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Miami Fort: An Ancient Hydraulic Structure


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Committee Chair signature: Ken Tankersley
Miami Fort: An Ancient Hydraulic Structure

A thesis submitted to the
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Marianne R. Ballantyne
B.A., University of Toledo 2007

Committee: Kenneth B. Tankersley, Chair
Vernon L. Scarborough
ABSTRACT

Miami Fort, located in southwestern Ohio, is a multicomponent hilltop earthwork approximately nine kilometers in length. Detailed geological analyses demonstrate that the earthwork was a complex gravity-fed hydraulic structure, which channeled spring waters and surface runoff to sites where indigenous plants and cultigens were grown in a highly fertile but drought prone loess soil. Drill core sampling, x-ray diffractometry, high-resolution magnetic susceptibility analysis, and radiocarbon dating demonstrate that the earthwork was built after the Holocene Climatic Optimum and before the Medieval Warming Period. The results of this study suggest that these and perhaps other southern Ohio hilltop earthworks are hydraulic structures rather than fortifications.
ACKNOWLEDGEMENTS

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Chapter 1
Introduction

For two hundred years, Ohio archaeologists have struggled to explain the function and meaning behind the phenomena of earthen mounds, embankments, and shapes constructed by prehistoric peoples. Investigators have attempted to draw meaning from nearly every facet of the earthworks, such as searching for meaningful patterns in their sizes and shapes of the earthworks (Romain 1996), exploring evidence that they may have been used for ritual or ceremonial purposes (Moorehead 1929; Morgan 1951), or arguing for the existence of a warlike ancient military nation based on their putative function (Fowke 1902; Moorehead 1929; Riordan 1996; Squier and Davis 1848; Whittlesey 1871). More recently, some researchers have proposed that earthworks, especially hilltop enclosures, served the more practical purpose of controlling water for agricultural and domestic use (Connolly 1996; Tankersley 2007, 2008b). The intent of this thesis is to contribute to the discussion by arguing for the role of hilltop earthworks as ancient water management systems based on recent data collected from the Miami Fort site.

The principal interpretation dominating the archaeological literature of Miami Fort postulates that the earthworks were military defensive fortifications built by peoples of the Hopewell tradition, spanning a period from about A.D. 200 to about A.D. 500. This conclusion is based on $^{14}$C samples obtained from sub-earthwork features assumed to be associated with earthwork construction, enclosed hilltop perimeters and indications of large-scale burning (Lepper 1996, Riordan 1996).

The assertions mentioned are problematic for numerous reasons. Sub-earthwork data do not necessarily dictate temporal or contextual conditions of phenomena situated above them stratigraphically, moreover the law of superposition does not imply continuity through the ages.
The defensive scheme interpretation of the earthen enclosure evidenced by the burning phenomena is problematic because multiple processes can reach the same end result; therefore equifinality cannot be ignored. Chapter 3 of this thesis identifies at least five different hypotheses for the function of earthen enclosures, all of which could result in the same or similar archaeological phenomenon. Modern era investigators also continue to use antiquated nineteenth century maps that contain numerous inaccuracies and stylized modifications (Riordan 1996). Puzzling features that do not fit into the fortifications explanation such as “borrow pits” and ditches, too small to account for the amount of soil used in the mounds and embankments, are simply left out of the site maps (Connolly 1996).

The University of Cincinnati conducted an investigation during the 2008 field season at the site of Miami Fort and the nearby site of Twin Mounds Village (33Ha24) in southwest Ohio that included excavation, survey, drill core sampling, magnetic susceptibility, x-ray diffraction, and radiocarbon dating in order to gauge the spatial and temporal significance of the site within the Shawnee Lookout Archaeological District. The research problem was to test a new hypothesis that rather than defensive fortifications, as Miami Fort was historically described, the complex of mounds, depressions, and earthen embankments actually represented an ancient water management system. The paleoclimate data, magnetic susceptibility and x-ray diffractometry data in conjunction with radiocarbon dates, suggest that the hydraulic structure was utilized during cold and dry periods when water was scarcer making the management of renewable sources of water necessary.

Miami Fort is located at the confluence of the Ohio and Great Miami rivers of Southwest Ohio in Shawnee Lookout Park of Hamilton Country. Figure 1 spatially orients Miami Fort within the United States as well as positions the earthworks within the boundaries of the park.
The features represented at the park-level map are the result of the GPS survey conducted by this study. Miami Fort is one of several hilltop earthworks’ sites in the Ohio River Valley that have been interpreted as military defensive fortifications for more than two centuries. The archaeological literature of the twentieth and twenty-first century is rife with interpretation-laden names like Miami Fort, Fort Ancient, Fort Hill, and Indian Fort, reflecting the antiquated nomenclature of the eighteenth and nineteenth century. This problem of interpretation is due, in part, to ethnocentric bias as well as early assessment based on personal experience supported by the fact that most early explorations of the Northwest Territory were military in nature. Given that the first investigators of these southern Ohio sites were almost exclusively males with a military background, it follows that their knowledge of military defensive strategy above all else would have colored their interpretations. Archaeologists over the last two centuries have little questioned this theory until only recently.

Archaeologists willing to explore alternative hypotheses at Miami Fort have criticized the descriptions of security walls, gates, and borrow pits as too simplistic (Connolly 1996). In the past 15 years, a hydraulic model has been introduced as an alternative hypothesis to explain the archaeological phenomena at Miami Fort, Fort Ancient and other Ohio hilltop enclosure sites. Tankersley (2007, 2008) and Connolly (1996) propose that the placement of the mounds and embankments in conjunction with anthropogenic ponds might have been constructed for catching and storing surface run-off water in reservoirs; furthermore the presence of fired clay at specific locations historically called “gates” suggest that the features might have actually functioned as dams for holding water. Water management as a factor in site formation and subsistence strategies has been largely underrepresented in descriptions of both modern and ancient societies in terms of how controlling water often entails dramatic alteration of the original landscape, with
a few notable exceptions (Connolly 1996; Scarborough 2003). This may be indirectly derived from a contemporary bias that many archaeologists possess, in which inhabitants of developed nations often take access to water for granted, making water logistics a low priority among research interests. For more than two centuries, ancient sustainable hydraulic systems around the world have gone unrecognized, mistakenly identified as defensive structures (Scarborough 2003b; Tankersley 2008b).

The purpose of this study is to re-examine the function of earthworks from a modern theoretical perspective by considering alternative hypotheses and employing a diverse set of materials and methods. It can be effectively argued, based on modern mapping techniques, radiocarbon dates obtained directly from the earthworks themselves, and environmental indicators of the paleoclimate record, that the hilltop earthworks at Miami Fort are neither fortifications in function nor Hopewell in origin. The strength of archaeological interpretations is based on the observation of physical evidence and not on assumptions derived from antiquated theory and personal bias, therefore a fortifications theory must be substantiated by specific observable physical markers in the archaeological record. If the physical evidence is not consistent with our expectations, then alternative hypotheses require consideration. This study aims to explore the function of earthworks in terms of water management, based on a set on expectations associated with water management behavior.
Figure 1. Shawnee Lookout Park within the United States.
Chapter 2
History of Archaeological Research

Early History

Miami Fort’s history as a fortified hilltop within the archaeological literature began in the late eighteenth century when Henry Lytle and Andrew Porter mapped the complex of earthworks because they were thought to be Shawnee military fortifications. Lytle and Porter were the first of several men who observed the shape and position of the earthworks and stated that they were likely to have been used for defensive purposes (Harrison 1839; Squier and Davis 1848).

About 40 years later, William Henry Harrison, who was a local area resident, named the site “Miami Fortress.” Harrison, having had military encounters with the Shawnee people, denied that indigenous people could have built the earthworks, and instead thought they were built by the Aztec. He published his postulations in a paper delivered to the Historical and Philosophical Society of Ohio (Harrison 1839). Squier and Davis (1848) were the first to suggest that the earthworks were a “fortified hill” of ancient but non-indigenous origin, sharing Harrison’s opinion that the ancestors of Shawnee people were not the builders.

Despite the inaccuracies, the map continued to be used by subsequent investigators who did not question the defensive function. The first test excavations at Miami Fort were conducted by Warren K. Moorehead in 1890 (Dalby 2007). Moorehead (1929) had also directed the expedition that discovered first evidence of an archaeological assemblage known as the Hopewell tradition on the property of C.M. Hopewell, and he believed that the Miami Fort earthworks were built by the same people. Whittlesey (1871) believed the “fort builders” belonged to an ancient military nation.
Fowke (1902) supported the views of the previous investigators; however he was puzzled by the absence of water at the site. This was the first time the subject of water ever appeared in the Miami Fort literature. Fowke renamed the site “Fort Miami,” but the name was changed again to “Miami Fort” to prevent confusion with other historic forts also named Fort Miami. In his description, he mentioned two mounds located on a ridge a few hundred yard east of the fortification, and it was very likely that he was describing the Twin Mounds (Bennett 1986).

**Modern Era**

The fortifications theory persisted into the twentieth century, and by the 1950’s it was generally accepted among archaeologists that the earthworks were built by ancient indigenous people characterized by a common material culture known as the Hopewell tradition. Morgan (1952) suggested that the earthworks might also have been used as ceremonial centers, integrating practical and ritual functions.

In 1958, S. Frederick Starr conducted a survey of archaeological sites in Hamilton County and published his results in 1960. Although there were two distinct occupation zones associated with the Twin Mounds, he classified them both under one site name and number (Hawkins 1986; Kaltenthaler 1992). Today those zones are named Twin Mounds Village East and Twin Mounds Village West.

The land around Miami Fort and Twin Mounds Village was donated to the Hamilton County Park Board by the Cincinnati Gas & Electric Company in 1966 and was turned into Shawnee Lookout (Dalbey 2007). Since that acquisition, the site has been protected from development and allowed to return from agricultural land to forest. The lack of development has been fortunate for archaeologists because the cultural materials have been preserved from further
destruction, and the environment has been restored to a state that would have been similar to prehistoric conditions. Today the park is covered with young deciduous forest with thick underbrush. The environment provides numerous edible plant species, especially nut and fruit bearing trees like black walnut, hickory, and pawpaw, which were likely exploited by prehistoric peoples.

The first modern era excavations were conducted by Fred Fischer (1965, 1966, 1968, 1969, 1970; Dalbey 2007) of the University of Cincinnati, who directed a field school at Twin Mounds Village. He conducted an archaeological survey as a development plan for the park, in which twenty sites were located and noted along the park trails (Fischer 1968, Dalbey 2007). In 1967, he opened a single 1.6 by 1.3 meter test unit near the center of Twin Mounds Village East and returned the following year to expand the excavation to 24.5 square meters (Hawkins-Bennett 1986). Fischer concluded that Twin Mounds Village East represented a Middle or Late Archaic occupation. In 1969, he excavated Twin Mounds Village West where he uncovered the post mold pattern of a Middle Woodland house (Bennett 1986). The 1970 field season was focused primarily on the house feature and three randomly chosen 10 square foot units.

The university continued to conduct archaeological investigations in the 1970’s, directed by Fischer’s successor Kent Vickery. Three graduate students under Vickery published master’s theses from Twin Mounds data. Lee (1972) explored the Archaic components of the site, Bennett (1986) integrated ceramics data from the Twin Mounds and Hopewell sites, and Kaltenthaler (1992) provided an analysis of chert debitage and tools.

Lee’s (1972) main objective was to report on the archaic assemblages recovered by Fischer’s 1968 excavation of Twin Mounds Village. The artifacts were classified according to functional categories including general utility, weapons, and fabricating or processing tools. He
concluded that Twin Mounds Village may have been part of a wider seasonal settlement pattern encompassing multiple southwest Ohio sites, including Maple Creek, Raisch-Smith, and McWhinney sites. Lee focused on the importance of including multiple contemporaneous sites in the study of seasonally nomadic populations, and asserted that the investigation of a singular site provides incomplete information about seasonally nomadic people.

Bennett (1986) addresses a handful of specific research questions in her master’s thesis. Her primary purpose was to address the problems in chronological classification of ceramic wares at Twin Mounds Village and Hopewell that did not appear to fall into any distinct category and had fallen into general Middle Woodland by default. One research problem was to determine if the Middle Woodland period in the region was characterized by a distinct cultural tradition. Furthermore, she wanted to determine if the ceramic assemblages showed evidence of spatial patterning, multi-component occupation, or culture change between components. Hawkins concluded, according to statistically significant changes in sample composition, that there were at least three different phases of Middle Woodland habitation. She also asserts that inhabitants of Twin Mounds Village during the Middle Woodland period participated in the Hopewell interaction sphere while maintaining a regional identity.

Kaltenthaler (1992) attempted to determine chert procurement strategies, detect discrete spatial areas of chipped stone tool manufacture and use, and identify cultural components at Twin Mounds Village. She believed that information on this site would be useful for developing a settlement pattern model for the sites within the Hopewell sphere, given that very few reports on sites of this type had been published. The sources of chert were nearby streams and glacial deposits, local outcrops, and Harrison County flint. Some degree of spatial patterning was detected at the site; tool debitage was found primarily around the outer units of site away from
the house feature. It was also concluded that there were no discernible differences in the chert assemblage between three occupation layers suggesting that they occurred within a short span of time.

In 2008, Ken Tankersley (2008a) of the University of Cincinnati conducted the first investigation to explore a hydraulic hypothesis at Miami Fort. Creating an updated and accurate map of the site with a focus on the spatial orientation of proposed hydraulic features was his foremost priority in order to avoid any erroneous assumptions derived from earlier mapping efforts. Considerable emphasis was also placed on developing an accurate paleoclimate record in order understand cultural activities in relation to environmental and climatological conditions. The field notes and data collected in 2008 are the basis for this thesis.

Mapping History

This study is unique not only with regards to its research problem, but also it supplies a radiocarbon age temporal framework as well as a precise geographic spatial framework that no previous study has provided. The problem of creating an accurate site map, due to the limitations of technology in the nineteenth and twentieth centuries, and coupled with the alteration of maps to strengthen a preferred hypothesis, have likely hindered the development of truly objective and viable interpretations.

Figure 2 is a nineteenth century map of Miami Fort that appeared in Squier and Davis’ *Ancient Monuments of the Mississippi Valley* (1848). Certain liberties were taken with the shape of the earthwork to give the impression of a military fort. The closed off rounded tips of earthwork in the northeast section of the map do not actually exist and were added in by the
When the map is georeferenced on a modern GIS map, numerous inaccuracies are apparent.

Figure 2. Nineteenth century Miami Fort map (Squier and Davis 1848)
Figure 3. Archaeological sites identified by aerial survey in 1968.
## Table 1. Archaeological sites as of 1968.

<table>
<thead>
<tr>
<th></th>
<th>Site</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
<td>33Ha62 sub-mound village</td>
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</tr>
<tr>
<td>3</td>
<td>33Ha62, mound No. 1</td>
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</tr>
<tr>
<td>4</td>
<td>33Ha62, mound No. 2</td>
<td>Mound</td>
</tr>
<tr>
<td>5</td>
<td>33Ha62, western village area</td>
<td>Habitation</td>
</tr>
<tr>
<td>6</td>
<td>33Ha62, Fort Miami</td>
<td>Enclosure</td>
</tr>
<tr>
<td>7</td>
<td>33Ha62, eastern village area</td>
<td>Habitation</td>
</tr>
<tr>
<td>8</td>
<td>Site 8</td>
<td>Berm</td>
</tr>
<tr>
<td>9</td>
<td>Site 9</td>
<td>Berm</td>
</tr>
<tr>
<td>10</td>
<td>Site 10</td>
<td>Habitation</td>
</tr>
<tr>
<td>11</td>
<td>33Ha24, Twin Mounds Village</td>
<td>Habitation</td>
</tr>
<tr>
<td>12</td>
<td>33Ha105 A</td>
<td>Mound</td>
</tr>
<tr>
<td>13</td>
<td>33Ha105 B</td>
<td>Mound</td>
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<tr>
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<td>Site 27</td>
<td>Habitation</td>
</tr>
<tr>
<td>28</td>
<td>Site 28</td>
<td>Habitation</td>
</tr>
<tr>
<td>29</td>
<td>33Ha113</td>
<td>Mound</td>
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<td>33Ha269, Tobacco Field Site</td>
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<td>31</td>
<td>33Ha272, Bean Field Site</td>
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</tr>
<tr>
<td>32</td>
<td>Site 32</td>
<td>Habitation</td>
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Figure 4. Shawnee Lookout Archaeological District sites identified in 1974.
### Table 2. Sites in the Shawnee Lookout Archaeological District as of 1974

<table>
<thead>
<tr>
<th>Site</th>
<th>Type</th>
<th>Culture</th>
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<tbody>
<tr>
<td>1 Miami Fort 33Ha62</td>
<td>Hilltop enclosure</td>
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<tr>
<td>2 Village</td>
<td>Habitation</td>
<td>Woodland</td>
</tr>
<tr>
<td>3 Dupont site 33Ha11</td>
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<td>Archaic</td>
</tr>
<tr>
<td>4 Village</td>
<td>Habitation</td>
<td>Woodland</td>
</tr>
<tr>
<td>5 Twin Mound Village 33Ha24</td>
<td>Habitation</td>
<td>Woodland</td>
</tr>
<tr>
<td>6 Columbia Park Village VI</td>
<td>Habitation</td>
<td>Multicomponent</td>
</tr>
<tr>
<td>7 Columbia Park Village VII</td>
<td>Habitation</td>
<td>Fort Ancient</td>
</tr>
<tr>
<td>8 Columbia Park Village VIII</td>
<td>Habitation</td>
<td>?</td>
</tr>
<tr>
<td>9 Columbia Park Village IX</td>
<td>Habitation</td>
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<tr>
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<td>Multicomponent</td>
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<tr>
<td>11 Stoveking Village</td>
<td>Habitation</td>
<td>Woodland, Fort Ancient</td>
</tr>
<tr>
<td>12 Lynch Site</td>
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<td>multicomponent</td>
</tr>
<tr>
<td>13 Miami Fort, East Village</td>
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<td>14 Miami Fort, West Village</td>
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<td>15 Village</td>
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<td>Hopewell</td>
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<td>16 Village</td>
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<td>17 Headquarters Site, 33Ha65</td>
<td>Habitation</td>
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<td>23 Tobacco Field Site</td>
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<td>24 Bean Field Site</td>
<td>Habitation</td>
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<td>25 Village</td>
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<td>26 Chopping Station</td>
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<td>Woodland</td>
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</tr>
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<td>Hopewell</td>
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<td>Mound</td>
<td>Hopewell</td>
</tr>
<tr>
<td>36 Mound</td>
<td>?</td>
<td>Woodland</td>
</tr>
<tr>
<td>37 Mound</td>
<td>?</td>
<td>Woodland</td>
</tr>
<tr>
<td>38 Mound</td>
<td>Mound</td>
<td>Hopewell</td>
</tr>
</tbody>
</table>
This was the only map of Miami Fort ever generated until the 1960’s, so for several decades investigators used highly inaccurate and stylized map without question.

The map in Figure 3 was adapted in GIS from a map made in 1968 showing 42 archaeological sites identified in and around the park from an aerial survey. Figure 3 is accompanied by corresponding Table 1, listing the sites names and types as they were interpreted in 1968. A separate survey was conducted in 1974, identifying a total 46 archaeological sites in the Shawnee Lookout Archaeological District. A map and corresponding table is represented by Figure 4 and Table 2 respectively. Because congruence between these surveys could not be established accurately and reliably, two maps and two complete tables are provided.

For the purpose of demonstrating the problems of using antiquated maps, modern GPS points and lines, as well as elevation contours provided by Cincinnati Area Geographic Information Systems (CAGIS) were overlaid on the original 1848 map in Figure 5. The older map is highly inaccurate in a number of ways. First, the enclosed area is shown to be much smaller than it actually is. Second, the map improperly represents two narrow pointed sections on the eastern side of the earthwork to be continuous and free of gaps, where the modern GIS clearly shows that gaps in the earthwork are present. Because the map shows sections of earthwork that do not exist, and likely never existed, it is possible that the authors added stylized
features to the map in order to make the site appear more like a fort. Third, the slope on the eastern side of the enclosure was exaggerated implying a much sharper distinction between the enclosure and the surrounding landscape than actually exists. The overlaid elevation contours show that no such separation is present but rather a much more gradual downhill slope. Finally, important mound and reservoir features are excluded from the map, likely because they did not conform to the prevailing hypothesis.

Instead of relying on antiquated maps produced with outdated technology, a brand new, highly precise and accurate map was generated in 2008. Archaeological features were geo-referenced using GPS and GIS technology. Figure 6 shows the results of that survey.
Figure 6. Map of Miami Fort earthworks generated in ArcGIS.
Conclusion

As shown by this brief history, Miami Fort has historically held a prominent place in Ohio archaeology. Although the site has been of archaeological interest since the early nineteenth century and has been surveyed and excavated by multiple individuals over the last 200 years, its significance as a water management system has only been realized within the last couple of years making this study the first of its kind at Shawnee Lookout Park. This study hopes to correct some of the problems of interpretation due to mapping inaccuracies by providing precise and accurate GIS mapping and original data supporting the hypothesis of water management in the context of the paleoclimate record.
The purpose of this chapter is to provide a set of possible hypotheses for the anthropogenic uses of earthworks in the archaeological record, accompanied by a set of expectations in each respective case. Furthermore, because this thesis is concerned primarily with earthworks as a water management system, this chapter also provides a summary of theoretical perspectives on the anthropogenic manipulation of natural water sources.

**Hypotheses**

There are multiple hypotheses that explain the incidence of anthropogenic earthen structures in the archaeological record, and it is important to explore each of these possibilities based on the phenomena observed at Miami Fort. The first and most obvious is the fortifications hypothesis which has already been proposed, (Moorehead 1929; Squier and Davis 1848). In other locations and cultures, people have manipulated the landscape for the purpose of water management and such a hypothesis requires consideration in cases of extensive ancient landscape modification elsewhere (Connolly 1996; Scarborough 1983, 1995, 1998, 2003a, 2003b; Steward 1929; Tankersley 2007, 2008b). The possibility of the earthworks having a ceremonial function is another hypothesis, and given the ambiguity of ceremonial activity in the archaeological record, this hypothesis can rarely be ruled out (Moorehead 1929, Morgan 1952). Driver and Massey (1957) proposed that people can build earthworks for the purpose of animal exploitation in terms of hunting blinds and corrals. The most likely hypothesis is some combination of possibilities mentioned above. As shown elsewhere (Scarborough 1998),
functional economic adaptations, like water management, are often integrated into other aspects of culture, especially ritual behavior.

The strength of hypotheses depend upon the presence of evidence to support their respective claims. Each hypothesis contains built-in assumptions about what we should expect to observe in each instance. If the Miami Fort site were built as an earthen fortification, then we would expect to observe specific phenomena in the archaeological record that indicate a defensive component. Chronometric dating would likely show a closely overlapping temporal framework (at one standard deviation) suggesting that all structural components were built contemporaneously. The presence of weapon-like artifacts and traumatic paleopathologies would be supportive, however their absence would not necessarily negate the hypothesis. Evidence of ceremonial function, proposed by Moorehead (1929) and Morgan (1952), may be represented by an assemblage containing symbolic artifacts and features, exotic trade goods, and an abundance of mortuary behavior. If the earthworks were used for animal exploitation, either as hunting blinds or corrals, we would expect to see contemporaneous chronometric dates, single entry enclosures, and artifacts associated with hunting and/or butchering. Water management would likely be characterized by evidence of ponds, dams, races, spillways, canals, and other features suited for the control and direction of water. Also, we would expect much more temporally dispersed chronometric dates than would be found in fortification or animal exploitation schemes. Finally, it is possible that people were using the earthworks for a combination of purposes outlined here. This study hopes to narrow these hypotheses to form a reasonable and coherent interpretation of the role of earthworks in ancient society.
Water Management Theory in Literature

Water management is a phenomenon that is virtually universal among ancient societies as a cultural adaptation to an unpredictable resource. Air, water, and food are three absolutely essential resources needed to sustain human life; and while even the most technologically advanced societies on earth have extreme difficulty in manipulating air, water is the easiest of these three resources for humans to control and manage. A number of individuals, including Steward (1929), White (1959), and Scarborough (1983, 1995, 1998, 2003a, 2003b) have contributed to the anthropological literature on the topic of water management in traditional societies.

Julian Steward

Steward’s “Irrigation Without Agriculture” article (1929) uses an ethnographic example from the Eastern Mono, a tribe in the Shoshonean language family of the American Great Basin to illustrate how some foraging societies cultivate wild plant species by the diversion of water from natural stream sources without engaging in full-scale agriculture. This led him to develop the notion that landscape manipulation of this kind predated and may have eventually led to the origin of agriculture. Steward attributes the presence of such irrigation to either cultural diffusion or independent invention. His interpretations of water management by foraging societies are reasonable, but if his perspective possesses any fault it would be that his use of language often implies an inherent directionality. To claim that the group utilized irrigation methods without quite achieving agriculture implies that the Eastern Mono would have been keen to take up tilling and planting had those technologies been known to them, when there may have been other factors involved in their subsistence decisions (Steward 1929). However despite
some built-in assumptions, Steward made a significant contribution to the scholarly discussion on water management and the origins of agriculture in anthropological thought.

**Leslie White**

Leslie White, another great contributor to anthropological theory, published his perspective on the origins of agriculture, which is intimately tied to water management. White attempted to combat a paradigm in the mid-nineteenth century Western thought that infected anthropological and archaeological theory at the time that was largely a consequence of the modern technological climate of inventions, patents, and industry. Many people believed in the logical structure of cause and effect, which in terms of the origins of agriculture implied that agriculture began as a result of a man or woman suddenly *coming up with the idea* and spreading it on to everybody else (White 1959). According to White (1959), people understood the relationship between seeds, soil, water, and plants centuries before agricultural subsistence took hold, and he describes water management and agriculture as organic processes that arise as a consequence of human need. Biological needs can be strained by population growth or changing environmental conditions in which humans must respond by (1) regressing to a lower standard of living (2) emigration or (3) changing their subsistence strategy (White 1959). A growing population, in which foraging subsistence becomes increasingly less adequate, and changing environmental variables create conditions where people must respond by intensifying their subsistence. While agriculture may indeed have spread as a consequence of diffusion, White’s perspective is much more congruous with the notion of multiple independent manifestations of agriculture than is Steward’s. Since water management and agricultural subsistence often go hand-in-hand, except in instances of high rainfall and low population densities, it is reasonable to
suggest that water management emerges under similar pressures. In terms of archaeology, White’s theory supports the need for investigation into factors of population growth and environmental conditions.

Vernon L. Scarborough

Scarborough (1983, 1994, 1995, 1998, 1999, 2003a, 2003b) builds off a foundation of cultural ecology theory laid by Steward, but also acknowledges the limitations of theory based on observations of hunting and gathering societies when applied to sedentary agricultural systems. Case studies at the Maya Lowland sites of Cerros, Kinal and La Milpa are examples of reservoir-based anthropogenically engineered microwatersheds, and another study in Bali of a canal-based water management scheme shows how topographic, geologic constraints lead to different functional and organizational strategies (i.e. still-water vs. flow-water schemes). Few natural stream sources exist as a consequence of the karstic limestone bedrock that constitutes most of the Maya Lowlands, which prohibits the development of canal-based irrigation. Despite the absence of permanent water sources, the Lowlands supported a large (larger than today, in fact) but spatially dispersed population. Rather than a sudden boom in technological innovation, landscape modification developed accretionally over time and was able to accommodate the population as it grew (Scarborough 1995, 1998). In contrast to the modern Western notion of community planning which conforms to a grid structure with water control systems built to accommodate the settlement pattern, Scarborough argues that topographical constraints of water catchment, diversion, and storage dictating settlement pattern were a key consideration for the Maya in town and city planning. As a result, Maya settlements were not organized in the same manner as Western conceptions of urban centers, but dispersed to make best use of highly
engineered artificial watersheds. These studies illustrate how water access acts as an independent variable affecting land use and settlement pattern and challenges deterministic assumptions that humans are at the mercy of their environment. Anthropogenic landscape modification in the Maya Lowlands dramatically increased the carrying capacity of the environment. In later publications, Scarborough further develops his theory on how water management plays an important role in social, economic, and political dynamics in ancient societies.

A pan-regional examination of the Maya Lowlands exemplifies the ancient Maya as a culture in which land use, economics, politics, and ritual were intimately tied to water management. Land use was largely constrained by the tropical rainforest. Although the ecosystem supports a huge biodiversity, there are very few of any one species and thus they prohibit the concentration and mass procurement of resources that is possible in temperate latitudes (Scarborough 1998). Instead, Maya land use mimicked the natural environment with the practice of polyculture, cultivating multiple plant species in a single patch while accommodating a dispersed settlement pattern through time. Gravity-fed hydraulic systems were controlled and managed by a central elite authority, and because of the decentralized and dispersed settlement pattern the elites established a number of ritual activities to maintain solidarity and legitimize their authority over dispersed populations (Scarborough 1998). Elite centers were situated on elevated hilltops located at the highest point or “head” of the gravity-fed system. One of the most notable examples of one of these “water mountains” is the site of Tikal in Guatemala (Scarborough 1995, 1998, 2003b).

Scarborough’s theoretical perspective on water management, as well as numerous case studies of water management systems around the world, are consolidated neatly as a
comprehensive cross-cultural examination in his 2003 book, *The Flow of Power*. The strategies people adopt to control water is highly dependent on environmental and topographical constraints. Hydraulic systems, according to Scarborough (2003b), can be divided into still-water and flow-water schemes. Still-water schemes incorporate impervious catchment surfaces, reservoirs and holding dams. This type of system is often seen in landscapes in which there are few or no natural permanent water sources. The cultural adaptations to a karstic landscape exhibited by the ancient Maya of Belize and Guatemala are good examples of a still-water scheme, in which large plazas were paved to create an impermeable surface for the catchment of run-off water. Flow-water schemes control the movement of water from a singular source by means of canals and diversion dams. There are several examples of ancient canal systems found in the archaeological record, the Hohokam system of the Southwest being one of the most extensive in North America (Huckleberry 1999; Scarborough 2003a). Because of the high level of labor organization required and the necessity of water access for survival, Scarborough (2003) describes water management in ancient societies as an economic and political force. The role of water management in early state formation has been hotly debated by anthropologists, and there is no general consensus on the subject; however the archaeological record shows that virtually all ancient states maintained some form of hydraulic infrastructure. Not only does water management require an organized labor force, but the high investment in an engineered landscape likely stimulated a territorial sense of land ownership as well as a cooperative alliance among water-users who share a system (Scarborough 2003).
Ohio Valley Water Management Literature

In addition to literature on water management and origins of agriculture theory in general, there has been some discussion, although sparse, of prehistoric water management in the Ohio Valley. A report from another southern hilltop enclosure, Fort Ancient, describes remarkably similar types of earthen features such as embankment walls and ponds; moreover the pond features appeared to be associated with “gateways” (Connolly 1996). These may be comparable to the pond and dam features described at Miami Fort in this study. In his published article on Fort Ancient, Connolly makes mention of faults and inconsistencies in the publications of previous researchers. “Although researchers in the past noted some pond locations (e.g. Moorehead 1890; Tichenor 1925), little evidence for the examination of these features is available” (Connolly 1996). Like Miami Fort, Fort Ancient also has been historically classified as a hilltop fortification and likewise possesses characteristics that shed doubt on that theory.

A dissertation by Romain (2004) hypothesizes that, in addition to mortuary and ceremonial purposes, earthworks were also being used for agricultural purposes. While Early Woodland, Archaic and earlier peoples likely subsisted from seasonally nomadic foraging, the Middle Woodland period was marked by the accretional development of an agricultural economy, which involved not only the introduction of domesticates (i.e. Zea mays, goosefoot, and sunflower), but also the cultivation of numerous indigenous plant species (Romain 2004). Although radiocarbon dates from this study indicate that the proposed water management features at Miami Fort were constructed at the tail end of the generally accepted time period for the Hopewell interaction sphere, it is likely that the agricultural/horticultural economy continued to thrive into subsequent occupations.
Finally, previous research conducted by Tankersley (2007, 2008b) shows additional evidence of Ohio Valley prehistoric water systems, which contribute to his skepticism of “hilltop fortifications” across the region. His recent article in *North American Archaeologist* examines possible hydraulic features at the Mariemont Earthwork in the town of Mariemont, Hamilton County, Ohio. He suggests that the earthwork’s resemblance to other hilltop earthworks like Miami Fort and Fort Ancient are likely the result of “similar economic adaptations to similar environmental conditions” rather than cultural convergence, as stated by earlier archaeologists. Additionally, Tankersley (2008b) proposes that the serpentine shape of the man-made drainage may be related to serpent symbolism expressed in eastern woodland native belief systems. While a connection is possible, it would be very difficult to test whether the Fort Ancient peoples shared the same symbolism and meaning with the Shawnee, who are generally accepted to be the modern descendents. He also acknowledges that there are practical and functional explanations for the serpentine shape. More importantly, however, are that the radiocarbon dates and paleoclimatic information obtained from magnetic susceptibility analysis at Mariemont show similar patterns of construction to those seen at Miami Fort. “Regardless of whether or not the earthwork had intrinsic symbolic significance, it is clear that Mariemont and the Madisonville village site represent a sustained and highly engineered landscape, which allowed Fort Ancient peoples to increase their agricultural [production] during a cold and dry climatic downturn” (Tankersley 2008b).

Numerous ethnographic and archaeological descriptions of cultures around the world show the capability and willingness of people, even with relatively simple technologies, to manipulate their landscape in order to optimize their subsistence strategies. This study hypothesizes that the Miami Fort earthworks were a cultural adaptation to the scarcity of water
due to changing environmental variables, most likely climate change. In an archaeological context, examination of the paleoclimate record of a landscape is instrumental to the accurate interpretation of the archaeological record.
Chapter 4

Materials and Methods

The 2008 investigation employed a variety of materials and methods, including GPS and GIS mapping, drill-core sampling, x-ray diffractometry, high-resolution magnetic susceptibility analysis, and radiocarbon dating. The use of multiple tools offers a multi-dimensional view of the history of the site in terms of geologic phenomena, paleoclimate variation, and anthropogenic activity.

The site was surveyed and mapped using a Trimble GPS unit, survey transit, and stadia rod. Mapping data was collected in order to spatially orient perceived human-built hydraulic features.

Because of diverse geological settings and unconsolidated deposits, three different drill rigs were used including a Forestry Suppliers bucket auger, compact slide hammer and extendable split core sampler, and an environmentalist’s subsoil probe. A 10 cm. diameter, Forestry Suppliers’ stainless-steel bucket auger with cross handles and one-meter extensions was used to extract anthropogenic sediment from the earthen embankments of Miami Fort. The bucket auger facilitated smooth and easy cutting through silt, silt-clay, and clay-silt with minimum cross-contamination. Samples were extracted every 22 cm. and approximately one kilogram of sediment was placed in one liter plastic bags and labeled according to depth and location. After extraction, soil colors were recorded using a Munsell soil color chart.

A compact slide hammer and extendable split core sampler was used to extract anthropogenic pond sediments. A four-piece, 30-centimeter, stainless-steel split barrel with a 5-centimeter internal diameter, thread-on hardened bit, and meter extensions, allowed the retrieval of continuous core samples of clay, silt, sand, and gravel, and avoided cross-contamination.
Extracted samples were wrapped in cellophane and aluminum foil and labeled according to depth and location. As with the bucket auger, soil colors were recorded using the Munsell soil color chart.

An Environmentalist's Subsoil Probe (ESP) was also used to extract anthropogenic pond sediments. A 5.6-kilogram slide hammer with 1-meter extensions was used to drive a 1-meter, stainless-steel sample tube with a thread-on hardened bit into clay, silt, and sand in a single plunge. Copolyester liners with a 2 cm. internal diameter allowed the retrieval of continuous core samples. A foot-operated jack was used to pump the sample tube out of the ground with more than 600kg of lifting force. Extracted samples were sealed with red (top) and black (bottom) vinyl caps to denote orientation and avoid cross-contamination and labeled according to depth and location.

The ESP cores and split-core samples were stored in a climate controlled environment in which temperature was maintained between 20°C and 25°C. Natural stratigraphy was marked, Munsell soil colors were defined, the depths in centimeters, and soil textures recorded. The ESP cores were then cut and separated into respective strata using a Dremmel saw, and the split-core samples were bilaterally split using a Marshalltown trowel.

Magnetic susceptibility readings were taken using a Bartington MS2 E Sensor in an area that had been cleared of all ferrous objects to prevent environmental contamination of the data. The sensor was pressed firmly into the soil surface ensuring complete contact with the instrument and a reading was taken. Between samples the sensor was cleaned with distilled demineralized deionized water to prevent cross-contamination between samples and sensor was moved to a distance approximately 100 cm. from the samples to zero the instrument.
Bucket auger samples were analyzed in a manner very similar to the ESP and split core samples. Magnetic susceptibility readings were taken using the Bartington MS2 E sensor, in which the entire distal surface of the sensor was pressed firmly into the sediment when the reading was taken. The sensor was cleaned between samples with distilled deionized demineralized water and was held at a distance of approximately 100 cm. from the samples to zero the instrument.

X-ray diffraction is a method used to determine the composition of materials and is highly useful for archaeological research because it can identify the mineral properties of geologic materials. Approximately 15-20g samples were dispersed in water using a high speed stirrer, and the <2 μm fraction was separated by gravity setting. Two oriented slides were prepared from each sample by smear method, and X-ray diffraction (XRD) patterns were recorded in the air-dried state and after glycolation. All slides were scanned from 2-32° 2θ on a Siemens D-500 X-ray diffractometer using a Cu-Kα radiation source. Minerals were identified on the basis of peak position and peak intensity.

The percentage of the clay minerals was determined by comparing the peak areas of the (001) diffraction pattern on glycolation (I, Ch/S) and 7Å air-dried peak (Ch+K). Peak areas for individual clay minerals were calculated using Apple Macintosh based software called MacDiff. These estimates serve simply to illustrate trends in abundance between samples, not absolute amounts.
Chapter 5
Data

GPS and Transit Survey

The hydraulic features were surveyed and mapped with a Trimble GPS unit, where GPS points where taken at top of each mound and the center of each reservoir, and line segments represent embankments. The illustration in Figure 7 shows a plan view and cross section of the catchment reservoirs, races, spillway, and dam. By measuring the length, width, and depth of each reservoir, the entire system could have held approximately 1,240,100 liters of water. The reservoirs increase in size and volume as the hill descends. Earthen walls enclose the perimeter of the hilltop and earthworks also appear to connect the hilltop enclosure with the Twin Mounds site.

Radiocarbon Dates

Five radiocarbon dates were recovered from $^{14}$C samples collected from Miami Fort and Twin Mounds Village East. An accelerator mass spectrometry (AMS) date from Twin Mounds Village East of 2030 ± 40 (Beta 247820), calibrated to BC 160 – AD 60, came from bone collagen of *Ursus americanus* (American black bear) remains. One wood charcoal sample collected from the north wall of Miami Fort produced an AMS date of 1360 ± 40 (Beta 249597) calibrated to AD 620 – 690. Two wood charcoal samples from the west wall of Miami Fort collected by this study dated to 240 ± 40 (Beta 248352) and 270 ± 40 (Beta 249682), calibrated to AD 1530 – 1680 and AD 1500 – 1670. Lastly, an additional wood charcoal sample from the sub-earthwork level of the north wall, borrowed from Riordan (1996), provided a β-decay counting date of 1680 ± 130 (M 1869) calibrated to AD 77 – 617.
Figure 7. Cross-section and plan-view of reservoir features.
Table 3. Shawnee Lookout Radiocarbon Dates

<table>
<thead>
<tr>
<th>Lab Number</th>
<th>Sample Composition</th>
<th>(^{14})C Dating Method</th>
<th>Context</th>
<th>RCYBP</th>
<th>Calibrated Age 2 Sigma (95.4%)(^1)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta 247820</td>
<td>Collagen (Ursus Americanus)</td>
<td>AMS</td>
<td>Twin Mounds</td>
<td>2030 ± 40</td>
<td>BC 160-AD 60</td>
<td>This Study</td>
</tr>
<tr>
<td>M1869</td>
<td>Wood Charcoal</td>
<td>(\beta)-Decay Counting</td>
<td>Miami Fort North Wall (sub-earthwork)</td>
<td>1680 ± 130</td>
<td>AD 77 – 617</td>
<td>Riordan 1996</td>
</tr>
<tr>
<td>Beta 249597</td>
<td>Wood Charcoal</td>
<td>AMS</td>
<td>Miami Fort North Wall</td>
<td>1360 ± 40</td>
<td>AD 620-690</td>
<td>This Study</td>
</tr>
<tr>
<td>Beta 248352</td>
<td>Wood Charcoal</td>
<td>AMS</td>
<td>Miami Fort West Wall</td>
<td>240 ± 40</td>
<td>AD 1530-1680</td>
<td>This Study</td>
</tr>
<tr>
<td>Beta 249682</td>
<td>Wood Charcoal</td>
<td>AMS</td>
<td>Miami Fort West Wall</td>
<td>270 ± 40</td>
<td>AD 1500 – 1670</td>
<td>This Study</td>
</tr>
</tbody>
</table>

After Stuvier and Reimer (2003) and Remier et al. (2004)

Drill Core Extraction

Organic samples for radiocarbon dating and sediment samples for magnetic susceptibility analysis and x-ray diffraction were collected by drill core extraction. Cores were extracted in 1 meter intervals from the center of each of the anthropogenic pond features, Reservoir 1, Reservoir 2, and Reservoir 3 to measure the depth of water held in the past using the ESP probe. Reservoirs 1 and 2 were both cored to a maximum depth of 2.5 meters before refusal. Reservoir 3 was cored to a maximum depth 3 meters before refusal. The north wall and west wall of Miami Fort were cored in 22 cm intervals to a maximum depth of 122 cm and 242 cm respectively with the Forestry Suppliers bucket auger. Charcoal samples for AMS radiocarbon dating were obtained from the cores via the flotation method.
Table 4 shows the raw data taken from the Reservoir 1 core sample, including the magnetic susceptibility, x-ray diffractometry, depth, and Munsell soil color. Magnetic susceptibility is represented by SI values; and based solely on the raw data, the SI column showed a high degree of variability, ranging from 15 to -3 SI, in relation to soil depth. The highest magnetic susceptibility occurred in sample 1 at a depth of 0 - 5.8 cm, and the lowest measurement occurred in sample 6 at 36.1 - 47.8 cm in depth. A secondary spike of 14 SI occurred in sample 12 at a depth of 141.5 – 143.3 cm. The mean of all 14 samples is 7.7 SI.

Table 4. Raw core data collected at Reservoir 1, including magnetic susceptibility (SI) and X-ray diffractometry.

<table>
<thead>
<tr>
<th>Sample</th>
<th>SI</th>
<th>Depth (cm)</th>
<th>Primary Color</th>
<th>Secondary Color</th>
<th>Smectite (%)</th>
<th>Illite (%)</th>
<th>Kaolinite (%)</th>
<th>Chlorite (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>0-5.8</td>
<td>7.5 yr 2.5/1</td>
<td></td>
<td>7.93</td>
<td>85.48</td>
<td>3.30</td>
<td>3.30</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>5.8-13.0</td>
<td>7.5 yr 3/2</td>
<td></td>
<td>19.44</td>
<td>72.52</td>
<td>5.36</td>
<td>2.68</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>13.0-16.8</td>
<td>7.5 yr 4/3</td>
<td></td>
<td>17.88</td>
<td>73.97</td>
<td>4.08</td>
<td>4.08</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>16.8-24.4</td>
<td>10 yr 5/3</td>
<td></td>
<td>25.99</td>
<td>54.09</td>
<td>15.93</td>
<td>3.98</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>24.4-36.1</td>
<td>10 yr 5/3</td>
<td></td>
<td>40.26</td>
<td>48.70</td>
<td>8.83</td>
<td>2.21</td>
</tr>
<tr>
<td>6</td>
<td>-3</td>
<td>36.1-47.8</td>
<td>10 yr 5/3</td>
<td>10 yr 4/6</td>
<td>45.28</td>
<td>42.14</td>
<td>11.32</td>
<td>1.26</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>47.8-63.5</td>
<td>10 yr 5/3</td>
<td>10 yr 4/4</td>
<td>44.98</td>
<td>43.58</td>
<td>6.86</td>
<td>4.57</td>
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<tr>
<td>8</td>
<td>3</td>
<td>63.5-74.7</td>
<td>2.5 yr 5/3</td>
<td>10 yr 5/6</td>
<td>52.24</td>
<td>44.85</td>
<td>1.45</td>
<td>1.45</td>
</tr>
<tr>
<td>9</td>
<td>7</td>
<td>66.0-74.1</td>
<td>10 yr 5/6</td>
<td></td>
<td>42.70</td>
<td>54.17</td>
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<tr>
<td>10</td>
<td>8</td>
<td>77.2-96.5</td>
<td>10 yr 5/6</td>
<td>2.5 yr 5/3</td>
<td>46.63</td>
<td>41.99</td>
<td>5.69</td>
<td>5.69</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>129.3-135.4</td>
<td>2.5 yr 6/4</td>
<td>2.5 yr 5/6</td>
<td>13.92</td>
<td>82.78</td>
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</tr>
<tr>
<td>12</td>
<td>14</td>
<td>141.5-143.3</td>
<td>2.5 yr 6/3</td>
<td></td>
<td>11.03</td>
<td>84.85</td>
<td>2.06</td>
<td>2.06</td>
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<tr>
<td>13</td>
<td>7</td>
<td>144.0-156.5</td>
<td>2.5 yr 5/4</td>
<td>10 yr 5/6</td>
<td>11.59</td>
<td>83.62</td>
<td>2.40</td>
<td>2.40</td>
</tr>
<tr>
<td>14</td>
<td>8</td>
<td>162.3-164.8</td>
<td>2.5 yr 5/4</td>
<td></td>
<td>12.22</td>
<td>83.96</td>
<td>2.54</td>
<td>1.27</td>
</tr>
</tbody>
</table>

A total of four cores were extracted by bucket auger from the enclosure walls to obtain samples for radiocarbon dating. Figure 8 shows the results of those extractions including the context of the radiocarbon dates. The two samples that dated to 240 ± 40 and 270 ± 40 (Beta
Figure 8. Cross-section of cores extracted from enclosure walls.
248352 and Beta 249682) came from the West Fort (South Berm) between 110 and 132 centimeters below the surface in 5YR4/4 clayey silt. The date of 1360 ± 40 (Beta 249597) came from the North Fort (West Berm) at the refusal depth of 132 centimeters. Three of the four core extractions hit anthropogenically placed limestone slabs.

**X-ray Diffraction**

X-ray diffraction (XRD) revealed four clay mineral components present in all 14 samples in the Reservoir 1 core; illite, smectite, kaolinite, and chlorite. All of these are common geologic minerals, and each possess specific attributes that will be explained in the analysis section. Illite is the most abundant clay mineral and characterized by peaks at 10.0Å, 4.98Å and 3.33Å, all of which remain unaffected by glycolation. Mixed-layer chlorite/smectite is identified by broad Ch diffraction around 14Å that shifted to a broad peak around 14.2Å to 17Å on glycolation. Chlorite is identified by diffraction at 14Å, 7Å, 4.7Å and 3.5Å and remained unaffected on glycolation. Kaolinite is identified using higher order (002) 3.57Å peak at 24.9° 2θ. Estimates of the relative percentages of different clay minerals show that illite is the most abundant clay mineral (86.17-41.99%). This is followed by mixed layer chlorite/smectite (52.24-4.07%), kaolinite (20.54-1.45%) and chlorite (11.18-1.10%) respectively. The diffractograms below display the results of the XRD analysis. Figures 9 and 10 show the XRD results from the control Illinoisian Terrace and Fairview Formation sediments obtained from naturally exposed stratigraphy, both glycolated and air-dried respectively. Figures 11 and 12 show the XRD patterns from the 14 sediment samples extracted from Reservoir 1.
Figure 9. XRD pattern of control samples (glycolated)

Figure 10. XRD pattern of control samples (air-dried)
Figure 11. XRD pattern of core samples (glycolated)
Figure 12. XRD pattern of core samples (air-dried)
Chapter 6

Analysis

The examination of water management at Miami Fort is a study of human activities and motives in both time and space. Elements of the landscape were altered to perform specific functions, but these activities were also likely a product of paleoclimate conditions that changed over time. This chapter examines the spatially distributed landscape modifications, how they served to catch and collect water, as well as the evidence for climatic shifts in mean temperature and moisture which may have provided motive for such modifications. The spatial dimension is studied using GPS and transit survey, which subsequently enable the creation of maps and illustrations for analysis. The temporal aspects of paleoclimate are studied by measuring magnetic susceptibility and x-ray diffraction in core samples – radiocarbon dates provide a chronometric framework.

Spatial Data

The objective of the GPS survey is to create maps that focus specifically on the units of analysis to clearly observe the spatial distribution of features and determine if any relationships can be argued. One of the first characteristics that was immediately conspicuous was that the site covers a much larger geographic area than was originally postulated. Historically, the site classified as Miami Fort consisted of only the 12 acres of enclosed hilltop mapped by Squier and Davis; however earthworks extending to the northeast of the main site, once considered completely separate elements, appear to be all part of a common system. However, more convincing congruencies must be established, such as contemporaneous radiocarbon dates before such an assertion can be proven. Secondly, similar patterns of earthworks in relation to habitation zones occur both in the southwestern and northeastern clusters. The southwestern
features, in which the reservoirs and dams are labeled in Figure 6, appear to lie in association with Twin Mounds Village via a graded way. Two parallel earthen features to the northeast may also have an associated occupation zone. Figure 6 in Chapter 2 is a GIS map highlighting the earthworks described above. The earthworks mapped here span an area of approximately 3 km², and likely more earthworks will be mapped in the approaching field season, which may expand the area to as much as 5 km².

Based on measurements taken by transit survey, the spatial pattern of the reservoirs is highly suggestive of an artificial watershed, because they are oriented in a downhill direction and increasing in size. These reservoirs contain naturally occurring artesian springs, drawing water from an underground aquifer, which was likely augmented and maintained by people. Mounds and embankments built up and around the reservoirs served to facilitate the collection of runoff water into the reservoirs and consequently increase the overall volume. The smallest pond, with a capacity of approximately 62,360 liters of water, is situated at the highest elevation in the pond sequence. Reservoir 1 is flanked by a mound facilitating the catchment of run-off water. Reservoir 2 held about 99,200 liters of water and is situated downhill from Reservoir 1 on a 12% slope. Overflow from Reservoir 1 is transported via an anthropogenic race alongside an earthen embankment that was built up to further facilitate water catchment. Another race runs downhill on a 20% slope to Reservoir 3 which would direct overflow from Reservoir 2. Reservoir 3 was created by placing a posited log dam between two artificially constructed earthen berms.

Figure 13 demonstrates a reconstruction of the dam. At the location of the proposed dam feature, fired clay impressed with evidence of logs and anthropogenically placed limestone slabs give clues as to how the dam was constructed. At least two openings show these phenomena and there may possibly be more. Limestone slabs were stacked on top of the Illinoisan sedimentation
deposits to create a foundation for the dam. Logs were stacked and clay was pressed in between them to act as chinking and subsequently fired to earthenware hardness. The dam served to prevent water from draining off the hilltop and joining the river system. The height from the bottom of the limestone slabs to the top of the berms measured approximately 5 meters.

Temporal Depth

Miami Fort has been previously classified as a Hopewell site; however, radiocarbon ages of charcoal taken from the west wall indicate that the earthworks postdate the end of the
Hopewell period. While the AMS date from Twin Mounds Village East sits comfortably in the Hopewell period, between B.C. 160 and A.D. 60, wood charcoal samples from the north wall date to A.D. 620 to 690, differing only three years from a date reported by Fischer in 1965. This range is clearly later than Hopewell, which ended around 500 A.D. It is possible that the period stretched into the seventh century A.D., however earthwork construction would have occurred at the tail end and been primarily used by later peoples.

A second set of dates from the west wall of Miami Fort, 240 ± 40 BP (Beta 248352) and 270 ± 40 BP (Beta 249682) are calibrated to about AD 1500 to AD 1600. The fact that the dates from the north and west walls are separated by over 900 years suggest that the earthworks were not built all at once, but rather underwent multiple stages of construction. Radiocarbon dates compiled from the Hopewell, Hopeton, and Miami Fort sites (Figure 14) show remarkably similar temporal distributions, in which construction activity was halted for approximately one thousand years. The fact that the chronology shows no overlapping dates makes the fortifications hypothesis look unlikely because such defensive features would likely require relatively rapid construction to enclose the entire hilltop all at once. The wider temporal distribution of radiocarbon dates suggest that that was not the case, instead the earthworks were built accretionally in multiple phases over time.

The overall chronology for the Miami Fort earthworks shows two main periods of construction activity. The earliest took place in the seventh century, followed by an approximately 1000 year hiatus with construction resumed around the fifteenth century. The hiatus coincides with a well documented climatic event known as the Medieval Warm Period or the Holocene Climatic Optimum. Lasting from about the tenth century to the fourteenth century A.D., this time period was characterized by warmer mean temperatures and high moisture.
Figure 14. Compiled radiocarbon dates from Hopeton, Hopewell and Miami Fort sites (adapted from Lynott 2008).
Furthermore, the Medieval Warm Period was followed by another climatic shift called the Little Ice Age, spanning from the sixteenth century until around the end of the American Civil War. The protohistoric dates obtained from the west wall are associated with construction activity during this time period. Based on the radiocarbon data, evidence suggests that earthwork construction coincides with cold and dry conditions and not with warm and wet conditions.

**Paleoclimate Data**

The examination of the paleoclimate record creates a multidimensional framework for conceptualizing water management in the Ohio Valley. We accomplished this by collecting pertinent data from ponded sediments in the core samples extracted from the Reservoir 1. Magnetic susceptibility was measured as a proxy variable to detect trends in mean temperature and moisture. The same samples were then exposed to x-ray diffraction to determine mineral composition. Changes in mineral composition further validate the fluctuations seen in the magnetic susceptibility, because mean moisture levels which are known to correlate strongly with mean temperature (i.e. climate) can influence the hydraulic deposition of minerals in ponded sediments. The objective is to determine if the paleoclimate record of the Ohio Valley corresponds with larger global trends.

The reservoir feature was chosen for coring for the acquisition of paleoclimate data to avoid contamination from anthropogenic variables such as burning from hearth fires, soil disturbances from building and burial practices, and phosphate deposition (Ellwood 1995, 1996, 1997, 2004). The graph in Figure 15 represents magnetic susceptibility values from Reservoir 1 in relation to their depth below the surface. The magnetic susceptibility values show rough trends in paleoclimate behavior (Tarling 1990). The climate is prone to cyclical
Figure 15. Magnetic susceptibility (SI) in relation to depth in centimeters below the surface.
oscillations between warm and wet, and cold and dry over long periods of time. The large drop in magnetic susceptibility between 50 and 150 centimeters below the surface suggests a dramatic shift in temperature and moisture, which I believe represents the Little Ice Age. The high spike at 150 centimeters is indicative of the Holocene Climatic Optimum, which was preceded by an earlier period of comparatively cold and dry climate. The shallowest sample, which should be an indicator of the most recent climatic behavior according the law of superposition, resulted in the highest SI value taken from the core. This falls perfectly in line with numerous modern climate studies which indicate that the earth is currently experiencing a warming period.

These trends are further substantiated by variations in the clay mineralogy of the same samples. Deposition of clay minerals by the movement of water is affected by climatological changes in moisture over time. In order to source the minerals control sediment samples were collected from known sedimentation layers of exposed strata, and their mineral composition was compared to the mineral composition of the Reservoir 1 core samples.

The control sample taken from the Illinoisan Terrace contained high levels of smectite and most likely the source of smectite found in the core samples. The presence of smectite in the ponded sediments of Reservoir 1 can be explained by the washing in of Illinoisan materials by way of surface runoff water during rainstorms. Cold, dry periods are associated with more intense storms (when they do occur) and flash flooding, interspersed with periods of drought, thus a horizontal inwash of smectite can be expected during both warm and cold climates.

The mineral illite is known to originate from the local bedrock layer of Ordovician Fairview Shale. The presence of illite in the sediments of Reservoir 1 can be explained by the upward movement of artesian spring water from the Cincinnati area underground aquifer. Illite deposition, therefore, increases with increased spring activity due to conditions of warm wet
Figure 16. Percentage of smectite in relation to depth in centimeters below the surface.
Figure 17. Percentage of illite in relation to depth in centimeters below the surface.
climate. Thus, it can be expected that periods of cold climate and low moisture result in the decreased deposition of illite. Based on the climate fluctuations that have been tracked with magnetic susceptibility data, an association between the SI values and abundance of illite should be expected.

Analysis of the raw data collected from Reservoir 1 showed that variability of the respective clay minerals behaved as expected. Using magnetic susceptibility (SI) as an environmental proxy to detect average temperature changes, the variability of abundance percentages of the clay minerals further supports the conclusions.

Given that the data is non-parametric and the sample sizes are under 30, Kendall’s tau beta correlations were run to test for an association between the variables. This statistic has been stated as useful when observation of two variables result from a causal connection between some other third variable (Thomas 1986). Because magnetic susceptibility and concentrations of the clay minerals are independent variables, the correlations do not imply causation or dependence. Using the data exclusively from Reservoir 1, the Kendall’s tau beta correlation coefficient for the SI and smectite percentage variables is -.549 with a two tailed probability of .008. This shows that variations in magnetic susceptibility and variations in percentages of smectite in relation to depth have a modest, however statistically significant, inverse association. At the depths where the magnetic susceptibility of the core sediment is relatively low, the dominance of smectite in the sample tend to be relatively high. Additionally, the same correlation coefficient for magnetic susceptibility and illite is .50 with a two tailed probability of .015, which shows a modest yet statistically significant positive association. Kendall’s tau beta correlations were also run for magnetic susceptibility and kaolinite, and also between magnetic susceptibility and chlorite, however neither showed statistically significant associations.
This study hypothesized that the earthworks were a response to water scarcity; therefore it can be expected that earthworks date to period of cold and dry climate, and conversely the data should show an absence of earthwork construction when the climate is warm and wet. The paleoclimate record demonstrated by the magnetic susceptibility and XRD in conjunction with the radiocarbon chronology show earthwork construction taking place in the expected environmental conditions.
Chapter 7

Conclusions

While other regional archaeologies have progressed theoretically over the past few decades to include a more holistic view of cultural dynamics, Ohio Valley archaeology has languished in a period of comparative stagnation largely due to a refusal to step away from a view of the past tainted by colonial militarism. Our understanding of prehistoric indigenous peoples has often been extrapolated from documentation of historical indigenous peoples, a history that was crafted to support a populist view of Western progress and expansion. As a result, Ohio archaeologists have ventured down a pathway paved with an a priori assumption of native belligerence that has not only de-emphasized but also disincentivized alternative theoretical postulations that could not only add to our knowledge of ancient human cultural heritage but also stimulate a productive theoretical discourse to the practical task of determining how humans have adapted to environmental change.

This study attempts to diverge from past problems of interpretation by investigating features of the archaeological record that have until present been largely neglected. The GIS and transit survey data shows that the spatial configuration of ponds, dams, and embankments are highly suggestive of an artificial watershed, characteristics of the enclosure interior that supporters of the fortifications hypothesis have failed to explain. Moreover, the openings in the enclosure walls correspond more predictably with water drainages than with planned restricted access features. Secondly, the radiocarbon dates indicate a temporal chronology that suggests accretional development in multiple phases rather than punctuated contemporaneous construction. Magnetic susceptibility and XRD data show that the Ohio Valley experienced the same global trends in climate that have been documented by other studies. The first building
phase occurred during a climatic episode of comparatively colder and dryer conditions before the
Holocene Climate Optimum, and according to our current knowledge, building did not resume
until around the time of the Little Ice Age. These data sets, most notably the paleoclimate
indicators, are not analogous to any that have been pursued before at Miami Fort and thus have
revealed aspects of the archaeological record that throw the fortifications hypothesis into
question.

It can be concluded that a fortifications function is not substantiated, given the findings of
this study. The possibility is therefore introduced that similar phenomena in the Ohio Valley
(i.e. hilltop enclosures) have been subject to the same errors in interpretation. Comparable
suggestions have been made at Fort Ancient (Connolly 1996) and water management schemes
elsewhere in the world have been misconstrued as fortifications in the past.

While the data sets discussed here point strongly in favor of the water management
hypothesis, they have not exhaustively examined all of possible roles of earthworks in
indigenous lifeways, nor should it be suggested that water management is satisfactory to explain
all earthwork enclosures. Other hypotheses, such as those mentioned in Chapter 3 have yet to be
investigated and it is entirely possible that earthworks served multiple secondary functions.
Ritual and ceremony, for example, may have been integrated into practical day-to-day use
(Moorehead 1929, Morgan 1952). The enclosure could also have enabled the capture of game
animals that are commonly attracted to the horticultural fields (Driver and Massey 1957). None
of these can be ruled out until each is examined in terms of physical traces left behind in the
archaeological record.

A critical investigation of Ohio Valley hilltop enclosures free from the bias of the last
two centuries is important for an accurate understanding of ancient eastern woodland cultural
heritage. To question the plausibility of a deeply engrained paradigm in Ohio archaeology is also to acknowledge a reconsideration of how archaeologists characterize ancient Ohioans. Also, framing past cultural behavior in terms of adaptation to climate change may prove useful as people today attempt to address current issues of survival in this modern period of global warming. As archaeologists of the twenty first century, we have a responsibility to approach these questions objectively by not simply searching for data to verify our own assumptions but to exhaustively explore all possibilities in order to arrive at conclusions that more closely resemble fact.
References Cited

Bennett, R.A.H.

Connolly, R.P.

Dalbey, T.S.

Driver, H. E., and Massey, W.C.
Ellwood B.B. et al.


Fischer, F.

1965  Preliminary report on 1965 archaeological investigations at Miami Fort. Manuscript on file, Department of Anthropology, University of Cincinnati.

1968  A survey of the archaeological remains of Shawnee Lookout Park. Manuscript on file, Department of Anthropology, University of Cincinnati.


Fowke, G.

1902  *Archaeological History of Ohio*. Ohio State Archaeological and Historical Society, Columbus.

Harrison, W.H.

1839  *A Discourse on the Aborigines*. Office of the Cincinnati Express, Cincinnati.

Holliday, V.T.

Huckleberry, G.

Kaltenthaler, L.A.

Lee, A.M.

Lee, A.M, and K.D. Vickery

Lepper, B.T.
Lynott, M.

Moorehead, W.K.


Morgan, R.G.

Riordan, R.V.

Romain, W.F.
2004  *Hopewell Geometric Enclosures: Gatherings of the Fourfold.* Ph.D. dissertation, Department of Archaeology, University of Leicester, Leicester.

Scarborough, V.L.


Steward, J.

Squier, E.G. and E.H. Davis
1848 *Ancient Monuments of the Mississippi Valley.* Smithsonian Contributions to Knowledge Volume 1, Washington D.C.

Tarling, D.H.

Tankersley, K.B.


Thomas, D.H.

Tichenor, W.C.
1925 *A Guide to Fort Ancient.* Self Published, Lebanon, Ohio.
White, L.A.

1959  *The Evolution of Culture: The Development of Civilization to the Fall of Rome.*

Whittlesey, C.

1871  *Ancient Earth Forts of the Cuyahoga Valley, Ohio.* Fairbanks, Benedict, and Company, Cleveland.