# 1. SMALL SCALE GEOARCHAEOLOGICAL INVESTIGATIONS OF EARTHEN WALL CONSTRUCTION AT THE HOPETON EARTHWORKS (33RO26)

By Erin C. Dempsey

Several geoarchaeological and geophysical investigations have been conducted at the Hopeton Earthworks (33RO26) and met with good success (Figure 1). As such, soil cores excavated in the summer of 2007 were studied using a two-pronged methodology of soil profile characterization and magnetic susceptibility testing. These techniques were employed to closely examine three sections of earthen wall at different locations at Hopeton as a means of understanding the soil composition of the walls and assessing possible uniformity in wall construction across the site. The following focuses solely on the geoarchaeological study of the selected locations.

The present study was conducted to achieve two goals: 1) to better understand how the earthworks at Hopeton were constructed and, 2) to describe Hopeton's architectural grammar. "Architectural grammar" is a term defined by Connolly (2004) and is related to the morphology of earthen enclosures (i.e., geometric shape, alignments, gateway placement, and the presence or absence of mounds at an earthwork site), the placement of earthen enclosures across a landscape, and the modification of earthen enclosures through time, possibly to meet changing cultural ideologies. Further subdivision of this term into design grammar and interpretive grammar is necessary. Design grammar controls and directs the construction of earthen enclosures while interpretive grammar standardizes the meaning associated with earthen enclosures and directs behaviors and cultural events at these sites.

As mentioned previously, three sections of the earthen enclosures at Hopeton were selected for magnetic susceptibility testing and soil characterization (Figure 2). The first section is located in an area northeast of the rectangular enclosure's northeast corner and was selected to examine a buried soil identified during trench excavation in 2005. Six cores were excavated in this area, comprising Core Set 1. Core Set 2, also containing six cores, was excavated at the confluence of the rectangular and circular enclosures to explore how this section was formed. The last set of cores, Core Set 3, was excavated to determine how a segment of earthen wall was terminated. To accomplish this, eight cores were excavated in the southwest corner of the rectangular enclosure.

Geomorphologic investigations at Hopeton have revealed two things essential to interpreting the data presented below. First, prior to the initiation of earthwork construction, the A horizon (topsoil) was stripped off the site, exposing and slightly truncating the B horizon (subsoil) and providing a foundation for wall construction (Lynott and Mandel 2006). Probably, the removed soil was used to construct the parallel walls that extended from the western wall of the rectangular enclosure, southwest toward the Scioto River. In order to build the earthwork walls, relocated and modified soils were carefully laid down, creating a discrete boundary between wall fill (those soils used in earthen wall construction) and subwall (*in situ* soils). The wall fill contains features filled with charcoal, burned earth, and artifacts such as mica, lithics, and burned logs, which are likely associated with wall construction events such as the

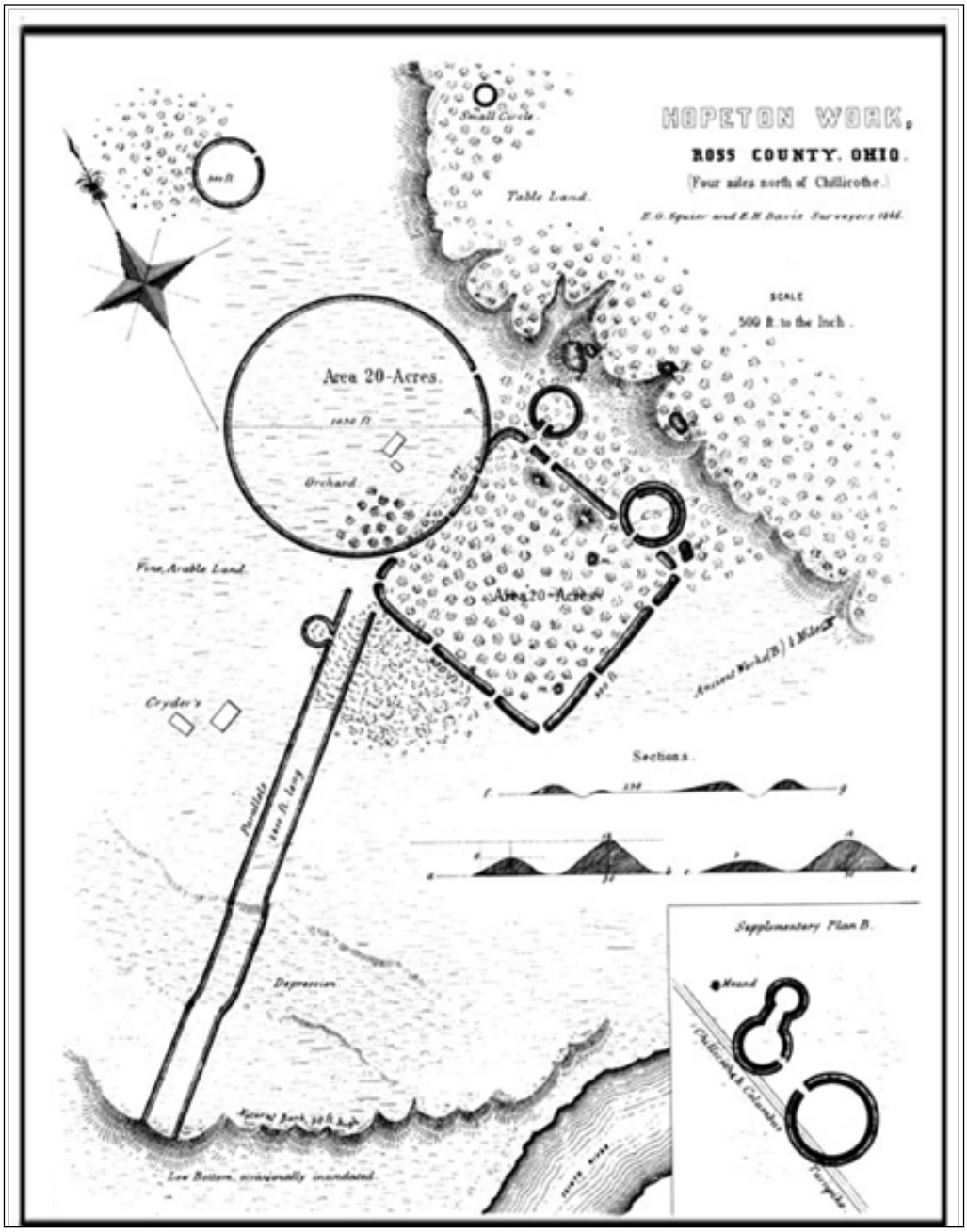


**Figure 1. Squier and Davis (1848:50) map of the Hopeton Earthworks.**

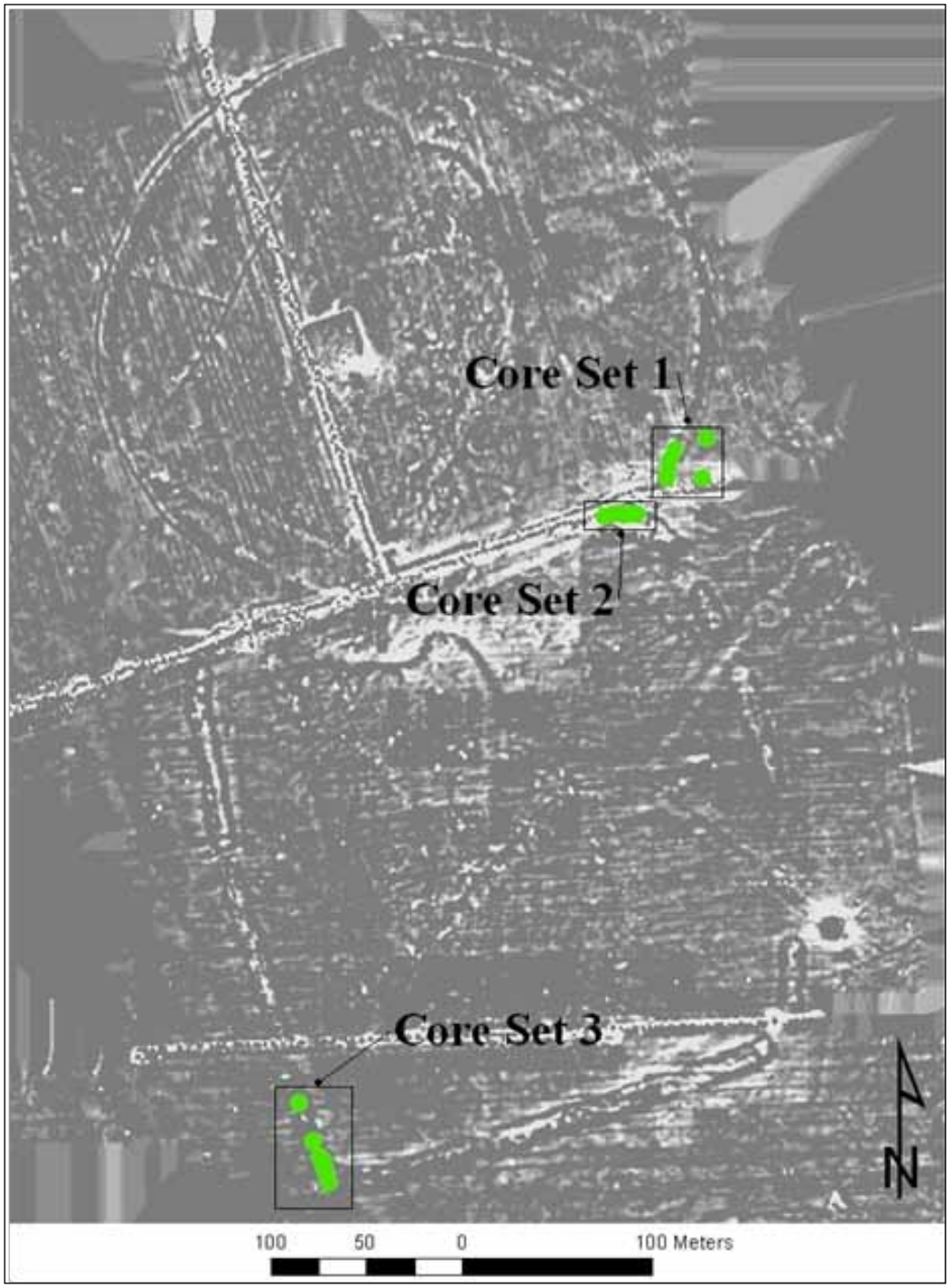


**Figure 2.** Locations of Core Sets 1, 2, and 3.

initiation or termination of construction for a day or season. Because of this method of construction, most of the cores excavated for this study contain a wall fill unit that directly interfaces with the subwall unit. Also, because only a few of the cores exhibit A horizon development between the bottom of the wall fill and the subwall, it is clear that, for the most part, no significant period of time elapsed between topsoil stripping and the construction of the earthwork walls. A "typical" core soil profile was developed using generalized soil stratigraphic data from the three core sets (Figure 3).

Second, as at most Hopewell and other earthwork sites, color appears to have been a key criterion in determining soil placement. Hopeton's earthen walls are comprised of soils in three colors: yellow, red, and brown (Figure 4). Generally, yellow soils form the inner core of the wall, topped with a red soil cap only on the exterior. A gray-brown soil was then laid over the yellow and red soils. This sequence does not pervade the site and appears to have been utilized only in certain areas. Additionally, soils of various textures were utilized in earthen wall and were probably considered carefully during construction. Soil texture placement, like that of soil color, does not occur consistently across the site.

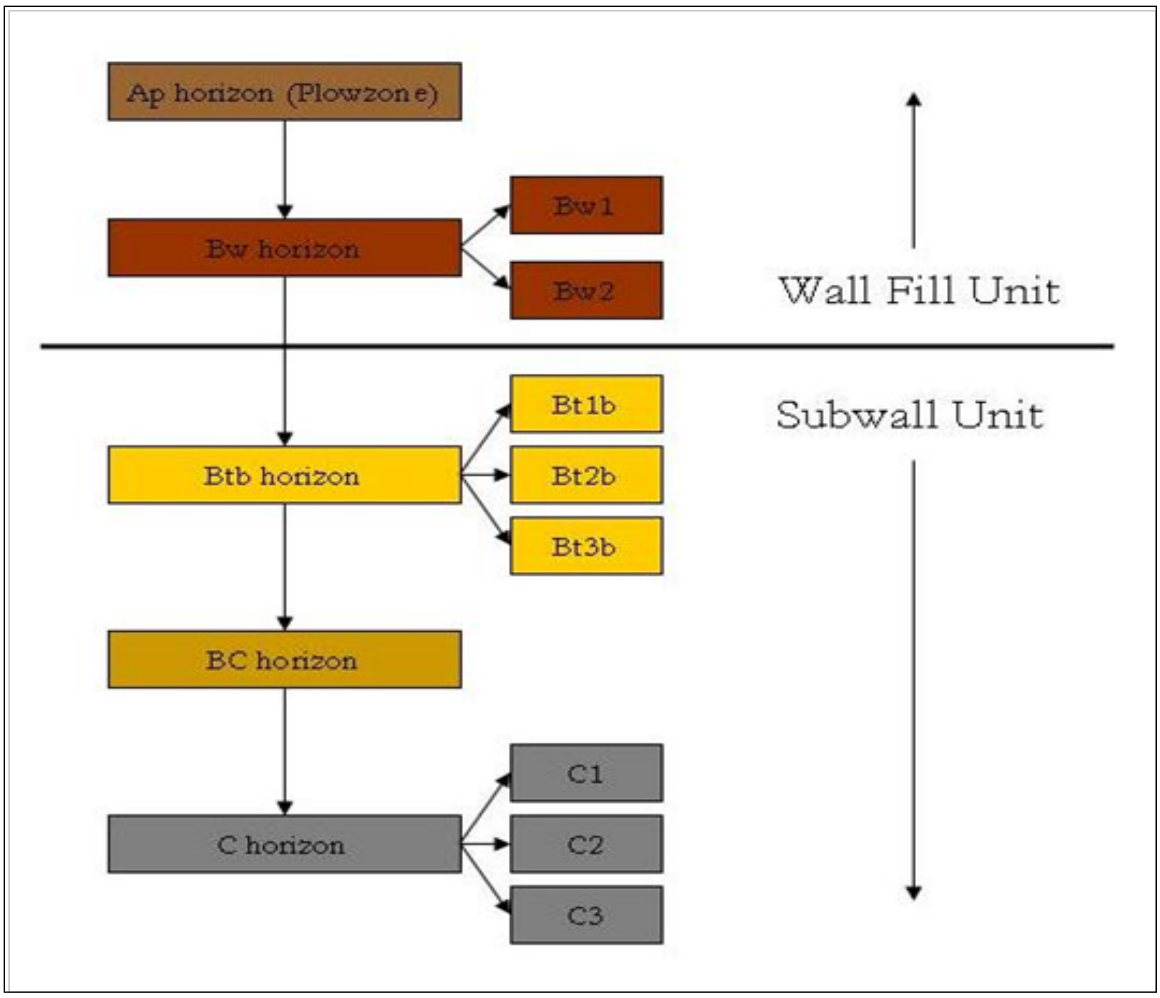


**Figure 3.** Typical soil stratigraphy seen in earthwork walls at Hopeton.

**Figure 4.** Soil stratigraphy in Trench 1 showing discrete soil units (courtesy of Mark Lynott).

Core Set 1 (Figure 5)

Important to understanding the stratigraphy in each core is the location of the cores in relation to the earthen enclosures. Core 1 and 2 were placed near the north-northeastern wall of the rectangular enclosure. Core 3, 4, and 5 were located within the circular earthwork wall. Core 6 came from slightly east of the circular enclosure and north of the rectangular enclosure. The stratigraphy in the six cores from Core Set 1 follows a general pattern. The wall fill unit progresses from an Ap horizon to a Bw horizon before interfacing with the subwall, although Cores 1 and 6 deviate from this slightly: Core 1 exhibits C horizon development below the Bw horizon and Core 6 contains a transitional AB horizon below the Bw horizon. The subwall stratigraphy generally begins with two buried Bt horizons (Bt1b and Bt2b), followed by a buried BC horizon, and finally, a C horizon. Cores 1 and 2, which are closest to the rectangular enclosure, are exceptions to this as they contain Ab and ABb horizons at the top of the subwall.

The variations in each core's stratigraphy can be attributed to their proximity to either of the enclosures since staging and construction of the two enclosures probably resulted in differential levels of disturbance. It is possible that the buried A horizon in Cores 1 and 2 developed when the topsoil was stripped from the footprint of the rectangle and the area was left exposed. However, the more likely scenario is that this A horizon was inverted and redeposited during cultivation. The upper portions of Cores 3-5 were truncated by cultivation but otherwise follow the expected earthen wall soil

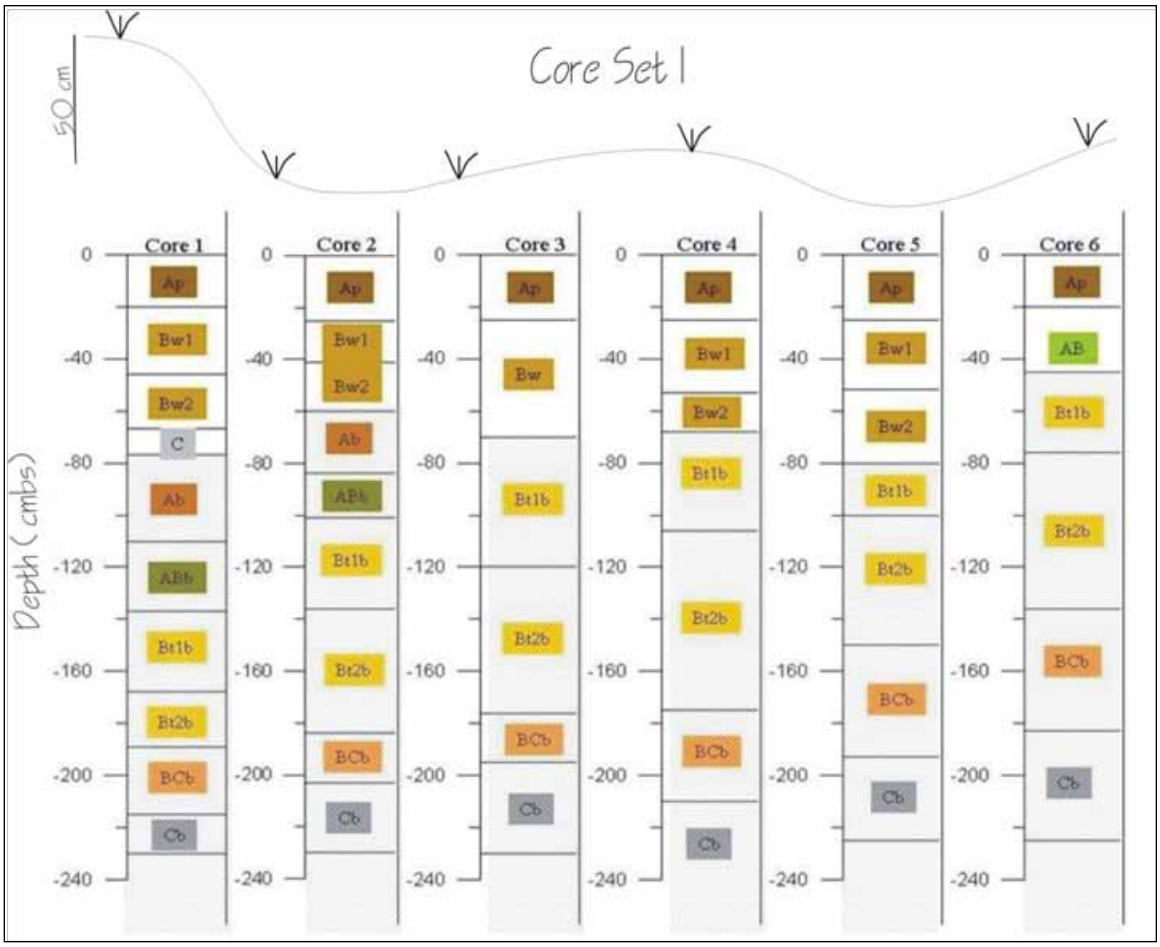


**Figure 5.** Soil horizons from Core Set 1. The shaded area indicates subwall soils.

profile. Core 6 is anomalous in that it does not contain a wall fill unit and though this area was probably subjected to topsoil stripping, it was largely unaffected by earthen wall construction-related disturbance.

Core Set 2 (Figure 6)

This core set did not follow as generalized a stratigraphic sequence as Core Set 1. In most of the cores in Core Set 2, the wall fill unit begins with an Ap horizon, which grades into an AB horizon, and then a Bw horizon. The exception is Core 7, which looks more like Core 1. In all of the cores, the base of the subwall is similar to that in Core Set 1 with two buried Bt horizons transitioning into a buried BC horizon and ending in a C horizon. Core 8 and 9, however, have a BC horizon that grades into a buried Bw horizon before transitioning into the Bt1b horizon. Core 7, 10, and 12 all have buried A horizons at the top of the subwall, and although it is possible that this is a construction-related anomaly, it is more likely redeposited wall fill.

Two possible scenarios for the construction of this portion of the site were identified before the core set was excavated. The first scenario postulated that the northern wall of the rectangular enclosure crossed over the top of the southern arc of

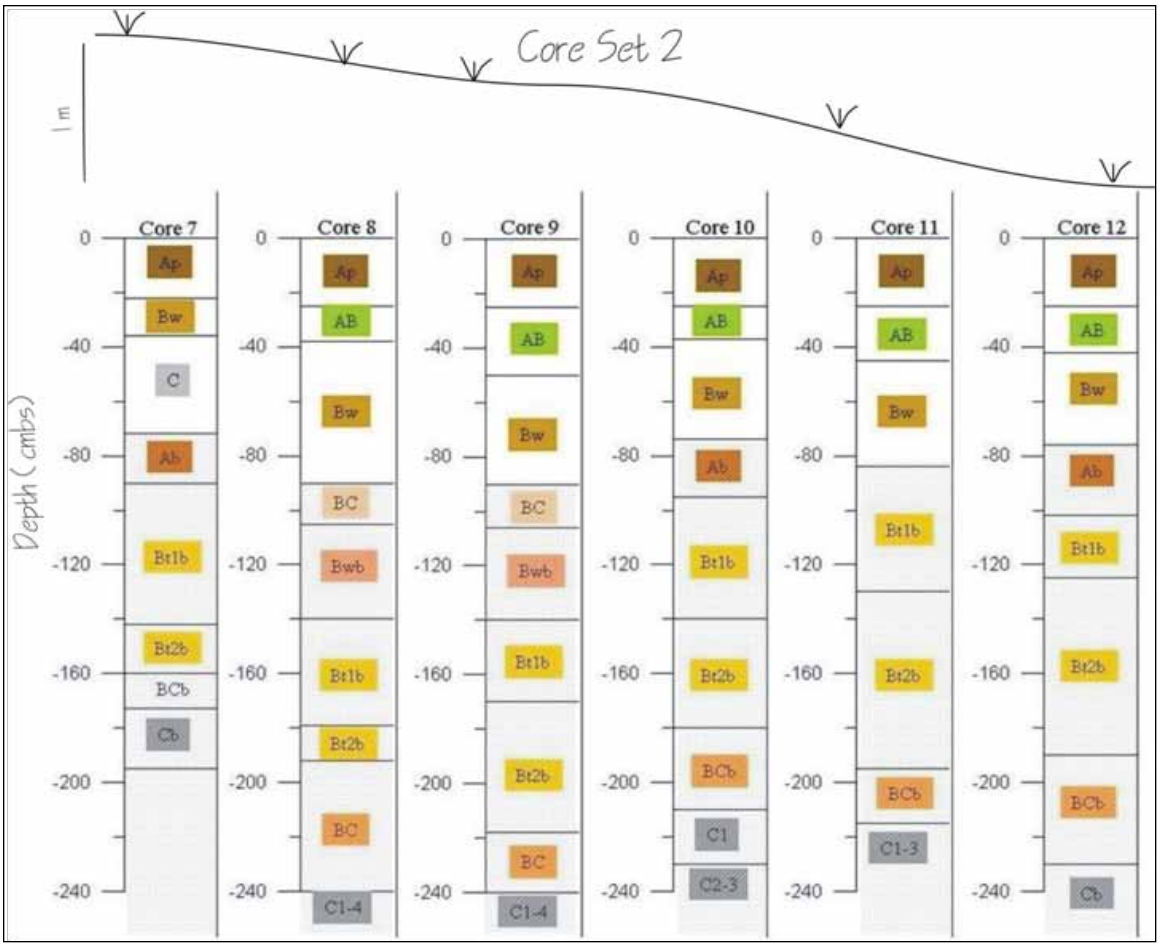


**Figure 6.** Soil horizons from Core Set 2. The shaded area indicates subwall soils.

the circular enclosure. The second scenario held that the two enclosures were built at approximately the same time and one enclosure's wall was simply modified to fit the other's. Instead, this study found that the confluence of the circular and rectangular enclosures was built as a single unit. This is corroborated by a close look at Squier and Davis' (1848) map of the site, which shows the southeastern portion of circular enclosure's embankment wall as a continuous unit and the northeastern corner of the rectangular enclosure intersecting it. This said, it is important to consider that cultivation practices at the site have immensely disturbed the earthwork soils as evident by the buried A horizon in three of the six cores in this set.

Core Set 3 (Figure 7)

The earthen wall segment the cores in this set were excavated from is located in the southeastern corner of the rectangular enclosure and runs north to south. The cores run down the center of the segment, through and past its termination. In all but Core 20, the wall fill unit is an Ap horizon that grades into a Bw horizon. Core 20 begins with an Ap horizon underneath which there is an AB horizon, followed by a Bw horizon. The subwall stratigraphy is similar to that seen in the other core sets, beginning with two buried Bt horizons, followed by a BC horizon, and ending in a C horizon (although

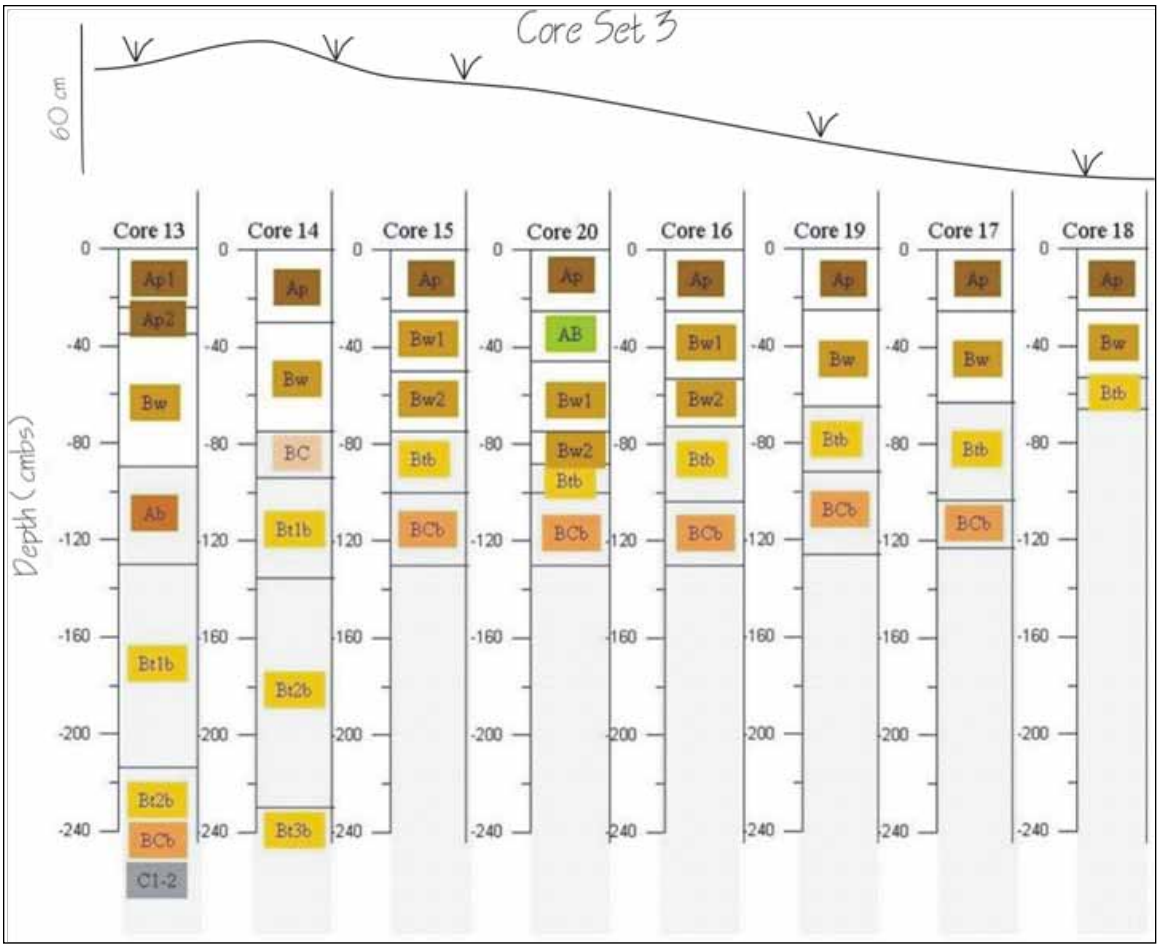


**Figure 7.** Soil horizons from Core Set 3. The shaded area indicates subwall soils.

only Core 13 was excavated to a depth where the C horizon was encountered). Moving south through the cores, the wall fill unit becomes shallower, indicating a sloping wall termination rather than an abrupt, square termination. However, other wall segments may terminate in different manners, especially in the gateways that occur in the centers of the earthen walls.

## Earthen Wall Construction at Hopeton

Sequencing the construction of the large earthen enclosures at Hopeton is difficult to achieve. The data from Core Set 3, however, indicate that the two large enclosures were constructed at approximately the same time. Either they were built simultaneously or one was built directly after the other. Given the stratigraphy encountered in the confluence of the circular and rectangular enclosures, it is likely that the circular enclosure was built first and the rectangular enclosure built soon after. Unfortunately, though a robust radiocarbon sequence is available for the site (Lynott 2008), the dates are too coarse for understanding construction events that most likely took place within a few years or decades of one another. A lack of evidence of A horizon development within the wall fill unit means that soil layers were not left exposed for extremely long periods; A horizons take approximately 30 to 40 years to

develop depending on environmental factors. Instead, various soils were laid down and subsequently covered within a relatively short time.

That the site was stripped of its topsoil prior to construction and that several sections of earthen wall reveal yellow-red-brown soil and textural sequences are the two main components to understanding Hopeton's architectural grammar; the findings presented here support this. In examining the soil stratigraphy of the three sections of earthen wall chosen for this study, it would seem that the soils used to construct these areas were placed somewhat randomly, with little regard to uniformity. Though the aberrant nature of these sections of earthen wall could be an additional component of the site's architectural grammar, it is difficult to fit these areas into our understanding of Hopeton's construction.

Some alignment issues are present at Hopeton that are not normally seen at other earthwork sites. A cesium gradiometer survey conducted across the site reveals that the circular and rectangular enclosures are not very well aligned; the circular enclosure sits slightly east of the axis it should share with the rectangular enclosure. Squier and Davis (1848) found that the circular enclosure extends down into the rectangular enclosure, something not seen at other sites. In addition to this, the southeast corner of the rectangular enclosure is not entirely square. Thomas (1880) found that the circular enclosure's north-south and east-west diameters are dissimilar and its curvature is imperfect. These facts may indicate that Hopeton was built either without the detailed planning exhibited at other earthwork sites or before precision in construction was implemented. Interestingly, radiocarbon dates place Hopeton's construction somewhat earlier in time than earthwork sites in the vicinity. These factors may help explain why the internal structure of the earthen wall sections studied here appear lacking in uniformity or standardization.

## Conclusion

It should be noted that the magnetic susceptibility data not provided in this article shows that the wall fill and subwall interface differently than that inferred from the soil stratigraphic profile. A closer examination of the geophysical data from this study is warranted and will be completed in the near future. Once these data are rectified, greater clarity about Hopeton's construction should be achieved. Though the soil stratigraphy does not fit the idea that Hopeton was constructed in a regimented manner, it does support two components that have been identified as comprising the site's architectural grammar, soil placement based on color and texture and topsoil stripping as an initial step in earthen wall construction. The variations observed in Hopeton's earthen wall stratigraphy may be due to its early position in the chronology of earthwork construction in the Scioto River valley. Further investigations need to identify the location and stratigraphy of the parallel walls, which may prove difficult if the stripped topsoil really was used to construct these walls.

Acknowledgements

Many thanks are owed to Mark Lynott, Rolfe Mandel, and LuAnn Wandsnider who were all significantly involved in this project. I'd also like to extend my sincerest gratitude to Jennifer Pederson Weinberger, Kathy Brady, and the staff at Hopewell Culture National Historical Park for sharing their time and knowledge and for providing access to the site. Finally, thank you to Dustin Gonzales for his help editing this paper. Any errors or inconsistencies found in this work are solely my responsibility.

## References Cited

Connolly, Robert P.
2004 The Evolution of Fort Ancient Embankment Wall Form. In The Fort Ancient Earthworks, edited by Robert P. Connelly and Bradley T. Lepper, pp. 35-50. Ohio Historical Society, Columbus.

Lynott, Mark J., and Rolfe D. Mandel
2006 Geoarchaeological Study of an Ohio Hopewell Earthwork. Paper presented at the Annual Meeting of the Geological Society of America, Philadelphia.

Lynott, Mark J.
2008 Embankment Wall Construction at the Hopeton Earthworks. Paper presented at the Midwest Archaeological Conference, Milwaukee, Wisconsin.

Squier, E.H., and E.G. Davis
1848 Ancient Monuments of the Mississippi Valley. Smithsonian Institution Press, Washington D.C.

Thomas, Cyrus
1880 The Circular, Square, and Octagonal Earthworks of Ohio. Government Printing Office, Washington D.C.

# 2. THE ROLE OF GEOPHYSICS AT HOPEWELL CULTURE NATIONAL HISTORICAL PARK

By Jennifer Pederson Weinberger, Ph.D. and Kathy Brady, Ph.D., National Park Service

Hopewell Culture National Historical Park is best known for its earthwork complexes built by the Hopewell during the Middle Woodland period. The park was originally established in 1923 to preserve the Mound City site after its use as a World War I training camp. In the past two decades, the park has added four additional earthworks—Hopeton Earthworks, Hopewell Mound Group, Seip Earthworks, and High Bank Works—and recently had its boundaries increased to include Spruce Hill. The recent growth in land located within the park has provided opportunities for archaeological research, most of which used some sort of geophysical technique.

Geophysical techniques measure physical properties of the surface and subsurface within a surveyed area. The differences in measurements, which can be very minute, result in higher or lower measurements from those of the surrounding area. These differences are called geophysical anomalies. These anomalies can be analyzed to determine if they are likely to be natural or cultural features. Additional analysis, partnered with existing archaeological knowledge and ground-truthing, may provide more detailed information about the type of feature detected. It should also be stated that no single geophysical technique will work on all archaeological projects because the physical property measured is dependent on the physical and/or cultural environment under study. However, the main advantage of using geophysical techniques in archaeology is the ability to quickly survey an area with little to no ground disturbance. This survey type preserves more of the archaeological record intact and saves time and money by pinpointing potential features to excavate. Disadvantages include the expense of the equipment and the high learning curve for field use and data interpretation.

The National Park Service has a strong interest in the archaeological use of geophysical techniques due to the potential to learn about site boundaries, feature types, and formation processes in a minimally destructive manner. And the Midwest Archeological Center of the National Park Service has conducted week-long training workshops about this topic for well over a decade. This article will review several case studies to examine the role of geophysics in cultural resource management at Hopewell Culture National Historical Park.

## Hopewell Mound Group

Hopewell Mound Group *(Figure 1)* consists of two large enclosures, two smaller enclosures, several gateways, and numerous mounds inside and outside its once massive earthen walls. The"type-site" for Hopewellian earthworks has been well documented with early maps from the first quarter of the nineteenth century and with several archaeological reports, namely from Squier and Davis, Moorehead, and Shetrone.
In the summer of 2001, park staff worked with Ohio State University to conduct research concerning site use within the site's earthen walls. The research used a combination of traditional and geophysical methods. A random sample of the interior space lead to the

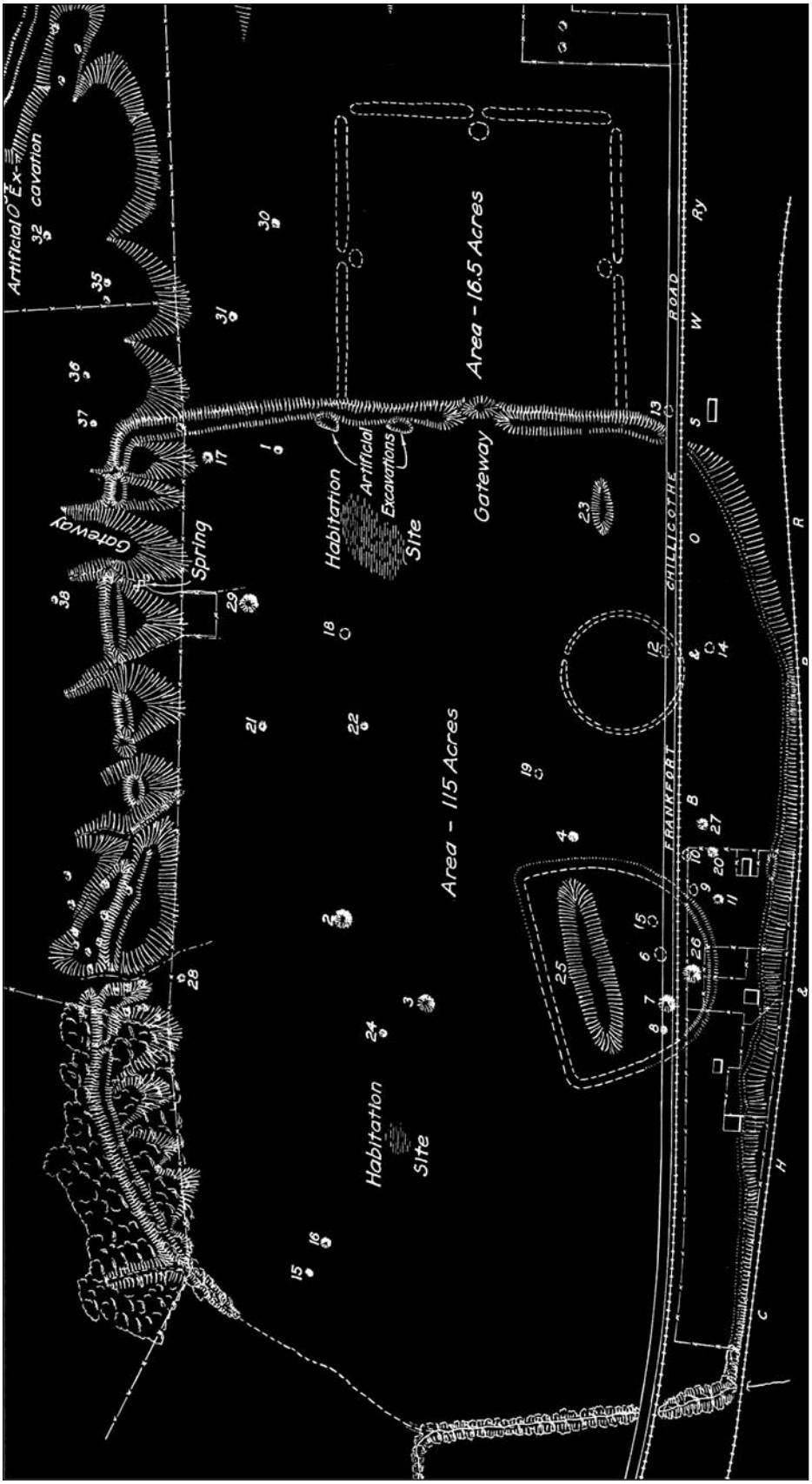
Artificial Ex-cavation
Gateway
Spring
Habitation Site
Artificial Excavations
Gateway
Area - 16.5 Acres
Area - 115 Acres
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Figure 1

testing of an area located near the center of the main enclosure, away from any known mounds. In this area, systematic shovel testing was conducted resulting in the finding of one piece of lithic shatter from chipped stone tool manufacture and 22 pieces of cinder. No cultural features were found in the shovel test units. Magnetic and electrical resistance survey data was collected from the area and showed surprising results. *(Figure 2)* Both types of data revealed a circular anomaly measuring 30 meters in diameter and 1.5 meters in width with a gap facing east. Interestingly, the resistance data show the circular anomaly as an area of higher resistance with an interior area of lower resistance. To determine the nature of this anomaly, a 1 by 4 meter trench was excavated through the southern portion of the anomaly. A shallow ditch 2.5 meters wide and 20 centimeters below plowzone was found. The only artifact recovered was a piece of fire-cracked rock. No charcoal was recovered. While the age of the feature is still in question, it is clear that the circular feature may not have been found using traditional archaeological methods. This example underscores the benefit of continuous land coverage offered by geophysical techniques, as well as its utility to provide new knowledge about previously documented sites.

Also in the summer of 2001, an area near Moorehead's and Shetrone's west village or habitation site in the western portion of the earthwork was tested using traditional and geophysical techniques. This area definitely has a Middle Woodland occupation based on artifacts collected from shovel tests and an earlier surface collection conducted in the 1980s by Mark Seeman. Two anomalies, both having strong signatures in the magnetic and resistance data, were excavated and found to be prehistoric in nature. *(Figure 3)* This feature was a deep cooking pit filled with refuse. Bivalve shells atop a layer of charcoal were found at the lower depths, while assorted trash were in the upper layers. A quartz crystal bladelet found at 5 centimeters below plowzone indicate a Hopewell occupation. However, the base of a biface point recovered from the feature indicates a later occupation as does the charcoal recovered from 90 to 100 centimeters below plowzone which yielded a date of 1040±60 RCYBP (radiocarbon years before present), at about the time of the transition from the Late Woodland to Late Prehistoric periods. A nearby feature was also found to be a deep cooking pit with a layer of FCR and charcoal at its base. Animal bones, chert flakes, and a few pottery sherds were found. Although Hopewellian diagnostic artifacts were found in the plowzone, charcoal obtained from 75 to 80 centimeters below plowzone returned a date of 1090±60 RCYBP, again during the transition from the Late Woodland to Late Prehistoric periods. Although this area contains evidence of a Middle Woodland occupation, two cultural features, found with geophysics and subsequently excavated, contain settlement debris from a later occupation dating to the Late Woodland to Late Prehistoric periods. Therefore, areas around the western village proposed by Moorehead (1922) and Griffin (1996) have a much later significant occupation. The use of geophysics in this instance led to the purposeful excavation of cultural features to answer a question of site use.

Riverbank Site

Located just a couple hundred meters southeast of the Hopewell Mound Group is the Riverbank Site. The 4-acre site sits atop a terrace overlooking the North Fork Paint Creek. The site was extensively documented from 2003 to 2006 during a project to determine how to correct the northward migration of the creek onto park lands. Prior to

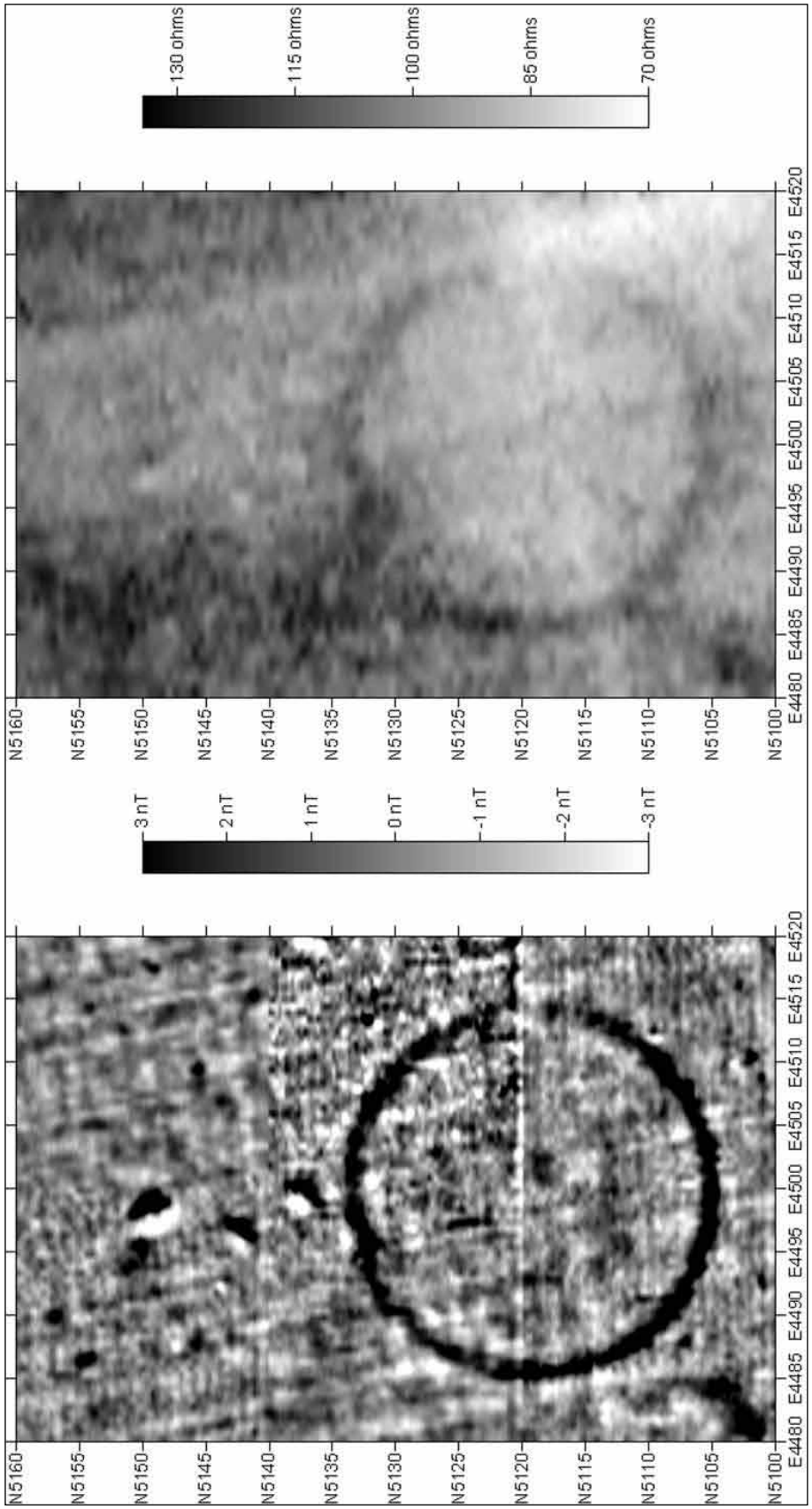
130 ohms
115 ohms
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Figure 2

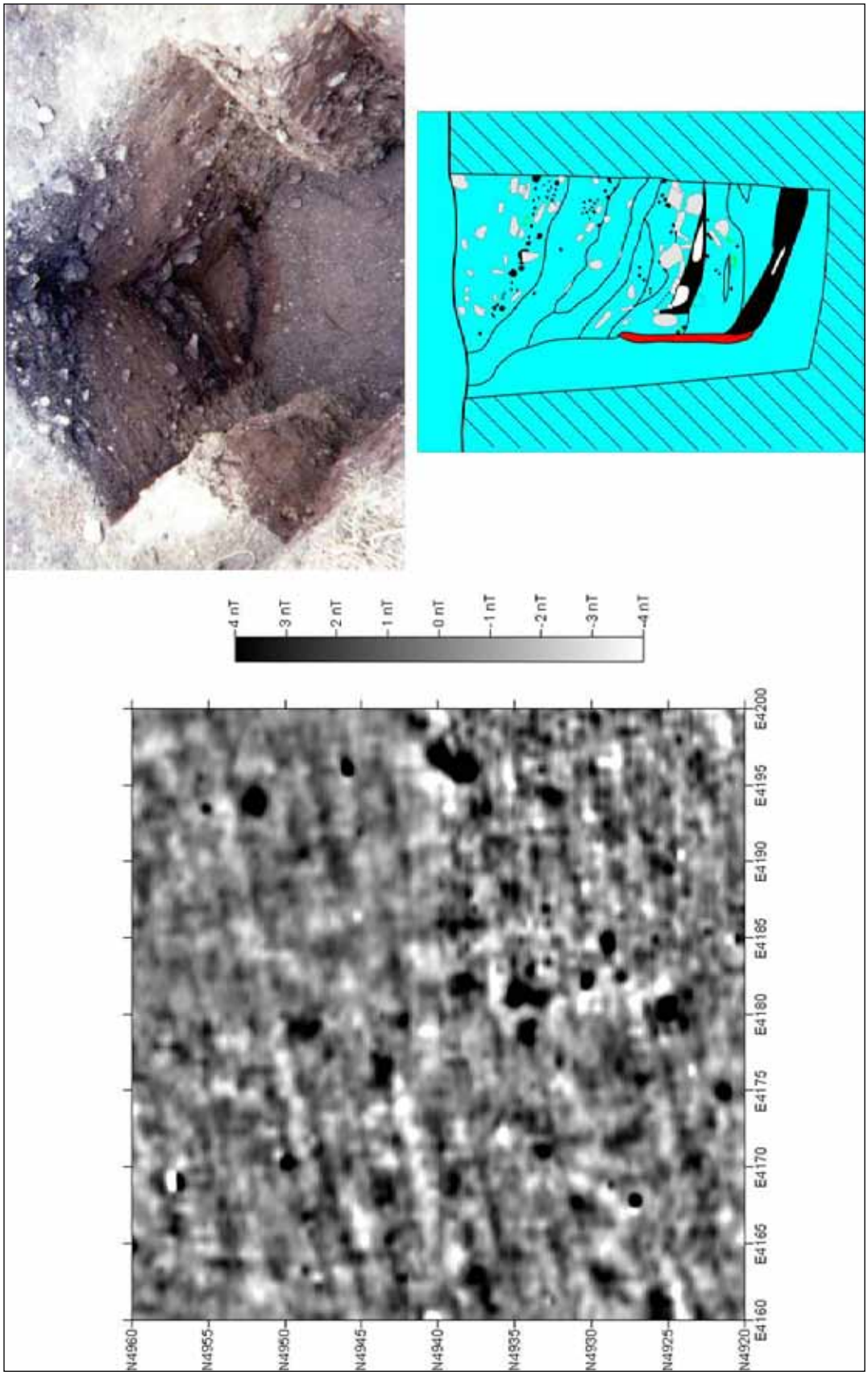
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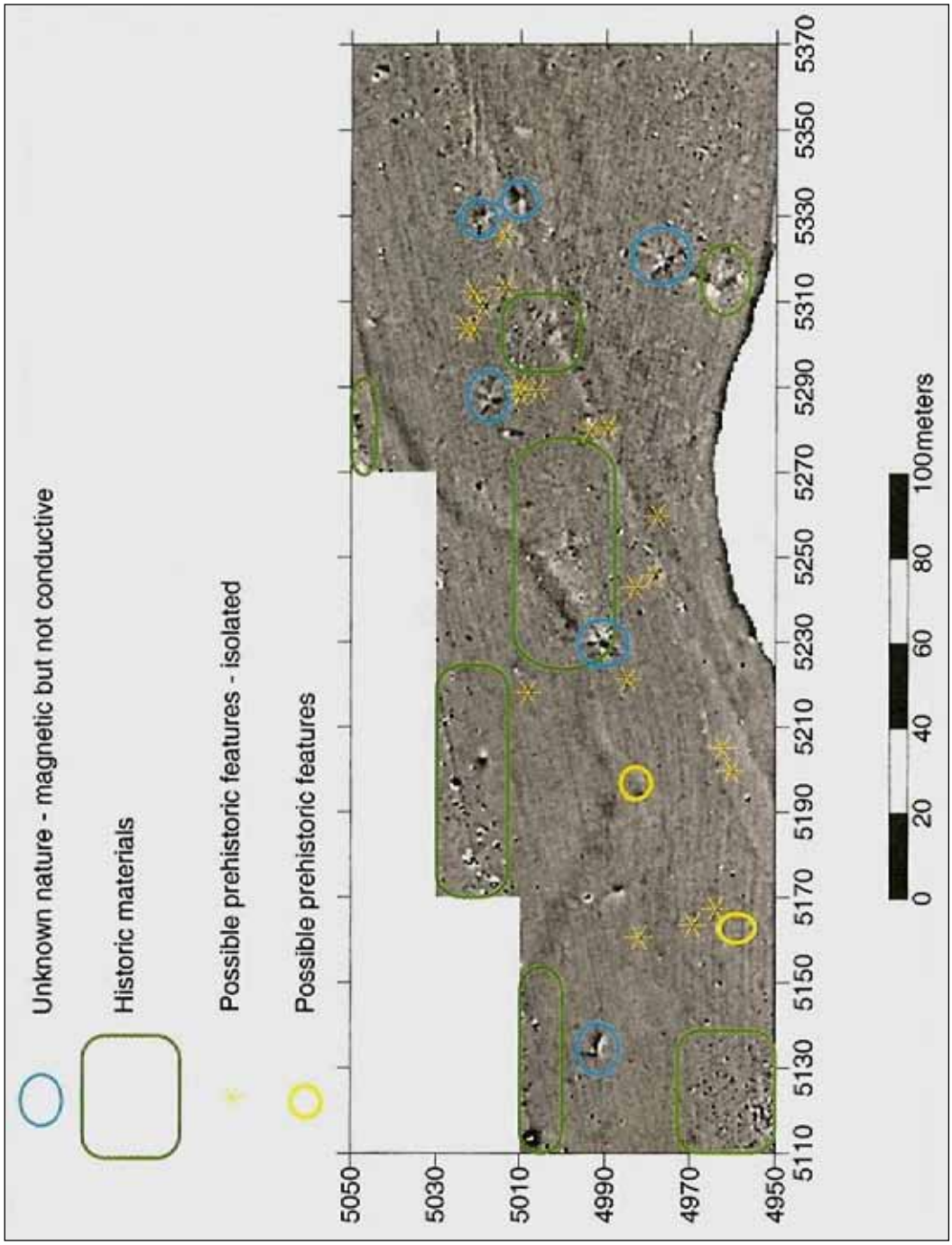
**Figure 3**

2003, research in the general area found artifacts dating to the Archaic, Woodland, Late Prehistoric, and 19th and 20th century periods. A controlled surface survey recovered 357 artifacts in three distinct artifact clusters: an historic cluster resulting from modern dumping; an historic cluster associated with a structure, probably a 19th century farm building; and a prehistoric artifact cluster possible related to use of the nearly earthwork complex. Additional research was undertaken to determine the nature and extent of the site, including geophysical survey and feature excavation.

The geophysical survey, conducted by the Midwest Archeological Center, covered approximately 4 acres. The entire project area was surveyed using a fluxgate gradiometer and selected areas were tested with electrical resistance and conductivity meters. *(Figure 4)* Several distinct anomalies are apparent in the magnetic data. The long linear feature corresponds to high ground associated with glacial geologic formations. Several starburst patterns in the data represent lightning strikes and strong dipoles represent metal objects. A number of strong monopole anomalies are indicative of prehistoric features. Excavations in the summer of 2006 found numerous features that, based on the feature content and radiocarbon dates, date to the Middle Woodland period. Artifacts from the features, such as small pieces of mica and footed pottery vessels, are indicative of a Hopewellian presence, probably a short-term habitation site directly related to the use of the mounds.

Another interesting study in this area was the examination of how prescribed fire impacts the magnetic data of archeological sites. The Park Service has long used prescribed fire to manage vegetation and reduce fuel loads. Park staff was concerned about the impact of prescribed fire on magnetic data of sensitive archaeological sites such as earthworks. We were especially concerned about the continued use of fire on a cyclical basis. Previously we had tested a small area at Battelle Darby Metropark in Franklin County, Ohio that was burned regularly over a period of fifteen years. We found the magnetic data was useless due to the accumulation of carbon rich sediments throughout the first couple inches of soil. An extensive literature search provided no references relating to prescribed burns and magnetic survey. In autumn of 2008, park land containing the Riverbank site was selected for a prescribed burn since the area had been documented for archeological resources through traditional and geophysical methods. *(Figure 5)* The low-intensity fire was conducted and magnetic data collected. A comparison of data collected before and after the burn has initially confirmed that fire, even low intensity, does affect magnetic data over the short-term. For instance, the magnetic strength of one anomaly was intensified from about 16 nT to 21 nT a week after the prescribed burn. Although the difference appears to be minute, we rely on very subtle changes when interpreting geophysical data. More research on this topic is clearly needed and this case study highlights the application of geophysical data to more complicated resource management issues.

Just north of the Mound City earthworks is a 40-acre parcel of land covered by alfalfa and orchard grass. In 2006, park officials suggested the possibility of a new vegetation management regime to revert the old agricultural field to forest. Perhaps somewhat surprising, the area has experienced only limited archaeological research. Archaeologists from the Midwest Archeological Center conducted investigations on this parcel during the early 1980s under the direction of Mark Lynott. Archaeological


Unknown nature - magnetic but not conductive
Historic materials
Possible prehistoric features - isolated
Possible prehistoric features
5050
5030
5010
4990
4970
4950
5110
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5210
5230
5250
5270
5290
5310
5330
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5370
0
20
40
60
80
100meters

Figure 4

Figure 5

investigation included controlled surface survey, shovel testing, and a limited number of test pits. Three historic scatters, including a prehistoric component on one of these scatters, and a Middle Woodland prehistoric site were located. The possibility of eventual reforestation spurred park archaeologists to return to the site in the summer of 2007 to re-examine the site and its relationship to Mound City Group.

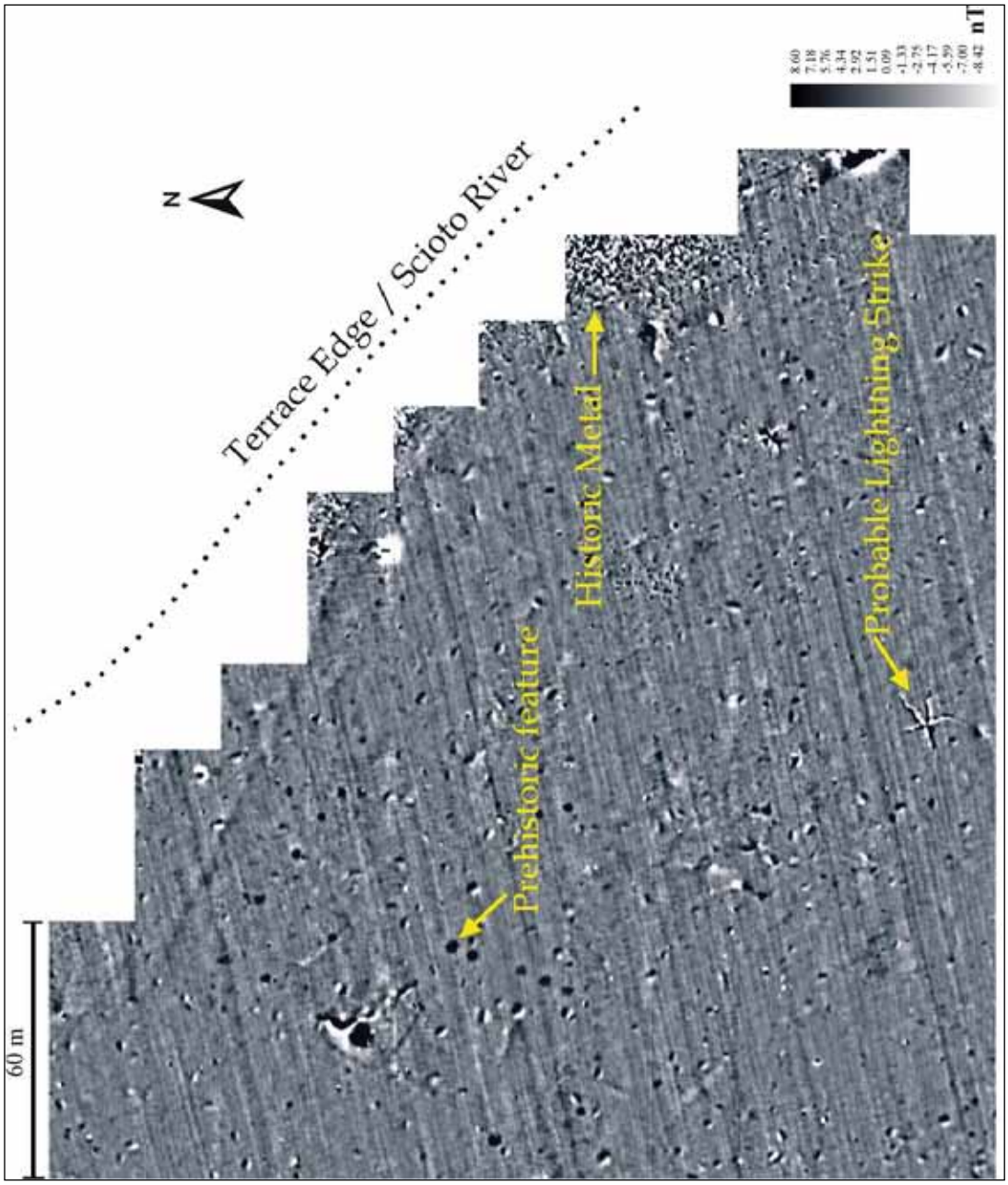
To make the best use of the limited staffing and funds and to best supplement the previous traditional fieldwork, a methodology of geophysical data collection combined with subsequent anomaly testing was employed. A magnetic survey was conducted over the southern portion of the parcel using a Geoscan FM-256 fluxgate gradiometer. *(Figure 6)* The survey consisted of approximately one hundred 20 x 20-meter survey blocks. The research strategy employed a fine-grained data collection technique by placing transects at half meter intervals and takings readings at a rate of 8 readings per meter. Preliminary analysis of the magnetic data located dozens of magnetic anomalies that based on their characteristics are probable prehistoric features.

Coring was chosen as the methodology to ground-truth magnetic anomalies because it is minimally destructive and can be executed quickly and efficiently. Seventeen magnetic anomalies were chosen for coring on the basis of strength or magnitude, as well as the overall configuration of the anomaly. Anomalies were relocated on the ground using a Total Station. Eleven of the seventeen cores were found to contain prehistoric artifacts at depths below the plowzone. We suspected an area containing two linear anomalies and five, large aligned anomalies of being a prehistoric structure with associated pit features.

Park staff and volunteers returned to the site in the summers of 2008 and 2009 to conduct excavations. *(Figure 7)* With respect to the linear anomalies, an excavation of 6 square meters in the summer of 2008 revealed four post holes. The post holes of the structure are readily visible in the surrounding gravel. It is not yet known whether the gravel is anthropogenic or natural, although its presence may contribute to the visibility of the posts in the magnetic data as a result of the good contrast between it and the organic-rich post fill. In 2009 the plowzone was stripped across the structure area in a transect 2 meters wide by 25 meter long. Additional post holes were found. Possible interior features exist across the floor of the structure.

Excavations were also conducted on two of the five aligned anomalies. The northern-most anomaly is a large irregular pit feature containing pottery, chert debitage and bifaces, as well as mica and copper. The middle anomaly is a large, circular pit feature containing bifaces, biface fragments, and associated chert debitage. Neither pit has evidence of in situ burning and contained relatively little charcoal.

When taken as a whole, current research supports the initial survey findings indicating a Middle Woodland site at this location. The presence of bladelets, sub-ovate bifaces, and mica fragments, along with AMS dates on wood charcoal from the post holes and from a pit feature indicate a Middle Woodland occupation associated with the adjacent mounds and earthwork. Therefore, the utility of geophysics in this case was the ability to direct limited staff and financial resources in a way that provided a rich set of


60 m
Prehistoric feature
Terrace Edge / Scioto River
N
Historic Metal
Probable Lightning Strike
8.60
7.18
5.76
4.34
2.92
1.51
0.09
-1.33
-2.75
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-7.00
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Figure 6

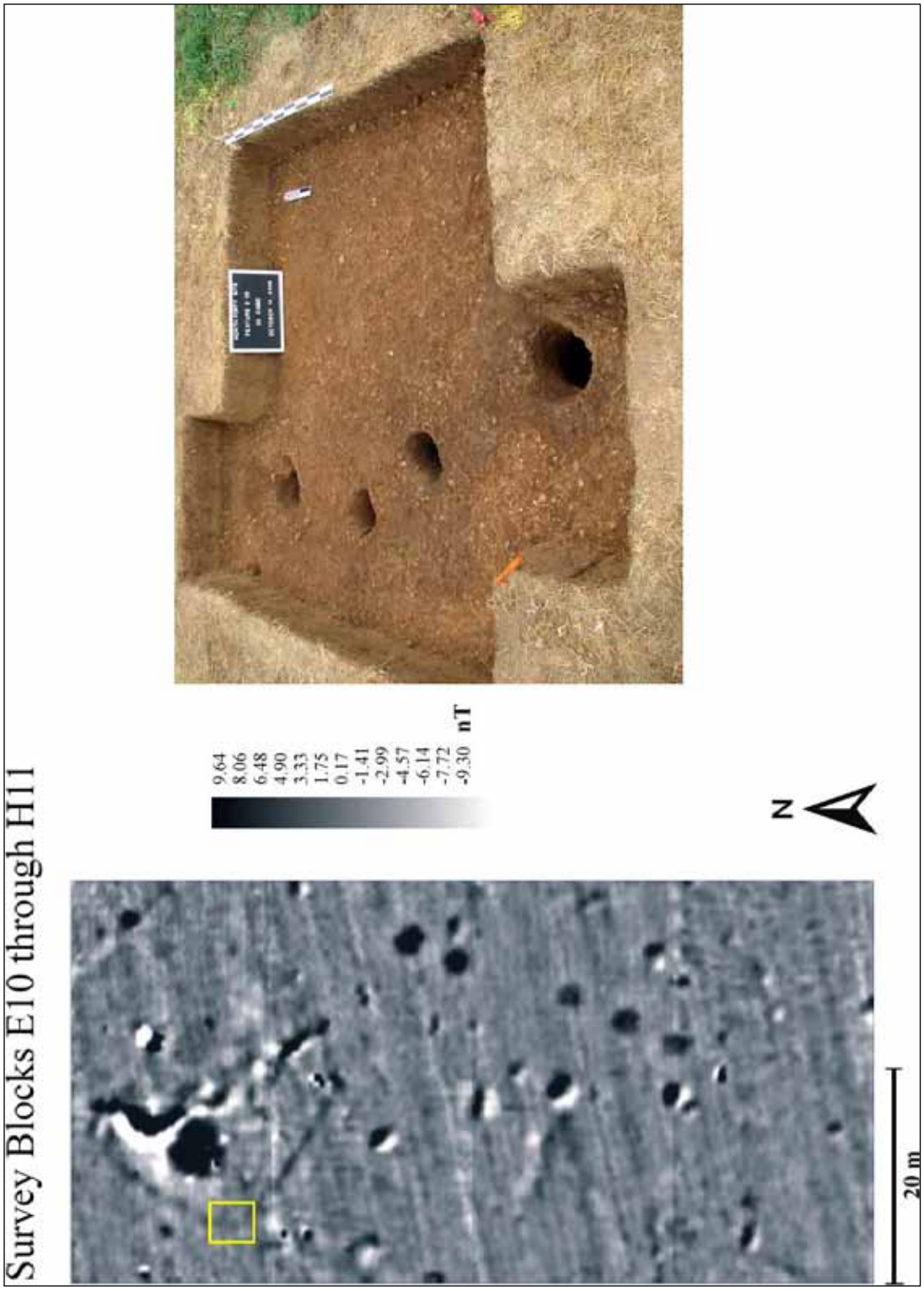
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Figure 7

data from which to draw conclusions; in this case, the information specifically related to use of space adjacent to a Hopewellian earthwork.

The last case study examines the location for the park's new museum collection facility. The new building, to be constructed in 2010 at the Mound City Group, will greatly improve storage conditions by providing a building with a stable environment, adequate space for the existing collection and anticipated growth, mitigate a radon gas problem in the existing facility, and provide handicapped accessibility. The 2,300 square-foot building is adjacent to the existing Resource Management building. The area of potential effect was not directly occupied by a Camp Sherman building and was used in the mid to late twentieth century as a garden and play area for park staff and their families residing on-site.

Systematic shovel tests were excavated within the area of potential effect. A total of nine artifacts were found: five historic artifacts dating to the 19$^{th}$ and 20$^{th}$ centuries and four prehistoric artifacts that were not temporally diagnostic. No cultural features were found. Due to the proximity to the Mound City earthworks and the historic use of the general vicinity, a magnetic survey was conducted to determine if any prehistoric or historic features were present.

*(Figure 8)* The magnetic data, collected with the FM-256, shows several interesting anomalies. A linear anomaly, although subtle, is clearly visible running east to west in the survey data. Its low magnitude or strength indicates a lack of metal and thus it appeared to be a narrow trench. Historic maps of Camp Sherman, a World War I training camp built over a vast stretch of land including Mound City, showed the area was used as a fire break. Current utility maps did not show any lines running in the direction of the anomaly. A conversation with park maintenance staff revealed the presence of an old geothermal injection well in that general direction. An outdated land-use map was found that showed the location of the well that lined up with the linear anomaly and a note that the line was a 2-inch PVC pipe placed in a narrow trench. Of interest here is that the location of non-metal utility lines can show up on magnetic data due slight magnetic variations resulting from the trench disturbance. Another curiosity in the magnetic data was the presence of two bipolar anomalies. We immediately recognized both as pieces of metal, which was confirmed after a maintenance staffer with 30 plus years at the park explained that those matched the locations of the two permanent anchors for volleyball net poles.

In this case, geophysical data provided a more complete picture of human activity within the area of potential effect and provided information on something that could have unnecessarily halted the project if inadvertently discovered during construction. In addition, it serves as a good reminder of the knowledge possessed by people who own, work at, or farm the land under survey. These people greatly aid the interpretation of geophysical data.

This article has reviewed several case studies from Hopewell Culture National Historical Park. The case studies have focused on the utility of geophysical techniques as an important addition to traditional archaeological fieldwork. Many times geophysics can either aid in locating archaeological resources or be used to re-examine documented

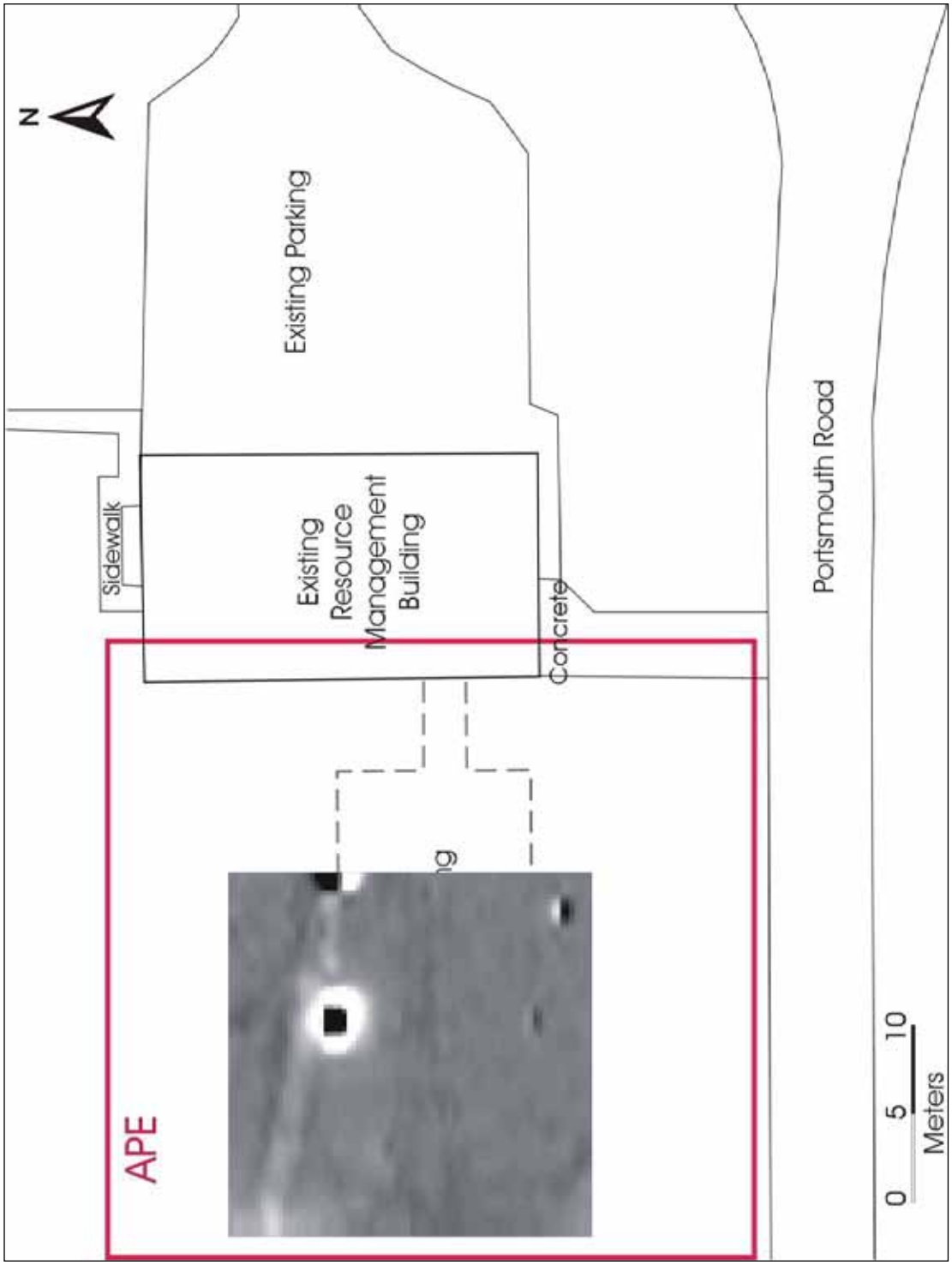
N
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Figure 8

sites. Projects conducted on prehistoric and historic sites throughout Ohio and the Midwest support the utility of geophysical techniques in archaeological research, provided that geophysics is thoughtfully placed within the research design based on the local environment and knowledge of cultural resources. The obstacles faced with using geophysical techniques, namely equipment cost or rental and learning curve, are significantly outweighed by the benefits of continuous data coverage, the ability to pinpoint excavations to save time and money, to accurately map large-scale archeological features, and conservation of the resource by minimizing ground disturbance.

# 3. RECENT INVESTIGATIONS AT THE MOUND CITY GROUP

By Kathy Brady, Ph.D. and Jennifer Pederson Weinberger, Ph.D., National Park Service

Ohio Hopewell earthworks have been studied extensively, both in historic and in modern times. Mound excavations during historic and modern times have revealed much about the construction and use of mound space. More recent research at Hopewell sites in Ohio has focused on non-mound areas both within and adjacent to the earthworks. This article focuses on current research conducted outside of the enclosure at the Mound City Group.

Mound City Group is a Hopewellian earthwork complex consisting of 24 mounds surrounded by an earthen embankment that encloses approximately 13 acres. Mound City Group itself was first investigated in the 1840s by Ephraim Squier and Edwin Davis for their volume titled Ancient Monuments of the Mississippi Valley, the first publication of the Smithsonian Institution. Mound City Group later underwent professional excavations in the 1920s by Mills and Shetrone of the Ohio Historical Society, and in the 1960s and 1970s by various archeologists including James Brown, Raymond Baby, and Martha Otto.

The land located just north of the earthwork is referred to as the North 40-acre tract (Figure 1). This area went relatively undisturbed despite the construction of a World War I training camp, Camp Sherman, over a vast area to the south including where the mounds are located. Archeologists from the Midwest Archeological Center conducted archeological investigations in the North 40 tract during the early 1980s under the direction of Mark Lynott. Archeological investigation of the tract included controlled surface survey, shovel testing, and a limited number of test pits. Results of the investigations indicated three historic artifact scatters and a prehistoric site. The prehistoric site was designated 33Ro338 and determined to be from the Middle Woodland period based on the types of artifacts recovered. In 2006, park officials proposed a new vegetation management regime to allow the field of alfalfa and orchard grass to revert to forest. The proposal led to new investigations of the site and its relationship to Mound City Group.

In the summer of 2007, park archeologists and college interns conducted a magnetic survey over a portion of the North 40 tract. A Geoscan FM-256 fluxgate gradiometer was used to conduct the magnetic survey. The survey consisted of approximately one hundred 20 x 20-meter survey blocks (Figure 2). Magnetic anomalies, measured in nanoTesla, are very slight distortions of the earth's magnetic field caused by differences in the subsurface sediments and contents. Prehistoric features such as storage/refuse pits, fire pits, and earth ovens tend to be visible in the data as positive anomalies, shown in black, resulting from the addition of magnetic mineral-rich topsoil or from the firing of sediments. Historic disturbances such as metal objects and buried utilities are visible as bipolar anomalies, shown in black and white. Preliminary analysis located dozens of magnetic anomalies that based on their characteristics are probable prehistoric features.

**Figure 1.** Mound City Group Earthworks is in the lower portion of the image. The North-40 Tract is outlined with a white dashed line. The Scioto River is on the right.

Soil coring was chosen as the methodology to ground-truth magnetic anomalies because it is minimally destructive and can be executed quickly and efficiently. A sample of seventeen magnetic anomalies was chosen for coring on the basis of strength or magnitude, as well as the overall configuration of the anomaly. Anomalies were relocated on the ground with the use of a Total Station surveying instrument. Each core was dug through the plowzone soil until sterile subsoil was encountered. The soil removed from each core was examined for the presence of artifacts. Eleven of the seventeen cores were found to contain prehistoric artifacts at depths below the plowzone soil.

We suspected two linear anomalies, located northwest of the five aligned circular anomalies, of being part of the post pattern of a prehistoric structure (Figure 3). Portions of the linear anomaly appear to reflect individual posts while other portions are more continuous in form. The area underwent preliminary testing in 2007, by removing one square meter of dirt over a portion of the anomaly. With the plowzone removed, several features were apparent: two closely spaced posts, a small area of light colored soils, and adjacent areas with high gravel content.

Based on the promising results of the 2007 fieldwork, park staff and volunteers returned to the site in the summer of 2008. Research objectives were two-fold—to continue testing the linear anomaly and to test one of the five aligned anomalies. A 2 x 2 meter unit was set out over the southwest corner of the linear anomalies. The

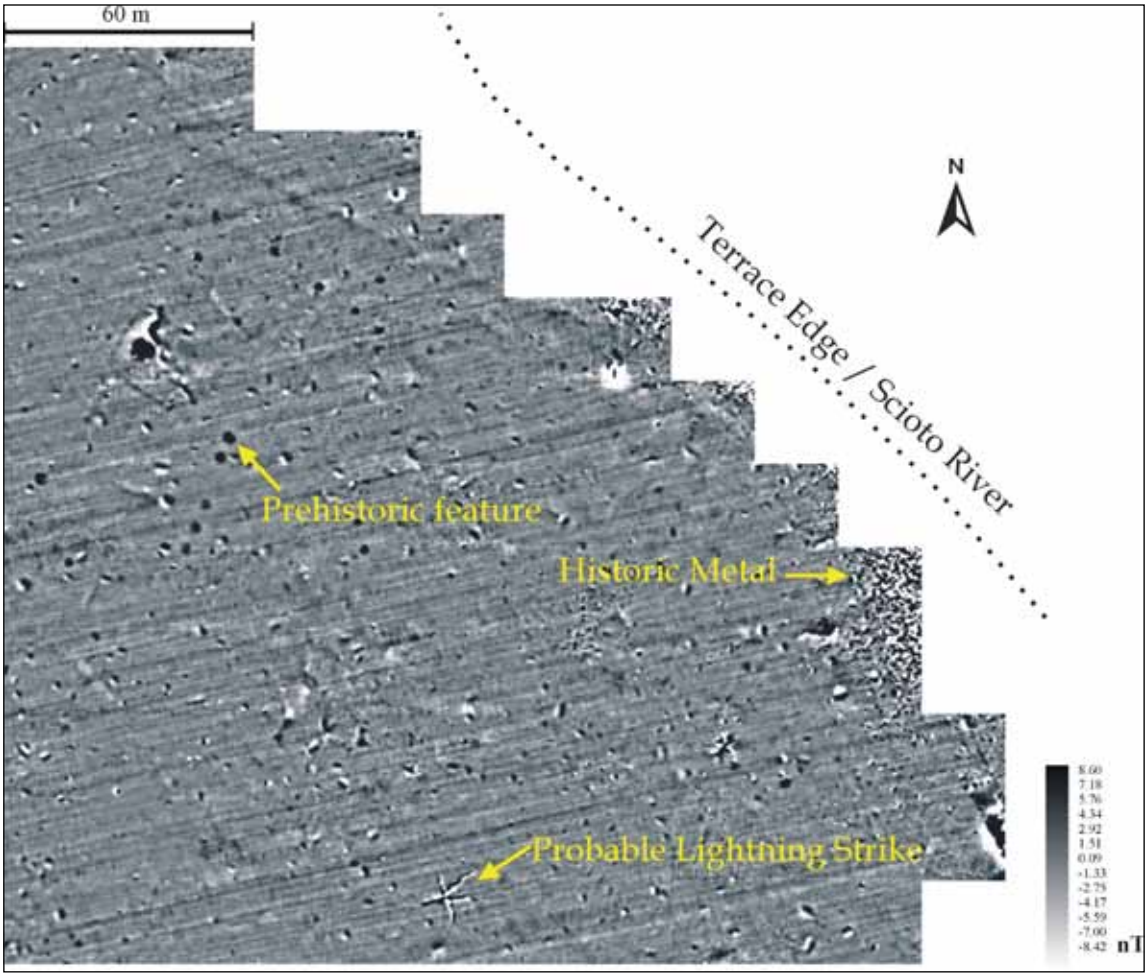


**Figure 2.** Magnetic survey data from the southern half of the 40-acre tract.

only diagnostic artifacts recovered during removal of the plowzone in this location were twelve bladelet and bladelet fragments (Figure 4). The presence of the bladelets provided evidence for some type of Middle Woodland/Hopewell occupation at this location. Removal of the plowzone soil over an area of approximately 2 x 3 meters revealed four post holes (Figure 5). The post holes of the structure are readily visible in the surrounding gravel. The gravel is of glacial origin but is much higher in the soil profile than is typically found on this outwash terrace, and is very dense. The post holes lacked this glacial gravel and contained organic-rich soil and wood charcoal. The posts are approximately 20-25 cm in diameter and 75-90 cm deep from the ground surface. The only artifact, other than charcoal, recovered from the post holes was the base of a corner-notched spear point. Therefore, the 2008 excavations based on the magnetic survey data did support the idea of a prehistoric structure in this location.

In 2009, we employed a backhoe to remove the bulk of the plowzone soil in a transect 2 meters wide by 25 meter long and oriented east-west across the structure (Figure 6). The remaining five centimeters of plowzone soil was removed with shovels and trowels so as not to disturb any sensitive features related to the floor of the structure. Additional post holes were confirmed and continued as expected along the

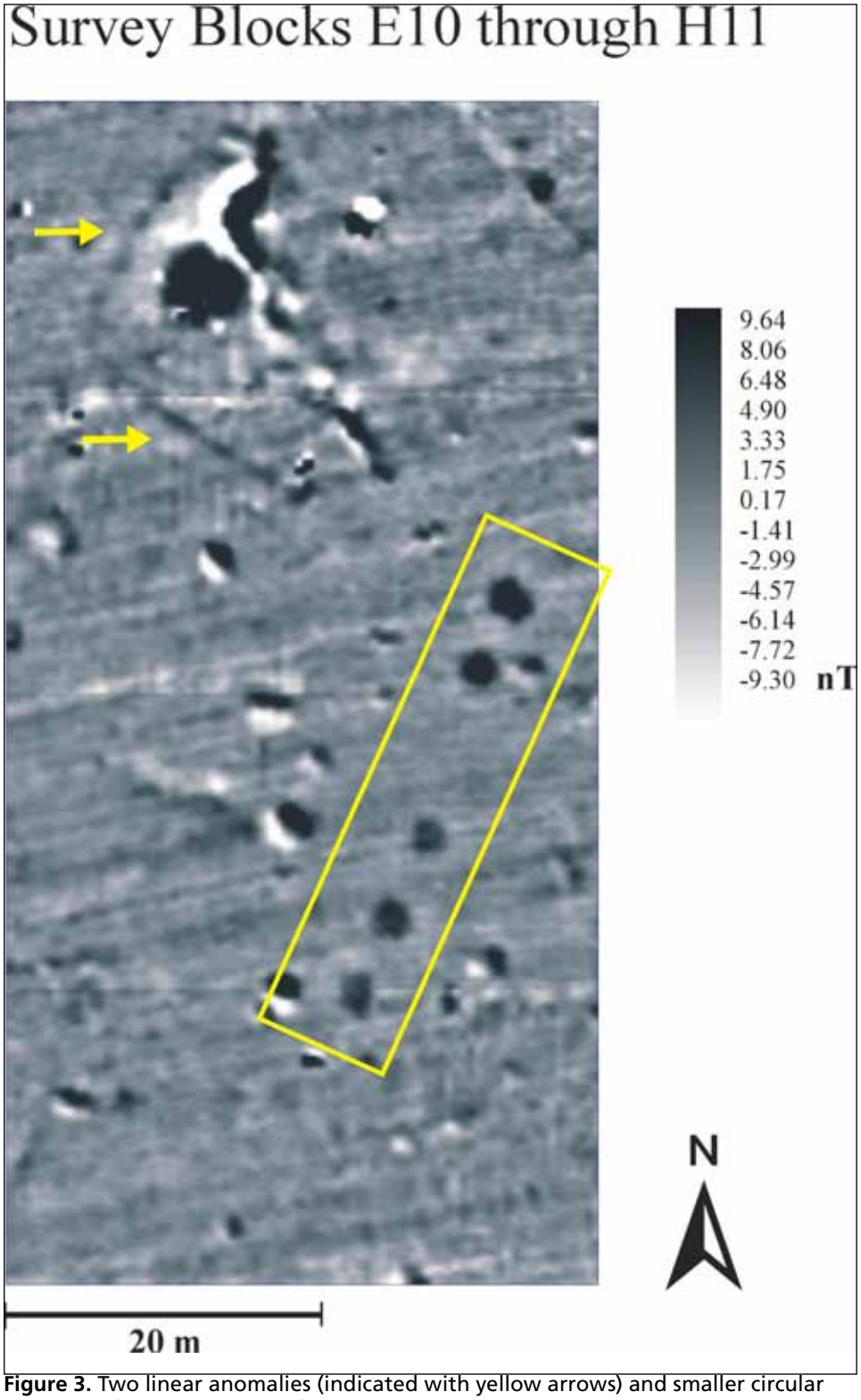


**Figure 3.** Two linear anomalies (indicated with yellow arrows) and smaller circular anomalies (outlined in yellow) that relate to a prehistoric structure and associated pit features.

**Figure 4.** Bladelet and bladelet fragments recovered from a 2 x 3 meter area of plowzone over the four excavated post holes.

**Figure 5.** Four post holes visible after the removing the plowzone soil. The four post holes after excavation inset.

western wall. The gravel layer was found not to be continuous but rather confined to the western end of the transect and found to terminate abruptly, suggesting the gravel was purposely laid as part of the architecture of the building. Possible interior features exist across the floor of the structure. This fieldwork is currently ongoing. Only two of the walls are visible in the magnetic data. No linear anomalies are visible in the magnetic data in the area where one would expect the other two walls of posts. Future excavations should allow us to determine if the other walls of posts are present and if they are, why they are not visible in the magnetic data.

Another goal of the prior and current field season was to investigate the five aligned anomalies. This area is located approximately 30 meters southeast of the excavated post holes. The strength of the aligned anomalies, on average 9.4 nT, are of a magnitude typically associated with prehistoric pit features, and these five anomalies tested positive for prehistoric artifacts below plowzone during coring. During the summer of 2008, park staff and volunteers excavated one of five aligned magnetic anomalies. The middle anomaly was chosen for excavation. A large, circular pit feature was uncovered, approximately 2 meters in diameter with a depth of 83 cm below ground surface. The feature was divided into quadrants and the northwest and southeast quads excavated. With the exception of one small, cordmarked pottery sherd and a few pieces of fire-cracked rock, only complete and fragmented ovate bifaces (stone tools that have their edges shaped out for later use or later finishing into specific tool types) and

**Figure 6.** Photo of the 2 meter x 25 meter transect to remove the bulk of the plowzone soil over the structure area.

associated chert debitage (flakes and shatter created during the tool making process) were recovered from this pit feature. To learn more about the pit's bifaces and debitage, Dr. Richard Yerkes of the Ohio State University was asked to conduct microwear and technological analysis on the stone tools recovered from the feature. His findings suggest the chert debitage resulted from many different reduction (knapping) episodes and represents a variety of chert types. None of the bifaces or biface fragments (Figure 7) in the North Forty sample had any visible use wear, hafting traces, or "bag wear" on the edges or faces that would indicate that they had been used as tools or kept in leather bags before they were deposited in the pit feature. Dr. Yerkes concluded the four complete bifaces in the sample were not discarded tools, nor were they preforms cached in the pit for future retrieval and finishing. The bifaces and biface fragments recovered from the pit feature seemed to have been rejected as a result of manufacturing errors such as humps or notches that would not allow them to be thinned further, or having been broken during the manufacturing process. The bifaces are similar to those found in several contexts at the Mound City Group.

Also during the 2009 field season, park staff and volunteers excavated the northern-most of the five aligned anomalies. The pit feature is slightly more irregular in shape with its widest dimension being approximately 4 meters in width. The southern half of the feature is being excavated thus preserving the northern half. The pit feature has a strong magnetic signature but has been found to contain relatively little charcoal and no evidence of in situ (in place) burning. The pit feature does however contain

**Figure 7.** Bifaces and biface fragments recovered from one of the pit features.

hundreds of pottery sherds (Figure 8) which may account for the strong magnetic signature given that the pottery has been fired and was in a large concentration. The pit feature also contained fire-cracked rock, chert debitage, biface fragments, and several pieces of mica, an exotic material quarried from the Appalachians of North and South Carolina and used by the Hopewell.

Karen Leone of Ohio Valley Archaeological Consultants performed the analysis on the charred plant remains recovered from the feature and from the post holes in the previous field seasons. Remains from the current field season have not yet been submitted for analysis. Only one category of plant remains, wood, was identified in the sediment from the post holes. Most remains were either hickory or oak. Bark fragments accounted for approximately half of the wood assemblage. She also analyzed the charred plant remains recovered from the pit feature containing the bifaces. The pit feature yielded less than .3 grams of charcoal, consisting of cedar, basswood, charred nutmeat, and unidentified plant material. Although both northern white cedar and western red cedar occur in Ross County, cedar is rarely recovered from archeological contexts and is usually associated with ceremonial activity such as mound contexts. The charred plant remains are very small and fragmented therefore the cedar identification is a tentative one.

**Figure 8.** Park volunteers excavating the pit feature containing hundreds of pottery sherds. Rim sherd of small vessel show in inset.

To date, the archeological investigations have uncovered evidence of a structure and associated pit features with specialized deposits of stone tool manufacture and of pottery. AMS (Accelerator Mass Spectrometry) dates obtained from wood charcoal recovered from three of the post holes and the pit feature containing the bifaces yielded dates of 1940 +/-40 RCYBP (radiocarbon years before present), 1920 +/-20 RCYBP, 2010 +/-40 RCYBP, and 1890 +/-40 RCYBP, respectively, and place the features within the Middle Woodland period. The dates obtained place the features within the early period of construction and use of the adjacent mounds and earthwork at approximately 2,000 years ago. Material from the current field season has not yet been submitted for dating.

In conclusion, site 33Ro338 seems to represents a Hopewellian structure and several associated pit features. Research questions for the project include, what was the function of the structure within the Hopewellian settlement system, and whether there is chronologically or stylistically sensitive material in the site to indicate contemporaneous use with the adjacent earthworks.

We would like to thank the following individuals for their support of this research: Brian Adams, Erin Dempsey, and Carly Sentieri, NPS interns; and dedicated park volunteers Jan Hatfield, Herb Wasserstrom, Bonnie Wildermuth, and Brenda Williams.

## REFERENCES

Lynott, Mark J. and Susan M. Monk
1985 Mound City, Ohio, Archeological Investigations. Midwest Archeological Center Ocassional Studies in Anthropology No. 12. United States Department of the Interior, National Park Service, Lincoln, Nebraska.

# 4. CLUES TO THE RELATIONSHIP OF THE RIVERBANK SITE (33RO1059) TO OTHER OHIO HOPEWELL SITES THROUGH INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS ON POTTERY

By Amanda J. Landon

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Abstract

Excavations were conducted at the Riverbank Site (33RO1059), located by the Hopewell Site (33RO27), in 2004 and 2006 to gather data from the site before it is eroded away by the Paint Creek and to improve understanding of the role of small sites located near large Hopewell earthworks. Instrumental Neutron Activation Analysis (INAA) was conducted on pottery from the Riverbank Site to help clarify its relationship with other nearby sites. Fifteen sherds from the site were sent to the University of Missouri Research Reactor (MURR) for INAA, and the results were compared to the larger database of Hopewell ceramics. Baed on the results, which show that the fifteen sherds formed a unique trace element compositional group, the site likely represents a short-term occupation, possibly for a pilgrimage to the Hopewell Site, and the ceramics were likely either locally constructed for use at the site or constructed elsewhere to carry items on the way to Hopewell.

## Hopewell Social Organization

There are still many questions surrounding the cultures and manners of interaction that the Hopewell represent, especially with regard to the role of the mounds. The archaeological culture is known for a particular set of artifacts and constructs, though each site is still quite unique, and there has yet to be a description of a "typical" Hopewell archaeological site. Many of the mound groups do, however, share a concentration of exotic and possible prestige goods in common, so they were very likely congregating at these areas, sometimes from a distance and with distant materials (Bernardini 2004; Gibson 1994; Lafferty 1994; Spielmann 2002). This paper focuses on the Hopewell Interaction Sphere theory, introduced in 1964 by Hopewell archaeologist Joseph Caldwell.

Caldwell (1964) interpreted the archaeological designation "Hopewell" as one of the interaction spheres active in the prehistoric Americas, an idea that is still used today. These interaction spheres are exchange networks in which similar items are traded over large areas, creating the illusion of a continuous "culture" based on similarities in material culture over large areas. The proposed Hopewell Interaction Sphere covers an area of Eastern North America that spans from Ontario in the North to Florida in the South, and from New York in the East to Nebraska in the West. The interaction sphere

was centered in Ohio, where the majority of sites and highest concentrations of Hopewell materials ocurr (Seeman 1979).

The Hopewell Interaction Sphere is represented by a complicated archaeological record that is likely representative of complicated social organization and interactions (Lepper 2006; Pacheco and Dancey 2006). Bernardini (2004) characterizes their interaction on a regional level, with earthworks being built and used by the people living in a region rather than just those living close to the earthwork, based on patterns in earthwork construction and shape in southern Ohio. Additionally, each group of people likely used more than one earthwork. Evidence for pilgrimages to the earthworks raises questions about sedentism and mobility among those living in the Hopewell Interaction Sphere.

Cowan (2006) studied the lithic materials from Hopewell sites and found evidence for mobility. Bladelets are small, thin, and rarely retouched tools that were likely costly to produce. Bladelets were made out of high quality material, required a great degree of skill, showed no evidence of hafting, and display little use wear. This data suggests that they were only used a little before discard and were only suitable for some tasks. Additionally, there are few bifaces, which are more easily carried, unlike bladelets, which can be made with less preparation (Cowan 2006).

Burks and Pederson (2006) found more evidence for at least some degree of mobility in a study of habitation site materials and Hopewell Mound Group debris clusters. Debris clusters refer to assemblages of fire-cracked rock, debit age, and pottery that ocurr on or near the survace of earthworks. Debris cluster materials differ in that they are less dense than habitation site materials and are found over much smaller areas. Burks and Pederson interpret the debris clusters to be small camps that were inhabited for short periods of time by people who were visiting or building the earthworks.

The Riverbank Site (33RO1059)

The Riverbank Site (33RO1059) is loated just south of the Hopewell Mound Group on the Paint Creek (Bauermeister 2006). The Hopewell Mound Group consists of two large enclosures. The Great Enclosure, the largest, more or less follows the topography of the land, whereas the smaller enclosure is a square (Figure 1). There are at least 40 mounds within the enclosures, but the original number is unknown because some may have been plowed or otherwise removed (Greber and Ruhl 2000:11-12).

The Riverbank Site is considered part of the Hopewell Mound Group Unit, though it is not located on the mounds themselves (Bauermeister 2006). Hopewell Culture National Historic Park (HOCU) permited excavations at the site to assess the types of resources present before the Paint Creek erodes more of the site away (Bauermeister 2004). The earlier pedestrian survey revealed Middle Woodland and Hopewell artifacts, including bladelets. One of the features excavated during the 2004 project revealed some Hopewell rocker-stamped pottery, and another preserved Late Woodland artifacts. This suggested that the Riverbank Site represents several occupations and potentially held important information related to how the site is related to the nearby Hopewell Earthworks (Bauermeister 2004). The purpose of the 2006 season excavations

was to determine the type of settlement, its relationship to the Hopewell Site, and its relationship to other Middle Woodland sites (Bauermeister 2006).

Excavators uncovered ceramics in four features at the Riverbank Site, all but one fragment originating in three of the features (Figure 2). Pottery from two of these features refitted, showing them to be contemporaneous (Bauermeister 2006; Hammons 2006). Those same two features produced diagnostic Hopewell materials (Bauermeister 2006). The excavations uncovered 484 sherds from three features, yielding a minimum of seven vessels and nine body sherd groups that could not be associated with a particular vessel due to a lack of articulating rim sherds. The two contemporaneous features produced sherds from three Scioto Series, McGraw cord marked vessels, two Southeastern Series, Untyped Cordmarked vessels, and one Hopewellian Series, Chillicothe Rocker-Stamped vessel (Hamons 2006, Prufer 1968).

Speakman and Glascock (2003) analyzed 103 Ohio Hopewell pottery samples from seven sites, which include Harness, Hopeton, Hopewell, McGraw, Russel Brown, Seip, and Turner. All but ten sherds were assigned to one of six groups. The results of the INAA analysis on the Riverbank Site pottery were added to the results from the 2003 analysis to compare the assemblages.

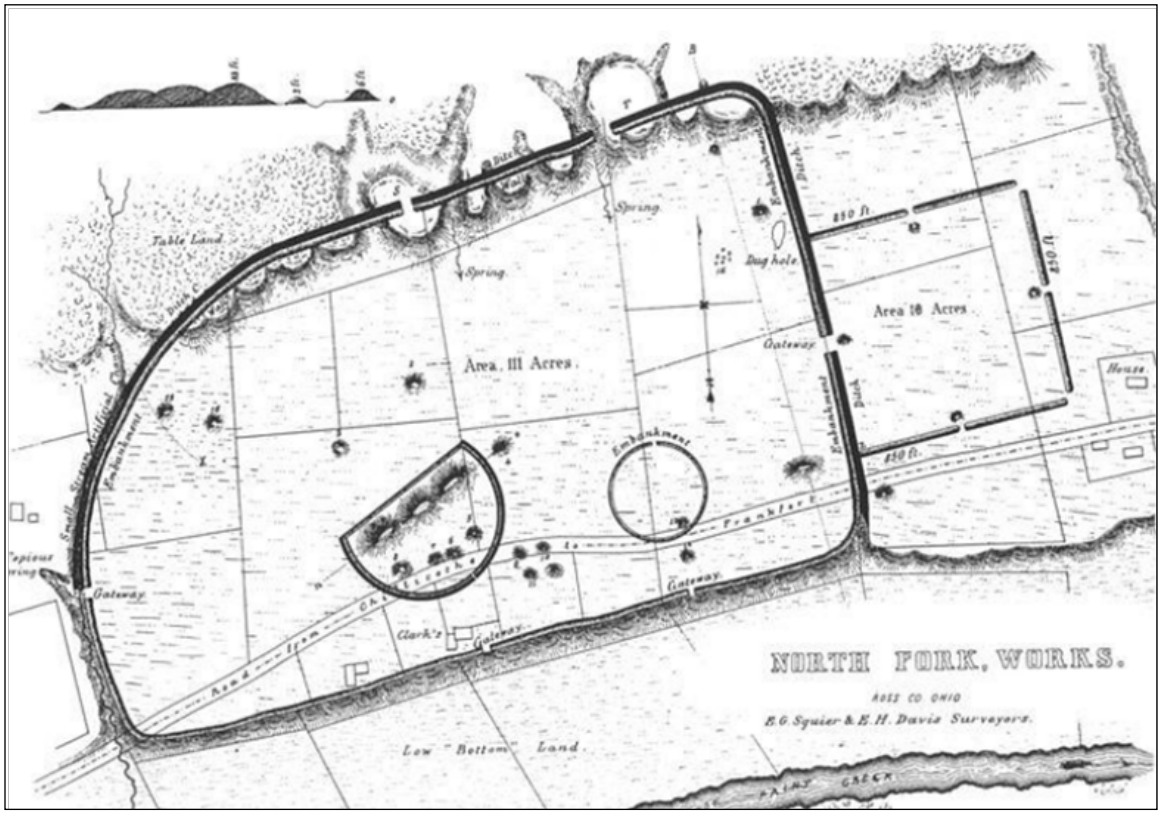


**Figure 1: Map of the Hopewell Earthworks from Squire and Davis 1998 (originally published in 1848).**

Methods

The Riverbank Bank Site assemblage came from three features: Feature 7, Feature 8, and Feature 10 in Block 1 of the excavations (Bauermeister 2006). Hammons (2006) analyzed the assemblage and largely based his typology on that of Prufer (1968). This analysis formed the basis on which the assemblage was sampled. One sherd from each of the identified vessels, with the exception of the vessel from Feature 10, which was too small, were chosen to be sent for INAA. In addition, the remaining nine samples were taken from each of the pottery groupings that Hammons identified, but that could not be articulated to a rim sherd. Each chosen sherd was assigned an identification number for MURR from RBS001-RBS015 (Table 1).

The sherds were sent by the Midwest Archeological Center (MWAC) to the MURR laboratory to be analyzed through INAA (for the procedure, see Glascock 1992). The conclusions in this paper are drawn from the data presented in the report from MURR (Ferguson and Glascock 2007). MURR used 33 elements (arsenic, lanthanum, lutetium, neodymium, samarium, uranium, ytturbium, cerium, cobalt, chromium, cesium, europium, iron, hafnium, nickel, rubidium, antimony, scandium, strontium, tantalum, terbium, thorium, zinc, zirconium, aluminum, barium, calcium, dysprosium, potassium, manganese, sodium, titanium, and vanadium) in the multi-variate analysis to compare the sherds from the Riverbank Site to other Hopewell sites. The results indicate that the ceramic sherds belong to the same compositional group. To demonstrate the results visually, Ferguson and Glascock (2007) plotted the concentrations of chromium and arsenic against each other on a scatterplot diagram because the concentrations of chromium were relatively higher and the concentrations of arsenic relatively lower than any of the other Ohio Hopewell ceramics. RBS001 at first appeared to be an outlier, with more chromium and less arsenic than the other samples, until Ferguson and Glascock (2007) overlayed the results from the Riverbank Site from the results from another site from another continent. RBS001 was well within the very tight compositional group of ceramics from the Riverbank Site (Figure 3).

Unfortunately, the 15 pottery sherds may not be a representative sample of the site, and there have so far been 118 total sherds included in the "Hopewell" analysis. Part of the Riverbank Site has already been eroded away by Paint Creek. Depending on how much of the site is missing and how homogenous the ceramics were distributed on the site, the sample may have missed some sherds from vessels that have a different composition. Additionally, during the block excavations, about 20 cm of soil was scraped off of the surface of the block by a backhoe, which also would have removed the top of the burn features. There may have been important data in that level that was missed. To improve this data, more samples from Hopewell sites will need to be analyzed through INAA to address any sampling errors.

Fortunately, the compositional clouds for the ceramic samples were very tight, moreso than other compositional groups (Ferguson and Glascock 2007). Due to the sample size being so small, 15 sherds, MURR was unable to perform a proper statistical analysis on the compositional group. They were, however, able to compare the Riverbank Site compositional group to many other groups and determine that the Riverbank Site ceramics were very similar.

| MURR ID | Ware | Form | Paste | Temper | Decoration | Provenience |
|---|---|---|---|---|---|---|
| RBS001 | Scioto Series, McGraw Cordmarked | Unknown | very dark brown | Grog | Smoothed Rough Cordmarking | Block 1, Feature 7 |
| RBS002 | Unknown | Unknown | very dark brown | Grit | Fabric-Impressed | Block 1, Feature 7 |
| RBS003 | Hopewellian Series, Chillicothe Rocker-Stamped | Unknown | light brown | Grit | Smothed Rocker-Stamping | Block 1, Feature 7 |
| RBS004 | Unknown | Unknown | very dark brown to light brown | Grit | Incised Chevron | Block 1, Feature 7 |
| RBS005 | Scioto Series, McGraw Cordmarked | Unknown | very dark brown to brown | Grit | Smoothed Cordmarking | Block 1, Feature 7 |
| RBS006 | Unknown | Unknown | dark brown to light brown | Grit | Smoothed Cordmarking | Block 1, Feature 7 |
| RBS007 | Scioto Series, McGraw Cordmarked | Unknown | brown to light brown | Grit | Coarse Cordmarking | Block 1, Feature 7 |
| RBS008 | Southeastern Series, Untyped Cordmarked | Unknown | brown to light brown | Grit | Smooth | Block 1, Feature 8 |
| RBS009 | Unknown | Unknown | brown | Grit | Smoothed | Block 1, Feature 8 |
| RBS010 | Unknown | Unknown | dark brown to brown | Grit | Smooth | Block 1, Feature 8 |
| RBS011 | Unknown | Unknown | very dark brown to light brown | Grit | Smooth/Smoothed Cordmarking | Block 1, Feature 8 |
| RBS012 | Southeastern Series, Untyped Cordmarked | Tetrapod | dark brown to brown | Grit | Smoothed Cordmarking | Block 1, Feature 8 |
| RBS013 | Unknown | Unknown | brown | Grit/Sand | Smoothed Coarse Cordmarking | Block 1, Feature 10 |
| RBS014 | Unknown | Unknown | very dark brown, reddish brown | Grit | Cordmarking | Block 1, Feature 10 |
| RBS015 | Unknown | Unknown | brown to light brown | Sand | Smoothed Cordmarking | Block 1, Feature 10 |

**Table 1: A list and description of the sherds chosen for INAA.**

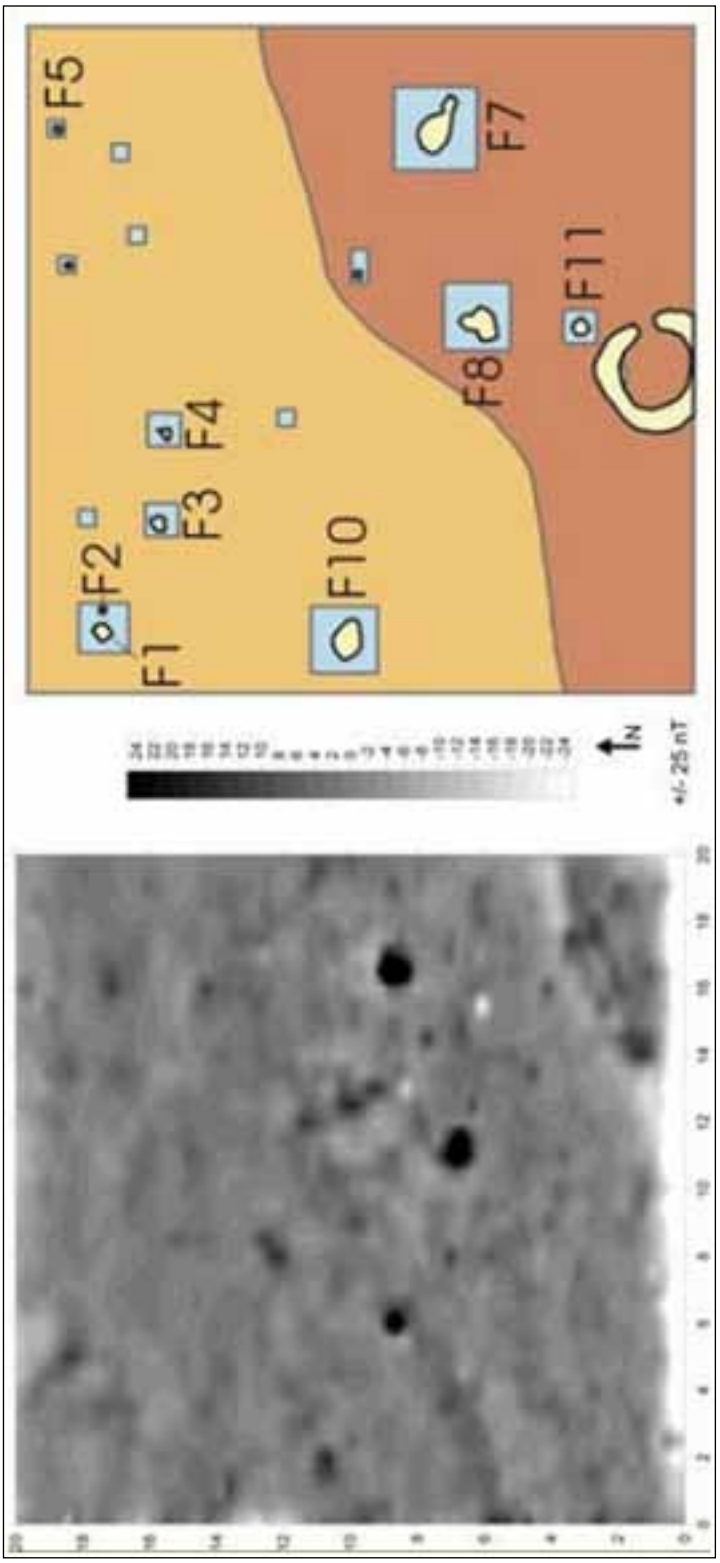


**Figure 2: Locations of the Features in Block 1 at the 2006 33RO1059 excavations (Bauermeister 2006).**

Discussion

There are a few possibilities for the origins of the ceramics. Considering that all of the ceramic samples share a common trace elemental composition, each identified vessel came from the same raw material source. None of the samples had a similar composition to any of the other ceramic samples from other contemporaneous sites, meaning that the Riverbank Site samples came from a different raw material source than the others.

The source could be a local clay deposit near with temper of unknown origin. Though it is difficult to transport raw clay (Mays 1961), some temper materials are easily transported over long distances (Lynott, personal communication 2007). Alternatively, the vessels could have been constructed at a different location and then traded or transported to the Riverbank Site because fired pots are relatively easy to transport (Mays 1961). One could also interpret the results to mean that there was no trade between the Riverbank Site and other sites because the Riverbank Site vessels did not overlap in composition with any other ceramics. The Riverbank Site might represent a short-term occupation for ceremonial purposes, given the ceramic composition and

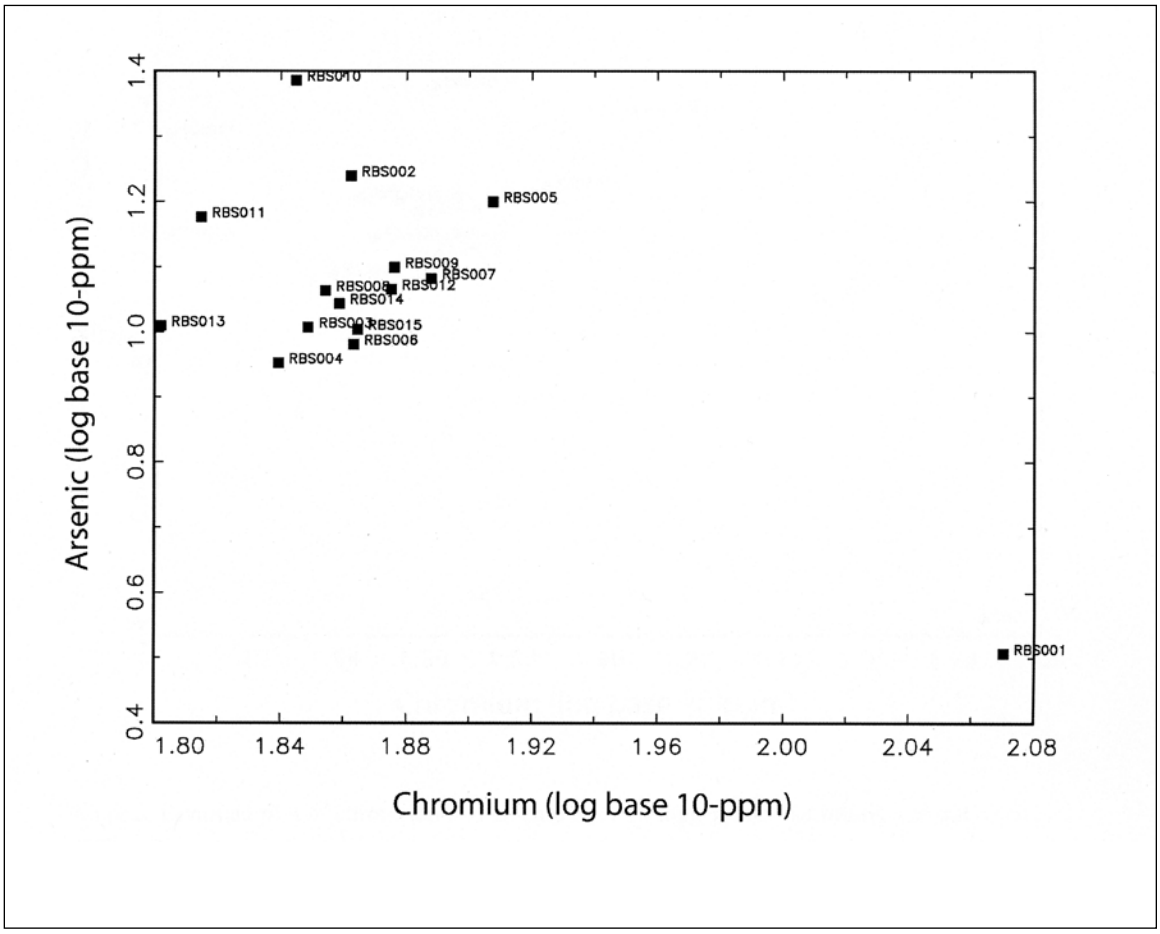


**Figure 3: "Bivariate plot of chromium and arsenic base-10 concentrations following calcium correction" (Ferguson and Glascock 2007:13).** Note that the compositional groups are formed through a multi-variate analysis.

other observations. Tetrapodal vessels, which at least one of the Riverbank Site vessels is, tend to be associated with ceremonial activities or areas (Greber and Ruhl 2000; Lynott, personal communication 2007). Additionally, the Riverbank Site is located very close to the Hopewell Mound Group, a major embankment earthwork complex that shows evidence of other short-term occupations (Burks and Pederson 2006). The Riverbank Site could represent another one of those short-term occupations, possibly for a group of people on a pilgrimmage, if the INAA results are representative of the entire assemblage. The only evidence of time at the site is two thermal features, each of which probably represents a few use events, suggesting that the location was not occupied for a long period of time. There is little evidence of long-term structures at the site. Though there are postmolds, there are not many, and there have yet to be distinguishable structures at the site (Bauermeister 2007). The excavations uncovered numerous bladelets, which have been interpreted as tools that one would find at short-term occupations due to the ease with which they can be manufactured (Cowan 2006). However, the site is more substantial than a debris cluster because the assemblage is much more diverse than fire-cracked rock, debitage, and pottery and extends beyond the surface of the ground (see Cowan 2006 for a description of debris clusters and Bauermeister 2007 for a description of the Riverbank Site).

## Conclusion

This study was an attempt to help clarify the relationship between the Riverbank Site (33RO1059) and other Ohio Hopewell sites. In accordance with Bernardini's (2004) study that suggests that the earthworks were built and visited by people on a regional rather than a local level, it is possible that the Riverbank Site represents a short-term occupation for pilgrims to the Hopewell Mound Group who were either building or visiting the earthwork. Spielmann (2002) suggests that prestigious, exotic items were traded over long distances, and that certain places appear to have accumulated large concentrations of these items. The Hopewell Mound Group could represent one of these areas, given the concentrations of objects made by skilled people and from long distances, and the Riverbank Site a temporary settlement for people who went to gather at that special site.

If the site is indeed a short-term occupation, one could hypothesize that the ceramics were locally constructed at the site for ceremonial use there or constructed elsewhere to carry items on a pilgrimmage to the Hopewell Mound Group. In the future, more raw clay samples and ceramic samples should be collected to add to the database to attempt to locate the clay source and assess the statistical likelihood that the Riverbank Site ceramics are in the same compositional group. In this way, one could test the archaeological record to see where the raw materials originated. It would be interesting to widen the database, as well, to compare Ohio Hopewell ceramics to ceramics from other areas in Eastern North America. Archaeologists might then be able to see how far people or ceramics would travel, and this project could test whether the Riverbank Site ceramics came from a long distance.

Future research should also include paleoethnobotanical and faunal data to test for possible seasonal correlations to the site. If the site is a short-term occupation, it could be a seasonal occupation, as Yerkes (2006) suggests that many Hopewell

"settlement sites" really are. There is both paleoethnobotanical and faunal data available for the Riverbank Site. Finally, all future research should consider the implications of the potential sampling issues regarding erosion and block excavations.

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## References Cited

Bauermeister, Ann C.
2004 Survey and Excavations in 2004 at 33RO1059. Hopewel Archeology 6(1). Accessed 07 May 2007 from http://www.cr.nps.gov/mwac/hopewell/v7n1/two.htm.

2006 Archeological Data Recovery Field Investigations at Site 33RO1059. Hopewell Archeology 7(1). Accessed 07 May 2007 from http://www.cr.nps.gov/mwac/hopewell/v7n1/two.htm.

Bernardini, Wesley
2004 Hopewell Geometric Earthworks: A Case Study in the Referential and Experiential Meaning of Monuments. Journal of Anthropological Archaeology 23:331-356.

Burks, Jerrod, and Jennifer Pederson
2006 The Place of Nonmound Debris at Hopewell Mound Group (33RO27), Ross County, Ohio. In Recreating Hopewell, edited by Douglas K. Charles and Jane E. Buikstra, pp. 376-401. University Press of Florida, Gainesville, Florida.

Caldwell, Joseph R.
1964 Interaction Spheres in Prehistory. In Hopewellian Studies, edited by Joseph R. Caldwell and Robert Hall, pp. 133-143. Scientific Papers, No. 12, Illinois State Museum, Springfield.

Cowan, Frank L.
2006 A Mobile Hopewell? Questioning Assumptions of Ohio Hopewell Sedentism. In Recreating Hopewell, edited by Douglas K. Charles and Jane E. Buikstra, pp. 26-49. University Press of Florida, Gainesville, Florida.

Ferguson, Jeffery R., and Michael D. Glascock
2007 Instrumental Neutron Activation Analysis of Pottery from the Hopewell Culture National Historic Park. Report on file, University of Missouri Research Reactor Center, Columbia.

Gibson, Jon L.
1994 Empirical Characterization of Exchange Systems in Lower Mississippi Valley Prehistory. In Prehistoric Exchange Systems in North America, edited by Timothy G. Baugh and Jonathan E. Ericson, pp. 127-175. Plenum Press, New York.

Glascock, Michael D.
1992 Characterization of Archaeological Ceramics at MURR by Neutron Activation Analysis and Multivariate Statistics. In Chemical Characterization of Ceramic Pastes in Archaeology, edited by Hector Neff, pp. 11-26. Prehistory Press, Madison, Wisconsin.

Greber, Noami, and Katherine C. Ruhl
2000 The Hopewell Site: A Contemporary Analysis Based on the Work of Charles C. Willoughby. Eastern National, Boulder, Colorado.

Hammons, Michael
2006 Ceramic Analysis -- 33RO1059. Report on file, Midwest Archeological Center, Lincoln, Nebraska.

Lafferty, Robert H. III
1991 Prehistoric Exchange in the Lower Mississippi Valley. In Prehistoric Exchange Systems in North America, edited by Timothy G. Baugh and Jonathan E. Ericson, pp. 177-213. Plenum Press, New York.

Lepper, Brad T.
2006 The Great Hopewell Road and the Role of Pilgrimage in the Hopewell Interaction Sphere. In Recreating Hopewell, edited by Douglas K. Charles and Jane E. Buikstra, pp. 122-133. University Press of Florida, Gainesville, Florida.

Mayes, Philip
1961 The Firing of a Pottery Kiln of a Romano-British Type at Boston, Lincolnshire. Archaeometry 4:4-30.

Pacheco, Paul J., and William S. Dancey
2006 Integrating Mortuary and Settlement Data on Ohio Hopewell Society. In Recreating Hopewell, edited by Douglas K. Charles and Jane E. Buikstra, pp. 3-25. University Press of Florida, Gainesville.

Prufer, Olaf H.
1968 Ohio Hopewell Ceramics: An Analysis of the Extant Collections. University of Michigan, Museum of Anthropology, Anthropological Papers 33, Ann Arbor, Michigan.

Seeman, Mark F.
1979 The Hopewell Interaction Sphere: The Evidence for Inter-regional Trade and Structural Complexity. Prehistoric Series Volume 5, Number 2, Indiana Historical Society, Indianapolis.

Speakman, Robert J., and Michael D. Glascock
2003 Neutron Activation Analysis of Pottery from Hopeton Earthworks, Ohio. Report on file, University of Missouri Research Reactor Center, Columbia.

Spielmann, Katherine
2002 Feasting, Craft Specialization, and the Ritual Mode of Production in Small-Scale Societies. American Anthropologist 104:195-207.

Squier, E. G., and Edwin H. Davis
1998 Ancient Monuments of the Mississippi Valley. Smithsonian Institute Press, Washington, D.C. Reprint. Originally published in 1848.

Yerkes, Richard W.
2006 Middle Woodland Settlements and Social Organization in the Central Ohio Valley: Were the Hopewell Really Farmers? In Recreating Hopewell, edited by Douglas K. Charles and Jane E. Buikstra, pp. 50-61. University Press of Florida, Gainesville.

# 5. FEATURE FINDS FROM THE RIVERBANK SITE, 33RO1059

By Ann Bauermeister

Located just south and east of the Hopewell site's Square Enclosure by about 225 meters is the Riverbank site, 33RO1059, which represents multiple occupations spanning the Archaic through historic periods, and includes a significant Middle Woodland component. Particularly noteworthy are two impressive pit features that were encountered in 2006 during a data recovery project undertaken by the Midwest Archeological Center. These pits, Features 7 and 8, would have been contemporaneous with Hopewell activities at the nearby earthwork complex, and the material culture recovered from them provides an intriguing glimpse of activities outside of the earthwork walls.

Feature 7 is a circular pit partially outlined in rock and measuring 87 cm in diameter at the top and 60 cm at its flat base, which is 32 cms deep (Figure 1). The feature fill includes dark, organic soil, burned earth, charcoal—particularly concentrated in the center and toward the bottom of the feature—and abundant artifacts. The assemblage includes over a thousand pieces of burned and/or calcined bone, including one bone tool fragment that is polished and striated, 314 pieces of lithic debitage, 194 fire-cracked rocks, 25 shell fragments, 16 mica fragments, 10 bladelets, and 1124 pottery sherds. A minimum of eight distinct vessels are represented, including a tetrapodal pot, fragments of which were also recovered from nearby Feature 8. Figure 2 shows this pot, partially reconstructed. Feature 7 yielded a radiocarbon date from a charcoal sample calibrated at 2 sigma of A.D. 20-220 (Beta-231668).

Feature 8 is a circular basin pit that measured 1.1 meters in diameter at its top. The feature fill was 30 cms deep and comprised of the same type of matrix as Feature 7, but with an even greater amount of cultural material (Figure 3). This features contains 785 pieces of debitage, 402 fire-cracked rocks, 118 mica fragments, 23 shell fragments, two bifaces and a core, and nine bladelets, all made from Flint Ridge flint, and a pitted stone. Nearly 5000 fragments (n=4728) of bone were recovered, most of which was burned. Several bone tools are present, including two burnishing tools, multiple pieces that are polished and striated, and two awls (Figure 4). The pottery assemblage includes 1077 sherds, representing a minimum of four distinct vessels, including the aforementioned tretrapodal pot, plus two additional partially complete tetrapodal vessels, which articulate from rim to base (Figures 5-6). These are identified as belonging to the Southeastern Series, Untyped Cordmarked. A charcoal sample from this feature, calibrated at 2 sigma, produced a radiocarbon date of A.D. 70-250 (Beta-231669). There seems to be no question that these two pit features were open and used at the same time.

These features, combined with additional archeological evidence from the site, support Hopewell use of the Riverbank site during the Middle Woodland period. Faunal and ethnobotanical remains indicate of a short term occupation, or occupations, in summer through fall. Occupants engaged in food processing and cooking (with an

emphasis on deer), stone tool manufacturing (based on the variety of lithic reduction stages represented), weaving, and other subsistence activities. Tetrapodal pots and mica are often associated with Hopewell ceremonial practices, and their presence at this site indicates such a use.

**Figure 1.** MWAC Archeologists excavating Feature 7.

**Figure 2.** Partially reconstructed tetrapodal pot, with sherds recovered from both Features 7 and 8.

**Figure 3.** Feature 8.

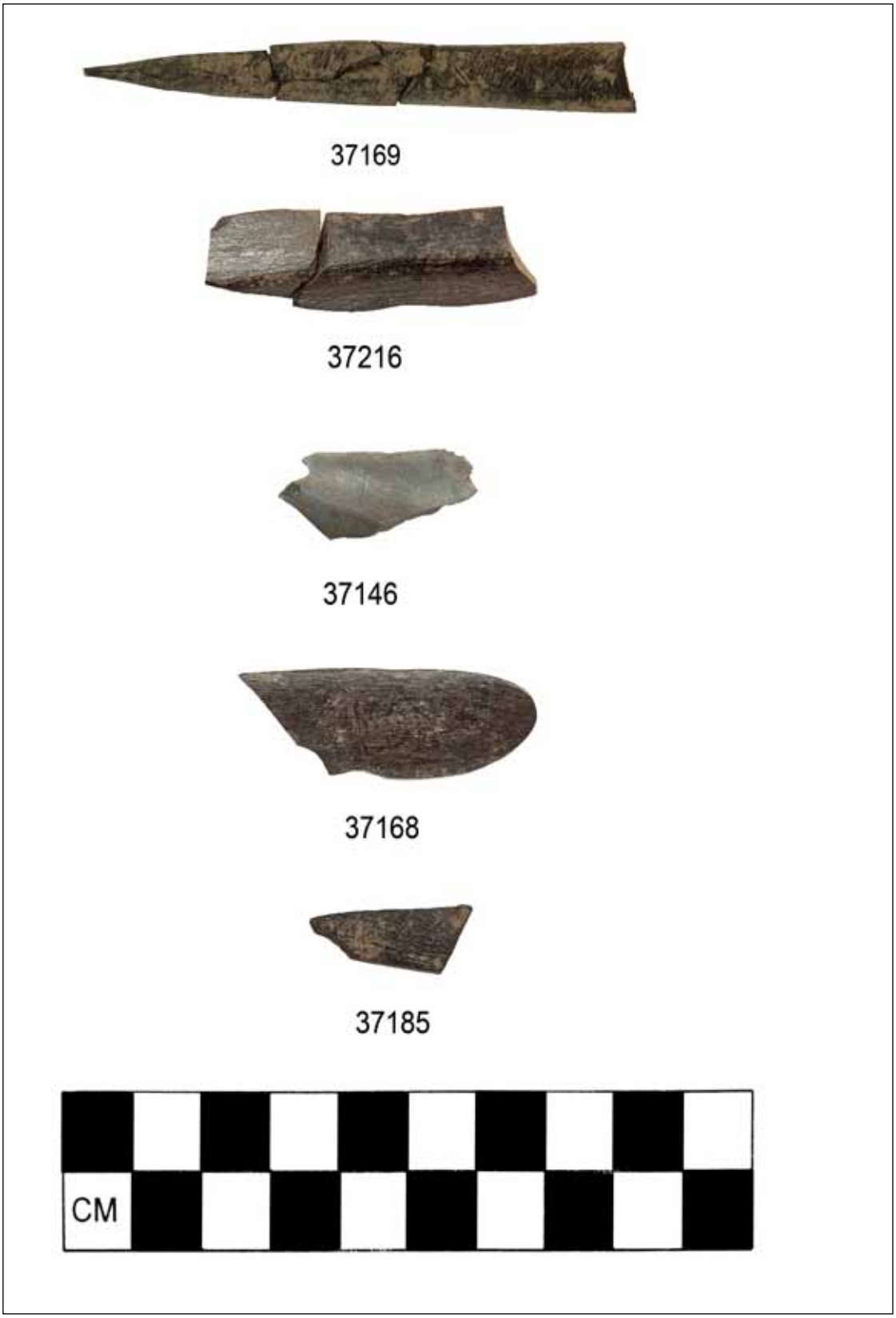


**Figure 4.** Bone tools recovered from Feature 7 and 8.

**Figure 5.** Tetrapodal pot recovered from Feature 8.

**Figure 6.** Tetrapodal pot recovered from Feature 8.

# 6. THE INITIAL PHASE OF THE MAGNETIC INVESTIGATIONS OF THE MOUND CITY GROUP (32RO32) AT THE HOPEWELL CULTURE NATIONAL HISTORICAL PARK, ROSS COUNTY, OHIO

By Steven L. De Vore

Abstract

The Mound City Group (Site 32RO32) covers approximately 13 acres. It contained at least 23 mounds when Squier and Davis made the first study of the mound complex in 1846. In the summer of 2009, the Midwest Archeological Center conducted the initial phase of a magnetic survey of the entire site. The magnetic survey in the southern portion of the site covered 11,200 $m^2$ or 2.77 acres. The magnetic data indicated the presence of numerous magnetic anomalies associated with the Hopewell occupation and with the World War I training facility of Camp Sherman.

## Introduction

The Mound City Group (Site 32RO32) is a large mound and earthwork ceremonial center located on the right bank of the Scioto River north of Chillicothe, Ohio (Figure 1). The rectangular earthworks cover approximately 13 acres with at least 23 mounds. The site is associated with the Hopewell Culture that flourished in the region between 200 B.C. and A. D. 500 (Willey 1966:273-280). The enclosure is approximately 625 meters across with the walls approximately one meter high. Since the initial investigations by Ephraim G. Squier and Edwin H. Davis in 1846 (Squier and Davis 1848:54-55 and Plate 14), several mounds within the site have been excavated or destroyed through agricultural practices or the construction of Camp Sherman in World War I; however, the majority has been reconstructed in order to provide the visual effects of the site on the present landscape. The Mound City Group represents the primary interpretive Hopewell site at the Hopewell Cultural National Historical Park (HOCU).

The present project is part of an on-going evaluation of Hopewell sites within the Hopewell Culture National Historical Park and the Midwest Archeological Center's (MWAC) research into earthwork construction at the Hopeton Earthworks (Lynott 2004; Lynott and Weymouth 2002). Geophysical investigations have provided useful information in evaluating the subsurface mound and earthwork construction. Geophysical techniques provide a means of rapid and non-destructive baseline evaluation of buried archeological resources. Keeping with these research interests, the Midwest Archeological Center has conducted the initial magnetic survey of the southern portion of the Mound City Group during the summer of 2009 (Figure 2).

## Historical and Archeological Background

The Mound City Group was first documented in 1846 by Squire and Davis (Squier and Davis 1998:54-55) on land belonging to Henry Schriver (Figure 3). Henry Schriver had purchased the land containing the Mound City Group in 1832 (Cockrell 1999:6). The

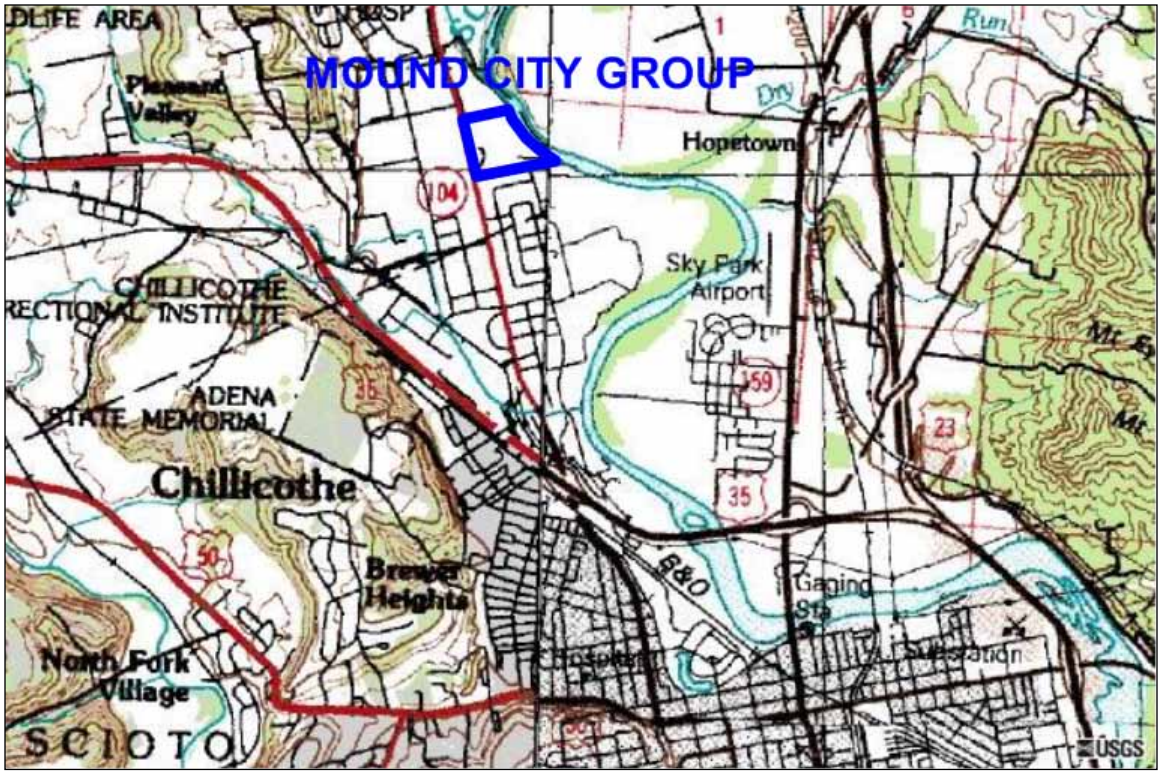


**Figure 1.** Mound City Group location and vicinity

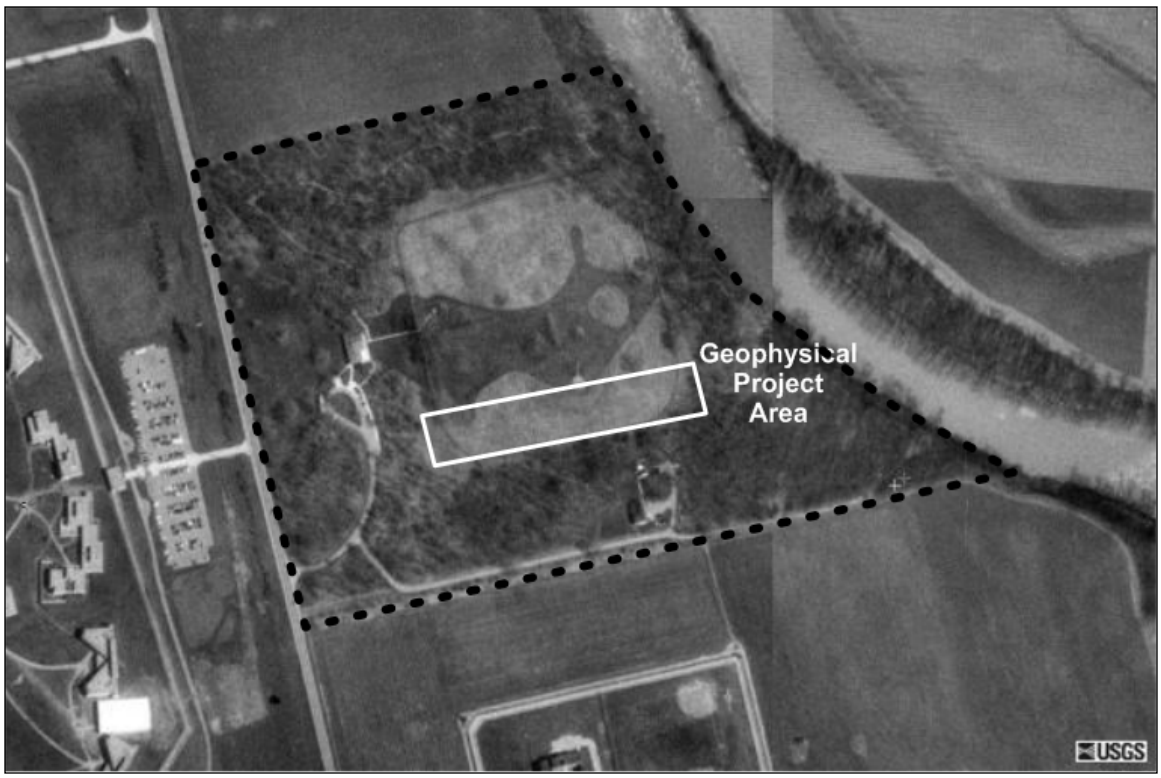


**Figure 2.** Geophysical project location at the Mound City Group.

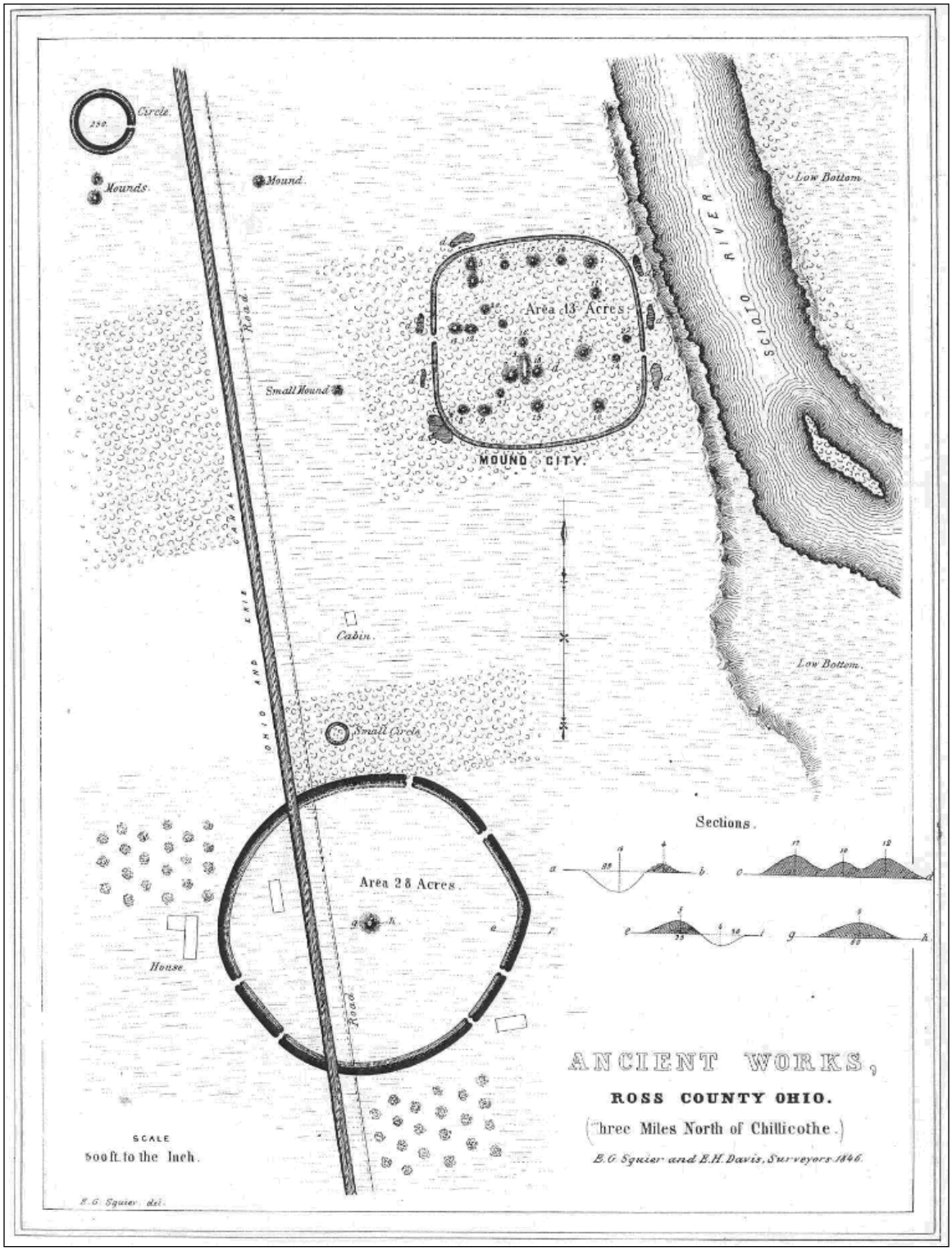


**Figure 3.** 1846 map of the Mound City Group (Squier and Davis 1998).

Squier and Davis investigations of several mounds within the Mound City Group yielded numerous discoveries including over 200 animal effigy pipes. The mounds appeared to be associated with mortuary activities and contained elaborate objects made from exotic raw materials from across the continent. The Schriver family retained ownership of the land and the site until 1917 when the U.S. Government originally leased the land for the construction of an Army training camp but by 1921 had purchase 2,000 acres along State Route 104 north of Chillicothe (Cockrell 1999:29-36; Ohio Historical Society 2005; Ross County Health District 2009). Camp Sherman contained 2,000 buildings that could accommodate two divisions (40,000 men). The camp consisted of barracks, offices, theaters, a hospital, a library, a farm, and a German Prisoner of War camp (Figure 4). In addition to the buildings, the camp had a railroad system and its own utilities system. Following World War I, the camp served as a trade school for the returning veterans. A veterans' hospital was also established at the camp following the war. The camp was closed during the 1920s and the buildings were dismantled. Over the years since the closure of Camp Sherman, the land has become home for the Veterans Affairs Medical Center, the Chillicothe Correctional Institute, Ross Correctional Institute, Unioto Schools, the Gateway Industrial Park, and the Hopewell Culture National Historical Park.

Archeological investigations at the Mound City Group were undertaken by the Ohio State Archaeological and Historical Society in 1920 and 1921 under the direction of William C. Mills and his assistant Henry C. Shetrone (Mills 1922). Of the 24 mounds mentioned by Squier and Davis, Mills was able to relocate only 12 mounds. Several of these mounds had been severely damaged by grading activities for streets and buildings during the construction of Camp Sherman along with the installation of buried utility lines (Figure 5). The archeological examination of these mounds yielded significant information on the Hopewell Culture in the region and lead to a public drive to preserve the mound group (Cockrell 1999:36). In 1923, President Warren G. Harding proclaimed the Mound City Group as a National Monument (Cockrell 1999:36-43). Ownership of the Mound City Group was transferred from the War Department to the State of Ohio shortly after receiving National Monument status (Cockrell 1999:43-49). With the establishment of several works programs under President Franklin Delano Roosevelt, the Mound City Group was transferred from the Ohio state parks to the Federal Government's National Park Service in the late summer of 1933; however, the State of Ohio continued to oversee the park operations until 1946 when the National Park Service took an active role in the management of the national monument (Cockrell 1999:49-70).

Archeological investigations on the Mound City Group ceased after the Mills and Shetrone excavations in 1920 and 1921. Although a significant site for our understanding of Hopewell Culture, archeological investigations at the site did not resume until 1963 when the National Park Service contracted work with Ohio Historical Society' curator of archeology, Raymond S. Baby to rectify the differences between the Squier and Davis survey with the restoration work by Mills and Shetrone (Cockrell 1999:135-142). James A. Brown from the Illinois State Museum served as Baby's onsite project manager throughout the 1963 field season (Brown 1994; Brown and Baby). The 1963 archeological investigations indicated that Mounds 10 and 13 were reconstructed in the wrong place during the 1920's restoration efforts, as well as the entire southern enclosure wall (Faust

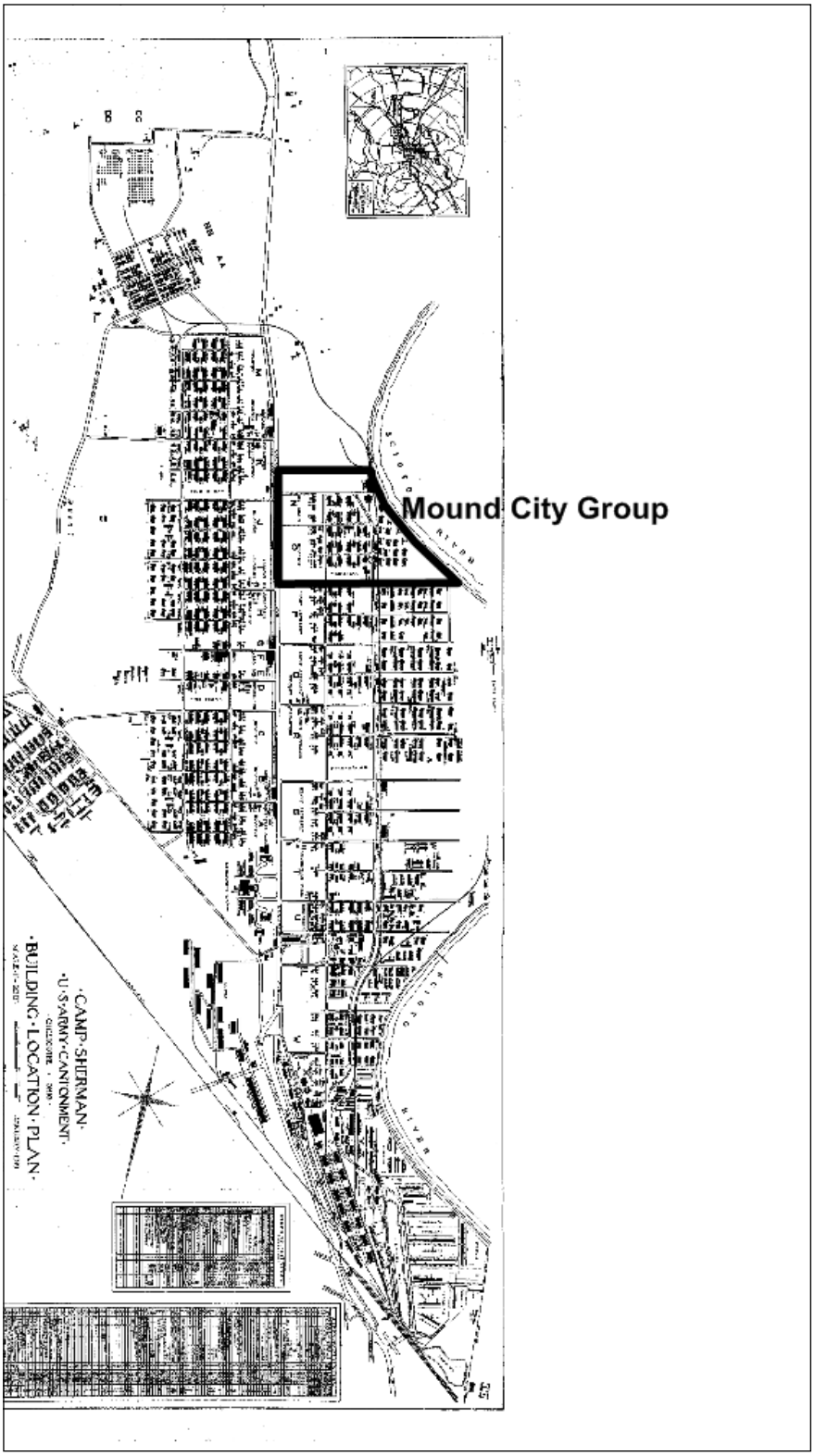


**Figure 4.** Plat map of Camp Sherman indicating location of the Mound City Group.

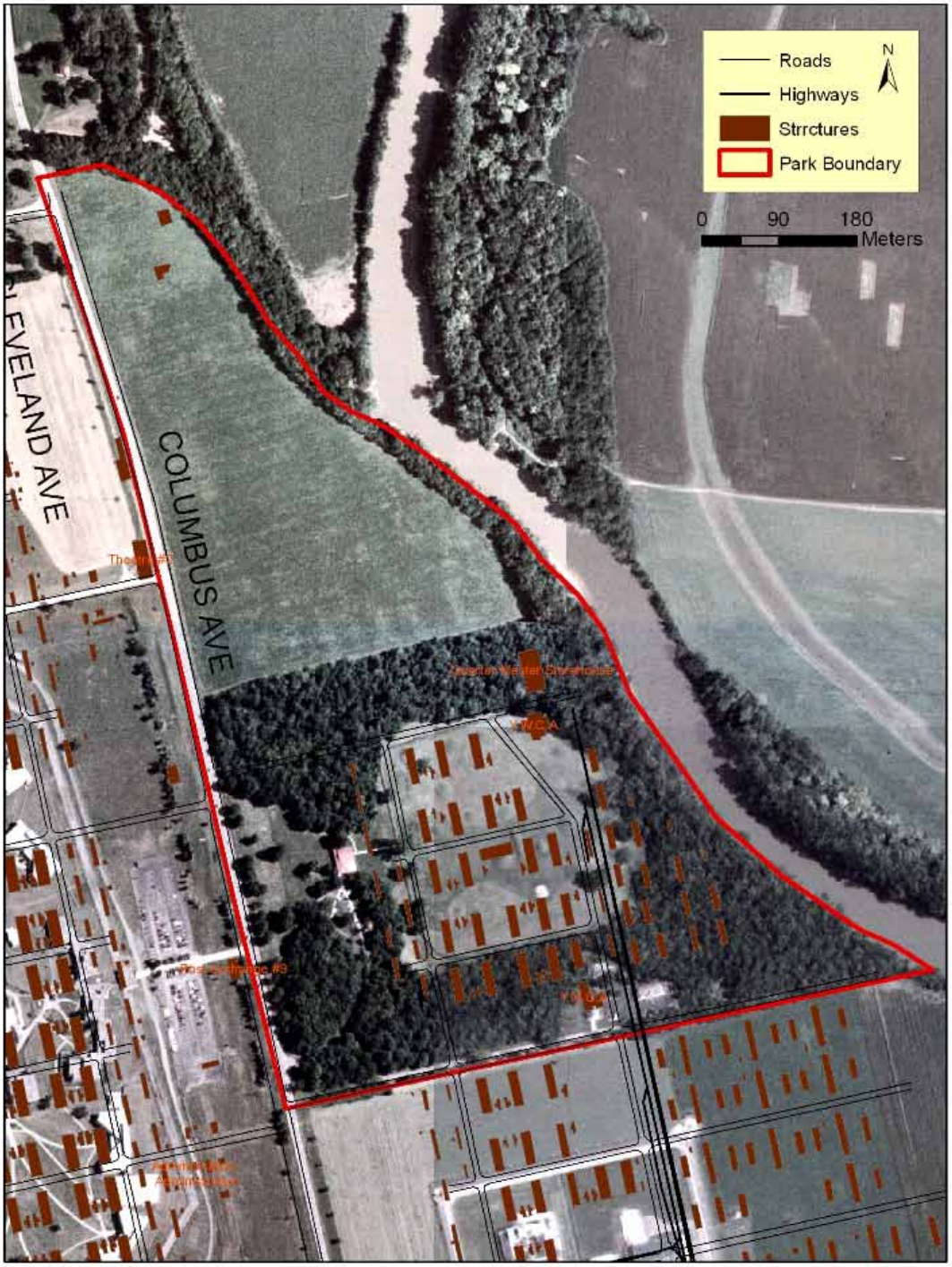


**Figure 5.** Location of Camp Sherman buildings within the Mound City Group.

1963). In 1964, Richard Faust supervised the restoration of Mounds 4 and 5 (Faust 1965). The National Park Service continued to contract with the Ohio Historical Society of archeological restoration of the mounds within the Mound City Group and landscaping modifications to the site through 1975 (Baby 1976; Baby, Bret, and Langlois 1975; Baby and Langlois 1977; Baby, Potter, and Koleszar 1971; Drennen 1972,1974; Hanson 1965,1966a,1966b,1967; Koleszar 1971a,1971b; Otto 1980; Saurborn 1968). A landscaping project was conducted in 1976 by David S. Brose of the Cleveland Museum of Natural History (Brose 1976). The National Park Service through its Midwest Archeological Center and through the park's archeological staff have conducted several inventory and compliance projects at the Mound City Group beginning in the 1980s to the present time along with an administrative history and ethnographic overview and assessment of the park (Cockrell 1999:154-159; Downs et al. 2002; Lynott 1982; Lynott and Monk 1985; Richner 1989). A geophysical project was conducted for the purpose of locating archeological features associated with the burial mounds (Bennett and Weymouth 1981). With the acquisition of the Hopeton Earthworks in 1990 by the National Park Service, efforts were soon in place to expand the Mound City Group National Monument. President George Bush signed Public Law 102-294 authorizing Hopewell Culture National Historical Park on May 27, 1992 (Cockrell 1999:337). Today, the park preserves five earthwork complexes including the original Mound City Group, Hopeton Earthworks, Hopewell Mound Group, Seip Earthworks, and High Bank Works.

## Magnetic Survey Methodology

Geophysical prospection techniques available for archeological investigations consist of a number of techniques that record the various physical properties of earth, typically in the upper couple of meters; however, deeper prospection can be utilized if necessary (Bevan 1998; Weymouth 1986). Geophysical techniques are divided between passive techniques and active techniques. Passive techniques are primarily ones that measure inherently or naturally occurring local or planetary fields created by earth related processes under study (Heimmer and De Vore 2000:55; Kvamme 2001:356,2005:424). The primary passive method utilized in archeology is magnetic surveying. Other passive methods with limited archeological applications include self-potential methods, gravity survey techniques, and differential thermal analysis. Active techniques transmit an electrical, electromagnetic, or acoustic signal into the ground (Heimmer and De Vore 2000:58-59; Kvamme 2001:355-356). The interaction of these signals and buried materials produces altered return signals that are measured by the appropriate geophysical instruments. Changes in the transmitted signal of amplitude, frequency, wavelength, and time delay properties may be observable. Active methods applicable to archeological investigations include electrical resistance/resistivity, electromagnetic conductivity (including ground conductivity and metal detectors), magnetic susceptibility, and ground penetrating radar. Acoustic active techniques, including seismic, sonar, and acoustic sounding, have very limited or specific archeological applications.

A magnetic survey measures the earth's magnetic field at a single point (Aspinall et al. 2008; Bevan 1998:29-43; Weymouth 1986:343). Its application to archeology results from the local effects of magnetic materials on the earth's magnetic field. These anomalous conditions result from magnetic materials and minerals buried in the soil

matrix. Iron artifacts have very strong effects on the local earth's magnetic field. Other cultural features, which affect the local earth's magnetic field, include fire hearths and soil disturbances (e.g., pits, mounds, wells, pithouses, and dugouts), as well as geological strata. Magnetic field strength is measured in nanoteslas. In North America, the earth's magnetic field strength ranges from 40,000 to 60,000 nT with a inclination of approximately 60° to 70° (Weymouth 1986:341). Magnetic anomalies of archeological interest are often in the ±5 nT range, especially on prehistoric sites. Target depth in magnetic surveys depends on the magnetic susceptibility of the soil and the buried features and objects. For most archeological surveys, target depth is generally confined to the upper one to two meters below the ground surface with three meters representing the maximum limit (Clark 2000:78-80; Kvamme 2001:358). Magnetic surveying applications to archeological investigations have included the detection of architectural features, soil disturbances, and artifacts (Bevan 1991; Clark 2000;92-98; Heimmer and De Vore 2000; Weymouth 1986:343).

Two modes of operation for magnetic surveys exist: the total field survey and the gradient survey. The instrument used to measure the magnetic field strength is the magnetometer (Bevan 1998:20). Three different types of magnetic sensors have been used in the magnetometer: 1) proton free precession sensors, 2) alkali vapor (cesium or rubidium) sensors, and 3) fluxgate sensors. The present magnetic survey utilizes a dual fluxgate gradiometer (Figure 6). The fluxgate sensors are highly directional, measuring only the component of the field parallel to the sensor's axis. They also require calibration. The fluxgate gradiometers are capable of high density sampling over substantial areas at a relatively rapid rate of acquisition (Clark 2000:69-71). The dual fluxgate gradiometer sensor configuration of the instrument uses two fluxgate sensor tubes separated by a distance of one meter. The fluxgate sensors in each tube are separated by one

**Figure 6.** Conducting magnetic survey with dual fluxgate gradiometer.

meter. The dual gradiometer records two lines of data during each traverse reducing the distance walked and the survey time by half compared to the time and distance covered with a single gradiometer system. The sensors must be accurately balanced and aligned along the direction of the field component to be measured. The instrument is carried so the two sensors in each tube are vertical to one another with the bottom sensors approximately 30 cm above the ground. Each sensor reads the magnetic field strength at its height above the ground. The gradient or change of the magnetic field strength between the two vertical sensors is recorded in the instrument's memory for both sensor tubes. These gradients are not in absolute field values but rather voltage changes, which are calibrated in terms of the magnetic field. The dual fluxgate gradiometer also provides a continuous record of the magnetic field strength across each line for each traverse across the grid unit.

## Magnetic Data Collection and Interpretation

The survey area (Figure 7) was a rectangular shaped block containing twenty-eight 20-meter by 20-meter grid units measuring 60 meters north-south by 220 meter (east-west). The block was located along the southern part of the Mound City Group inside the perimeter enclosure wall (Figure 8). The grid units were laid out with a total station and wooden stakes were placed at the 20-meter grid unit corners. During the survey, 20-meter ropes were placed between the wooden corner stakes on the north and

**Figure 7.** General view of magnetic survey area.

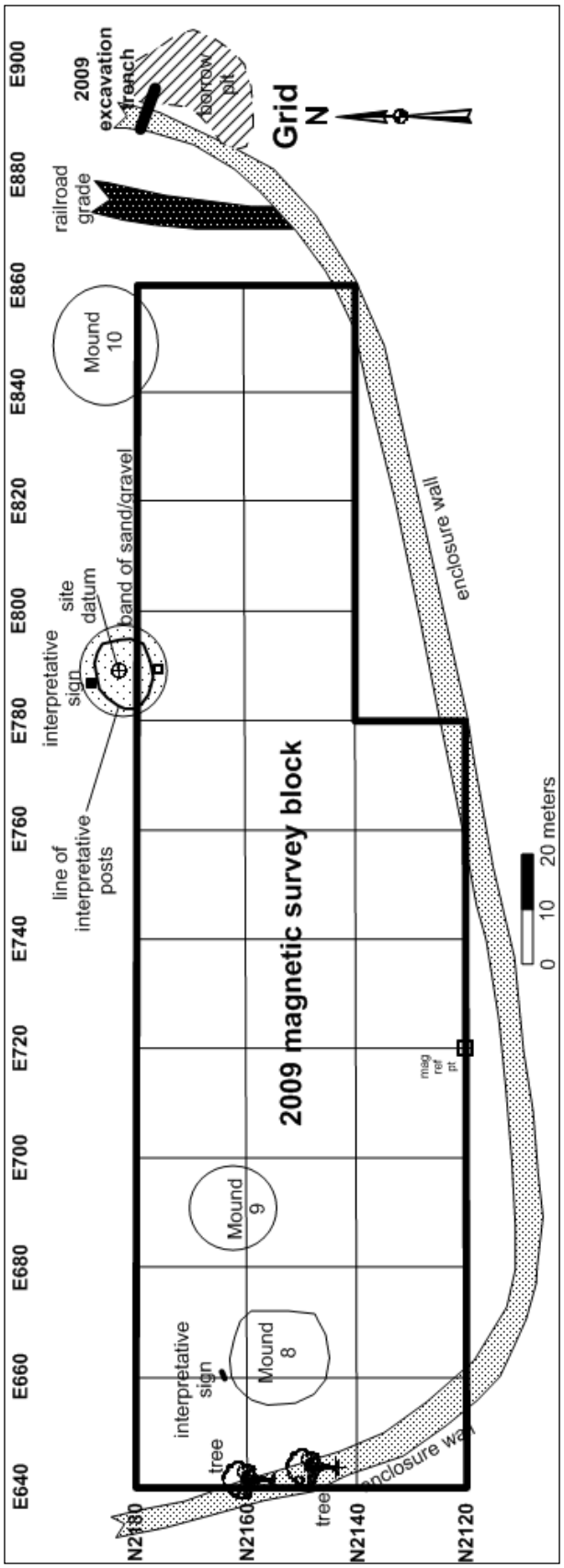


**Figure 8**. Magnetic survey grid.

south sides of the grid units to form a boundary for the data collection. Additional survey ropes were placed at 2.0-meter intervals across the grid units between the boundary ropes to serve as guides during the collection of the magnetic data. The magnetic survey for the dual fluxgate gradiometer is designed to collect eight samples per meter along 1.0-meter traverses or eight data values per square meter. The data were collected in a zigzag fashion with the surveyor alternating the direction of travel along each traverse across the grid. The reference point for balancing and aligning the dual gradiometer was located at N2120/E720 and the instrument is aligned on Magnetic North. The magnetic data were downloaded from the dual fluxgate gradiometer at the end of each day to a field laptop computer for processing.

Processing of geophysical data requires care and understanding of the various strategies and alternatives. The following series of common steps are used in computer processing of geophysical data (Kvamme 2001:365):

*Concatenation* of the data from individual survey grids into a single composite matrix;
*Clipping and despiking* of extreme values (that may result, for example, from introduced pieces of iron in magnetic data);
*Edge matching* of data values in adjacent grids through balancing of brightness and contrast (i.e., means and standard deviations);
*Filtering* to emphasize high-frequency changes and smooth statistical noise in the data;
*Contrast enhancement* through saturation of high and low values or histogram modification; and
*Interpolation* to improve image continuity and interpretation.

It is also important to understand the reasons for data processing and display (David et al. 2008:45-49; Gaffney et al. 1991:11). They enhance the analyst's ability to interpret the relatively huge data sets collected during the geophysical survey. The type of display can help the geophysical investigator present his interpretation of the data to the archeologist who will ultimately use the information to plan excavations or determine the archeological significance of the site from the geophysical data.

Upon completion of the magnetic survey with the dual fluxgate gradiometer system at the HOCU geophysical project area, the individual grid data files were assembled into a composite file. The data were first destriped to remove any traverse discontinuities that may have occurred from operator handling or heading errors. Upon completion of the destripe function, the data were interpolated by expanding the number of data points in the traverse direction and by reducing the number of data points in the sampling direction to provide a smoother appearance in the data set and to enhance the operation of the low pass filter. This changed the original 8 x 1 data point matrix into a 4 x 4 data point matrix. The low pass filter was then applied over the entire data set to remove any high frequency, small scale spatial detail. This transformation resulted in the improved visibility of larger, weak archeological features. An image map of the dual fluxgate gradiometer data was generated for the survey grid area (Figure 9).

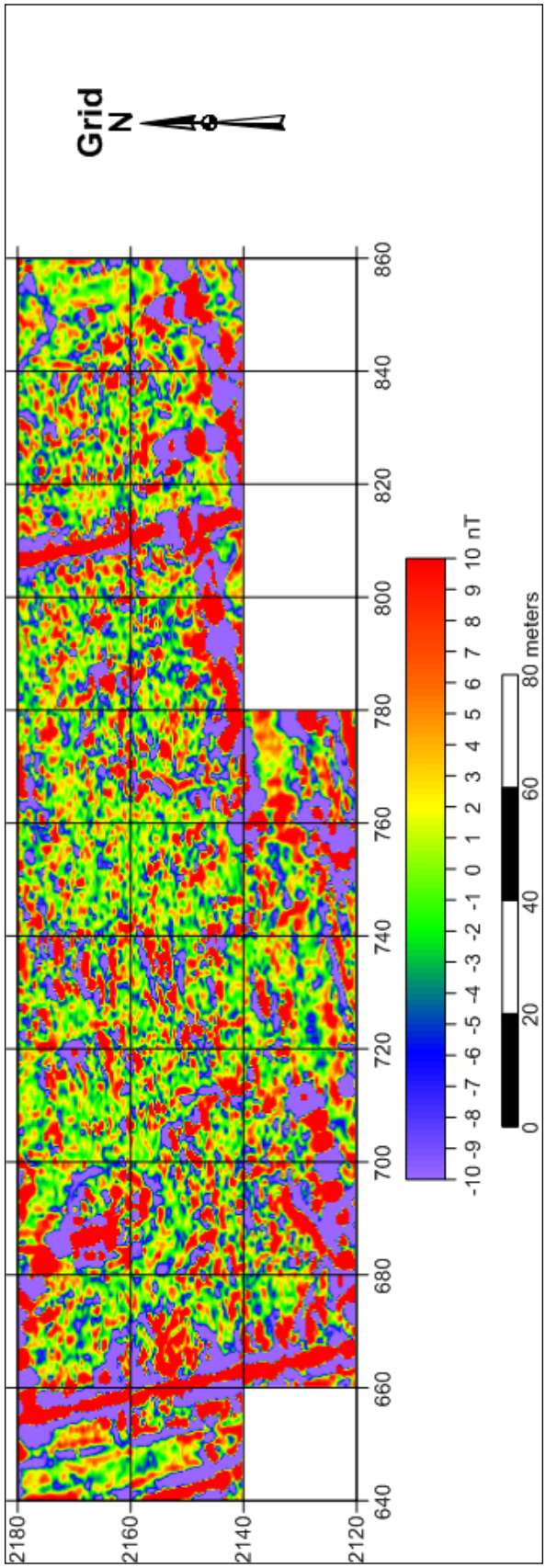


**Figure 9.** Image of the magnetic survey data.

Andrew David (1995:30) defines interpretation as a "holistic process and its outcome should represent the combined influence of several factors, being arrived at through consultation with others where necessary." Interpretation may be divided into two different types consisting of the geophysical interpretation of the data and the archaeological interpretation of the data. At a simplistic level, geophysical interpretation involves the identification of the factors causing changes in the geophysical data. Archeological interpretation takes the geophysical results and tries to apply cultural attributes or causes. In both cases, interpretation requires both experience with the operation of geophysical equipment, data processing, and archeological methodology; and knowledge of the geophysical techniques and properties, as well as known and expected archeology. Although there is variation between sites, several factors should be considered in the interpretation of the geophysical data. These may be divided between natural factors, such as geology, soil type, geomorphology, climate, surface conditions, topography, soil magnetic susceptibility, seasonality, and cultural factors including known and inferred archeology, landscape history, survey methodology, data treatment, modern interference, etc. (David 1995:30; David et al. 2008:49). It should also be pointed out that refinements in the geophysical interpretations are dependent on the feedback from subsequent archeological investigations. The use of multiple instrument surveys provides the archeologist with very different sources of data that may provide complementary information for comparison of the nature and cause (i.e., natural or cultural) of a geophysical anomaly (Clay 2001). Each instrument responds primarily to a single physical property: magnetometry to soil magnetism, electromagnetic induction to soil conductivity, resistivity to soil resistance, and ground penetrating radar to dielectric properties of the soil to (Weymouth 1986:371).

Interpretation of the magnetic data (Bevan 1998:24) from the project requires a description of the buried archeological feature of object (e.g., its material, shape, depth, size, and orientation). The magnetic anomaly represents a local disturbance in the earth's magnetic field caused by a local change in the magnetic contract between buried archeological features, objects, and the surrounding soil matrix. Local increases or decreases over a very broad uniform magnetic surface would exhibit locally positive or negative anomalies. Magnetic anomalies tend to be highly variable in shape and amplitude. They are generally asymmetrical in nature due to the combined effects from several sources. To complicate matters further, a given anomaly may be produced from an infinite number of possible sources. Depth between the magnetometer and the magnetic source material also affect the shape of the apparent anomaly. As the distance between the magnetic sensor on the magnetometer and the source material increases, the expression of the anomaly becomes broader. Anomaly shape and amplitude are also affected by the relative amounts of permanent and induced magnetization, the direction of the magnetic field, and the amount of magnetic minerals (e.g., magnetite) present in the source compared to the adjacent soil matrix. The shape (e.g., narrow or broad) and orientation of the source material also affects the anomaly signature. Anomalies are often identified in terms of various arrays of dipoles or monopoles. A magnetic object in made of magnetic poles (North or positive and South or negative). A simple dipole anomaly contains the pair of opposite poles that relatively close together. A monopole anomaly is simply one end of a dipole anomaly and may be either positive or negative depending on the orientation of the object. The other end is too far away to have an effect on the magnetic field.

Magnetic anomalies of archeological objects tend to be approximately circular in contour outline. The circular contours are caused by small size of the objects. The shape of the object is seldom revealed in the contoured data. The depth of the archaeological feature or object can be estimated by half-width rule procedure and an approximate mass can be calculated along with the location of the center of the anomaly (Bevan 1998:23-24). It is likely that the depth and mass estimates are too large rather than too small. Archeological features are seldom compact but spread out in a line or lens. The archaeological material may be composed of something other than iron such as fired earth or volcanic rock. Such materials are not usually distinguishable from the magnetic data collected during the survey (Bevan 1998:24). The depth and mass of features comprised of fired earth, like that found in kilns, fireplaces, or furnaces could be off by 100 times the mass of iron. If the archeological feature were comprised of bricks (e.g., brick wall, foundation, or chimney), estimates could be off by more than a 1000 times that of iron. One should also be cautious of geophysical anomalies that extend in the direction of the traverses since these may represent operator-induced errors. The magnetic gradient anomalies may be classified as three different types: linear, 2) dipole, and 3) monopole.

The first step in interpreting the magnetic anomalies from the project area is to identify areas of high magnetic contrast and, especially, the positive magnetic anomalies or the North pole of the dipole and then try to determine the causes of contrasts.. The results of the magnetic survey indicated the presence of numerous magnetic anomalies associated with the Hopewell occupation and twentieth disturbances from World War I activities associated with Camp Sherman (Figure 10). Mounds 8, 9, and 10 are visible in the magnetic data along with streets and buried utilities associated with Camp Sherman. Overlaying the locations of the World War I buildings on the magnetic data resulted in the association of several magnetic anomalies with the Camp Sherman facilities; however, other groupings of magnetic anomalies suggest the presence of Hopewellean features at the site including possible mound remnants or activities areas and possible habitation structures.

## Conclusions

During a three day period, twenty-eight 20-m by 20-m grid units were surveyed with a dual fluxgate gradiometer. The magnetic survey covered 11,200 $m^2$ or 2.77 acres in the southern part of the Mound City Group (Site 32RO32) in Ross County, Ohio. Over all, the magnetic survey resulted in significant information related to the presence of buried archeological resources within the southern part of the Mound City Group and to the extent of the disturbances created by the construction of Camp Sherman. Further ground truthing activities are needed to determine the nature of these magnetic anomalies. The potential for acquiring additional geophysical information about the nature and extent of the buried archeological resources at the site is extremely high and will provide an invaluable baseline data set for future archeological research at the Mound City Group.

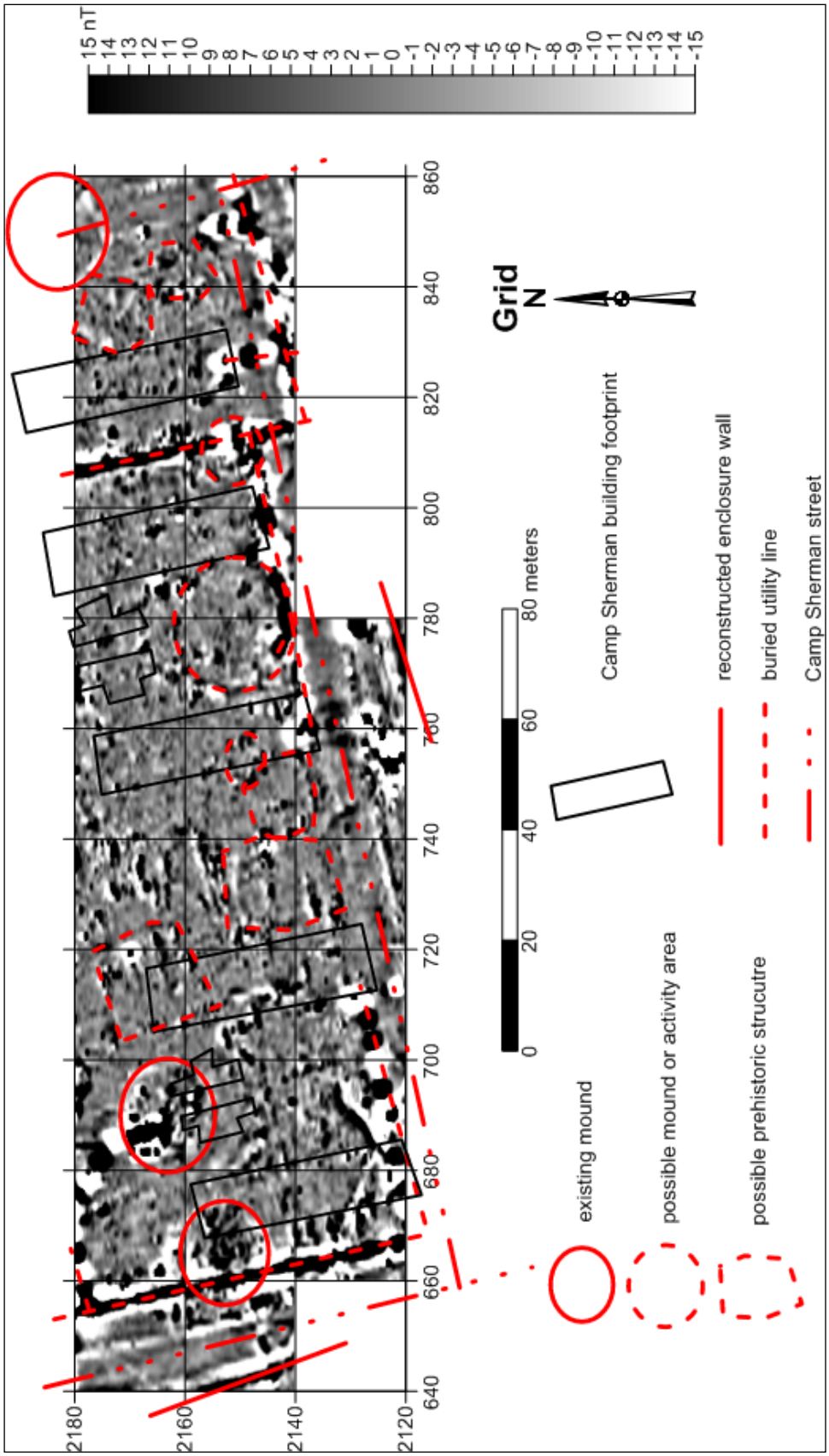


**Figure 10.** Interpretation of the magnetic data.

## References

Aspinall, Arnold, Chris Gaffney, and Armin Schmidt
2008. *Magnetometry for Archaeologists*. AltaMira Press, Lanham, Maryland.

Bevan, Bruce W.
1998. *Geophysical Exploration for Archaeology: An Introduction to Geophysical Exploration*. Special Report No. 1. Midwest Archeological Center, Lincoln, Nebraska.

Brose, David S.
1976. An Archaeological Testing beyond the Walls of the Mound City Group, Ross County, Ohio. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Baby, Raymond S.
1976. Excavation of Sections 01 and 02 of Mound City Group National Monument. Ms. on file, Ohio Historical Society, Columbus.

Baby, Raymond S, Bert C. Drennen III, and Suzanne M. Langlois
1975. Excavation of Section M1 and M2, Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Baby, Raymond S., and Suzanne M. Langlois
1977. Excavation of Sections 01 and 02 Mounds 8 and 9, Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Baby, Raymond S., Martha A. Potter, and Stephen C. Koleszar
1971. Excavation of Sections I and J, Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Bennett, Connie, and John Weymouth
1981. Analysis of a Magnetic Survey of Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Brown, James, A., and Raymond S. Baby
1966. Mound City Revisited. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Brown, James A.
1994. Inventory and Integrative Analysis: Excavations of Mound City, Ross County, Ohio: Overview of Archaeological Investigations of the Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Clark, Anthony
2000. *Seeing Beneath the Soil: Prospecting Methods in Archaeology*. Reprint. Routledge, London. Originally published in 1990 by B. T. Batsford, Ltd., London.

Cockrell, Ron
1999. *Amidst Ancient Monuments: The Administrative History of Mound City Group National Monument/Hopewell Culture National Historical Park, Ohio*. National Park Service, Omaha, Nebraska.

David, Andrew
1995. *Geophysical Survey in Archaeological Field Evaluation*. Research & Professional Services Guidelines No. 1. Ancient Monuments Laboratory, English Heritage, London.

David, Andrew, Neil Linford, and Paul Linford
2008. *Geophysical Survey in Archaeological Field Evaluation*. Second Edition. Research & Professional Services Guidelines No. 1. Ancient Monuments Laboratory, English Heritage, London.

Downs, Michael A., Rebecca A. Hawkins, Betsy R. Strick, and N'omi Greber
2002. *Ethnographic Overview and Assessment: Hopewell Culture National Historical Park*. EDAW/KEA Environmental, Inc., San Diego, California.

Drennen, Bert C., III
1972. Mound City Group National Monument Examination and Restoration of Embankment. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

1974. Excavation of Section L, Mound 15, Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Faust, Richard D.
1963. A Review of the APW-2 Program, 1963. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

1965. Investigations at the Site of Mound 4, Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Gaffney, Chris, John Gater, and Sue Ovenden
1991. *The Use of Geophysical Techniques in Archaeological Evaluations*. Technical Paper Number 9. Institute of Field Archaeologists, University of Birmingham, Birmingham, England.

Hanson, Lee H., Jr.
1965. Excavation of Section F, Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

1966a. Excavation of Section B, The East Gateway at Mound City Group National Monument. Ms on file, National Park Service, Philadelphia, Pennsylvania.

1966b. Excavation of the Borrow Pit, Section F, Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

1967. Concrete Walk, Mound City Group National Monument, Archeological Investigations Report. Memorandum on file, Hopewell Culture National Historic Site, Chillicothe, Ohio.

Heimmer, Don H. and Steven L. De Vore
2000. Near-Surface, High Resolution Geophysical Methods for Cultural Resource Management and Archaeological Investigations. In *Science and Technology in Historic Preservation*, edited by Ray A. Williamson and Paul R. Nickens, pp. 53-73. Advances in Archaeological and Museum Science, Volume 4. Kluwer Academic/Plenum Publishers, New York.

Koleszar, Stephen C.
1971a. Excavation T, the Mound City Group, 1970, Mounds #6, 20, and 24. Ms. on file, Ohio Historical Society, Columbus.

1971b. A Preliminary Report of the Excavation of Mound 12, Mound City Group National Monument. Ms. on file, Ohio Historical Society, Columbus.

Kvamme, Kenneth L.
2001. Current Practices in Archaeogeophysics: Magnetics, Resistivity, Conductivity, and Ground-Penetrating Radar. In *Earth Sciences and Archaeology*, edited by Paul Goldberg, Vance T. Holliday, and C. Reid Ferring, pp. 353-384. Kluwer Academic/Plenum Publishers, New York.

Lynott, Mark J.
1982. An Archeological Investigations of an Area Adjacent to Mound City Group National Monument: A Preliminary Report. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

2004. Earthwork Construction and the Organization of Hopewell Society. *Hopewell Archeology: The Newsletter of Hopewell Archaeology in the Ohio River Valley* 6(1). http://www.nps.gov/history/mwac/hopewell/v6n1/six.htm.

Lynott, Mark J., and Susan M. Monk
1985. *Mound City, Ohio, Archeological Investigations*. Occasional Studied in Anthropology No. 12. Midwest Archeological Center, Lincoln, Nebraska.

Lynott, Mark, and John Weymouth
2002. Preliminary Report, 2001 Investigations, Hopeton Earthworks. *Hopewell Archeology: The Newsletter of Hopewell Archaeology in the Ohio River Valley* 5(1). http://www.nps.gov/history/mwac/hopewell/v5n1/one.htm.

Mills, William C.
1922. Exploration of the Mound City Group. *Ohio Archaeological and Historical Publications* 31:422-584.

Ohio Historical Society
2005. Camp Sherman. *Ohio History Central*, July 1, 2005, http://www.ohiohistorycentral.org/entry.php?rec=670.

Otto, Martha Potter (editor)
1980. Excavation of Mounds 12, 11, and 16, Mound City Group National Monument, Chillicothe, Ohio. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Richner, Jeffery J.
1989. An Archeological Survey of a Proposed Sewer Line at Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Ross County Health District
2009. *Walking Map and Guide to Chillicothe's Past: Camp Sherman*. Ross County Health District, Chillicothe, Ohio.

Saurborn, Barbara S.
1968. A Re-examination of Mounds 23 and 17, Unit H, Mound City Group National Monument. Ms. on file, Midwest Archeological Center, Lincoln, Nebraska.

Squier, Ephraim G., and Edwin H. Davis
1998. *Ancient Monuments of the Mississippi Valley Comprising the Results of Extensive Original Surveys and Exploration*. Reprint. Smithsonian Institute Press, Washington D.C. Originally published in 1847 by the Smithsonian Institute.

Weymouth, John W.
1986. Geophysical Methods of Archaeological site Surveying. In *Advances in Archaeological Method and Theory, Volume 9*, edited by Michael B. Schiffer, pp. 311-395. Academic Press, Orlando, Florida.

Willey, Gordon R.
1966. *An Introduction to American Archaeology: Volume One North and Middle America*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.