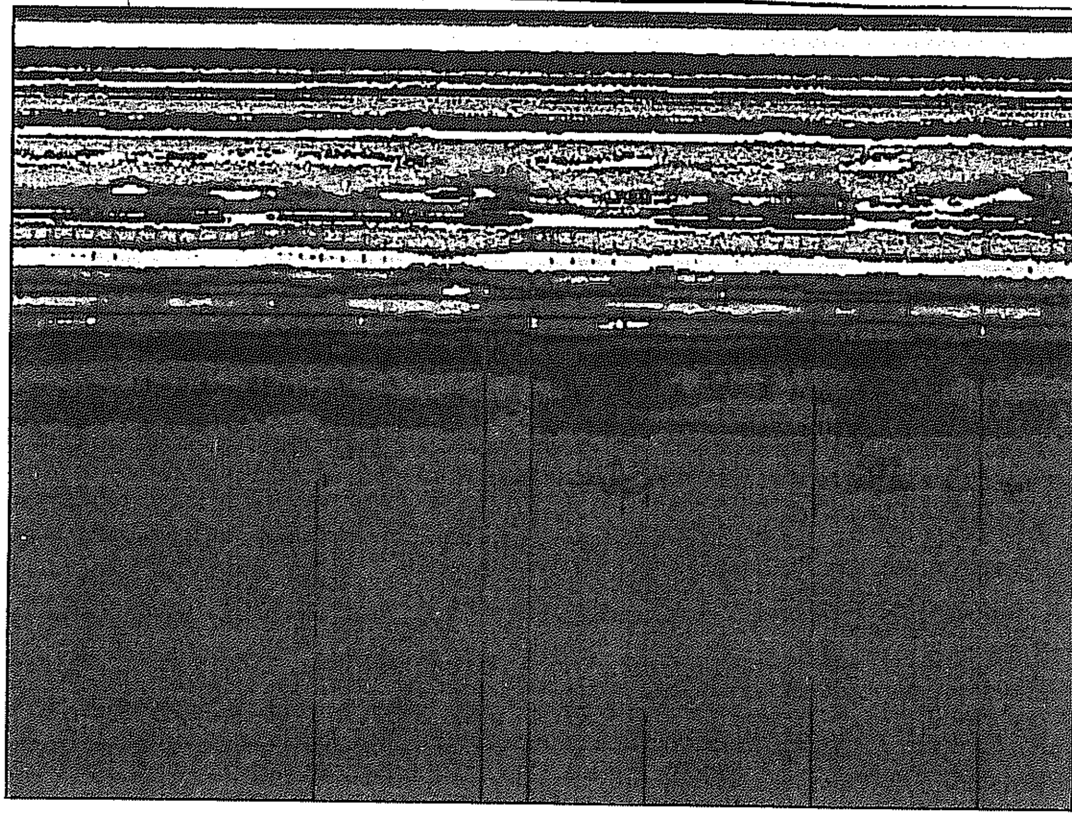

Figure 14. Stratified deposits visible within the GPR profiles.

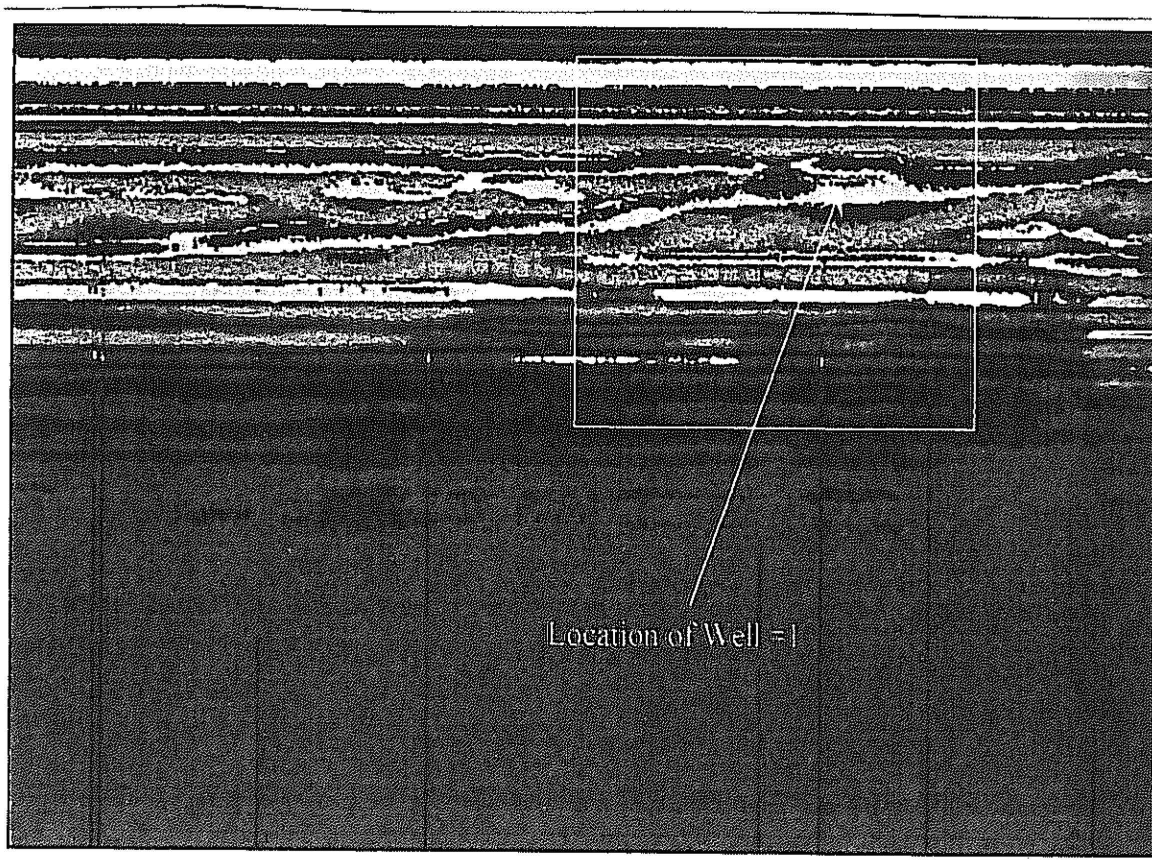

Figure 15. Well 1 and the area of onlapping visible in GPR profile.

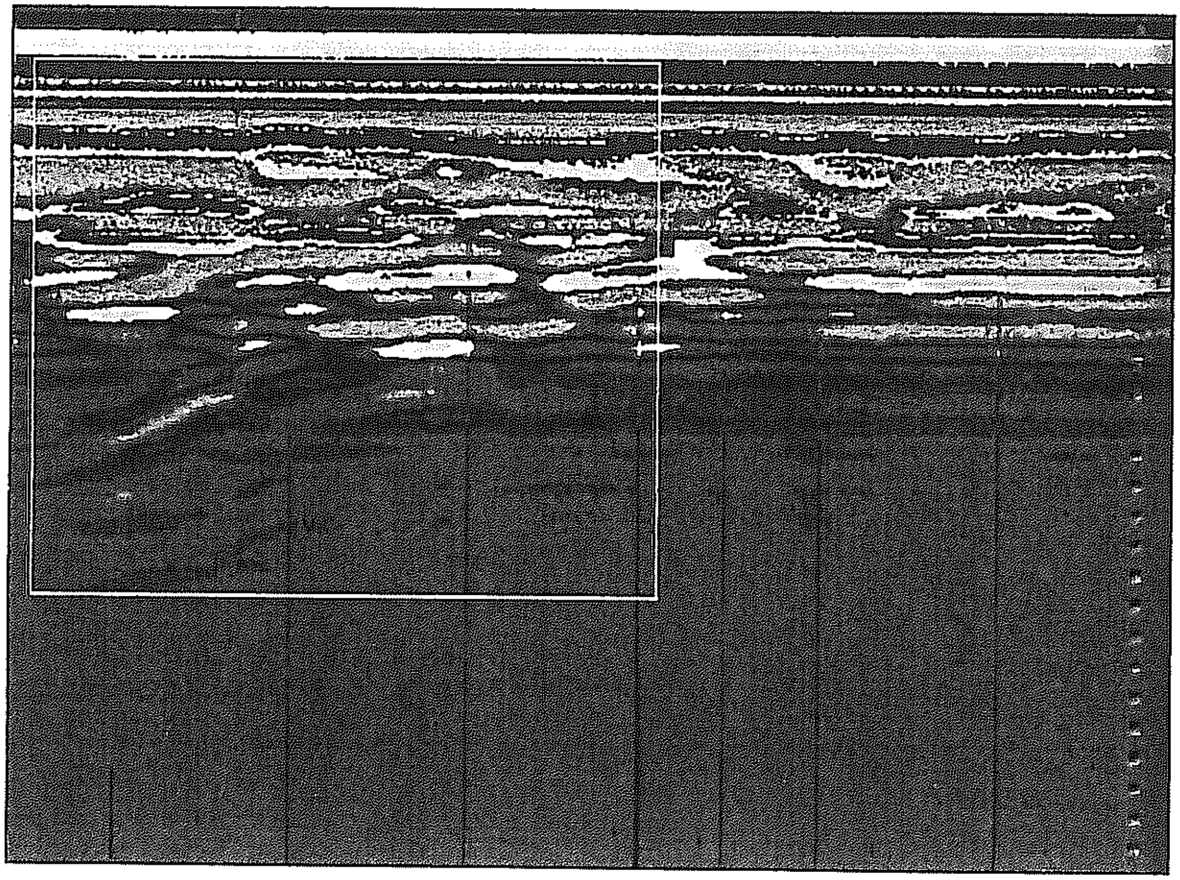

Figure 16. Well 2 anomaly on the east side of Mound A.

Well 4: Transect 23 at 15 m. Well 4 is associated with a seam that runs in a general north to south direction across the mound. Unlike samples 2&3 the taper appears to originate on the western side of the mound and dissipate to the east.

Well 5: Transect 32 at 13.5 m. Well 6: Transect 55 at 16.5 m. Well 7: Transect 63 at 16 m. Wells 5, 6, and 7 are also associated with this linear anomaly and are located at the following locations.

Note: These cores are all associated with a linear anomaly that runs across the mound. The analysis indicates this feature could represents a significant building episode or historic disturbance. It is probable that other cultural features will present themselves within the cores. The original research design was to study building episodes, as a consequence the 120 MHz antenna was used in an attempt to define these larger episodes. However, in the event that house floors, pit features, etc, are encountered in the cores, additional GPR work (with the 300 or 500 MHz antenna) could be done in order to further define the features.

Well 8: Transect 67 at 7 m. This well is associated with a high amplitude anomaly and may represent a feature such as a living floor.

Well 9: Transect 43 at 4 m. This well was set to penetrate the area around the artificial drain located on the eastern side of the mound. The radar seems to penetrate to a deeper depth in this area, and this core should provide some historic information about the mound.

Well 10: Transect 3 at 21 m. This core is also associated with the linear anomaly. It is also possible that this area represents a previous northern edge of the mound.

Well 11: Transect 14 at 35 m. Well 12: Transect 40 at 35 m. Well 13: Transect 62 at 35 m. Wells 11, 12,and 13 were all located on the western side of the mound. The GPR data indicates this area to be less disturbed than the eastern side. These cores should have provided an interesting contrast to the cores from the eastern side of the mound.

Well 14: Transect 68 at 25 m. Well 15: Transect 36 at 28 m. Wells 14 and 15 represent amplitude anomalies observed in the time slices.

Core Sample Analysis

Core Sample 1 (CS 1): The first sample includes 913 cm of sediment and pre-mound soils. Approximately 612 cm of the sample consists of mound fill. Again, the location was selected to penetrate an area shown to exhibit on-lapping and considered a possible buried slope.

Submound deposits include a cultural-material-bearing pre-mound humus layer underlain by gray sandy clay. The color of the submound deposits is the result of gleying caused by percolating water levels. The constantly hydrated soils become gray or, in the case of heavily gleyed soils, blue. The color change is a result of the alteration of the iron in the soil to a reduced state (Waters 1996). This factor was noted in several of the other mounds as well. In particular, the submound and lower mound deposits of Mound L included gleyed soils and sediments. Mound L is situated adjacent to a modified lake. Given the extent of the gleying in the submound deposits, it is likely that springs, present beneath Moundville, are responsible for the extensive soil and sediment hydration. As water percolates up into the sandy clays within and just below the mounds, it alters the iron content. Initially, the cores pulled from Mound A were considered to hold high levels of ash and soot. However, the difference is noticeable when compared with clayey sand mixed with burned ash, soot, and charcoal. The discoloration is limited in the burned sample, while the Mound A sediments are consistently discolored.

The initial stage of construction noted within CS 1, Stage I, consists of 14 cm of sorted sand and silt bands (Figure 17). The deposits are the result of water sorted sediment settling into graded beds near the buried base of the mound. The colors of the sand and silt also indicates the effects of gleying.

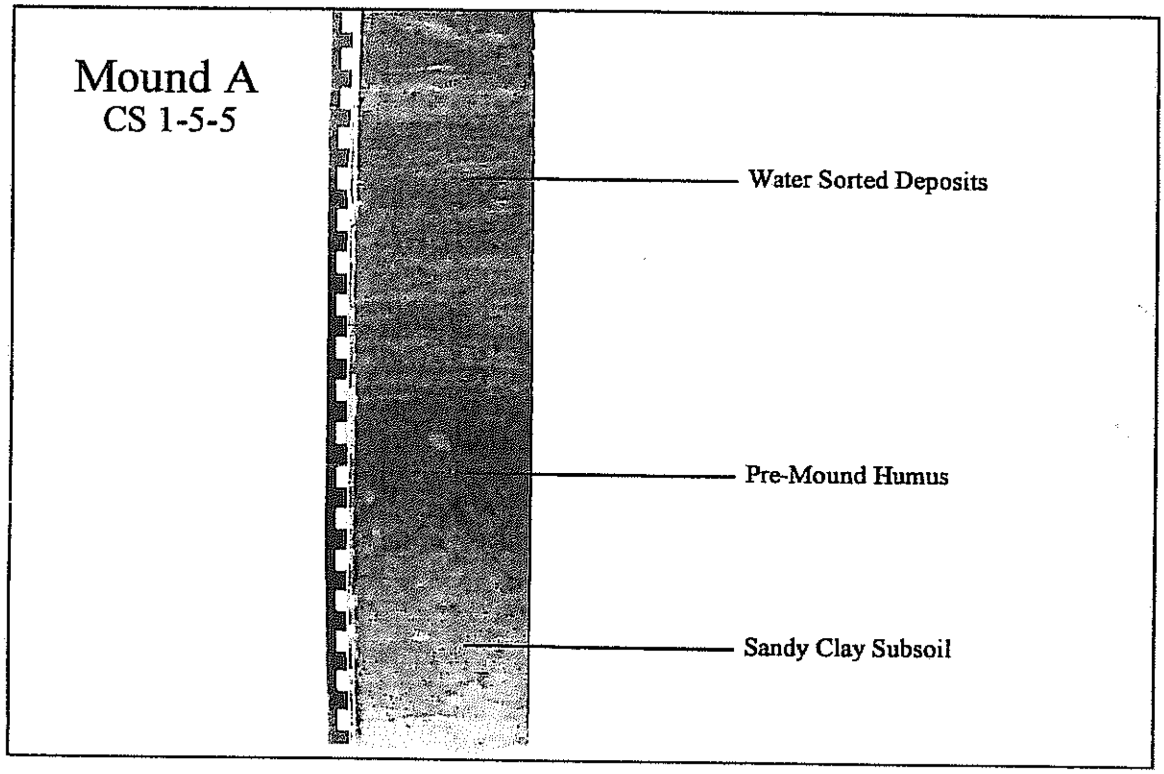

Figure 17. Water sorted deposits at the base of Mound A.

Stage II is a large addition consisting of approximately 195 cm of fill. A relatively large amount of charcoal was noted in the Stage II deposits. Again, the sediments are various shades of gray. With the addition of the Stage II deposits, Mound A was raised to more than two meters above the surrounding ground level.

Stage III deposits do not exhibit gleying, however, oxidation is a prevalent factor. Hardpans have formed within the oxide rich Stage III fill as a result of loaded sediments compressing the deposits. The silicates and oxides present with the mound fill serve as the cementing agent for the hardpans. The upper break of the stage is marked by a burned surface covered by a clay lens. In total, Stage III includes approximately 199 cm of fill, raising the mound to almost four meters above the plaza. The upper deposits within the sample indicate the presence of a buried slope and are likely the cause for the onlapping images noted in the GPR data.

Stage IV begins with a series of thin, water sorted, layers of graded sands. These are overlain by 98 cm of yellowish-brown and brown clayey sand with charcoal inclusions and manganese nodules. The stage is truncated by the historic plow zone, capped by restoration fill and, finally, modern humus.

Core Sample 2 (CS 2) is located in the northeastern portion of the mound. The well was also intended to penetrate the area of onlapping recognized in the GPR profiles. The well was measured to 7.26 m with approximately 574 cm appearing in the samples. The compaction rate, 21 percent, is unusually high for any of the mounds and may be a result of the relatively sandy deposits. Many of the core samples taken from the mound included a high moisture content in the lower deposits. However, those of CS 2 were relatively dry. The deposits were still gleyed and suggest that the area is also subject to hydration.

The pre-mound soils recognized in CS 2 include yellowish-brown sandy clay overlain by a light brownish-gray buried humus.

Stage I consists of only 2 cm of water sorted clayey sand deposits, similar to those noted to the south in CS 1. These deposits are again believed to be the result of slope wash deposited at the base of a buried mound slope.

Stage II is again a large addition to the mound. The fill measures approximately 201 cm in thickness and consists of gleyed clayey sands. These deposits are very similar to those noted in Stage I of CS 1. They include a relatively high content of charcoal and may include secondary deposit of midden materials. Stage II is capped by the remains of a burned surface (Figure 18). Fired clay and charcoal were prevalent at the upper break.

The overlying deposits of Stage III include a 5 cm thick layer of light gray clayey sand slope deposits. The remainder of the Stage III fill includes approximately 108 cm of sediment, raising the summit to over three meters above the plaza. The majority of the Stage III deposits exhibit gleying. Again, the Stage III deposits are capped by a burned surface with high charcoal content.

Stage IV includes approximately 150 cm of fill truncated by the historic plow zone. No evidence of sloping deposits are noted in Stage IV. Instead the GPR recognized anomaly may be attributable to the burned surface at the top of Stage III at roughly 211 cm below the surface.

Core Sample 3 (CS 3) was also placed into the northeastern portion of the mound's summit. The well was measured to 6.88 m with 650 cm measured in the core samples (compaction equals 5.5 percent). The onlapping anomaly was recognized in the GPR data as slightly different in this portion of the mound.

Submound soils are consistent with those recognized in CS 1 and CS 2. Again, the humus layer, replete with manganese nodules and root stains, was encountered.

Stage I deposits also appear consistent. They include a 7 cm thick layer of water sorted sediments. Stage II includes approximately 229 cm of fill, slightly more than seen in CS 1 or CS2. Distortion of the Stage II deposits within the core samples is unusually extensive. The distorted layers exist within the deposits noted as being wet when removed. The high moisture content turned the deposits into mud, which, when forced into the sampler, altered their appearance. A thin distorted layer of heat altered sediments and associated charcoal does appear in CS 3-4.

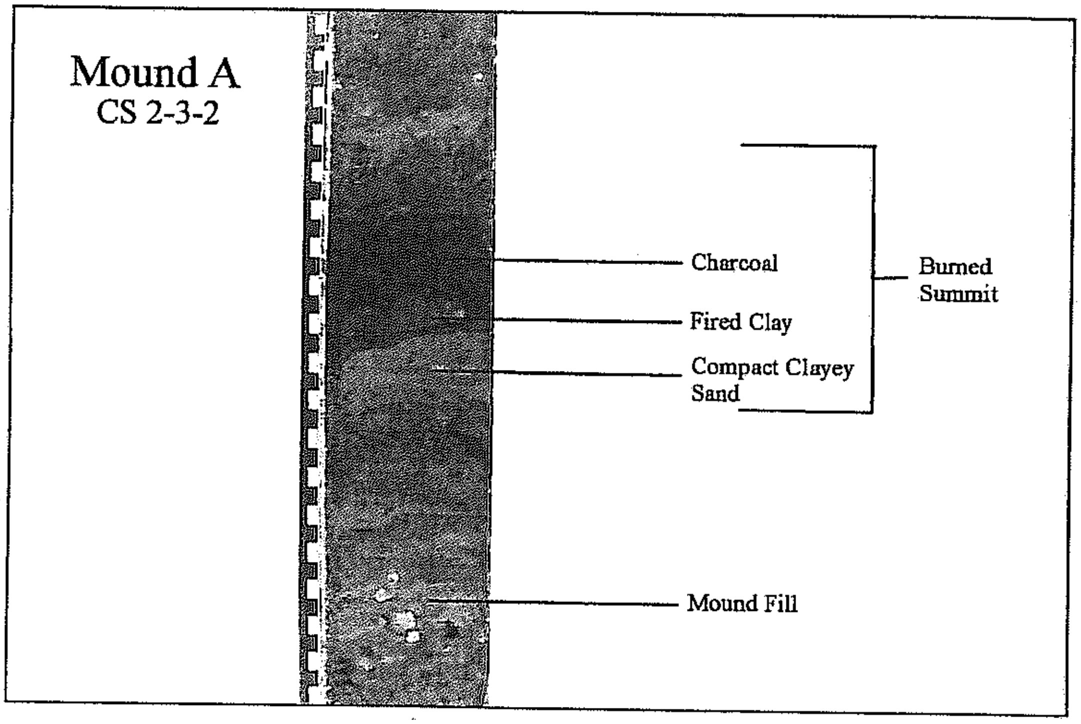

Figure 18. A burned surface caps the Stage II deposits in CS 2.

Stage III includes approximately 127 cm of fill with unusual bands of heat altered sand at 83 cm below the top of the stage.

Stage IV is unusual in that it contains almost pure clay fill in 153 cm of the 206 cm thick deposit. The uppermost 40 cm of the stage is composed of homogeneous brown sand containing cultural material and 13 cm of mottled gray clay. These deposits are, in turn, truncated by the historic plow zone. The high clay content is believed to be responsible for the altered GPR signal.

Core Sample 4 (CS 4) was placed into the central portion of the mound. Again, four stages of construction were noted. The well was measured to 8.61 m while the sediments contained within the samples measured approximately 717 cm (compaction equals 16.7 percent). Six sections were taken with sterile soils appearing in the fifth section.

Submound deposits include gray sandy clay with gray clay inclusions. The first cultural deposits include a 10 cm midden layer capped by water sorted sands (Figure 19). Bone and charcoal were noted within the midden deposits. The 2 cm thick sand layer is overlain by 12 cm of midden deposits for a total of 24 cm. All of the midden deposits and the intervene sand layer are referred to as Stage I deposits.

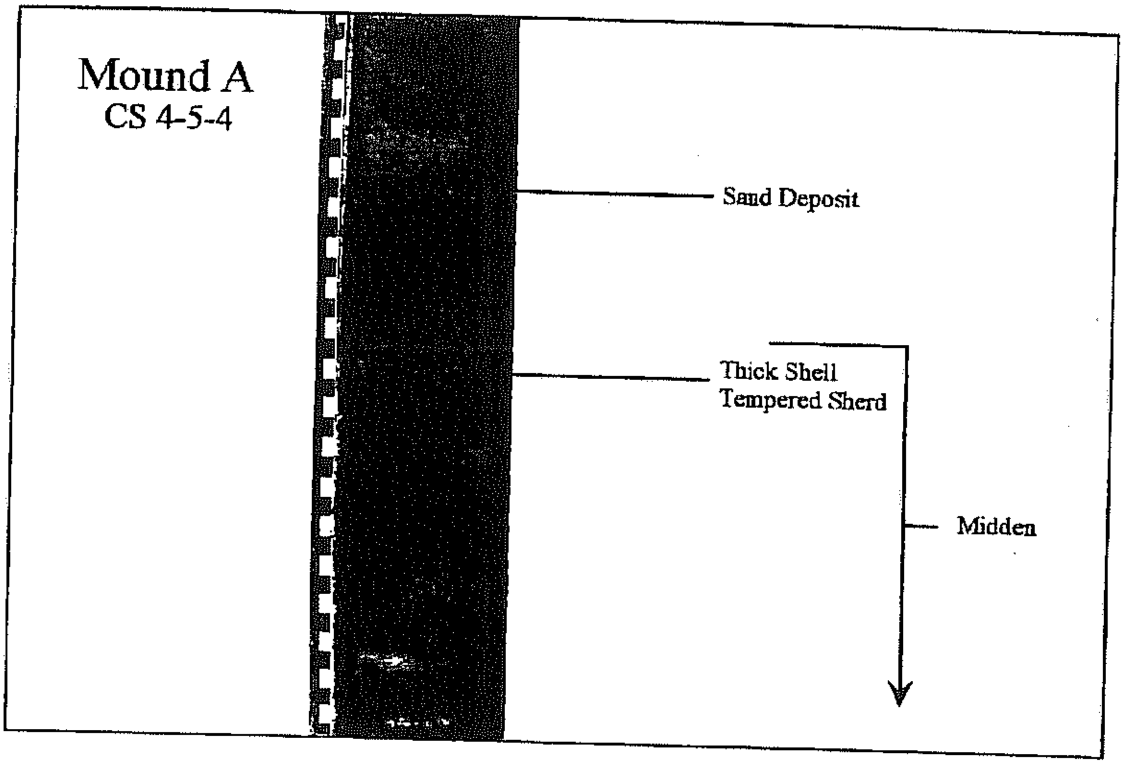

Figure 19. Stage I midden deposit and overlying sorted sand at the base of Mound A.

Stage II consists of the first large episode of construction. It includes approximately 125 cm of banded mound fill, all of which exhibit signs of gleying. A lens of fired clay marks the upper break of the Stage II.

Stage III is much larger than Stage II. It includes approximately 238 cm of mound fill. The Stage III and Stage II deposits of CS 4 are in contrast to those of CS 3 and may represent an attempt to build the central portion of the mound up to match the height of the northeastern portion. At the completion of the Stage III addition in CS 3, Mound A stood 360 cm above the plaza. In CS 4, the Stage III summit was 387 cm above the ground surface. Again, the Stage III deposits are predominantly discolored by hydration. The upper break also indicates an episode of burning, similar to that seen in the other samples.

Stage IV consists of approximately 111 cm of fill added to the mound to increase its height to 498 cm. These deposits are truncated by the historic plow zone and capped by restoration fill.

Mound E

Mound E is situated on the northeast side of the plaza (Figure 2). It is a relatively large mound, the fourth largest at Moundville, with a base measuring approximately 68 m by 60 m and a maximum height of approximately 5 m (Figure 20). The summit plateau is more than 40 m on a side and is terraced with the east half being about one meter higher than the west. The mounds plan view is roughly square with several modifications to the assumed original form of the mound. The ramp on the southern side of the mound, currently used to provide access to the summit by mowing equipment and our drilling rig, is not shown on either Miller's 1905 map of Moundville, or the 1930 map surveyed by G.W. Jones and Co. It is believed that this ramp is a result of 1930s restoration work and was built to provide access to Mound E's summit (Knight 1995). Miller's map does show a ramp on the northwest corner of the mound at the edge of the deep erosional gully to the west. This ramp is believed to be the result of erosion rather than an intentionally built feature (Knight 1995).

Moore's writing of Mound E is short and to the point. Thirty-three trial holes were excavated into the summit of the mound with no indication of burials (Moore 1905:188). He does, however, note the effects of agriculture on the mound's summit. Mound E "has undergone much cultivation, and there is much slant to the northwestern part of the plateau where heavy repeated wash of rain has eaten deeply into the mound" (Figure 13) (Moore 1905:188). Restoration of Mound E, undertaken in the 1930s and 1940s, called for the 190 cubic yards of fill to be brought in to repair the effects of erosion and to fill a hole in the side of the mound (Jones 1934)

The next episode of investigation into Mound E was undertaken by Knight between 1993 and 1998. Work began on the mound in the Fall of 1993 with a series of tests placed around the base of the mound. These tests were set at 10 m intervals in an effort to identify concentrations of flank midden. A location on the central portion of the south flank was selected based on a higher than average amount of pottery by weight (Knight 1995:52-53). Two one meter by four meter reference trenches were then excavated into the base and top of the flank. A one meter by two meter control trench was excavated adjacent to each of the reference trenches.

As result of these investigations, three stages of construction and a pre-mound occupation were recognized. The pre-mound occupation is represented by a house basin found beneath a humus layer below Mound E (Knight 1995:54-56).

Stage I consisted of a laminated wash of sand and silt which Knight tentatively attributes to a complete stage of construction. Stage II consisted of a massive episode of construction which appeared in the upper reference and control trenches and was cored in an effort to locate the base of the stage. The total thickness of the Stage II fill is estimated at more than 1.8 m.

Figure 20. Southeastern elevation of Mound E.

The buried summit of Stage II included several large post holes, 80 cm in diameter and approximately 95 cm in depth. These posts are related to a massive bit of architecture uncovered during later work.

Stage III was a much smaller addition to the mound. Intermixed with the relatively clean Stage III fill were both large and small chunks of poorly fired daub. Stage III was overlain by a modern humus layer The 1993 field season was followed in 1994 by an extensive excavation of the summit of Mound E and in 1998 by smaller field school excavations of the southeast, south, and central portions of the summit. The focus of these excavations was the architecture encountered during the 1993 season on the buried Stage II summit. During the course of these investigations, several of Moore's trial holes were located and three large structures were identified in various locations around the mound summit (Knight 1995; Ryba 1997). The stratigraphy identified during the 1993 flank trenching was supported in the deposits excavated during the following field seasons with some modification. A midden filled trench was encountered at the southern end of the Stage III addition and intruding into the Stage II summit. The Stage III addition to Mound E is attributed to "rededicatory" activities on an abandoned Stage II summit (Knight 1995:63). Structure I, situated on the east central summit of Stage III, included a collapsed daub wall and a burnt timber (Knight 1995; Ryba 1997).

Structure 2, was a massive bit of architecture, more than 22 m east to west by 19 m north to south. Knight found that except for a small bit of fire-reddened sediment on the north wall, the structure had not been burned. Instead, the structure had been dismantled with the support post pulled and the post-holes filled. The south wall of the structure was set on the very edge of Mound E's Stage II summit.

Structure 3 was also built on the Stage II summit, north of Structure 2. Structure 3 was also a large building, 13.8 m wide by 15.5 m long. North, south, east, and west walls of the structure were uncovered during the 1994 excavations. The roof of the structure was supported on four large posts, each measuring 80 cm to 95 cm in diameter and set 1.2 m to 1.9 m below the floor (Ryba 1997).

Mound E was included in our study for several reasons. First, Knight had suggested the possibility that a stage existed which had not been encountered in his three field seasons of work. In addition, the west half, or lower terrace of the mound had not been excavated. These points afforded us an opportunity to increase the available information on one of the most extensively excavated and most well understood mound's at the site. Second, Knight's excavations would again serve as a ground truth for the GPR survey. The average depth of Knight's Stage II summit was approximately 70 cm below the surface. This gave us a large area with which to establish or signals depth of penetration with the GPR. The nature of Knight's Stage II summit is extremely disturbed. Besides the large post ramps and wall trenches attributed to Structures 2 and 3, several other features, including Moore's trial holes, were encountered. Finally, the mound's size and form, as well as the nature of the southern ramp, made it conducive for drilling equipment.

GPR Data

The GPR survey on Mound E was conducted between February 24th and March 16th ,1999. The survey was conducted within a 35 by 40 meter grid established to encompass the summit of the mound. We were hopeful, as will be discussed with Mound Q, that the presence of recent excavations and the knowledge of their location and depth, would provide a useful ground truth signature. In addition, we hoped to gain information from images in the unexcavated areas of the mound. For the initial profiling, we utilized a 500 MHz antenna with a number of range and gain settings, however, we were unsuccessful at acquiring suitable data with this antenna. We imaged a series of north to south transects utilizing a 300 MHz antenna with a range setting of 75 nanoseconds. A total of 20 north to south transects were imaged at 2 meter intervals across the summit of the mound for conversion into a three dimensional time slice.

Following the ground truthing experiment and the summit data collection, it was apparent that Mound E was not wholly conducive to radar imaging. The results of imaging over known tests units as well as the series of ground truth experiments all resulted in inconclusive data when viewing the individual vertical profiles of the transects (Figure 21). However, when the data was modified into the horizontal amplitude slices, the excavation units and several additional anomalies were recognizable (Figure 21).

Core Sample Analysis

Eight core samples were recovered from Mound E's summit. Ten had originally been planned for extraction, but because of mechanical problems and limitations of the GPR data, Core Samples 7 and 8 were not drilled. Four locations were selected for an overall sample of the mound, while four were set to sample anomalies recognized in the GPR data. Because of the extensive excavations on the eastern side of Mound E and because we hoped to study more of the areas which had not been excavated, drilling was concentrated on the western half. Five samples (3, 4, 5, 6, and 10) were taken on the lower west side. Three samples (1, 2, and 9) were taken from the higher east side. Core Samples 2 and 9 were intentionally set to penetrate Knight's 1994 excavations. Core Sample 1 was set to penetrate an area of the east side which had not been previously excavated.

Core Sample 1 (CS 1) was placed on the southeast portion of Mound E, within an area not previously excavated. The abandoned hole was measured to a depth of 7.01 m below the summit of the mound and five core sample sections were taken. The core samples included 5.15 m of mound fill. The compaction of deposits recovered was approximately 5.4 percent.

Submound soils consist of light, yellowish-brown clayey sand. These were overlain by approximately 30 cm to 49 cm of heavily mottled clayey sand capped by gray and brown clayey sand laminae with charcoal inclusions. Knight refers to the water sorted sands found at the base of his flank trench as Stage I. His description matches what we encountered, as the lenticular beds of clayey sand and charcoal appeared as sorted deposits. The semi-subterranean structure he encountered may be related to the mottled clayey sand underlying the water sorted sediments.

Stage II includes a relatively large episode of construction with approximately 106 cm of fill. Again, the Stage II fill appears as sloping, sandy, water sorted deposits. The slope appears to suggest an east dip. Given the proximity of the core sample location to the east flank of Mound E, it is plausible that we have encountered a buried east flank.

Stage III is less than half the thickness of Stage II at 50 cm. It is composed of a combination of fill material that includes from the lowest strata to the highest: gray, fine sandy clay, strong brown clayey sand with fired clay and charcoal inclusions, mottled brown clayey sand, and more gray fine sandy clay mottled with yellowish-brown and light gray clay and having fired clay and charcoal inclusions. Again, the upper interface of Stage III is sloping. However, here the slope indicates a westerly dip. Stage III is capped by yellowish brown clayey sand.

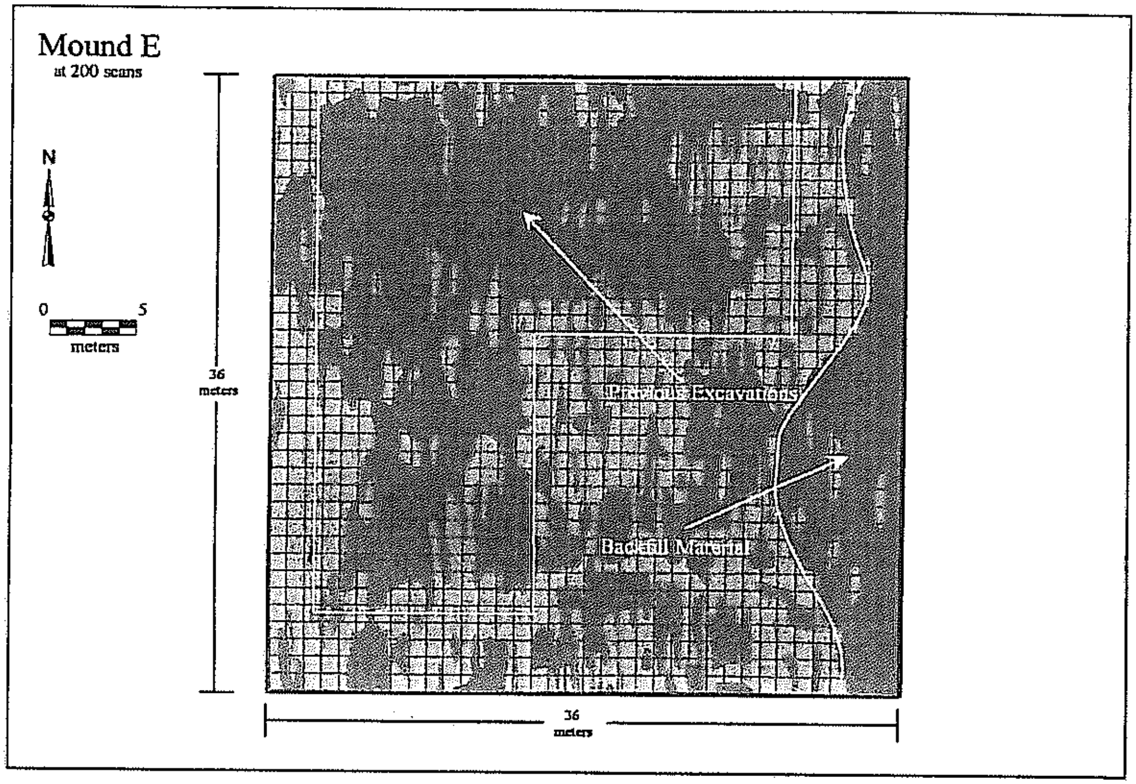

Figure 21.

Stage IV was a massive addition to Mound E at 183 cm thick. Given the thickness of the deposits, it is considered likely that our Stage IV matches Knight's Stage II. The fill consisted of heavily mottled yellowish-brown sandy clay as well as brown and brownish-yellow sand and brown mottled clayey sand. The Stage IV addition raised the height of the mound to 3.84 m above the ground surface.

Stage V in CS 1 consists of midden fill measuring 61 cm in thickness. The midden was recognized in Knight's excavations as part of Stage III (Knight 1995:63-64).

Overlying Stage V was a 66 cm deposit of mottled sandy clay which may represent sediment which has migrate into the area of the midden deposit. The uppermost 16 cm of the mound included a modern humic zone.

Core Sample 2 (CS 2) was drilled into the northeastern portion of the summit. The location was selected to penetrate the northern portion of Knight's 1994 excavation and to sample the deposits below his Stage II summit. The location was slightly west of the location of the insertion/extraction ramps (Knight 1995:70-74; Ryba 1997:9-17) of Structure 3. Five sections were removed in CS 2. The abandoned drill hole was measured at 7.01 m deep. Approximately 6 m of cultural deposits were encountered. The compaction rate was 1.7 percent.

The sterile submound soils were the same here as in CS 1 located 17.5 m to the south. The first of the anthropogenic deposits consists of a midden approximately 39 cm thick. A gray sandy humic layer, 4 cm thick, overlay the midden deposits. This layer is in turn overlain by a lamina of charcoal and fired clay.

Stage I consists of a thin layer (10 cm to 12 cm thick) of sandy clay. The upper contact of the Stage I deposits consist of an east dipping slope with an overlying clay cap. This may, again, represent the a buried east slope of Mound E.

Stage II is made up of 31 cm of midden deposits. The upper contact is also an east dipping slope with a brown clay cap. Rather than refer to the deposits as a complete stage, we should probably have referred to these sediments as a buried east flank midden. However, without more conclusive evidence, and because its inclusion as Stage II is consistent with Stage II of CS 1, we maintain its recognition as a stage.

Overlying the Stage II midden deposits is 8 cm to 12 cm of brownish-yellow, clayey sand, Stage III fill. The upper contact of the fill is also sloping and consists of water sorted sand washed from the Stage III summit.

Stage IV is the first truly large episode of construction noted in the sample, with between 155 cm and 160 cm of fill. Again, the upper contact is sloping. Unlike the previous stages, this slope is north dipping.

Stage V is the last stage of fill below Knight's excavation unit. The 193 cm to 197 cm of fill is very similar in nature to that seen in Stage IV, consisting of mottled yellowish-brown sandy clay with fired clay and charcoal flecks throughout. The uppermost Stage V deposits include 17 cm of charcoal rich sediments and a 4 cm layer of fired clay and charcoal believed to be the floor of Structure 3 on Knight's Stage II summit.

A 4 cm layer of gray clayey sand overlies the burned floor and is believed to be sediments deposited on the floor of Knight's excavation prior to backfilling. Several months elapsed between the completion of the 1994 excavations and the backfilling of the units. Overlying the clayey sand was heavily mottled sandy clay backfill and 9 cm of modern humus.

Core Sample 3 (CS 3) was taken from the southwestern summit, more than 10 m north of the south flank and slightly east of the summit of the ramp. The location was selected to provide a sample of the southwest quarter of the mound and to penetrate a high amplitude area. It was believed that the high amplitude might be the result of a suspended water table concentrated in the sandy sediments of the later stages of construction. The abandoned hole was measured to 5.49 m below the surface. Approximately 4.5 m of the samples included culturally modified deposits. The compaction of sediments was less than 1.0 percent.

Submound deposits were consistent with those seen in CS 1 and CS 2. A 33 cm humic zone lay beneath the first episode of mound building. Stage I included approximately 58 cm of mottled brown clayey sand. The fill was overlain by one of the most unusual features noted in the samples. A timber, identified as pine, was bisected by the auger and sampler (Figure 22). The calibrated intercept, AD 1210, places the 17 cm thick timber within the Late Moundville I phase. The age range at 95 percent probability places the date between AD 1035 and 1285. The calibrated intercept is relatively consistent with the current theory that the majority of the mounds at Moundville were built during the Late Moundville I and Early Moundville II phases roughly between AD 1190 and 1330.

The nature of the timber is unusual, not only in its preservation quality, but also in its basic presence. Speculation as to why a timber would be set atop the Stage I deposits requires extensive consideration. Given its diameter and lack of charring, it is unlikely that we are simply seeing the remnants of a Stage I fire. More likely, the timber is related to architectural features associated with Mound E. One possible explanation is that a structure built nearby collapsed. Without any evidence of a living floor beneath the timber, it is suggested that the wall of which the timber was a part fell outward. Rather than remove the fallen structural member, the timber was simply incorporated into the Stage II fill. Another possibility is based on the location of CS 3--relatively close to the south and west flanks of Mound E. The grain of the timber suggests it was laid lengthwise from north to south. It is possible that the location penetrated by CS 3 was close to a buried west flank. The timber may have represented an erosional barrier set to hold flank deposits as the mound was being built. Again, rather than remove the log, it was simply incorporated into the fill. Whatever the reason for the presence of the timber, its preservation in the relatively acidic sediments of Mound E is unusual. The timber is covered by light gray to white clay, similar to that described as a surface treatment of Mound X (Jean Allen, personal communication 2000).

The Stage II deposits refer to a thin layer, 12 cm to 14 cm thick, of gray clayey sand. The upper contact of Stage II the deposits is marked by a thin sheet, less than 1 cm thick, of wood, possibly bark.

Stage III is much larger, approximately 106 cm thick. The fill consists of brown clayey sand and sandy clay. The uppermost deposits of Stage III include mottled grayish brown clayey sand with fired clay and charcoal flecks capped by a lamina of strong brown sand.

Stage IV likely represents additional evidence of the position of the west flank. Measuring 23 cm to 28 cm thick, the upper contact of the fill consists of a west dipping slope. The uppermost deposits include a heated surface of yellowish red clayey sand and charcoal.

Stage IV is overlain by midden deposit attributed to Stage V. The lower portion of the midden deposits include root stains and manganese nodules, suggesting that at one time, the deposits were relatively close to the surface. The uppermost deposits of Stage V include mottled brown

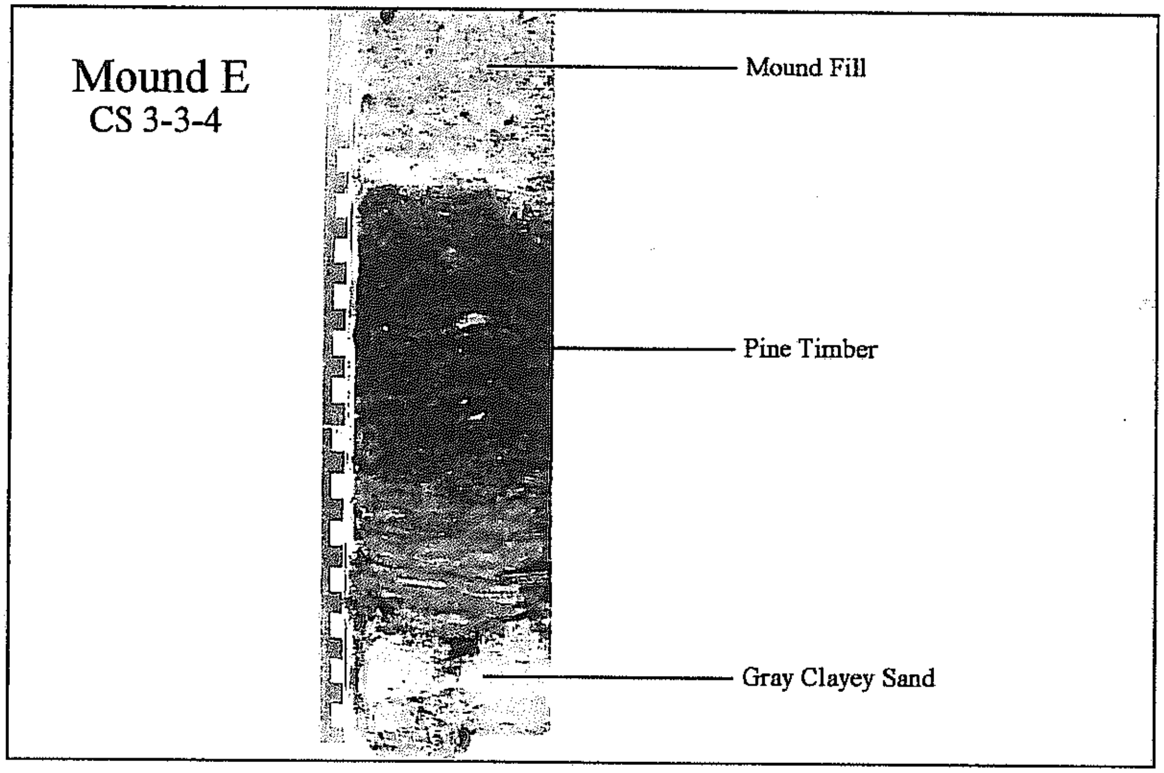

Figure 22. Timber located near the top of the Stage I deposits.

clayey sand atop a water sorted yellowish brown sand overlying the midden. The midden may have accumulated during the Stage IV occupation of the summit, but, because of the nature of the lower and upper deposits, It is attributed to the Stage V building episode. The total depth of the combined Stage V fill and midden is between 132 cm and 137 cm. At the completion of the Stage V addition, the western summit of Mound E stood approximately 3.81 m above the ground surface.

Stage VI offers a similar scenario to the presented below it in Stage V. The deposits consist of midden and sediment washed from the elevated area to the east. Approximately 70 cm of sediment is included in what is referred to as Stage VI. This may, in fact, simply represent a Stage V midden buried by sediment migration of the abandoned summit of Mound E. Approximately 20 cm of modern humus and plow zone overlies the Stage VI deposits.

If we alter our consideration of the middens and their overlying deposits as actual stages, a rather different, slightly more coherent understanding of Mound E's western summit and flank is possible. The initial episode of construction visible in CS 3 remains Stage I. The deposits are capped by a pine log, possibly set in place to serve as an erosional barrier. The sediments used in the construction of Mound E are slightly sandier than those found in the other mounds so far examined. Stage II represents a small window into the next episode of construction which required similar erosion control. The remnants of this are evidenced by the presence of the narrow layer of wood/bark. Stage III is also a small portion of the next episode of construction, revealing the western flank of Mound E at the completion of the Stage II addition. Stage IV is very similar to Stage III. However, the Stage IV occupation of Mound E's summit left behind an extensive midden deposits, which we have referred to as Stage V. The midden was then capped by a small Stage V addition of mottled, brown, clayey sand. During the Stage V occupation, the area continued to serve as a refuse disposal area, and midden deposits built up atop the Stage V fill. Finally, the abandonment and subsequent cultivation of the summit of the mound, caused sediment to wash from the elevated eastern half of the mound covering the Stage V midden deposits.

Core Sample 4 (CS 4) was selected to provide a sample of the northwestern summit. The abandoned hole measured 5.66 m deep with 5.46 m of sediment and soil present in the samples. The compaction rate is approximately 3.5 percent. About 4 m of culturally modified deposits are present in the samples.

The first deposits above the pre-mound sandy clay consist of 18 cm of water sorted sand deposited in narrow laminae. The sediments are believed to be the result of slope wash. Because of an absence of any charcoal flecks, fired clay, or other evidence of occupation, the deposits are not considered as a stage. Instead the first episode of construction is believed to be represented above the dark brown sandy clay overlying the sorted sand.

Stage I consists of 51 cm to 52 cm of mottled grayish-brown sandy clay overlain by water sorted silt and sand, 8 cm to 9 cm thick. The Stage I midden deposits noted in CS 2 to the east are not present under this portion of the mound.

Stage II is a relatively small addition to the mound. It includes 31 cm of mottled light, brownish-gray sandy clay overlain by 6 cm to 8 cm of water sorted dark gray sandy clay. At its completion, the Stage II summit would have stood about one meter above the surrounding ground surface.

Stage III is the first large episode of construction noted in CS 4. Approximately 132 cm to 137 cm of mottled yellowish brown clayey sand was added, more than doubling the height of the mound.

Stage IV consists of 37 cm to 38 cm of heavily mottled brown sandy clay fill. The contact between the Stage IV deposits and the overlying Stage V fill is tenuous at best. The break is marked by a change in the concentration of mottling between the heavily mottled Stage IV and the less mottled Stage V. The majority of the upper deposits are similar to midden fill, although the charcoal present within these deposits is slightly less than usual. The upper contact of this fill episode is marked by distinct light gray clay and charcoal overlying yellowish brown sandy clay fill. If these deposits are part of Stage IV, then the entire episode included a 169 cm to 175 cm thick fill layer. Considering the thickness of the Stage IV deposits noted in CS 1 and CS 2, this later interpretation seems more convincing. The height of the mound would have been between 2.5 and 3.0 m at its completion. The gray lamina and the charcoal suggests an episode of burning took place close by. Because the sediment beneath this lamina does not appear to have been altered, the charcoal does not appear to suggest an in situ episode of burning.

The final episode of building, tentatively referred to as Stage VI includes 30 cm of mottled yellowish brown sandy clay. These deposits are likely the result of the down-slope migration of sediments from the elevated eastern summit. The uppermost deposits include 28 cm of modern humus and plow zone.

Core Sample 5 (CS 5) was selected to sample the lowest portion of the western summit of the mound. The samples removed were relatively dry. This is considered unusual considering that this is the location where water tends to pool on the summit following rainstorms. The abandoned hole was measured to 5.34 m. Because of the sandy nature of the sediments recovered in CS 5, the compaction rate was slightly higher than usual, at 11.4 percent.

Above the submound sandy clay, the first deposits noted are contained within laminae of sandy hardpan. The gray and light brownish-gray clayey sand situated between the hardpans are narrow, averaging only about one centimeter thick. The hardpan is formed by the cementation of particles precipitated through the sediments. In this case, these are namely silica and iron oxide. Its presence is rather unusual in comparison to the other core samples. The absence of cultural material within these laminae suggests they predate the mound's construction.

Stage I consists of between 17 cm and 18 cm of water sorted midden wash, replete with bands of charcoal rich sediment. The upper contact is mark by a lamina of light gray to white clay. The deposits are again laid down at an angle, suggesting the location was near the west flank of Mound E. This is not unusual considering CS 5 is the furthest west sample taken.

Stage II is similar to the preceding stage and likely represents further midden wash from the Stage II west flank of the mound. The deposits are only 24 cm to 25 cm thick, but the successive layers of sediment which make up the stage are all set at a consistent west dip.

Stage III is yet another layer of midden wash, 21 cm to 23 cm thick. Sediments have been deposited in a series of thin laminae, each measuring between one centimeter and 5 cm. The upper contact of this stage is not sloped, but instead is marked by another layer of hardpan.

During the Stage IV addition to the west flank, Mound E was expanded far enough to the west to incorporate the location of CS 5 within the mound's summit plateau. The successive layers of sediment which make up the fill are consistently west dipping, except those near the upper contact. Stage IV is the first large episode of construction, approximately 189 cm thick. The Stage IV summit includes a lamina of brownish-yellow clay with a horizontally deposited sherd on the buried summit surface. The completion of Stage IV would have raised the summit of Mound E to approximately 2.5 m above the ground surface.

The Stage V deposits consist of 34 cm to 37 cm of mottled brown and yellowish-brown clayey sand and weak red clay. The upper contact is marked by a sloping lamina of sorted gray sand. The west dip of the slope and the water sorted nature of the sediment, again suggests that CS 5 penetrated another portion of the west flank.

Stage VI includes 56 cm to 59 cm of mottled brown sandy clay and clayey sand. The deposits are capped by 16 cm of loose, yellowish-brown, clayey sand and 32 cm of plow zone and humus.

Core Sample 6 (CS 6) was selected to penetrate a portion of the northwest corner of the mound where a relatively large anomaly had been identified. The abandoned core sample hole was measured to 5.23 m below the surface while the core sample measured approximately 5.45 m. The roughly four percent expansion of the recovered samples is blamed on shifting sediments within the upper portion of Sections 1 and 2. CS 6 exhibited an unusual number of stages, more than any other sample recovered from the mound. Eight individual stages are documented for the core sample, whereas six stages are noted for CS 4 and CS 5, the two samples taken closest to CS 6.

Again, Stage I includes the midden deposits. Here they include 34 cm of grayish-brown clayey sand with charcoal flecks and light gray ash and clay inclusions. The midden is capped by hardpan and a lamina of gray clay.

Stage II consists of approximately 36 cm of mottled yellowish-brown fill overlain by very pale brown water sorted sand. By the completion of Stage II, Mound E stood only 70 cm above the ground surface.

Stage III is a small addition to Mound E. Consisting of approximately 17 cm to 22 cm of gray and light brownish-gray fill capped by a one centimeter lamina of gray sandy clay. Overlying these deposits is 17 cm to 18 cm of midden deposited along a relatively consistent north dipping slope. The midden likely represents north flank refuse disposal during the Stage III occupation.

Stage IV is comparatively large, consisting of approximately 69 cm of mound fill capped by nine centimeters of brown clay. The clay is overlain by a thin hardpan.

Stage V consists of approximately 38 cm of mottled brown sandy clay fill with charcoal and fired clay in the uppermost deposits. The burned material is capped by a lens of pale brown water sorted sand and a brown clayey sand with clay inclusions. The thickness of deposits included within Stage V measure approximately 67 cm.

Stage VI consists of approximately 84 cm of mottled yellowish-brown fill capped by a three centimeter lamina of brown sorted sand. With the completion of the Stage VI addition to Mound E, the earthen structure stood roughly 3.5 m above the surrounding ground surface.

Stage VII includes approximately 30 cm of mottle brown sandy clay fill capped by two centimeters of banded sandy clays.

Stage VIII consists of only 15 cm of mottled brown sandy clay fill truncated by the historic plow zone and humus. Following the addition of the Stage VIII deposits, Mound E was raised to more than 4 m above the pre-mound ground surface.

As noted earlier, the eight stages of construction noted for CS 6 is unusual. The CS 6 stages found deep within the mound (Stages I, II, and III) are consistent with those found in the other cores placed in the western portion of the mound. The inconsistency is found in the break between the clay and hardpan contact of Stages 4 and 5. Within the other samples the Stage IV deposits are much larger. The fact that these CS 6 deposits are split into two separate stages has some interesting implications for the northwest corner of the mound. One possibility is that the Stage IV summit was actually a loading area where sediments were carried, basketload by basketload, from the terrain northwest of the mound, up to the summit and deposited. The northwestern summit was finished last and the compacted staging area was buried. Thus, the Stage IV and Stage V deposits are actually part of a single building episode.

Even if this is the case, at least one additional stage is present. The most likely candidate for this is Stage VIII. Given the location of CS 6, in the northwestern summit, at a lower elevation that the eastern half, it is possible that the Stage VIII deposits consist of materials washed downslope by natural weathering processes.

The last possibility we will mention for the extra stages also deals with natural weathering processes. As noted in the discussion of Mound E's form, evidence of past erosion has been identified for the Mound's northwestern summit. Undoubtedly, erosion was a problem during the prehistoric occupation as well. The amount of water sorted sands noted overlying several of the stages suggests this portion of the mound experienced relatively frequent episodes of sheet erosion. The unusually high number of building episodes may be the consequence of frequent repairs performed on the northwestern summit.

Core Sample 9 (CS 9) penetrated the northeastern summit of the mound and Knight's 1994 excavation units. A total of 7.08 m was drilled, including approximately 1.6 m of sterile submound soils. Compaction was approximately six percent. The mound fill contained within the core samples measures approximately 5.44 m.

Stages I, II, and III consist of narrow (less than 10 cm) deposits of sands silts and clays. Stage I is a narrow midden zone of grayish brown clayey sand. A feature intrudes into the subsoil from the base of the Stage I deposits. A flake of Tuscaloosa gravel was noted within the feature and was deposited vertically within the fill.

Stage II consists of approximately six centimeters of brown sand and gray silty clay capped by hardpan.

Stage III consist of a series of silt and sand deposits capped by a charcoal and sandy clay lamina. Each of these stages consists of sediments deposited during weathering events or episodes of sheet erosion. They are all sorted deposits with multiple episodes of graded sediment deposition.

Stage IV is the first large episode of mound building noted in CS 9. The deposits consist of 182 cm of mottled midden fill intruded by a feature which extends approximately six centimeters into the midden. The feature consists of a sand capped south dipping slope of grayish brown silt. The gray sand cap includes fired clay and charcoal at the upper contact. The amount of charcoal and fired clay present points to an episode of burning atop the feature.

Stage V consists of mottled brown clayey sand and sandy clay. The addition includes approximately 121 cm of fill, raising the summit of Mound E to approximately 3.4 m above the ground surface.

Stage VI includes approximately 93 cm of mottled yellowish-brown sandy clay. The uppermost sediments consist of brown sandy clay mottled with yellowish-brown clay. This five centimeter thick layer is the living floor identified by Knight's 1994 excavation as the summit of his Stage II.

Overlying the Stage VI deposits is a lamina of dark grayish brown sandy clay loam washed into the base of the excavation unit. Above the loam lamina was a mottled backfill and thin humic zone of the newly established root mat.

The presence of the thin laminae at the base of Mound E in CS 9 suggests the location was either occupied prior to the initial construction of the mound, or during the initial construction, the location was slightly east of the east flank. As sediments were eroded down the slope of the east flank, they settled into graded laminae at the base of the mound. The breaks between these stages provide evidence that some time elapsed between depositional episodes.

Core Sample 10 (CS 10) was selected to penetrate the center of the mound in the area which slopes up to the east. The stratigraphy was similar to the core samples placed nearby (Figure 23), although The submound soils were slightly more clayey than in either CS 3 or CS 5. A total of

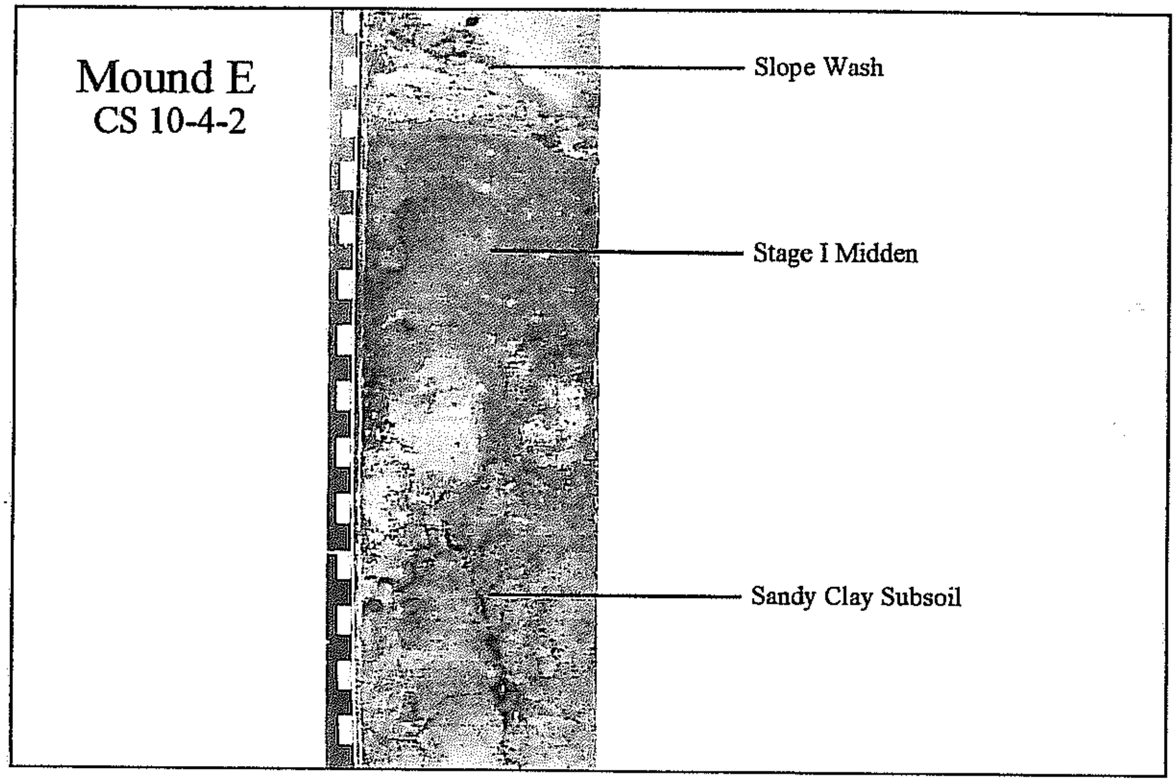

Figure 23. Stage I midden and slope wash at the base of Mound E.

6.94 m was drilled with a compaction rate of between two and five percent. Approximately 4.65 m of mound fill was recorded for CS 10.

Mound L

During Moore's first field season at Moundville, he expended a relatively large amount of energy in the exploration of Mound L. The mound is large, approximately 93 feet east to west and 80 feet north to south and standing 12 feet 9 inches on the north, 13 feet 4 inches on the west, and 14 feet 10 inches on the south according to Moore's reckoning (1905:199) (Figures 2 and 24). The summit, like many others at the site, was cultivated at the time of Moore's visit. Noting that the mound is oriented closely to the cardinal directions, Moore believed the origin for the fill used in its construction was found in the depression[4] to the south and west (Moore 1905:199) (Figure 25). His interest in the earthen structure compelled him to direct his crew to excavate 29 trial holes into the mound. These tests revealed "only negative results" compelling him to open an excavation into the center of the mound's summit. Measuring 18 feet square at the uppermost depths, the excavation was taken to 14 feet 10 inches. Because the bottom of the hole still appeared to Moore to be

[4]The depression noted by Moore as an "artificial pool of water" is currently referred to as Lake 2.

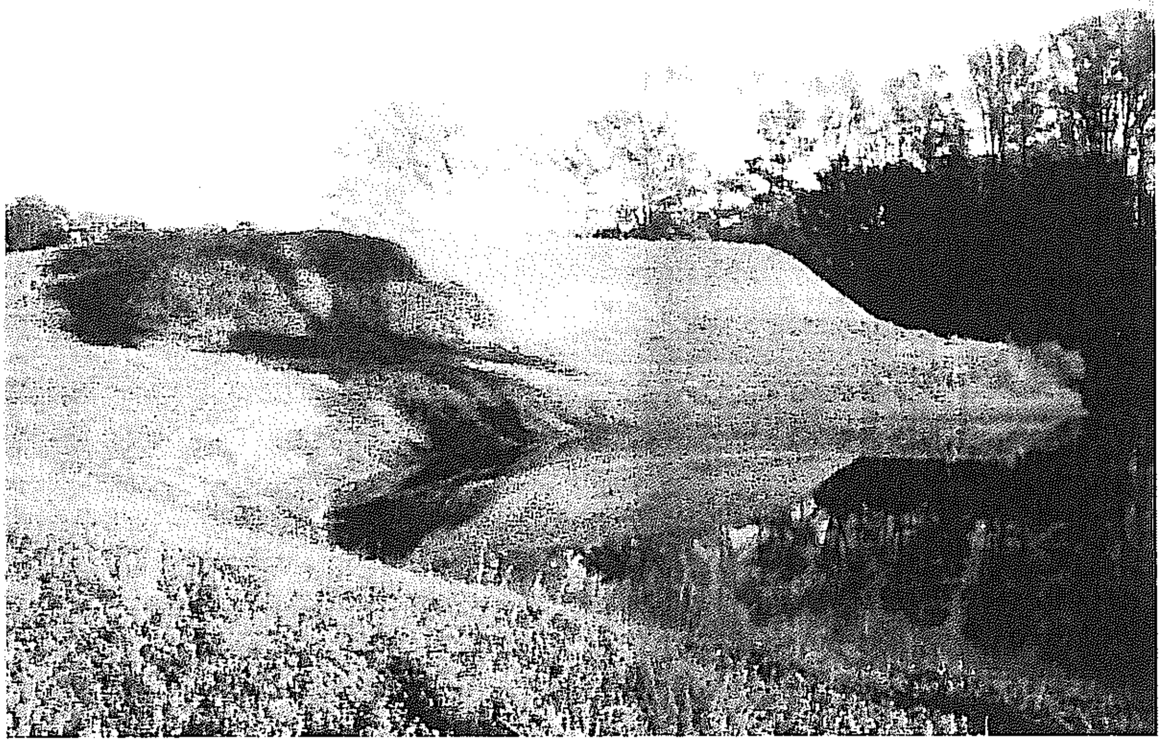

Figure 24. Western elevation of Mound L and Lake.

Figure 25. Mound L circa 1902.

disturbed clay, the excavation was narrowed to a four foot diameter hole. This was dug another one foot ten inches before encountering sterile "lead color" clayey sand.

Throughout the trench, Moore noted no stratigraphy which would suggest multiple stages of construction or occupation. Instead, he found only "several small bits of pottery." Given these findings, Moore decided Mound L was a domiciliary structure with no secondary use as a place of burial (Moore 1905:199).

Moore's recognition of the depression south and west of the mound as the source of fill used in its construction was an astute observation. The natural lay of the terrace within the vicinity of Mound L is rolling enough to suggest other reasons for its existence. The color of the underlying clayey sand as a "lead color" offers some interesting aspects to the soils below and around the mound. The existence of such a color within the soils of the terrace suggests the effects of the close proximity of the pond to the south and west. Water percolating through the clayey sand would have changed the normally brownish yellow and reddish brown deposits of the majority of the terrace to a dull gray or lead color. As has been discussed elsewhere, this factor also influenced the fill deposits in other mounds at Moundville tested during this project.

The next recorded work to be conducted on Mound L was by The AMNH. The location of excavations into Mound L were not recorded and any actual excavation into the summit is uncertain. A single burial is recorded as having been found on the "Top of L." The location of any excavation on the summit is, again, unknown but the remains were found at a depth of five feet suggesting a relatively extensive, or at least deep, trench (Anonymous n.d.). What we do know about these excavations is that they were undertaken in 1937 by Jones and his staff. In an effort to divine the original form of the mound, trenches were excavated into the four flanks corresponding to the cardinal directions. The artifact records refer to each as "square," such that the four trenches are; Square Mound L S., Square Mound L W., Square Mound L E., and Square Mound L N. The work is documented in a paper by Walter B. Jones (1941) describing mound and lake restoration work at Moundville. Included within the document is a photograph taken around 1900 which shows the mound as seen from the south side of the ponded depression. The summit of the mound appears to be sparsely vegetated in submature pine and hardwoods. Knight summarized the excavations into Mound L as best as possible in a paper presented at the 1989 Southeastern Archaeological Conference in Tampa, Florida. He went on to examine the collections from these investigations finding Mound L to be one of the few mounds on the southern periphery of the site which contained evidence of relatively late occupation. The presence of Carthage Incised *var. Carthage* and *var. Fosters* as well as a frog effigy fragment and a sherd of Bell Plain *var. Hale* with a beaded rim suggest occupation dating to Moundville III. In addition, materials indicative of a late Moundville I and Moundville II phase components are also present (Knight 1989:8-9).

However, regardless of the inclusion of Moundville I and II pottery within the mound's ceramic assemblage, profiles suggest the presence of only a single stage of construction (Knight

1989, Moore 1905). As such, if only a single episode of construction occurred and Moundville III phase ceramics were found within mound context, the indiction would be that the construction of Mound L was a late addition to the Moundville landscape. The presence of the Moundville I and Moundville II ceramics and Moore's recognition of them as "small bits of pottery", suggest they were possibly fragments mixed in with construction fill. The fill, if excavated near the mound, would have included material from earlier occupation of the site, namely sherds of Moundville I and Moundville II phase pottery.

To clarify, the presence of Moundville III pottery within a mound of single episode construction suggests Mound L was not built until Moundville III. While many mounds show evidence of sediment additions during Moundville III, few are believed to have been initially constructed this late in the site occupation (Knight and Steponaitis 1998).

Another option is clear given the lack of stratigraphic control of the 1937 excavation and the limits of The provenience information provided. Mound L may be the result of an earlier, Moundville I initial construction episode with a limited Moundville III occupation. The Moundville III marker pottery recovered and noted by Knight (1989) may have come from the shallower portions of the trenches excavated by the Museum. The Moundville III occupation of the mound and any possible contributions attributed to this occupation, in terms of mound building, may have been disturbed by the extensive cultivation and erosion of its summit.

GPR Data

GPR data collection from Mound L was begun on October 20, 1998. Profiling was conducted within a 27 m by 27 m grid established at the summit of the mound. Beginning in the northeastern corner of the grid, profiles were gathered from east to west at 1 meter intervals. Location markers were spaced at 5 meter intervals along the transects. The survey was conducted using a 300 MHz antenna with a range setting of 80 nanoseconds. At present Mound L stands roughly 4 meters above the surrounding plaza. At this height, and with an estimated dielectric permittivity of 5 ns\m, a range setting of 80 nanoseconds of travel time should allow for profiling to depths in excess of 4 meters below the summit of the mound.

The data from the mound indicate that features within the upper deposits are relatively sporadic while those in the lower deposits are few. In fact, examinations of the GPR profiles reveal that the upper sediments are so irregular that no relevant clarification as to the sequence of the deposits can be determined. The data did reveal that the areas along the perimeter of the mound are more irregular possibly indicating erosion episodes prior to the renovation of the mounds by The AMNH in The 1940s. In addition a series of horizontal slices of the transects exposed the remnants of what is believed to be the large test pit dug by C.B. Moore in the early 1900s. The horizontal slices also revealed a high amplitude anomalous reflection in the northeastern 1/4 of the summit grid (Figure 26).

Core Sample Analysis

Four well locations were drilled on Mound L. Two locations were intended to sample areas where anomalies were not recognized in the GPR data. The remaining two locations were selected based on the known presence of anomalies.

Core Sample 1 (CS 1) was placed into the northeast corner of the mound. CS 1 was intended to penetrate a high amplitude anomaly which extended west and south. Five sections were recovered for a total depth of 7.05 m, well below the base of the mound which Moore suggested at 3.89 m for the northern side (1905:199). None of the breaks noted were diagnostic of buried summits. Instead, the entire mound includes what appear to be only two stages. The most distinguishing break, although not attributed to a buried summit, was a layer of light gray clay with white clay inclusions noted in CS 1-2 at approximately 1.87 m below the surface.

The submound deposits consist of a light gray clayey sand, undoubtedly the lead colored clayey sand noted by Moore (1905:199). Below this are yellowish brown and yellowish red sandy clays. The discoloration of the clayey sand is considered the result of saturation caused by percolation of water from the adjacent pond. At the time of drilling portions of section 1-4 where the light gray clayey sand appeared were saturated while above and below remained relatively dry.

Stage I consists of a gray sandy clay with charcoal flecks, fired clay, and sherds. The layer appears below yellowish brown sandy clay mound fill. It measures approximately 8 cm to 12 cm in thickness. Given the nature of the inclusions and the matrix of the fill itself, Stage I is considered to be midden deposit.

Stage II consists of yellowish brown sandy clay overlying the midden deposits. Breaks do exist within the fill zone, but none are diagnostic of a buried summit. The light gray clay lens which appears in this stage is noteworthy. The uppermost portions of this stage are truncated by plow zone and modern humus which extend to approximately 50 cm below the surface.

Compaction of the sediments from Core Sample 1 was 13 cm.

Core Sample 2 (CS 2) was also placed into the northeast corner of the mound southwest of CS 1. It was selected with the intent of examining another point where the high amplitude anomaly was recognized by the GPR. Four sections were recovered from this location obtaining a total depth of 5.12 m (16.79 feet).

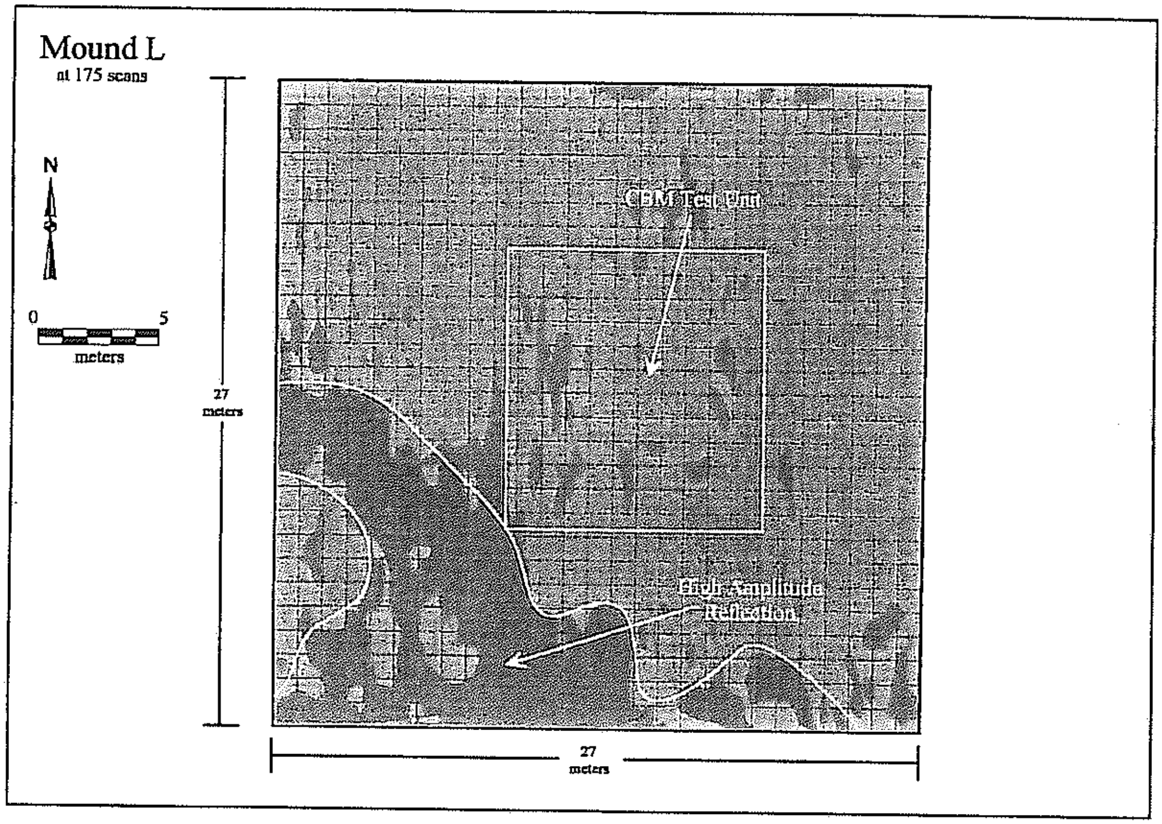

Figure 26. Amplitude slice map of Mound L showing C.B. Moore's large, excavated hole and high amplitude reflection in the northeast quarter of the summit.

The submound deposits in Well 2 are the same as in Well 1. They consist of the light gray clayey sand deposits with an unconformity at the upper contact.

Stage I consists of the same midden deposits noted in Well 1. However, the upper contact between these and the overlying deposits appear as a gradual slope.

Stage II consists of yellowish brown fill. Again, the gray clay lens appears, this at approximately 2.09 m below the surface (Figure 27). The lens is apparently continuous across the area which includes Wells 1 and 2, and is likely the cause of the high amplitude anomaly. Given a dielectric constant of 5, the anomaly appears in the GPR data at approximately 2 m below the surface, within the range of the clay lens. The stage is truncated by the plow zone and modern humus layers.

Compaction of the core sample from CS 2 was 15 cm.

Core Sample 3 (CS 3) was placed south of CS 1 and CS 2 on the eastern side of the mound. CS 3 varied greatly from the first two locations sampled. More breaks appeared, although none were

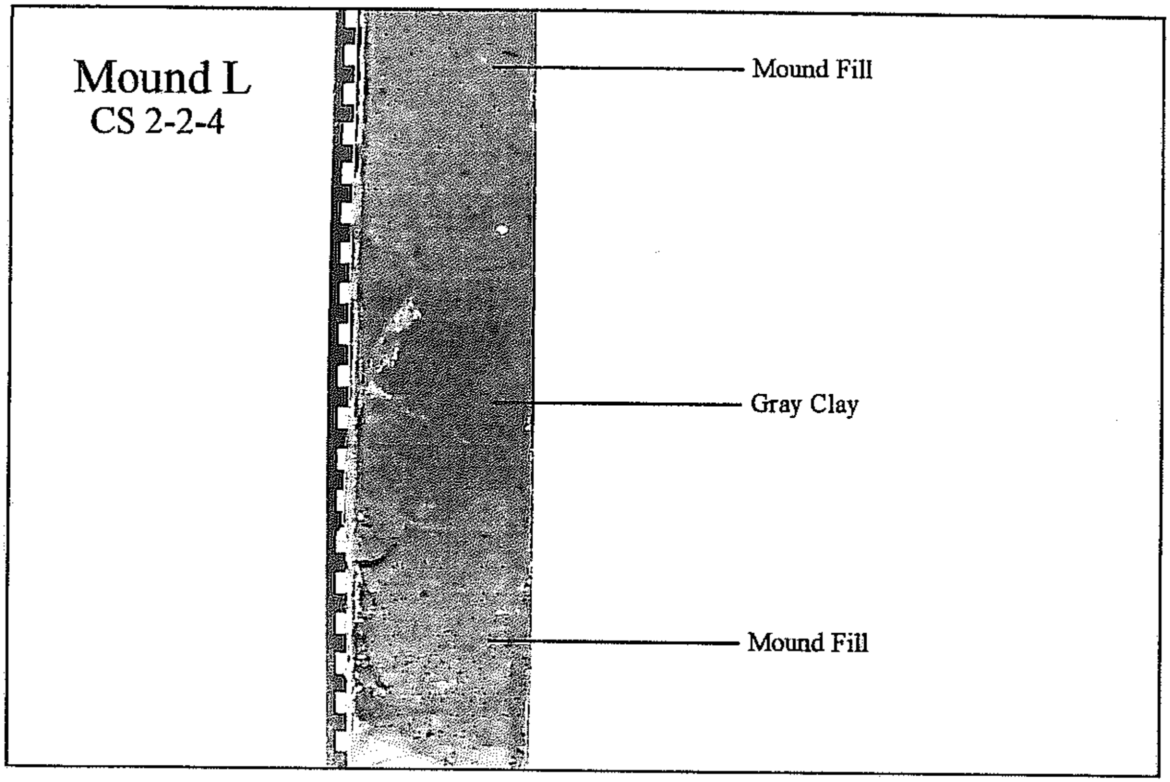

Figure 27. Clay lens within Mound L.

indicative of buried summits. The total depth obtained was 5.65 m. In addition, the break separating mound fill from sterile submound material lacked the midden deposits noted in CS 1 and CS 2.

Again, The submound material consisted of light gray clayey sand. However, the upper contact with the overlying deposits was more distinct with no midden zone.

It is considered likely that the deposits sampled within Well 3 represent disturbed materials. The relatively complex stratigraphy with at least 14 breaks noted above The submound sterile deposits and the summit of the mound. The upper two breaks include the truncation resulting from the plow zone and the modern humus layers. Moore's well excavated into the center of the mound was 18 feet square. It is possible that the well location penetrated through the backfill of Moore's trench and that the distinct break at the base of the mound is actually the bottom of his excavation located at approximately 4.49 m (14 feet 7.5 inches) below the surface .

Compaction of the core samples from CS 3 was 54 cm.

Core Sample 4 (CS 4) was intended to penetrate the area believed to be occupied by Moore's 18 feet square excavation trench. CS 4 was set in the center of the summit of Mound L. Expectations suggested that the sample would appear as heavily mottled backfill with no evidence of stages and a clean break separating The submound deposits from the backfill. This was not the case. The total depth of CS 4 was 5.38 m.

Submound materials consist of the light gray clayey sand seen in each of the other wells (Figure 28).

In contrast with expectations Stage I is evident in CS 4-4. The same midden deposits seen in CS 1 and CS 2 are evident at the base of the mound here. In this instance, a portion of a rim sherd was evident protruding from the sample profile within the gray sandy clay fill. Also noted were fragments of fire clay and charcoal flecks.

Stage II consists of compact yellowish brown sandy clay mottled with light gray, gray, red, yellow, and brown clay. Manganese nodules, fired clay, and charcoal flecks also exist within the Stage II fill. Unlike the Stage II fill noted from CS 1 and CS 2 which were truncated near the surface by the historic plow zone and modern humus, the Stage II fill noted here was truncated at a lens of yellowish brown sand at approximately 4.1 m below the surface. Above this break was material much like that noted from CS 3 truncated by the plow zone and humus zones.

CS 4 was apparently set into a portion of Moore's excavation which was not dug to the same depth as the area noted in CS 3. Moore notes in his discussion of the excavation,

> Next, an excavation 18 feet square, having for its center the central part of the summit plateau, was carried to a depth of 14 feet 10 inches [14.52 m], at which level the excavation was 13 feet 6 inches by 12 feet 4 inches. The mound showed no distinct stratification. No pits were met, and no sign of dual occupancy; the only artifacts found were several small bits of pottery.
>
> As the base of our excavation, however, still seemed to be composed of disturbed clay, a circular hole 4 feet in diameter was made, which, at a depth of 1 foot 10 inches[55 cm], came upon homogeneous material, clayey sand of lead color, which extended down to an unascertained depth (Moore 1905:199).

It is possible that CS 4 penetrated the shallower portion of the excavation as did CS 3.

The compaction of core samples from CS 4 was 11 cm.

Given the large size of Mound L and the drilling of only four well locations, two of which are believed to have penetrated into almost completely disturbed portions of the mound, recognition of stages of construction is relatively speculative. However, given the presence of the midden deposits at the base of the mound in three of the four samples and the nature of the breaks which appear in the remainder, as well as Moore's observations (1905), and Knight's information (1989), it is possible to speculate that Mound L was originally built sometime during the Moundville I occupation of the site. The presence of the Moundville III ceramics on the mound comes from an unusually late occupation of the mound's summit, that portion of which was destroyed through

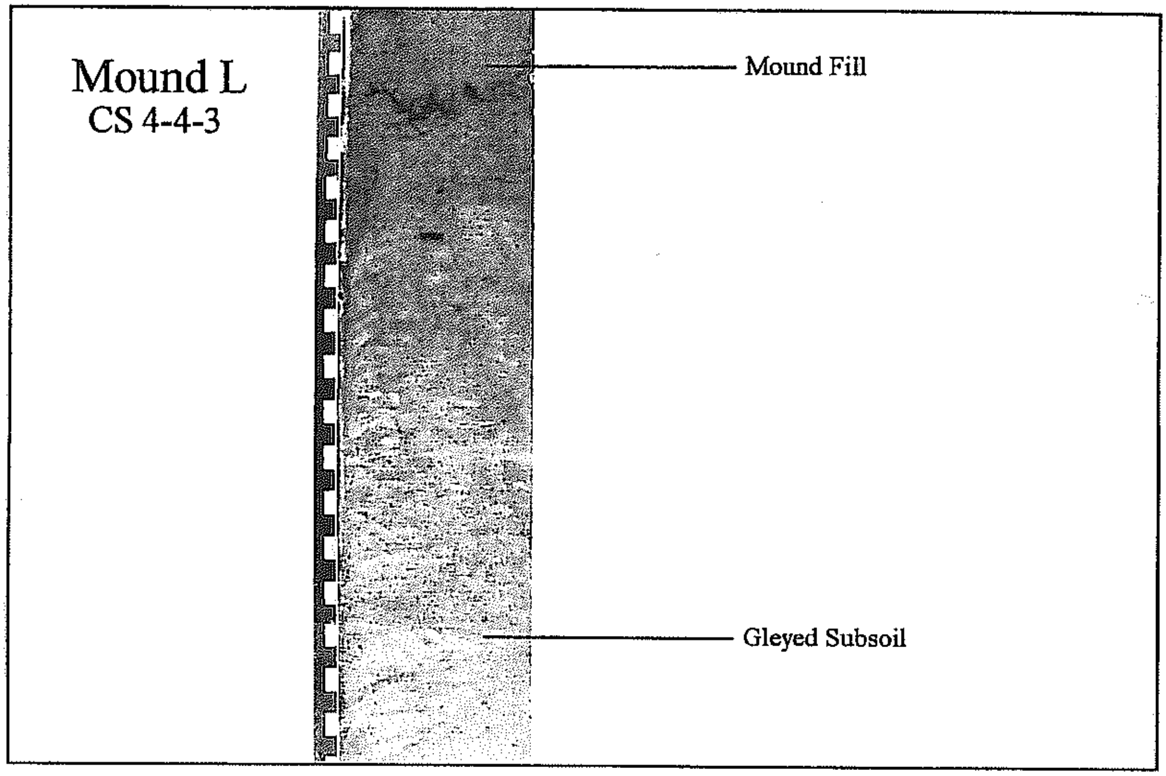

Figure 28. Gleyed soils beneath Mound L.

cultivation and erosion. However, the alternative is also an outside possibility: That Mound L was the result of a single episode of construction which occurred during Moundville III and incorporated fill from portions of the site contaminated with Moundville I and II ceramics. If so, it would represent an anomaly in the current understanding of the development of the Moundville Site..

Mound Q

Mound Q is situated in the northwestern portion of the site along the edge of the road which currently loops through Moundville Archaeological Park (Figures 2 and 29). The mound is relatively small, with the northern slope being gradual, the result of apparent historic modifications. The mound is oriented, like the majority of the mounds at the site, with the cardinal directions. The northern base of the mound is higher than the southern, partially in accordance with modifications related to the elevation of the roadway and partially as a result of the natural gradual increase in elevation to the north. The mound's summit, standing approximately 4.5 m above the plaza to the south, measures roughly 17 m east to west and 16 m north to south.

Mound Q was also subject to the scrutiny of C.B. Moore. During his first field season, he reported that the mound was neither cultivated nor showed any signs of having been previously excavated. The major impact to the mound had been a roadway which led up the north slope to the

Figure 29. Southern elevation of Mound Q.

top. He presumed that the road was intended to led to a house which had at one time occupied the summit. Nine trial holes were excavated into the mound, but no burials were encountered (Moore 1905: 219).

To Moore, Mound Q exhibited certain characteristics he attributed to burials; namely the presence of "rich soil", a pottery effigy head, and a copper ornament (Moore 1905:219). He was so sure of the mound's use as a place of burial that during his second visit to the site in 1906 he again excavated several trial holes into the earthen structure (1907:337). Again, he found no burials within the confines of the mound. Instead, Moore uncovered several burials just north of the mound's base.

The only burials found within the mound are reported by Knight (1992). Between 1989 and 1994, excavations were conducted in Mound Q by the University of Alabama through field schools of the Department of Anthropology and through the summer expedition program of the Alabama Museum of Natural History. During the course of these excavations a trench was dug into the west flank of the mound with a 6 m by 10 m block excavated into the summit. In addition, supplemental test units were excavated on both the eastern and northern portions of the earthen structure (Knight 1992).

It was during these excavations that Knight encountered two burials within Mound Q. The first included a child buried with a vessel near the head, a "pavement of sherds" below the skull, and a stone discoidal at the elbow. The second included a burial pit lacking preserved bone, but Knight had little doubt of the features identification (Knight 1992:12). Within the pit a Moundville Engraved bottle with the winged rattlesnake motif was encountered as was a copper-covered wooden object suggested to be an earspool.

Knight's excavations have yielded some of the best recorded information regarding identified stages of construction of any of the mounds at Moundville. He noted the existence of five major stages (I-V) of construction and two "minor" stages (IIIa and IVa) (Knight 1992:9). The first stage is simply the deepest stage encountered within a test unit on the eastern edge of the summit and is considered unlikely to be the earliest stage of construction.

Stage II was extensively investigated for evidence of summit architecture which included multiple small buildings of wall trench construction. In addition, Knight noted a heavily oxidized basin or hearth, a scatter of potsherds, sandstone fragments, mica, small pieces of sheet copper, and random fragments of human bone (1992:9).

Above Stage II was IIIa, a minor stage which apparently represents a brief episode of activity between the time the Stage III was begun and before its summit was completed. It consists of a small level burned area with abundant deer bones scattered around the margins and a Moundville Engraved bottled encrusted with the green mineral glauconite. Knight's students referred to the feature as the "builder's banquet" not so subtly suggesting its use as an episode of ceremonial feasting (Knight 1992:10, Beasley 1998). Finally, the burned area was sealed with a cap of yellow and gray clay. A date of 1257 A.D. is reported for the feature (Knight 1992:10).

Stage III was occupied by a single larger building with more substantial wall trenches and central roof supports (Knight 1992:10). The building episode was capped with a layer of yellow clay that encompassed the summit and flanks. Charcoal from this stage yielded a calibrated date of 1263 A.D.

Between Stage III and IV is another minor stage, IVa. It consists of an ashy humic layer similar to midden deposits. The layer covers the entire mound including the flanks. The nature of the material and its superposition atop Stage III suggested to Knight that the layer was the result of midden fill from somewhere else redeposited onto Mound Q. Its designation as a stage comes from the presence of unusual pit features and at least one post hole originating from the level. Calibrated C-14 dates suggest dates 1257 A.D. and 1279 A.D for the episode while an additional early date, 1043 A.D., supports the idea that the material represents redeposition (Knight 1992:11).

Stage IV is similar to Stage III in that it was also capped by yellow clay and supported at least one structure. The floor of the Stage IV summit is extensively disturbed.

Finally, Stage V represents a construction episode dating to the Fifteenth Century, approximately a century after Stage IV was capped. During this Moundville III reoccupation, a large midden was developed on the east, north, and west sides. Because of historic truncation of the mound, no evidence of architecture remains. However, some features have survived including the two burial pits mentioned earlier and a small irregular midden-filled pit.

The lack of extensive midden fill during the Stage III and IV occupations of Mound Q and the much different extensive midden which developed during the Stage V occupation have led Knight to suggest that the mound use changed over time. During the Stage III and IV occupations, when larger more substantial architecture occupied the mound's summit, Mound Q supported a series of special-purpose buildings. Later, the mound was utilized for residential purposes (Knight 1992:13).

GPR Data

The inclusion of Mound Q in our study was relatively unique. Because of the recent nature of the extensive disturbance on the mound's summit as well as the existence of Knight's maps and documentation pinpointing the location of these disturbances, Mound Q was intended as a ground-truthing test for the GPR survey and core sampling. If the variations in the mound's matrix was modified in particular known locations by the backfilling of excavation units, it was believed that the GPR survey would have little trouble distinguishing the areas of disturbance and the areas of relatively intact deposits. In addition, the depths of these units, also being a known factor, would contribute to the determination of the general dielectric constant of Mound Q's fill.

The GPR survey on Mound Q was conducted between January 13th and February 15th, 1999. All imaging was conducted within an 11 by 14 meter grid established at the summit of the mound. The survey grid was placed in a manner to include the boundaries of previous excavations as well as undisturbed materials. The initial profiling was conducted with a 300 MHz antenna with a range setting of 75 nanoseconds. It was hoped that the known location and depth of the previous excavation units would provide a ground truth signature, by which we could determine the dielectric permativity of the sediments. However, the initial attempts failed to produce the desired results . Subsequent attempts with both a 300 and 500 MHz antenna as well as numerous adjustments to the range and gain settings also failed to produce satisfactory data. As a final attempt at recovering data from the summit, a series of 1 m transects were imaged for conversion into a three dimensional time slice. The results of this imaging technique were successful in recognizing the boundaries of the previous test units, as well as a high amplitude reflection at the apex of the north ramp (Figures 30-31).

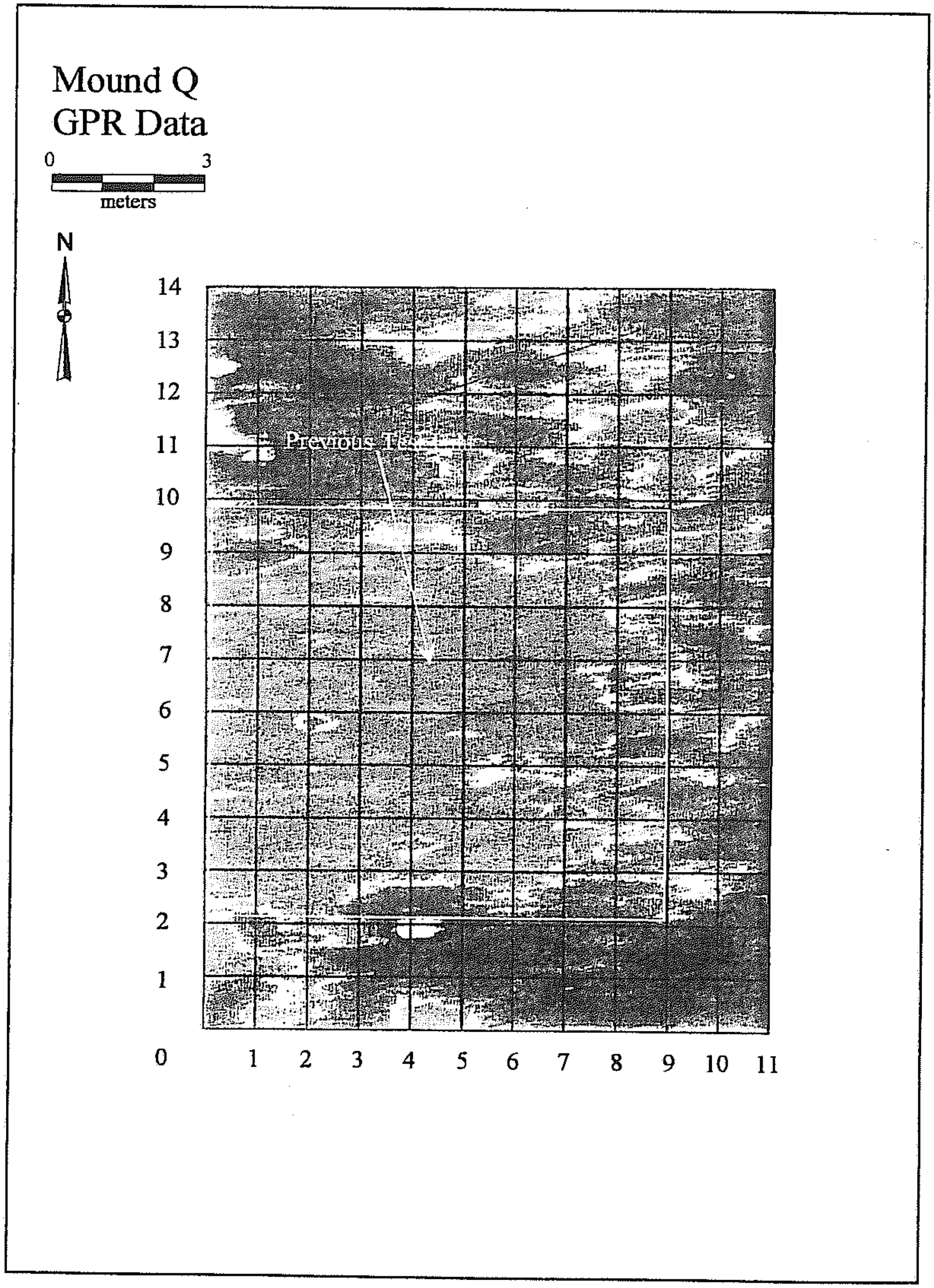

Figure 30. Amplitude slice map showing previous excavations.

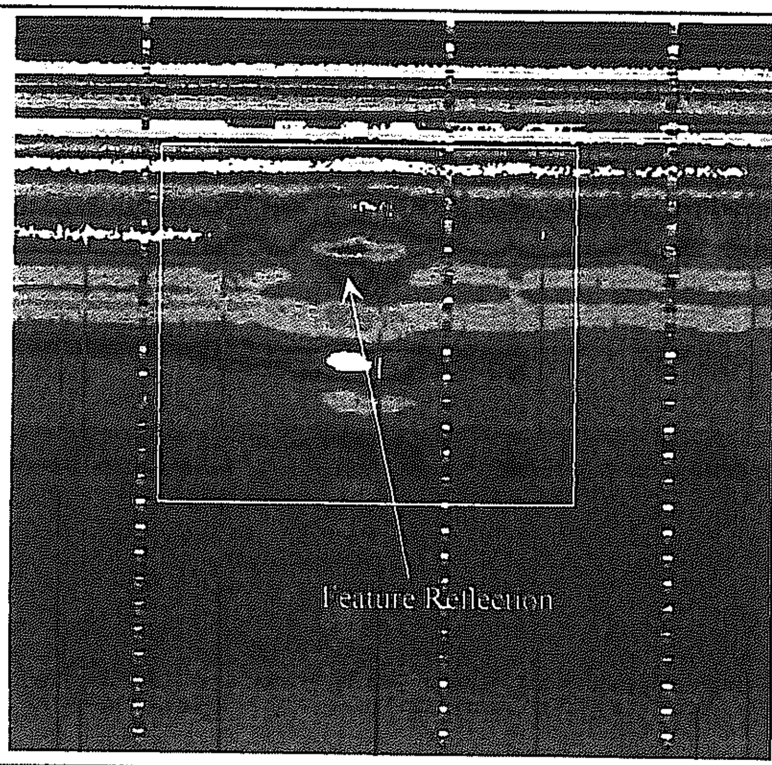

Figure 31. Vertical profile of high amplitude reflection.

Core Sample Analysis

Four well locations were drilled on Mound Q (Figure 32). Two locations were intended to sample areas where anomalies were not recognized in the GPR data. The remaining two locations were selected based on the known presence of anomalies.

Core Sample 1 (CS 1) was intended to penetrate the southwest corner of the mound where Knight's excavations had not disturbed the mound deposits. The location was just outside the GPR anomaly attributed to the large block excavation. Five sections were taken to ensure recovery of a good submound sample. The total depth of the well was 7.05 m. Moore recorded the height of the mound as between 3.53 m and 5.18 m. The tallest portion of the mound is recorded for the southern summit. Mound Q is approximately 4.50 m tall in the southwest corner where Well 1 was drilled. However, deposits suggest the southwest corner of the mound is only approximately 2.9 m tall.

The submound material of Mound Q consists of yellowish red very fine sandy clay. These sterile deposits appear in CS 1-3. A fourth core sample section (CS 1-4) was recovered from the well. It revealed the consistent presence of the clay to greater than 560 cm below the surface.

Figure 32. Drill rig atop Mound Q.

The contact between The submound and mound deposits of what is considered Stage I is well defined. Stage I is a midden-like dark grayish brown sandy clay zone which included charcoal flecks, fired clay, and potsherds. A Bell Plain *var. Hale* bowl sherd with interior burnish was recovered in the 11 cm thick midden-like deposit. The upper-most portion of this zone includes water sorted deposits, just below the contact with the overlying brown clayey sand mound fill. The presence of these sorted deposits suggests the upper contact had been exposed to weathering. Whether this zone represents an actual episode of mound building or midden deposits established prior to the construction of Mound Q is unclear. In either event, the deposits represent occupation of the Mound Q location.

Stage II consists of mottled brown clayey sand mound fill capped by gray sandy clay with ash and charcoal. The mottled zone includes approximately 90 cm of fill with the overlying gray zone consisting of approximately 6 cm. The presence of such a high concentration of charcoal and ash suggest Stage II is capped by a midden.

The next addition to Mound Q included approximately 11 cm of brown sandy clay. Stage III includes a relatively heavy concentration of fired clay and charcoal, suggestive of the presence of a burned structure.

Stage IV includes approximately 44 cm of fill. The brown sandy clay fill is heavily mottled with yellowish brown and grayish brown sandy clay. It is capped by yellowish brown sandy clay.

Stage V represents another relatively small addition to the mound. It consists of approximately 10 cm of brown clayey sand with sorted deposits at the upper contact. Charcoal and fired clay also exist atop this break suggesting the presence of another burned structure.

Stage VI consists of similar material as that which appears in Stage V, with a slightly greater amount of clay included. The Stage is truncated by plow zone and modern humus layers.

The compaction of the deposits in Well 1was 11 cm or roughly 1.9 percent.

Core Sample 2 (CS 2) was selected for its location within the boundaries of the area excavated by Knight. The deposits here were expected to be completely disturbed consisting of mottled back fill. Indeed, the majority of the core sample consisted of brown clayey sand heavily mottled with yellowish brown and yellowish red sandy clay. The mottling within these samples is slightly different than that which appears in mound fill. Rather than firmly compacted deposits, these sediments are more loosely consolidated with more consistent uniformity in the mottling pattern. However, breaks were noted at approximately 210 cm below the surface. Here, three breaks, exist at consistent 26 degree angles. The loosely consolidate nature of the material within these layers and the presence of roots, again evidence the deposits as backfill. The total depth of Well 2 is 4.07 m.

Within the lowest 30 cm of the mound, brown sandy clay, more compact than the overlying deposits, was noted. These sediments are more consistent with intact mound fill. Included within this layer was a sheet of mica measuring 3 cm in length and several sherds of greater than 1 cm in diameter. It is considered likely that these deepest 30 cm of the mound represent unexcavated deposits below Knight's units (Figure 33).

Sterile submound consists of yellowish red very fine sandy clay. At the contact with the base of the mound, The submound includes material slightly mixed with the overlying deposits. This zone is likely a buried O horizon covered over by Mound Q's construction.

The compaction of deposits in Well 2 was 16 cm or roughly 3.9 percent.

Core Sample 3 (CS 3) was placed at the top of the northern ramp. The location was selected because of a recognized high amplitude anomaly. Again, three sections were recovered, revealing approximately 2.45 m of mound fill. Comparing this to the southern side of the mound we notice a difference of roughly 45 cm. This difference is a result of the contour of underlying deposits which dip to the south. In addition, the crest of the northern ramp is at a slightly lower elevation than the southwest corner of the mound.

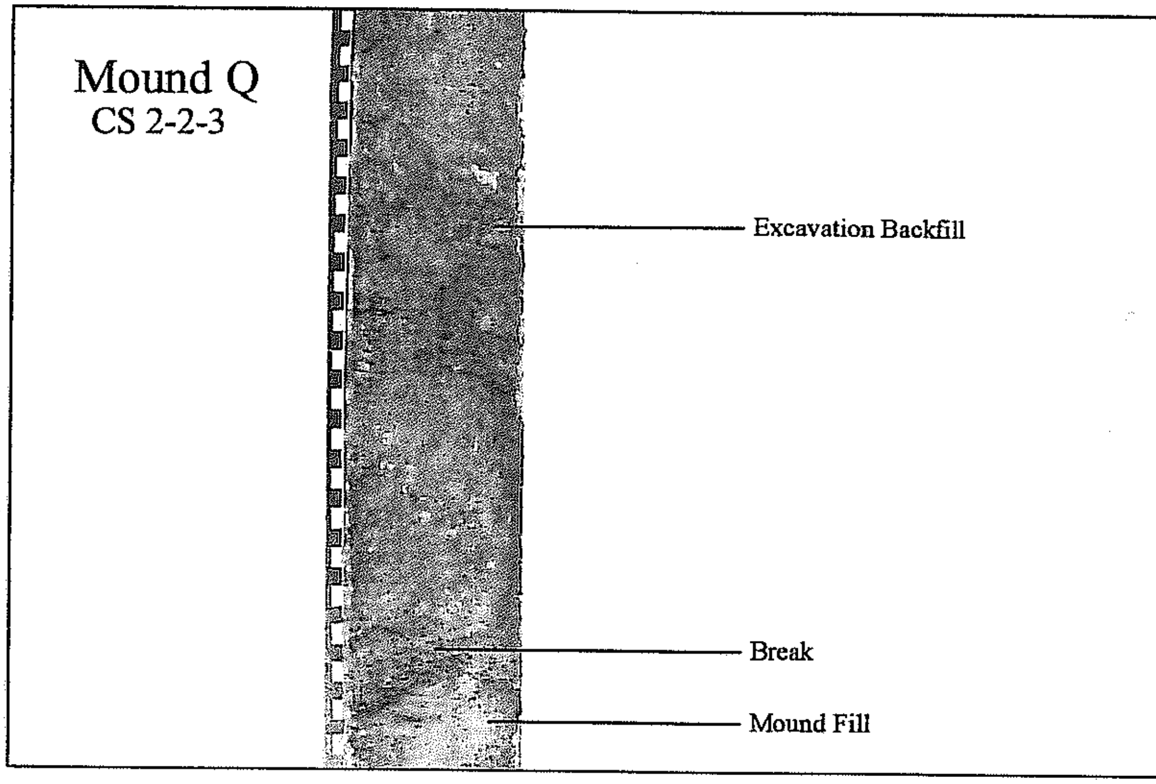

Figure 33. The contact between backfilled excavation units and underlying deposits.

Submound deposits consist of the same yellowish red fine sandy clay deposits. This is overlain by a strong brown sandy clay which contains minimal amounts of small, less than 1 mm, charcoal flecks and fired clay inclusions. This zone is a buried humus layer into which cultural materials have migrated.

The first stage of mound fill includes between 11 and 17 cm of dark yellowish brown clayey sand mottled with brown clayey sand and includes charcoal flecks and fired clay. The upper contact of Stage I is a 30 degree slope which the directional marker indicates to be slightly east of north. The direction of the dip and strike is relatively consistent with the current northern slope. If, in fact, this represents a buried north slope of Mound Q, the base of the Stage I mound would be approximately 9 m south of its current location.

Stage II consists of a relatively small, 16 cm to 19 cm brown clayey sand addition to the mound, similar to that seen in Core Sample 1. No slope is indicated in the break indicating the mound was extended to the north during this episode. The upper contact includes fired and clay and charcoal in a dark brown sandy clay matrix, suggestive of the presence of a burned structure.

Stage III consists of another relatively small, 19 cm, addition to the mound. IT consists of brown sandy clay mottled with yellowish brown and grayish brown sandy clay capped by sorted deposits and dark yellowish brown clayey sand. Again, charcoal flecks and fired clay suggest the presence of a burned summit structure.

Stage IV consists of yet another small addition to the mound. Here, approximately 22 cm of fill, very similar to the mottled brown sandy clay below in Stage II, is capped by gray very fine sandy clay in a dark grayish brown sandy clay matrix. Yet again, the presence of relatively high concentrations of fired clay and charcoal suggest the presence of a burned structure.

Stage V is a much larger addition to Mound Q. More than 80 cm of mottled dark yellowish brown sandy clay fill was added to the mound. The actual amount of material is unknown as the stage was intruded upon by a feature (Figure 34). Deposits within the feature include bone, sherds, fired clay, and charcoal. The feature fill, in turn is capped by the historic plow zone. At least a couple explanations are possible for the presence of the feature. The feature fill may be the backfill of a C.B. Moore trial hole or it may be a pit excavated into the fill of Stage V.

Core Sample 4 (CS 4) was situated in the northeast corner of the Mound Q's summit. The location was chosen in an effort to determine the true height of the mound as well as to determine the number of construction episodes. Again, three core sample sections were recovered for a total drilled depth of 3.90 m. Deposits were not consistent with expectations in this area. Instead, it was apparent that we had drilled into an area of backfill.

The submound deposits below this portion of the mound are consistent with the remainder of the structure; yellowish red very fine sandy clay. The contact between The submound and mound deposits was distinct. No buried humus layer was noted as appears below other portions of the mound.

The first recognized mound fill deposits consist of approximately 29 cm of relatively compact brown mottled sandy clay with sherds, small bone fragments, fired clay, and charcoal flecks. The upper contact of this Stage I appeared as a convex surface. The compactness of these deposits as well as the mottling pattern is indicative of mound fill.

The deposits above this consisted of less compact yellowish brown sandy clay heavily mottled with brownish yellow sandy clay. Charcoal flecks and a relatively high and consistent concentration of manganese nodules existed throughout these overlying deposits. They are very similar to the deposits noted in Knight's backfill encountered in Well 2, CS 2-3, and are considered to be backfill from an excavation unit.

The compaction of the deposits from Well 4 was 7 cm or roughly 1.8 percent.

Mound Q offered itself as an interesting comparison to the other mounds investigated. Namely, because so much of the mounds summit, especially the area accessible to the drilling rig,

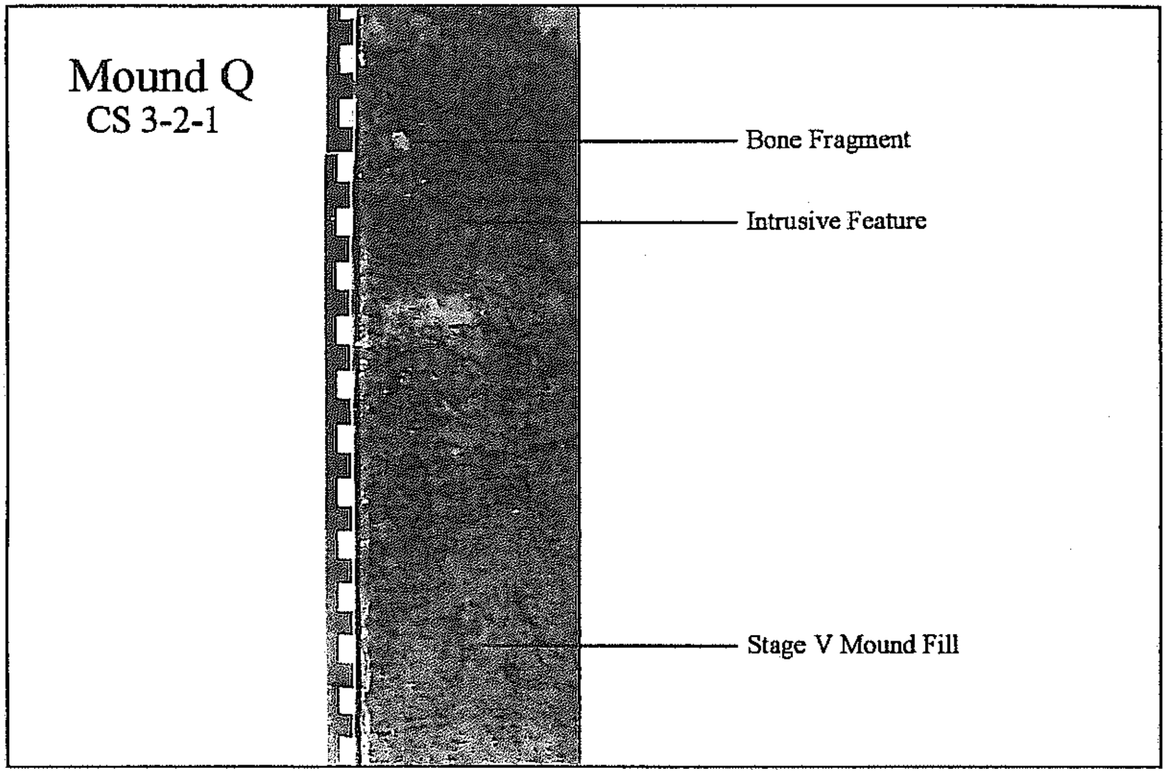

Figure 34. Intrusive feature into Mound Q's Stage V deposits.

was limited to excavated deposits. Well 2 was intentionally placed in an effort to hit Knight's excavation unit, however, Well 4 was not. The similarities between the two were uncanny. They consist of predominantly mottled brown and yellowish brown clayey sand backfill. Yet, the existence of the 24 cm and 29 cm, respectfully, of mound fill at the bottom of each core sample was unexpected.

The comparison of stages of construction between our data and Knight's is especially interesting. Knight had seven stages of construction including Stage I, II, IIIa, III, IVa, IV, and V. We observed only six within the area of Well 1 and only five in Well 3. Setting aside the obvious limitations of the core sample data, the locations of these wells may hold the explanation for these differences. Although Knight's Stage I was recognized by him as simply the first or deepest episode of construction observed, its characteristics, that of a thin midden layer, is similar to what we observed at the base of section CS 3-2, and recognized as Stage II. Knight's profile, which we used for comparison, was from 5 m of the north wall of his large excavation. Well 3 provides the core samples closest to this profile. At least three of Knight's stages (V, IV, and IVa) are within the uppermost 50 cm of the mound below the humus layer. Within CS 3, this portion is dominated by the disturbed fill of what is believed to be a feature.

CS 1 is situated on the southwest corner of the mound. This location is more than 8 m south of Knight's profile in an area where the elevation is approximately 60 cm lower. Again, this would mean that the uppermost stages recognized by Knight, are not present at this location.

If we count the midden material noted in the very lowest deposits of Mound Q as an episode of construction, Mound Q and combine Knight's uppermost stages with those recognized in the core samples, eight stages are recognized.

Mound Y

Mound Y (Figures 2 and 35) was not given a specific letter designation until sometime after 1941. On one map it is referred to as Mound M-2 (Peebles 1969), on another Mound M-1 (Knight and Steponaitis 1998:3), on a third no letter designation is provided at all (Reynolds 1941, Jones n.d.). Moore refers to the mound as "Field Near Mound M", 325 feet WSW. from Mound M (Moore 1907:343. In field notes of The AMNH's excavations of the Winter 1930 to 1931 field season, the mound is referred to as "SWM" for southwest of Mound M (Jones 1931). The "Mound Y" appellation appears on a 1992 map of Moundville Archaeological Park (University of Alabama 1992, Astin 1996). Here it will be referred to as Mound Y with the expressed understanding that other identifiers have and will continue to be used to indicate the feature.

The first recorded excavations into Mound Y were documented by Clarence B. Moore in 1907 (Knight 1996, Moore 1907:343). Excavations were undertaken in 1906 during Moore's second visit to the site. When he first arrived at Moundville in 1905, Moore found the area planted in cotton at a stage "...too far advances to be disturbed..." Prior to this, he had become aware of the presence of "...interesting 'finds' made..." within the vicinity of Mound Y. Between 1857 and 1862, two effigy pipes were found while a ditch was being excavated on the Prince Plantation near Mound M (Moore 1905:131). With this in mind, Moore began excavations in the area the following year.

For two days, twelve men dug a trench from the base of the "...remnant of the mound..." north approximately 65 feet. Fifty-nine burials were encountered within the excavation (Moore 1907:343).

The next excavations to be conducted within the vicinity of Mound Y were those of The AMNH. The first field season at Moundville began in the Winter of 1929 and 1930. The following Winter, excavations were begun on December 2, 1930. A crew of more than a dozen, directed by acting field supervisor James D. Hays, began work in the field southwest of Mound M. Judging from burial records and field notes of the 1930-31 excavations, 131 burials were encountered and more than 270 artifacts were recorded (Jones 1931). Within the field notes reference is made to "...previous excavation..." Whether this refers to excavations of The AMNH during prior years or

Figure 35. West elevation of Mound Y.

to C.B. Moore's visit to Moundville is unknown. Field notes from the previous year do not include any reference to SWM or the general area.

Aerial photographs from the late 1930s or early 1940s show the area of Mound Y as existing in a combination of field and wooded drainage. The 1924 USGS 15' Tuscaloosa, Alabama topographic quadrangle shows the area as not wooded with a drainage south and west of the mound. The drainage is likely that dug in the mid-Nineteenth Century on the Prince Plantation. Even now, a drainage exists south and west of the mound.

Peebles (1971:83, 87; 1978:381) suggests the layout of the mounds at Moundville conforms to a planned use of "status space", with more elite occupation to the north and degrading status towards the south (Knight 1998:51). Since Mound Y is situated in the southwest corner of the mound cluster, it should represent one of the less elite areas. This seems poorly supported in light of the effigy pipes, ceramics, carved stone pendants, and copper items found. However, if we consider Moore's discussion of his finding from the field near Mound M, he notes that with the relatively deep burials no artifacts were found and with those found more shallow, the artifacts were "...but few-." Based on Moore's findings, Knight (1998:5) suggests the feature may be a true burial mound.

In either event, Mound Y has been subjected to extensive excavations. Where the excavations were actually conducted is unknown as no records for their locations exists. Prior to David L. DeJarnette's field school at the University of Chicago in 1932, excavations at Moundville were undertaken in the Antiquarian technique of artifact recovery. Only later were records of excavation and feature locations generated. The same can be said of Moore's excavations. While a site map was generated, no information as to the actual location of excavations was provided. As such, Peebles (1969) only labels the general area of the 1930 and 1931 excavations.

GPR Data

The lack of information regarding the excavations locations influenced the initial decision to include Mound Y in this project. The GPR survey was designed to cover the highest portion of the mound as well as much of the gradually sloping terrain around it. The GPR grid measured 50 m by 100 m with the long axis set to magnetic north. In addition, the low, broad appearance of Mound Y has led to much speculation regarding its true nature. The feature was questioned as to whether it was a mound at all, or just an erosional remnant rising slightly from the surrounding terrace. It was obvious that occupation had occurred and the location had been used as an area for burial, but the question still existed as to whether the rise was an intentionally constructed earthen mound or simply a natural expression of the landscape.

To these ends, the project data recovery methods were directed. If the feature was an intentionally constructed earthen mound, the GPR survey should reflect the presence of varying material between on-mound and off-mound areas. In addition, it should reveal contact points between varying deposits to show the possibility of stages of construction. Finally, AMNH excavation pits, C.B. Moore trial holes, and his 65 foot long trench should be outline within the GPR data. The core samples should reveal the presence of anthropogenically modified areas as well as the depth of sterile sub-mound sediments, stages of construction, and sample anomalies located during the GPR survey.

The GPR survey on Mound Y was conducted October 10-19, 1998. Mound Y is recognizable as a slight rise with less than 2 meters of change in elevation from the surrounding ground surface. For the initial profiling, we utilized a 500 MHz antenna with a range of 50 nanoseconds of travel time. Due to the mounds low profile and the opportunity for improved resolution this antenna was chosen for imaging. However, the data were inconclusive, leading us to change to the 300 MHz antenna in hopes of better results. Determining the dielectric permeability of a mound is difficult due to the mixture of sediments used during construction. Previous ground truth experiments indicated an estimated travel time of 10 ns/m (nanoseconds per meter). Using this value and allowing for attenuation of the signal due to clay sediments, we estimated the depth of penetration at between two and three meters below the surface.

Profiling began in the northeastern corner of the grid along a series of parallel 50 m wide east to west transects. After 25 meters of imaging with the 500 MHz antenna no notable anomalies or interfaces were recognized. In an attempt to obtain better signal penetration, we switch to a lower resolution 300 MHz antenna for the remaining transects. In addition to the east-west transects, a series of north to south profiles were also imaged. These transects also originated in the northeastern corner of the grid. The initial transect was imaged along the eastern baseline with the ensuing profiles spaced at 5 m intervals.

A total of 101 east to west transects as well as 11 north to south transects were imaged on Mound Y. With the exception of the first 25 transects, all imaging was conducted with a 300 MHz antenna with a range setting of 50 nanoseconds. The results of GPR profiling at Mound Y were generally inconclusive. No to distinguishing reflections were detected that could be perceived as relating to the construction of the mound. In general, the data was rather languid, with very little differentiation from one profile to the other. However, there were a scatterings of reflections that warrant delineation. The following is a brief description of these reflections and their location within the grid.

For the most part the data revealed a uniform soil matrix along the outer edges of the grid. Analysis of the data revealed a rather homogeneous stratum from the beginning of the transects to a point approximately 10 meters to the west, where a more irregular stratigraphy is present for approximately 30 meters before reverting back to a more homogeneous stratum.. While not specifically associated to the sloped areas of the mound, the irregular stratum appears more pronounced along the sloped areas as well as at the summit of the mound. Although this stratum was more evident in the area of the suspect mound, no specific order was observed that would indicate modification related to the construction of the mound. In fact the stratum appears more vertically aligned rather than the horizontal distribution and compaction you would expect from an intentionally constructed mound.

While the preceding is a general description of the study area, several noteworthy features were detected. Three anomalies detected in Transects 50, 75 and 76 are represented by singular high amplitude hyperbole(Figure 36). Based on the intensity of the reflection these anomalies are probably the result of historic metallic objects, although aboriginal origins cannot be ruled out.

In addition to the singular anomalies two groups of trough like reflections were also detected. The first group is located between 35 and 40 meters in transects 40 through 48 (Figure 37). The second group was also detected between 35 and 40 meters in transects 73, 74 and 75 (Figure 38). Although their origins are not known the regularity of which the reflection occur suggest the possibility that the reflections could represent previous excavation unit conducted by AMNH or test holes excavated by Moore.

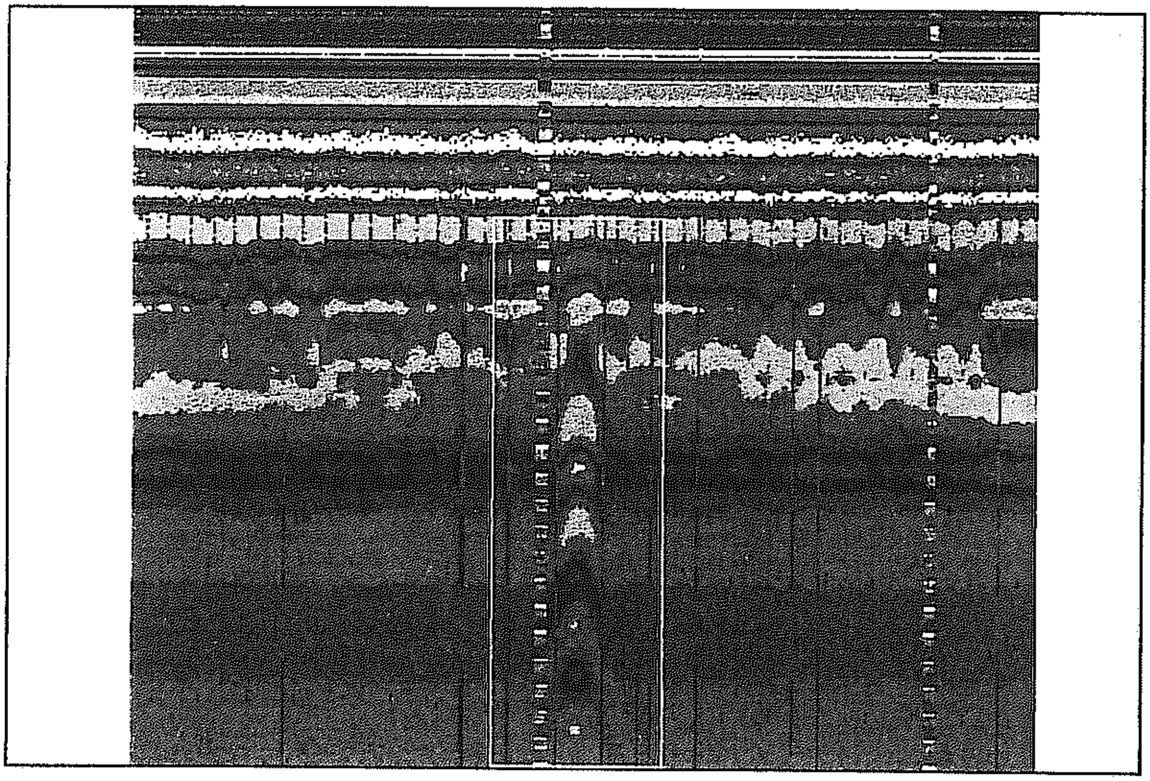

Figure 36. View of hyperbola as observed in Transect 50.

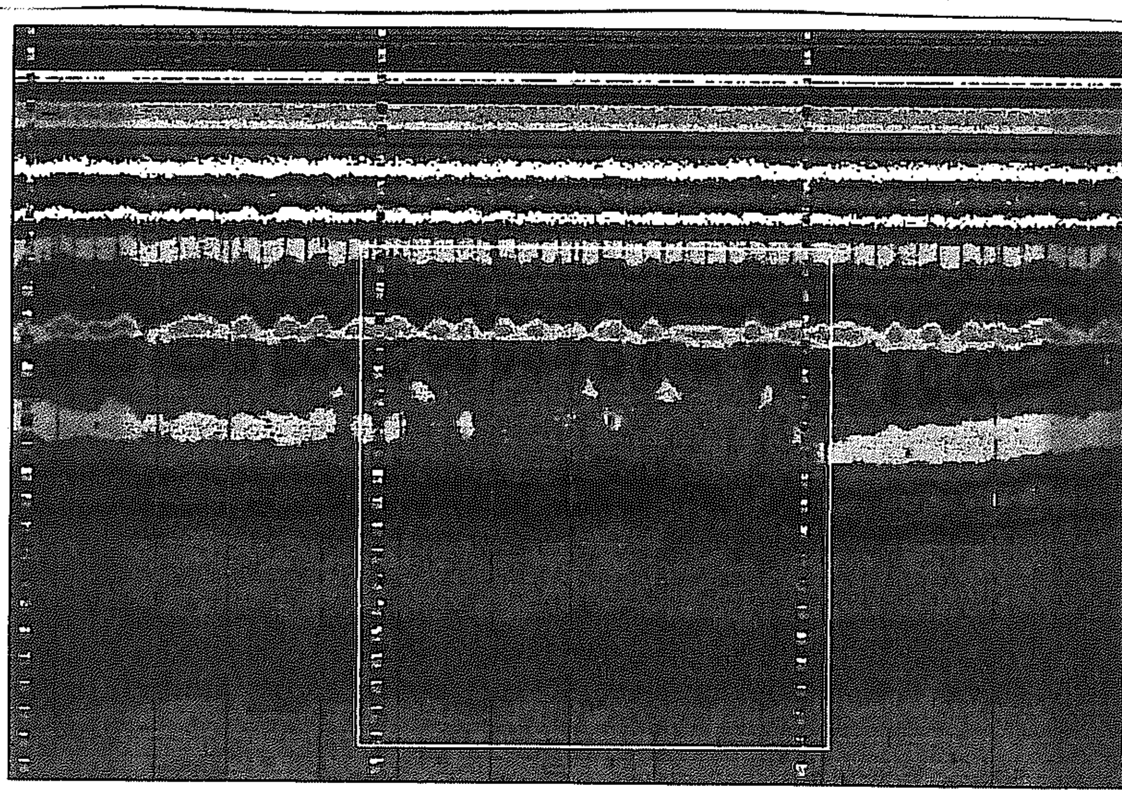

Figure 37. View of suspected test unit as seen in Transect 45.

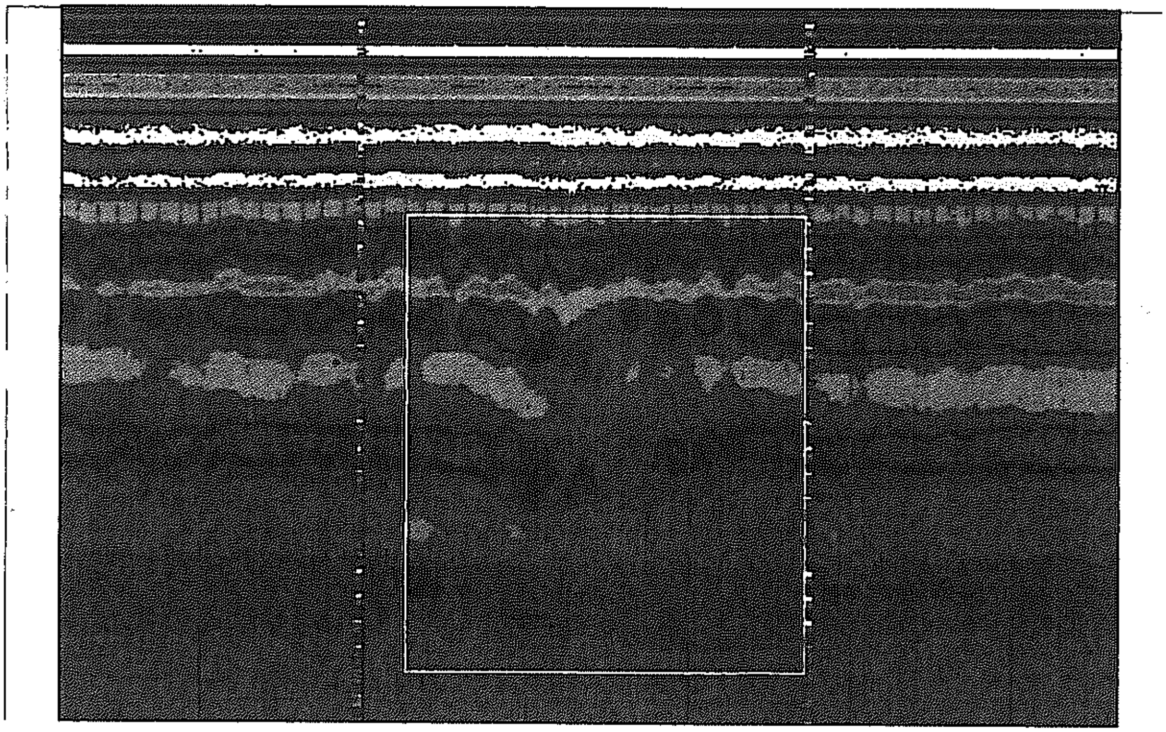

Figure 38. View of suspected test unit as seen in Transect 7.

The only other notable reflections were related to a substantial surface depression visible on the surface between 30 to 45 meters in transects 65 through 69.

Core Sample Analysis

Only four well locations were selected for drilling on Mound Y because of the mounds relatively small size. Because of the relatively homogeneous appearance of the subsurface noted during the GPR survey, our targets were limited to the highest area and two locations beyond the edge of what was considered the mound proper.

Core Sample 1 (CS 1) is situated in the northern gradual slope of the mound, the well produced two samples with cultural deposits in both. At least two stages, and possibly a third exist. Stage I, atop sterile sub-mound, begins at a slope whose direction is unknown[5]. The slope suggests the mound was built (1) atop a natural uneven surface-based on the angle, the uneven surface would have had to have been an erosional gully; (2) a prehistoric feature excavated into the plateau prior

[5]To alleviate this problem Technical Drilling Services included a north scoring marker into the sampler. As the cores were forced into the sampler, a welded ridge scored the sample on the northern edge.

to mound construction; (3) or an area excavated by historic investigations. Given the nature of the break in CS 1-1 at approximately 45 cmbs to 47 cmbs, The latter possibility is unlikely.

An intrusive feature into the fill of Stage I is suggested by the nature of the break at the top of CS 1-2 (approximately 4 cm from top of CS 1-2 and approximately 57 cmbs). Bone present within the feature was sampled as was some of the surrounding fill. Although it may represent a midden, the presence of so many burials SW of Mound M (Field Notes for 1930-33 AMNH excavations) suggests another alternative for the intrusive feature other than historic excavation. The shallow nature of the feature however, approximately 15 cm, suggests midden and not a burial pit.

Stage II or possibly III, consists of mound fill truncated at approximately 28 cmbs by the historic plow zone. This, in turn, is capped by modern humus.

The compaction of the two samples taken was determined by subtracting the length of material recovered in the core samples from the depth of the well measured prior to backfilling. For Well 1, the compaction was 23 cm.

Core Sample 2 (CS 2), situated at the apex of the mound, this well also produced two samples with cultural deposits in both. At least three stages are noted. Stage I is built atop what appears to be a prepared sandy clay surface set atop the original humus layer and sterile sub-mound soil. The strong brown sandy clay of Stage I terminates at between approximately 60 cmbs and approximately 64 cmbs. At this depth, the layer appears to have been heated/burned, evidenced by the brown sandy clay with red fired clay inclusions. The remnants of the fire include the overlying lens of charcoal at approximately 60 cmbs (Figure 39).

Stage II includes fill capped by fired clay at approximately 47 cmbs. The fill is a possible midden with dark organic rich deposits.

Stage III is truncated at approximately 22 cmbs by the plow zone which is capped by the modern humus layer.

The compaction of CS 2 was 35 cm.

Core Sample 3 (CS 3), situated slightly west of the apex of the mound, the well was placed into a depression which also appeared as one of the few anomalies in the GPR survey of Mound Y. Only a single sample was taken from the location as sterile deposits were achieved within the first approximately 75 cmbs. Two or three stages exist in this well.

Stage I begins with a banded sandy clay lens, likely a prepared surface above sterile sub-mound soils. No evidence of a humus layer exists.

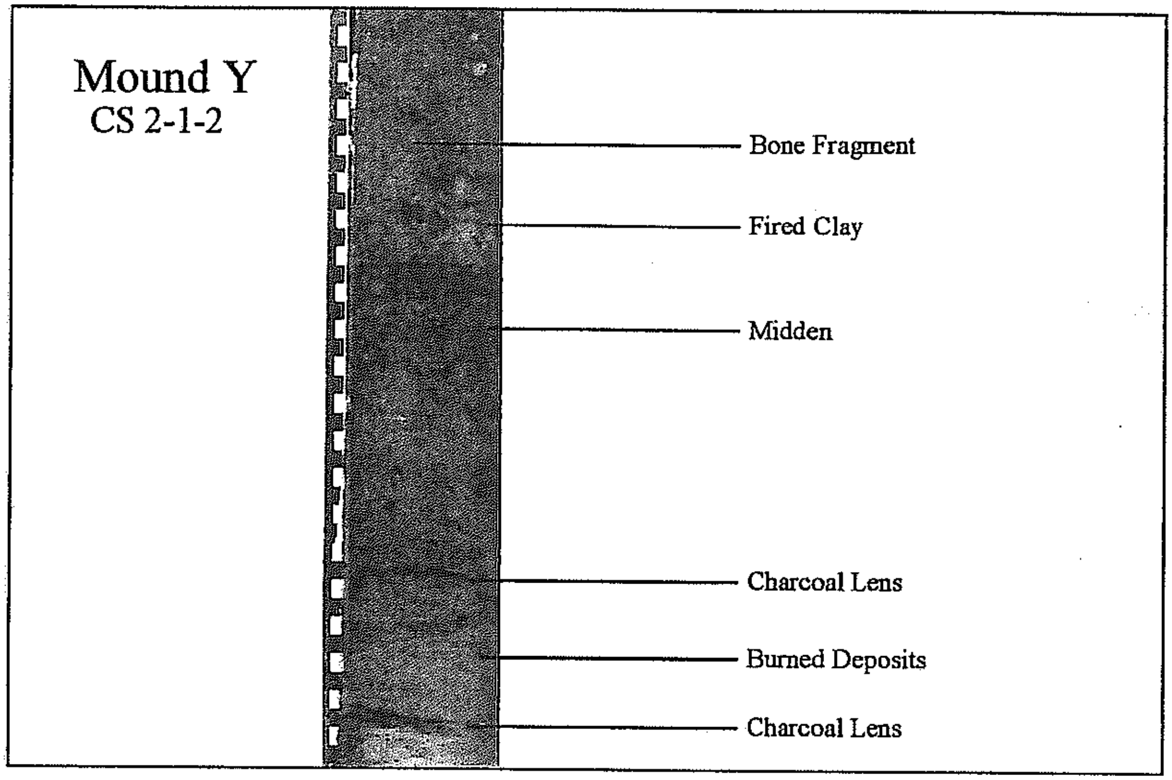

Figure 39. Burned structure and underlying midden deposits in Mound Y.

Stage II consists of the midden also noted in Well 2. Here it exists between approximately35 cmbs and approximately41 cmbs. The midden includes charcoal, fired clay, and bone fragments in a highly organic rich brown fine sandy clay matrix.

Above the midden, and possibly an addition to it, is brown fine sandy clay loam fill with fired clay and charcoal inclusions slightly varying in color and consistency from the underlying midden deposit. If not the upper portion of the midden, then the fill represents the third stage noted in Well 2. The distinct break of fired red clay covering the midden in Well 2 is not present here in Well 3. In either event, the stage is truncated by the plow zone at approximately26 cmbs. The plow zone on this slope contains more manganese nodules than noted in any of the previous samples from Mound Y.

The compaction of CS 3 was 14 cm.

Core Sample 4 (CS 4), situated beyond the edge of what was believed to be the west flank of the low mound and slightly northwest of CS 3, this well was intended to sample off-mound deposits just outside the general high amplitude area noted during the GPR survey.

The strata from the well shows only a single zone of cultural deposits overlying sterile sub-mound soil and intruded upon by historic plow zone. All of which is covered by the modern humus.

The zone can safely be called a midden given the organic material, sherds (Mississippi Plain *v. Warrior*), charcoal, and fired clay.

The compaction of CS 4 was 24 cm.

The possibility was considered that Mound Y was simply an erosional remnant with minimal cultural deposits appearing as accretionary midden, elevating the surface above the surrounding ground level. Given the presence of what appears to be a prepared surface beneath the tallest portion of the rise; the definite breaks in sediment stratigraphy; and greater height of deposits in the central portion, as opposed to the northern and western lower portions; It is now believed to indeed be a mound built atop an erosional remnant. The presence of the sloping surface in Well 1 will require further investigation.

The utilization of the area for agriculture purposes greatly transformed the appearance of Mound Y. Plowing was apparently predominantly performed in a south to north direction causing deposits to be spread in a generally tear-drop shape with the highest area being closer to the southern edge of the elevated area than the northern. The truncation of the mound is revealed in the plow zone lying atop cultural deposits. Whether intentional leveling of the mound was ever undertaken is unknown. The only intentional modifications to the structure of which we are definitely aware is its cultivation. No restoration was performed on Mound Y.

Concluding Remarks

The use-life of Moundville spans more than three hundred years. Its initial building within the northern section of the 29 mound complex coincides with the massive episode of construction undertaken by the occupants of Moundville. Perhaps two centuries after the end of Moundville's occupation, its abandonment is followed by that of the remainder of the Black Warrior Valley. The mounds, the site, and eventually the entire river valley, once home to the second largest civic-ceremonial center, gradually became relegated to a borderland between cultures.

As a result of the remote sensing and core drilling of Mounds A, E, L, Q, and Y, more than 7,796 m of GPR transects were imaged and approximately 215.5 linear meters of mound and submound soils and sediments were sampled. Outgrowths from the project include: The development of a museum exhibit intended for the Moundville Archaeological Park Museum following renovations: the *Southeastern Remote Sensing and Core Sampling Seminar* which brought together researchers from throughout the nation interested in non-invasive and minimally invasive archaeological testing methods; as well as several presentations presented at state, region, and national archaeological meetings. Without the support of the Alabama Historical Commission, none of this would have been possible.

The use of combinations of relatively non-invasive investigative techniques in archaeological inquiry is undoubtedly going to become a more common occurrence. This is partially the result of ever improving technology, but predominantly because of a shift in the interest of preserving archaeological sites and their deposits. More and more often, opposition to excavation and, ultimately, at least partial destruction of archaeological deposits, is voiced by both the public and governing bodies which control aspects of access to archaeological sites. These take the form of state, federal, and special interest groups who either hold legal jurisdiction or personal interest in the site. Legislation such as the Native American Graves Protection and Repatriation Act, the new regulations dictating the need for Tribal Historic Preservation Officer and State Historic Preservation Officer notification, as well as Native American groups who have legitimate ties to certain sites, are all influencing the future of archaeological investigation. Consequently, it is rapidly becoming more expensive and more difficult to acquire permission and the capabilities to excavate archaeological sites. If other means of data recovery are available, possibly at least a portion of the available information can be collected and investigated without the loss of the entire body.

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APPENDIX

DIRECTORY LISTING OF ENCLOSED CD CONTAINING CORE SAMPLE IMAGES

F: \ Mound A

Name	Size	Type	Last Modified
M-A CS 5-2-5(120-END).JPG	402KB	JPEG Image	03/21/2001 2:20 PM
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M-A CS 1-1-3(120-END).JPG	449KB	JPEG Image	01/08/1980 3:02 AM
M-A CS 1-2-1(40-75).JPG	449KB	JPEG Image	01/08/1980 3:03 AM
M-A CS 1-2-2(70-105).JPG	442KB	JPEG Image	01/08/1980 3:05 AM
M-A CS 1-2-3(100-135).JPG	440KB	JPEG Image	01/08/1980 3:06 AM
M-A CS 1-2-4(120-END).JPG	435KB	JPEG Image	01/08/1980 3:07 AM
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M-A CS 1-3-2(35-70).JPG	454KB	JPEG Image	01/08/1980 3:10 AM
M-A CS 1-3-3(65-100).JPG	427KB	JPEG Image	01/08/1980 3:11 AM
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M-E CS 5-2-2(70-105).JPG	426KB	JPEG Image	09/11/2000 3:36 AM
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M-E CS 5-2-4(120-END).JPG	422KB	JPEG Image	09/11/2000 3:39 AM
M-E CS 5-3-1(4-40).JPG	434KB	JPEG Image	09/11/2000 3:40 AM
M-E CS 5-3-2(35-70).JPG	421KB	JPEG Image	09/11/2000 3:42 AM
M-E CS 5-3-3(65-100).JPG	441KB	JPEG Image	09/11/2000 3:43 AM
M-E CS 5-3-4(95-130).JPG	420KB	JPEG Image	09/11/2000 3:44 AM
M-E CS 5-3-5(120-END).JPG	424KB	JPEG Image	09/11/2000 3:46 AM
M-E CS 5-4-1(41-70).JPG	417KB	JPEG Image	09/11/2000 3:47 AM
M-E CS 5-4-2(70-105).JPG	436KB	JPEG Image	09/11/2000 3:48 AM
M-E CS 5-4-3(100-135).JPG	438KB	JPEG Image	09/11/2000 3:50 AM
M-E CS 5-4-4(120-END).JPG	438KB	JPEG Image	09/11/2000 3:51 AM
M-E CS 6-1-1(76-110).JPG	445KB	JPEG Image	09/30/2000 9:37 AM
M-E CS 6-1-2(105-140).JPG	440KB	JPEG Image	09/30/2000 9:38 AM
M-E CS 6-1-3(120-END).JPG	439KB	JPEG Image	09/30/2000 9:40 AM
M-E CS 6-2-1(10-45).JPG	435KB	JPEG Image	09/30/2000 9:41 AM
M-E CS 6-2-2(40-75).JPG	430KB	JPEG Image	09/30/2000 9:43 AM
M-E CS 6-2-3(70-105).JPG	432KB	JPEG Image	09/30/2000 9:44 AM
M-E CS 6-2-4(105-140).JPG	437KB	JPEG Image	09/30/2000 9:45 AM
M-E CS 6-2-5(120-END).JPG	453KB	JPEG Image	09/30/2000 9:47 AM
M-E CS 6-3-1(0-35).JPG	448KB	JPEG Image	09/30/2000 9:48 AM
M-E CS 6-3-2(35-70).JPG	458KB	JPEG Image	09/30/2000 9:50 AM
M-E CS 6-3-3(65-100).JPG	456KB	JPEG Image	09/30/2000 9:51 AM
M-E CS 6-3-4(95-125).JPG	458KB	JPEG Image	09/30/2000 9:52 AM
M-E CS 6-3-5(120-END).JPG	457KB	JPEG Image	09/30/2000 9:54 AM
M-E CS 6-4-1(0-35).JPG	457KB	JPEG Image	09/30/2000 9:55 AM
M-E CS 6-4-2(30-65).JPG	434KB	JPEG Image	09/30/2000 9:57 AM
M-E CS 6-4-3(65-100).JPG	443KB	JPEG Image	09/30/2000 9:58 AM
M-E CS 6-4-4(100-135).JPG	445KB	JPEG Image	09/30/2000 9:59 AM
M-E CS 6-4-5(120-END).JPG	436KB	JPEG Image	09/30/2000 10:01 AM
M-E CS 9-1-1(45-75).JPG	392KB	JPEG Image	12/11/2000 9:13 AM
M-E CS 9-1-2(70-105).JPG	381KB	JPEG Image	12/11/2000 9:14 AM
M-E CS 9-1-3(100-135).JPG	392KB	JPEG Image	12/11/2000 9:16 AM
M-E CS 9-1-4(120-END).JPG	404KB	JPEG Image	12/11/2000 9:17 AM
M-E CS 9-2-1(4-35).JPG	451KB	JPEG Image	09/30/2000 10:08 AM
M-E CS 9-2-2(35-70).JPG	453KB	JPEG Image	09/30/2000 10:09 AM
M-E CS 9-2-3(65-100).JPG	450KB	JPEG Image	09/30/2000 10:10 AM
M-E CS 9-2-4(95-130).JPG	436KB	JPEG Image	09/30/2000 10:12 AM
M-E CS 9-2-5(120-END).JPG	450KB	JPEG Image	09/30/2000 10:13 AM
M-E CS 9-3-1(55-85).JPG	394KB	JPEG Image	12/13/2000 3:30 AM
M-E CS 9-3-2(80-115).JPG	398KB	JPEG Image	12/13/2000 3:31 AM
M-E CS 9-3-3(110-145).JPG	382KB	JPEG Image	12/13/2000 3:32 AM
M-E CS 9-3-4(120-END).JPG	398KB	JPEG Image	12/13/2000 3:34 AM

M-E CS 9-4-1(35-65).JPG	434KB	JPEG Image	09/30/2000 10:17 AM
M-E CS 9-4-2(60-95).JPG	435KB	JPEG Image	09/30/2000 10:19 AM
M-E CS 9-4-3(90-125).JPG	432KB	JPEG Image	09/30/2000 10:20 AM
M-E CS 9-4-4(120-END).JPG	452KB	JPEG Image	09/30/2000 10:21 AM
M-E CS 9-5-1(10-45).JPG	446KB	JPEG Image	09/30/2000 10:23 AM
M-E CS 9-5-2(45-80).JPG	451KB	JPEG Image	09/30/2000 10:24 AM
M-E CS 9-5-3(80-115).JPG	446KB	JPEG Image	09/30/2000 10:26 AM
M-E CS 10-1-1(60-95).JPG	383KB	JPEG Image	12/11/2000 8:50 AM

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Name	Size	Type	Last Modified
Testdir.tmp	0	TMP File	08/16/2000 11:19 AM
M-L CS 1-1-1(75-125).JPG	423KB	JPEG Image	08/15/2000 9:13 AM
M-L CS 1-1-2(110-END).JPG	438KB	JPEG Image	08/15/2000 9:14 AM
M-L CS 1-2-1(0-45).JPG	448KB	JPEG Image	08/15/2000 9:16 AM
M-L CS 1-2-3(80-125).JPG	440KB	JPEG Image	08/15/2000 9:18 AM
M-L CS 1-2-4(110-END).JPG	442KB	JPEG Image	08/15/2000 9:20 AM
M-L CS 1-3-1(0-45).JPG	445KB	JPEG Image	08/15/2000 9:21 AM
M-L CS 1-3-2(40-85).JPG	447KB	JPEG Image	08/15/2000 9:23 AM
M-L CS 1-3-3(80-125).JPG	447KB	JPEG Image	08/15/2000 9:24 AM
M-L CS 1-3-4(110-END).JPG	442KB	JPEG Image	08/15/2000 9:25 AM
M-L CS 1-4-1(0-50).JPG	434KB	JPEG Image	08/15/2000 9:27 AM
M-L CS 1-4-2(40-85).JPG	448KB	JPEG Image	08/15/2000 9:28 AM
M-L CS 1-4-3(80-125).JPG	447KB	JPEG Image	08/15/2000 9:30 AM
M-L CS 1-4-4(110-END).JPG	446KB	JPEG Image	08/15/2000 9:31 AM
M-L CS 1-5-1(0-45).JPG	430KB	JPEG Image	08/15/2000 9:32 AM
M-L CS 1-5-2(40-85).JPG	431KB	JPEG Image	08/15/2000 9:34 AM
M-L CS 1-5-3(80-125).JPG	444KB	JPEG Image	08/15/2000 9:35 AM
M-L CS 1-5-4(110-END).JPG	434KB	JPEG Image	08/15/2000 9:36 AM
M-L CS 2-1-1(70-115).JPG	431KB	JPEG Image	08/15/2000 9:38 AM
M-L CS 2-1-2(110-END).JPG	436KB	JPEG Image	08/15/2000 9:39 AM
M-L CS 2-2-1(0-45).JPG	442KB	JPEG Image	08/15/2000 9:41 AM
M-L CS 2-2-2(40-85).JPG	431KB	JPEG Image	08/15/2000 9:42 AM
M-L CS 2-2-3(80-125).JPG	427KB	JPEG Image	08/15/2000 9:43 AM
M-L CS 2-2-4(110-END).JPG	442KB	JPEG Image	08/15/2000 9:45 AM
M-L CS 2-3-1(0-45).JPG	459KB	JPEG Image	08/15/2000 9:46 AM
M-L CS 2-3-2(40-85).JPG	445KB	JPEG Image	08/15/2000 9:47 AM
M-L CS 2-3-3(80-125).JPG	444KB	JPEG Image	08/15/2000 9:49 AM
M-L CS 2-3-4(110-END).JPG	442KB	JPEG Image	08/15/2000 9:50 AM
M-L CS 2-4-1(15-60).JPG	453KB	JPEG Image	08/15/2000 9:52 AM
M-L CS 2-4-2(55-100).JPG	450KB	JPEG Image	08/15/2000 9:53 AM
M-L CS 2-4-3(90-135).JPG	442KB	JPEG Image	08/15/2000 9:54 AM
M-L CS 2-4-4(110-END).JPG	450KB	JPEG Image	08/15/2000 9:56 AM
M-L CS 3-1-1(80-125).JPG	449KB	JPEG Image	08/15/2000 9:57 AM
M-L CS 3-1-2(115-END).JPG	438KB	JPEG Image	08/15/2000 9:59 AM
M-L CS 3-2-1(10-55).JPG	443KB	JPEG Image	08/15/2000 10:00 AM
M-L CS 3-2-2(50-95).JPG	447KB	JPEG Image	08/15/2000 10:02 AM
M-L CS 3-2-3(90-135).JPG	445KB	JPEG Image	08/15/2000 10:03 AM
M-L CS 3-2-4(115-END).JPG	436KB	JPEG Image	08/15/2000 10:04 AM
M-L CS 3-3-1(10-45).JPG	427KB	JPEG Image	08/16/2000 10:03 AM
M-L CS 3-3-2(40-85).JPG	431KB	JPEG Image	08/16/2000 10:04 AM
M-L CS 3-3-3(80-125).JPG	434KB	JPEG Image	08/16/2000 10:05 AM
M-L CS 3-3-4(110-END).JPG	431KB	JPEG Image	08/16/2000 10:07 AM
M-L CS 3-4-1(13-50).JPG	426KB	JPEG Image	08/16/2000 10:08 AM
M-L CS 3-4-2(40-85).JPG	432KB	JPEG Image	08/16/2000 10:09 AM
M-L CS 3-4-3(80-125).JPG	416KB	JPEG Image	08/16/2000 10:11 AM
M-L CS 3-4-4(110-END).JPG	426KB	JPEG Image	08/16/2000 10:12 AM
M-L CS 4-1-1(82-115).JPG	432KB	JPEG Image	08/16/2000 10:13 AM
M-L CS 4-1-2(110-END).JPG	425KB	JPEG Image	08/16/2000 10:15 AM
M-L CS 4-2-1(12-50).JPG	435KB	JPEG Image	08/16/2000 10:16 AM
M-L CS 4-2-2(40-85).JPG	446KB	JPEG Image	08/16/2000 10:17 AM
M-L CS 4-2-3(80-125).JPG	436KB	JPEG Image	08/16/2000 10:19 AM
M-L CS 4-2-4(110-END).JPG	438KB	JPEG Image	08/16/2000 10:20 AM
M-L CS 4-3-1(5-45).JPG	433KB	JPEG Image	08/16/2000 10:21 AM
M-L CS 4-3-2(40-85).JPG	442KB	JPEG Image	08/16/2000 10:23 AM
M-L CS 4-3-3(80-125).JPG	448KB	JPEG Image	08/16/2000 10:24 AM
M-L CS 4-3-4(110-END).JPG	445KB	JPEG Image	08/16/2000 10:26 AM
M-L CS 4-4-1(13-55).JPG	446KB	JPEG Image	08/16/2000 10:27 AM
M-L CS 4-4-2(50-95).JPG	436KB	JPEG Image	08/16/2000 10:28 AM
M-L CS 4-4-3(90-135).JPG	423KB	JPEG Image	08/16/2000 10:30 AM
M-L CS 4-4-4(110-END).JPG	449KB	JPEG Image	08/16/2000 10:32 AM
M-L 1-2-2(40-85).JPG	445KB	JPEG Image	08/15/2000 9:17 AM

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Name	Size	Type	Last Modified
M-Q CS 4-3-4(115-END).JPG	440KB	JPEG Image	08/23/2000 3:06 AM
M-Q CS 1-1-2(110-END).JPG	425KB	JPEG Image	08/18/2000 11:03 AM
M-Q CS 1-2-1(13-55).JPG	443KB	JPEG Image	08/18/2000 11:04 AM
M-Q CS 1-2-2(50-95).JPG	441KB	JPEG Image	08/18/2000 11:06 AM
M-Q CS 1-2-3(80-125).JPG	428KB	JPEG Image	08/18/2000 11:07 AM
M-Q CS 1-2-4(110-END).JPG	431KB	JPEG Image	08/18/2000 11:08 AM
M-Q CS 1-3-1(4-45).JPG	441KB	JPEG Image	08/18/2000 11:10 AM
M-Q CS 1-3-2(40-85).JPG	452KB	JPEG Image	08/18/2000 11:11 AM
M-Q CS 1-3-3(80-125).JPG	437KB	JPEG Image	08/18/2000 11:13 AM
M-Q CS 1-3-4(110-END).JPG	443KB	JPEG Image	08/18/2000 11:14 AM
M-Q CS 2-1-1(87-130).JPG	438KB	JPEG Image	08/18/2000 11:15 AM
M-Q CS 2-1-2(110-END).JPG	439KB	JPEG Image	08/18/2000 11:17 AM
M-Q CS 2-2-1(1-45).JPG	456KB	JPEG Image	08/18/2000 11:18 AM
M-Q CS 2-2-2(40-85).JPG	454KB	JPEG Image	08/18/2000 11:20 AM
M-Q CS 2-2-3(80-125).JPG	452KB	JPEG Image	08/18/2000 11:21 AM
M-Q CS 2-2-4(110-END).JPG	436KB	JPEG Image	08/18/2000 11:22 AM
M-Q CS 2-3-1(7-45).JPG	435KB	JPEG Image	08/23/2000 2:40 AM
M-Q CS 2-3-2(40-85).JPG	426KB	JPEG Image	08/23/2000 2:41 AM
M-Q CS 2-3-3(80-125).JPG	448KB	JPEG Image	08/23/2000 2:42 AM
M-Q CS 2-3-4(110-END).JPG	427KB	JPEG Image	08/23/2000 2:44 AM
M-Q CS 3-1-1(84-125).JPG	435KB	JPEG Image	08/23/2000 2:45 AM
M-Q CS 3-1-2(115-END).JPG	419KB	JPEG Image	08/23/2000 2:46 AM
M-Q CS 3-2-1(15-45).JPG	446KB	JPEG Image	08/18/2000 11:24 AM
M-Q CS 3-2-2(40-85).JPG	449KB	JPEG Image	08/18/2000 11:25 AM
M-Q CS 3-2-3(80-125).JPG	449KB	JPEG Image	08/18/2000 11:27 AM
M-Q CS 3-2-4(110-END).JPG	456KB	JPEG Image	08/23/2000 2:38 AM
M-Q CS 3-3-1(2-45).JPG	444KB	JPEG Image	08/23/2000 2:48 AM
M-Q CS 3-3-2(40-85).JPG	450KB	JPEG Image	08/23/2000 2:49 AM
M-Q CS 3-3-3(80-125).JPG	437KB	JPEG Image	08/23/2000 2:51 AM
M-Q CS 3-3-4(110-END).JPG	444KB	JPEG Image	08/23/2000 2:52 AM
M-Q CS 4-1-1(87-125).JPG	431KB	JPEG Image	08/23/2000 2:53 AM
M-Q CS 4-1-2(115-END).JPG	424KB	JPEG Image	08/23/2000 2:55 AM
M-Q CS 4-2-1(4-45).JPG	446KB	JPEG Image	08/23/2000 2:56 AM
M-Q CS 4-2-2(40-85).JPG	434KB	JPEG Image	08/23/2000 2:57 AM
M-Q CS 4-2-3(80-125).JPG	432KB	JPEG Image	08/23/2000 2:59 AM
M-Q CS 4-2-4(110-END).JPG	446KB	JPEG Image	08/23/2000 3:00 AM
M-Q CS 4-3-1(2-45).JPG	431KB	JPEG Image	08/23/2000 3:02 AM
M-Q CS 4-3-2(40-85).JPG	437KB	JPEG Image	08/23/2000 3:03 AM
M-Q CS 4-3-3(80-125).JPG	442KB	JPEG Image	08/23/2000 3:04 AM
M-Q CS 1-1-1(90-130).JPG	438KB	JPEG Image	08/18/2000 11:01 AM