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Chapter 3

Between the Monuments

Landscape-Scale Geophysical Surveys at Hopewell Culture National Historical Park-Seip Earthworks

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This chapter presents the results of a recent large-scale, high-resolution geomagnetic survey of the Seip Earthworks, an ancient American Indian ceremonial complex of monumental scale and complexity, a unit of the US National Park System, and a candidate for nomination to the UNESCO World Heritage List. This recent survey is one example of an emerging trend toward landscape-scale approaches to monumentality and heritage management worldwide. Prehistoric ceremonial complexes are well-known from different parts of the world (Darvill 2016). At one of the earliest sites, Göbekli Tepe in eastern Turkey, megalithic stone circles formed by six-meter-high sculptured monoliths were erected during the eleventh millennium BC on platforms specially carved out of the natural rock. Later, these circular monuments were completely covered and *buried*, finally forming a large mound 15 m high, leaving no visible traces of the buried monumental architecture (Dietrich et al. 2017; Gresky et al. 2017; Schmidt 2011). Even after 18 years of large-scale excavations, only about two percent of the mound has been investigated. The recent application of geo-radar has shown other areas of large monumental structures and, thus, helped create an understanding of the overall structure (Dietrich et al. 2016, 56f.).

The iconic sites at Stonehenge and Avebury in Wiltshire, United Kingdom, are among the oldest examples of ceremonial complexes from prehistoric Europe. Both start as far back as the eighth millennium BC (Darvill 2006; Pollard and Reynolds 2002) and developed into ritual landscapes that extend over an area of 25 km^2. The international community has recognized these ceremonial complexes to be of outstanding universal value and and inscribed them on UNESCO´s list of World Heritage in 1986. Although 300 years of antiquarian interest have led to an extraordinarily detailed knowledge about the development of society and of ritual and mortuary practices throughout the millennia, most of the area between the monuments has never been investigated. The application of a high resolution large-scale magnetometry survey held during five days in July 2010 covered an area of 200 ha, discovering hundreds of previously unknown features (Darvill et al. 2013).

All these places serve as good examples of how prehistoric societies shaped and structured their landscapes both physically and socially. Erecting monumental stone structures, embankments, earthworks, or ditch systems are part of land use in prehistory and numerous such superstructures remain visible today. But many, if not most, of the prehistoric ritual landscapes have undergone changes in their use and have now been under agricultural regimes for many decades, if not for a century or more. As a result, most of the originally visible human-made constructions have been plowed down to the field surface, leaving no visible traces.

Investigating prehistoric ritual landscapes in high resolution and in a cost-effective way requires a combination of methodologies and analytical tools. Modern technologies are part of the portfolio of archaeological investigation methods: aerial photography has been frequently used since the 1920s, followed by satellite imaging since the 1970s and LiDAR since the 1990s. Each of these methods have contributed to an overall insight of large prehistoric sites and monuments. It was not only the overview of still-visible structures and their settings in the landscape that made the difference, it was the discovery of hidden structures in the subsoil that helped to complete the picture and better understand the complexity of prehistoric monuments. While the aerial photography and satellite imaging have made large contributions since the 1970s, different geophysical methods have been successfully used on archaeological sites and contributed even deeper insights into the (internal) structure of monuments. Some of the pioneering applications of these geophysical techniques were successfully carried out on Hopewellian ritual sites in Ohio (e.g., Burks 2014; Burks and Cook 2011; Greber 1980, 1981, 1984; Greber and Shane 2009; Lynott and Mandel 2009; Lynott and Weymouth 2002; Weymouth 1998, 2005; Weymouth et al. 2009).

Hopewellian ritual landscapes are well known from impressive earthworks documented by Euro-American missionaries and military men since the eighteenth century, followed by early archaeological investigations during the nineteenth and early twentieth centuries (Lepper 2005; Lynott 2014). While all these early investigations were directed at visible features such as mounds, ditches, embankments, and ramparts, large areas in-between these monuments were not in their focus.

Research has made obvious that humankind not only built monumental architecture at isolated points in the landscape, but used vast areas of the landscape in order to express their ritual beliefs and needs through monumental architecture. Questions on the research agenda include which parts of the modern landscape humans utilized in the past, and whether various ways of modifying the landscape are of significance. From an analytical point of view, it has to be investigated whether such changes in the landscape made in prehistoric and historic times can be made visible, and whether these comprise just short or longer phases of change, just like layers in a mound. Questions of continuity and discontinuity in land use appear, and one of the most important questions is: what kind of use was made of the land between the monuments we know? Are there empty spaces and were they part of the design concept? Such modern research is now being applied to World Heritage sites such as the landscape around Stonehenge and Avebury, where the still-ongoing magnetometry analysis has revealed hundreds of new features around both of these iconic English sites (Darvill and Lüth 2016).

Forty-six Member States of the Council of Europe have signed and ratified the European Convention on the Protection of the Archaeological Heritage (Revised; 1992). As one of many concerns the State parties agreed in Article 3 to give noninvasive methods preference:

To preserve the archaeological heritage and guarantee the scientific significance of archaeological research work, each Party undertakes:

> i. to apply procedures for the authorisation and supervision of excavation and other archaeological activities in such a way as:
> . . . b. to ensure that archaeological excavations and prospecting are undertaken in a scientific manner and provided that:
> –non-destructive methods of investigation are applied wherever possible; . . .

Consequently, research has focused on developing methods and standards to achieve these goals, especially in the arena of heritage management and the Heritage Agencies tasked with the legal responsibilities of managing the archaeological heritage of Europe.

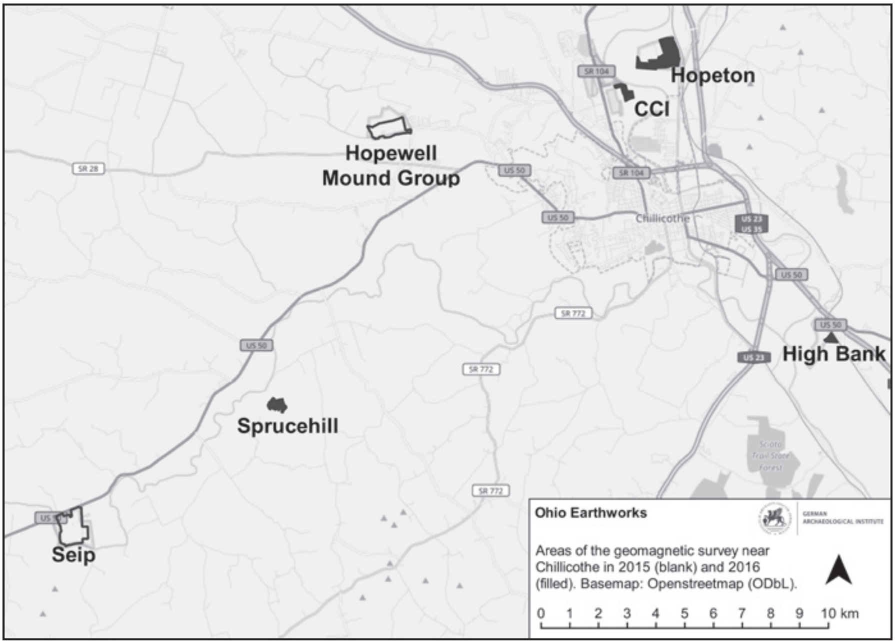

Figure 1. Survey areas of HOCU-sites near Chillicothe accomplished during the campaigns 2015 and 2016. (drawing L. Goldmann (DAI) based on Openstreetmap)

We recently attempted to extend these European models of landscape-oriented heritage management and research to a North American context. In 2015 and 2016, large-scale geomagnetic surveys were carried out at six Hopewellian mound and earthwork complexes managed by the National Park Service at Hopewell Culture National Historical Park (HOCU). Five of the sites are included on the United States World Heritage Tentative List as components of the Hopewell Ceremonial Earthworks serial nomination (US Department of the Interior 2008). Nearly 300 ha of meadows with high value for cultural heritage were examined within this initial agenda (Figure 1). The first results, focusing on Seip Earthworks, are discussed below.

The results reveal a stunning quality of subsurface preservation and a host of newly discovered earthen architectural elements in the heretofore unremarkable spaces between the known monuments. These results demonstrate that the sites possess a high degree of integrity and authenticity, and help define the outstanding universal value of an early society using and forming the landscape as an expression of human creative genius. The results also contribute to our understanding of needs for the future management of the properties, and highlight the challenges of making these hidden landscapes visible for the public at large.

SEIP EARTHWORKS

SOME HISTORY

Despite being one of the largest Hopewell earthwork complexes in Ohio and appearing in early mapping efforts by Atwater (1820) and Squier and Davis (1848), relatively little is known about the full extent of the Seip Earthworks. The early maps describe the site as a monumental mound and earthwork complex comprised of three conjoined geometric figures enclosing almost 50 ha: the Great Circle, Small Circle, and Square Enclosure. The second largest Ohio Hopewell mound dominates the center of the Great Enclosure, and several other mounds are scattered in and around the complex. But only portions of the site's features are visible on the surface today, and the earthworks rarely appear in aerial photographs. Surface surveys have documented numerous artifact clusters—from Middle Woodland and other time periods—spread across the site, but little is known of their subsurface contexts (Greber 1995).

Archaeological work at the site to date has focused on excavating the site's two largest mounds, the Seip-Conjoined (Mills 1909) and the Seip-Pricer mounds (Shetrone and Greenman 1931), as well as investigating an area north of the Seip-Pricer mound, where in the 1970s the Ohio Historical Society (OHS)[1] found a cluster of building foundations covered with low mantles of artifact-rich sediment (Baby and Langlois 1979; Greber 2009). Though the postholes of these structures may be too small to be detected in a magnetic survey, hearths, larger areas of burning, and large pits filled with rock and refuse were also found associated with these structures. These types of features may be detected by a magnetometer.

Renewed work in 2005, in the same general area north of Seip-Pricer mound, by Arizona State University located additional large pit-like features filled with rock (Spielmann 2005, 2011). Reexamination of the Ohio Historical Society excavation data suggested to Burks and Greber (2009) that the rock-filled pits might be large postholes rather than pit features, thus spawning the idea that the arcs of large rock-filled pits found by OHS in the 1970s might be portions of a post circle measuring about 30 meters in diameter. Spielmann and Burks set out to test this idea with a high-density radar survey and subsequent excavations, during which they located more large rock-filled pits, including one that was at least a meter wide and over 1.65 m deep (Spielmann and Burks 2010, 2011). While hard evidence for a complete post circle in this area of Seip has yet to be found, there is clear evidence for large pit or posthole-like features that occur individually or in arcing lines, along with extensive remains of structures covered by low mounds. Many of these features likely would be detected in a magnetic survey, and they could occur in other areas within and around the embankments at Seip.

Several small-area geophysical surveys have been undertaken in select areas of Seip. N'omi Greber oversaw one of the earliest applications of geophysical survey on a Hopewell earthwork, with some early ground-penetrating radar and resistance survey work near the area where OHS found the cluster of structures north of the Seip-Pricer mound (Greber 1980, 1981, 1984). Several small surveys were conducted in this area again by Burks (2005) and DeVore (2005) ahead of and during the 2005 excavations by Arizona State University. DeVore also collected magnetic data from a larger area within the large enclosure and west of Seip-Pricer mound (DeVore 2004). While features of note were detected by each of these surveys, the Seip Earthworks site is so large that it is difficult to discern earthwork-scale patterns in such small surveys. Unlike other earthwork sites in Ross County, where filled ditches make it relatively easy to locate earthworks in magnetic surveys, the known enclosures at Seip may be difficult to detect because they lack ditches, and the now-plow-deflated embankments were erected with soil likely scraped up from nearby. Embankments of this sort have proven difficult to detect in other areas of Ross County, especially when they are significantly plow-damaged (see e.g., Burks 2013a, 2013b; Weymouth 1998). Large area surveys are required to make much sense of these subtle, plow-deflated earthworks. In addition to the remains of earthen enclosures, a variety of other feature types also have been found in magnetic data from earthworks in Ross County, including numerous pit features (e.g., Bauermeister 2004, 2010; DeVore and Bauermeister 2015), "crematory" style basins (Lynott and Weymouth 2002), post circles (Burks 2013b, 2013c, 2014; Pederson Weinberger 2006; Ruby, this volume), structures (e.g., Brady and Pederson Weinberger 2010), additional enclosures (Pederson Weinberger 2006, 2009; Burks 2013c), and previously undocumented borrow pits (Ruby, this volume).

METHODOLOGY AND EQUIPMENT

Geomagnetic survey is a well-established, rapid, and nondestructive method for detecting archaeological features. Magnetometers combine speed with high spatial resolution, and their measurements are largely independent of the current soil-water content (in contrast to geoelectrics). Human activity can modify the

Figure 2. SENSYS Magneto® MX v3 magnetometer system in action. (Photo R. Komp (DAI))

magnetic signature of the soil. Only slight deviations of soil magnetic susceptibility distinguish natural soil from human intervention. Due to the necessity of an adequate magnetic contrast, it is not always easy to recognize features clearly. Moreover, iron-bearing material, e.g., some bedrock-like basalt, can in effect blind the magnetometer to the more subtle magnetic signatures of archaeological features. In general, pits and ditches, refilled with organic-rich material, are detectable as positive anomalies; deposits of stone that displace magnetic sediments appear as negative anomalies. Iron objects, igneous rocks, and intensely burned features create magnetic dipoles, which are related to permanently magnetized, or thermo-remnant, features. Historic-era waste dumps are a common source of dipolar anomalies in agricultural fields.

A SENSYS Magneto® MX v3 magnetometer system was used for the survey work at Seip. It was set up as a towed array of 16 fluxgate gradiometers attached to a nonmagnetic frame at 25 cm intervals, producing a four-meter swath of data with each pass of the system. Four wheels joined by brackets with efficient suspension provide mobility to the whole frame. By adjusting the suspension, the height of the sensors above ground can be managed between 10 and 40 cm—according to the roughness of the terrain. An off-road vehicle was used to tow the array, as well as carry the electronics, power supply, control unit, and the system operator. An appropriate driving speed considering the terrain and technical limits of the frame is about 10 mph max (Figure 2).

The fluxgate sensors in the SENSYS model FGM650/3 used for the Seip survey have a standard measurement range of ±8, 000 Nanotesla (nT, unit for the strength of the magnetic field). In each probe, or gradiometer, the sensors are spaced 65 cm apart, one atop the other, and provide measurements of the difference between the top and bottom sensor to within 0.1 nT. The magnetic measurements in each probe are transmitted at a frequency of 100 Hz; therefore, and depending on the driving speed, the system records 16 evenly spaced measurements every three to four centimeters in driving direction. This produces a data density of about 100 measurements per square meter.

The system is equipped with a high level (Survey Grade), Realtime Kinematic (RTK) global positioning system (GPS) to provide exact coordinates for each magnetic reading. While the GPS antenna of the moving device (the rover) is fixed on the frame holding the magnetometers, a nearby reference station, ideally positioned on top of a calibrated geodetic point, steadily transmits correction values to the rover by radio. The GPS coordinates are recorded once per second. To apply the coordinates to the collected magnetometry values, the data values are matched using timestamps; therefore, the clocks of the GPS and the magnetometer's data logger are synchronized at the beginning of each session. Magnetic readings recorded between GPS positions are assigned evenly spaced positions between the GPS readings. Interruptions in GPS data and radio signal transmission between the rover and the base station can be a problem, so there are some locations where this system cannot be used to record magnetic data.

A consistent survey method was used while collecting the magnetic data. Very large areas were divided up into smaller areas, perhaps the size of several American football fields. Within these smaller areas, the survey began with four to five tracks/swaths circling around the border of the area. Once the area was outlined, the system continued to be run in loops, but without collecting data in the outlined ends. In this way most tracks of data were collected with the system pointing in the same direction as neighboring tracks, which reduces changes in the magnetic readings related to the driving direction and the angle of the earth's magnetic field. Sensor and position data are recorded in a live stream by the control unit so that tracks can readily be seen on the fly on the control monitor; this, and being able to see the previous tracks' tire marks in the grass, helps ensure even coverage over the survey area.

Processing the resulting magnetic data is relatively straightforward. A set of software for field recording and data processing is provided for the system. Alternatively, the German Archaeological Institute has developed open-source tools to handle and integrate the raw data into a GIS. This allows for selection of data and removing failed readings, if necessary, as well as fast visualization of the survey results. One of the first processing steps is the removal of striping from the data. Since the sensors cannot be calibrated to exactly the same base level in the field, the values of each sensor row are shifted somewhat compared to the other rows. Hence, a stripe effect occurs when values are illustrated as grey shades. A compensation function is applied to the data with the software, which sets all lines of data to the same background level. Interpolation is used to fill small spaces in case of missing data. The resulting magnetogram shows the magnetic data as a greyscale map, where lower values are light and higher values are dark. It is possible to enhance the picture by emphasizing a tight range of values, since archaeological features usually only show very slight deviations from the general magnetic background. Therefore, setting a range between -7 nT and +7 nT focuses on details of interest for further analysis. The GIS allows the magnetic data to be integrated with other survey or excavation data. The data can be exported as a georeferenced tagged image (geoTIFF).

THE SURVEY

The land area owned and managed by Hopewell Culture National Historical Park at Seip Earthworks is, generally speaking, bounded by State Route 50 (between Bourneville and Bainbridge) on the north, the Paint Valley Schools to the east, and Paint Creek to the south and west. The terrain slopes down from the northeast across two fluvial terraces to the active floodplain and channel of Paint Creek to the south and west. The survey, performed within two weeks, covered the whole area of about 100 ha.[2] Only minor parts, like a nineteenth-century house lot, parking areas, and the steep slope of the Seip-Pricer mound had to be left out.

DISTURBANCES AND NATURAL FEATURES

Besides the two large mounds and portions of the northern arc of the Great Circle, none of the previously discussed above-ground features are readily visible. At first glance, the image of detected magnetic anomalies in Figure 3 mainly provides a view of modern disturbances and geological structures. (Figure 3)

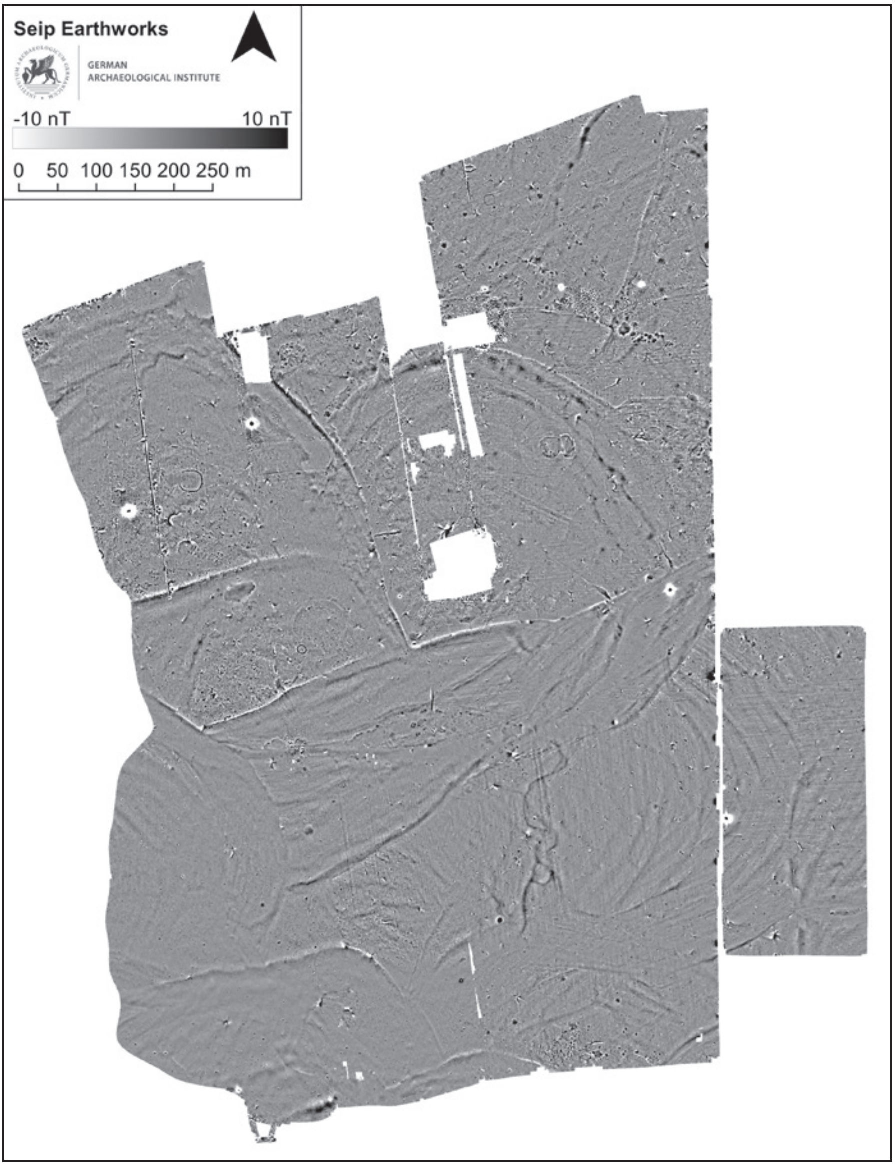

Figure 3. Seip Earthworks. Overall magnetometry plan 2015.

Concentrations of modern trash are found in areas alongside State Route 50, in the vicinity of nineteenth- and twentieth-century farm buildings, near the current parking space for park visitors, and in isolated spots scattered over the northern part of the site. Former field borders are indicated by remains of posts and pieces of fences (see northwest area); furthermore, past and current power poles were detected. All of these features are visible, since they contain some iron material and therefore influence the magnetic field. This view gives us insight into recent human activity.

The formation of the terrain has left its traces in the process of the geologic history, when the creek changed its course from time to time, forming sinuous channels and terraces in alluvial deposits of soil, gravel, and sand. Mainly the lower half of the whole area can be attributed to a floodplain. Those natural processes may have accounted for the selection of this space and possibly influenced the location of any activity; moreover, these alluvial deposits served as raw materials for earthwork constructions.

Another natural phenomenon also catches the observer's eye in the magnetic data: many lightning strikes have left their traces as magnetic signatures similar to large iron materials, with high-contrast positive and negative magnetic values (see Burks et al. 2015). Counting only the major ones, there are at least 100 of these anomalies, scattered all over the site but with a core area in the northeast.

EMBANKMENTS

The archaeological remains of the Hopewell culture are not as prominent in the overall picture, but on close inspection, can easily be recognized (Figure 4). By referring to the descriptions of Atwater (1820) or Squier and Davis (1848), the general outlines of the earthworks can be verified and confirmed in their dimensions. The magnetogram discloses fragments of what would have been the embankments: the Great Circle with a diameter of 495 m, the Small Circle measuring 310 m in diameter, portions of the Square Enclosure, and parts of the walls linking these figures together. Indeed, only parts of the northeastern wall of the Great Circle, the northern curve of the Small Circle, the link between both, and the irregular southern wall are still extant below surface and detectable in the magnetics. All walls appear to be about five meters in width.[3]

In addition to the large circular enclosures, the attached Square Enclosure is also faintly present in the magnetic data. It shows as a nine-meter-wide linear anomaly with low magnetic values in the center and high-valued bands on both

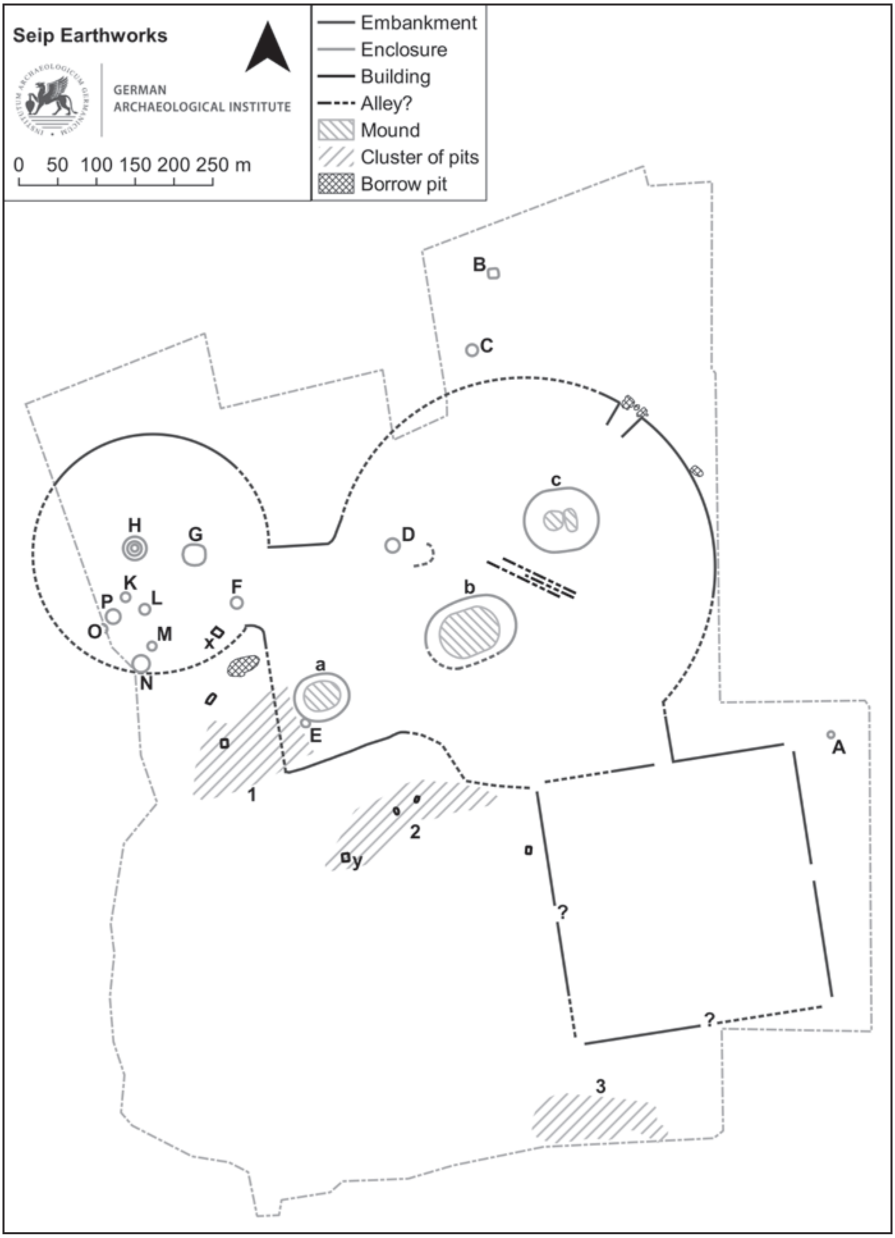

Figure 4. Seip Earthworks. Interpretation of features and monuments based on magnetic anomalies. Dashed lines indicate uncertain/reconstructed items. (Drawing L. Goldmann (DAI))

sides; this representative appearance of an earthen wall in a magnetic image is the result of the erosion and accumulation of relatively more magnetic topsoil at the base of the embankments. Unfortunately, in this case, they are often obscured by plow lines running in the same direction and are therefore hard to distinguish. The remnants of the Square Enclosure visible in the magnetogram include a 225 m long section of the west side, and shorter wall signatures north and south with lengths of 170 and 120 m, respectively. The east wall is best preserved with a total of 300 m. Early maps depict openings or gateways at each corner of the Square, and these are confirmed in the magnetic data. A 25 m wide gate is clearly visible in the middle of each wall, except on the western side where a gap is less clearly detected. There are no signs in the magnetic data of the mounds shown just inside each of these gates on nineteenth-century maps. The inner dimensions of the Square Enclosure are within the originally described range of 329 m (1080 ft) per side, enclosing a respectable space of about 11 ha.

We should point out that missing earthwork components in the magnetic data are not an indication that the earlier maps are incorrect; rather, it is an indication of the regrettable loss of historic fabric due to erosion and the long history of intensive agriculture in the region.

Even at this scale of analysis, several new observations related to the earthworks and other occupations are present in the magnetic data. For example, there is a previously unknown reentrant gateway configuration in the northeast section of the Great Circle (Figure 5). The embankment wall there bends inwards, creating an opening 34 m wide. On both sides of the gateway the five-meter-thick walls extend 33 m in the direction of the Seip-Conjoined Mounds and farther towards the center of the large Seip-Pricer Mound, narrowing in funnel-like fashion to 25 m wide. Atwater (1820:147) recorded five gateways in the northeast wall of the Great Circle. The gateway described above may be one of those, perhaps the largest one Atwater noted. Interestingly, Atwater's map depicts these five gateways with reentrant wing walls, corresponding to the gateway discovered here. Unfortunately, the other gates were not detected in the magnetic survey data.

We should note that the overall shape of the tripartite embankment visible in the magnetic data, enclosing about 42 ha, is only a rough match to the shape recorded by the early observers. Squier and Davis (1848:57) emphasized the accuracy of their surveying, but an attempt to superimpose their sketch on top of the magnetometry fails.

BORROW PITS

Squier and Davis (1848:58) denoted "deep pits or excavations, usually called 'wells'" surrounding the entire work. In the magnetometry only a few probable borrow pits are distinguishable. First, at the mouth of the newly discovered reentrant gateway is a large pit measuring 14 x 17 m, as well as smaller ones up to four meters in diameter. Second, just outside the southeastern arc of the Small Circle is a large cavity measuring 22 x 44 m. No doubt there were many other areas of soil-borrowing for the construction of the earthwork, but these likely have been refilled with the same type of sediment as was removed for use in creating the embankment walls and mounds, which makes these borrow areas hard to detect.

MOUNDS

The monumental Seip-Pricer Mound near the center of the Great Enclosure was not surveyed due to the steepness of its flanks and the fact that it has been completely reconstructed. Nevertheless, the magnetometer did detect an oval embankment (84 x 120 m) surrounding the mound. Although Squier and Davis (1848) noticed this enclosure, it has not been visible since their day. The area surrounding the base of the mound is unfortunately impacted by modern disturbances including fences, a gravel road from the park's early development as a State Memorial in the 1920s, and a huge lightning strike of unknown date.

While the embankment around the Seip-Pricer Mound was known (cf. Squier and Davis 1848:58), no embankment had been documented around the partly-excavated Seip-Conjoined Mound to the northeast . . . until now (Figure 5).

A four-meter-wide, lozenge-shaped perimeter feature with dimensions of 96 x 80 m is clearly visible surrounding the mound remnants (Figure 4C). The outlines of the conjoined mounds are also clearly visible, marked by a magnetic signature that is typical for an eroded wall. The magnetic signature conforms quite closely to the three-roomed floor plan N'omi Greber reconstructed for the submound structure beneath Seip-Conjoined (see Greber 1976; Figure 8). The western mound has a nearly circular pattern (or rather a square with rounded corners) of 26 m in diameter. At its southern edge there may be an opening, about six meters wide, with flanking walls leading inside. Near this probable entrance in the northwest part are two round anomalies of 2 and 2.5 m in diameter, which are located about four to five meters away from the walls. These smaller anomalies have magnetic characteristics typical of burned features, with highly magnetic centers surrounded by a ring of decreased magnetism. A third similar feature is present in the

Figure 5. Seip Earthworks. Seip-Conjoined Mounds and gateway in northeastern part of the Great Circle.

northeast corner of this part of the mound, or perhaps it is in-line with the wall. This anomaly does not appear to be burned. The eastern mound has a more oblong shape and is 18 x 30 m. Although this side of the mound appears to have one irregular outline, this is likely two nested mounds covering two of the three rooms in Greber's reconstructed floor plan (also see Squier and Davis 1848: 58, Plate XXI No.2c). Much like its neighbor to the west, this smaller mound(s) also has a burned feature, in this case measuring 1.6 x 2.2 m.

A singular feature is evident in the space between the Seip-Pricer and Seip-Conjoined mounds. Two linear anomalies form a possible 12 m wide avenue, running for almost 100 m from southeast to northwest towards the cluster of seven low mounds and structures investigated by the Ohio Historical Society in 1971–1977 (Baby and Langlois 1979; Greber 2009). Unfortunately, this structure is not precisely connected to anything at either end.

At a distance of about 150 m west of the Seip-Pricer Mound, near the lower southwest corner of the main embankment, the magnetics revealed another intriguing feature that matches the location of the circle A mentioned by Squier and Davis (1848:58, pl. XXI No.2; Figure 4 A). They suggest that it had a diameter of 76 m and was already difficult to trace in the 1840s due to plowing (Figure 6). In fact, the magnetic image nevertheless discloses some details. The faint signature of an embankment forms an ellipsoidal shape measuring about 74 x 65 m, with a four to five-meter-thick wall. The west side seems to be flattened a bit, while at the north a nine-meter wide gateway might be present, accompanied by a barrier (11 x 8 m) inside between both rings. About eight meters to the inside of the outer embankment is an inner structure, most probably a ring of small postholes, 50 x 38 m. This could be another mound, in this case very low, surrounded by an enclosure. Shetrone discovered a single cremated burial accompanied by two copper earspools in an unprepared grave near this location (Shetrone and Greenman 1931:479–480). Immediately adjacent to this enclosure we find a small circle, which is discussed below as "Enclosure E."

ENCLOSURES

Perhaps the most striking result of this magnetic survey is the discovery of more than a dozen entirely new enclosures (Figure 7). The majority of them are located within the Small Circle, while isolated ones are scattered widely across the site (Figure 4). Most of these appear to be ditched enclosures rather than walled spaces enclosed by wooden posts, as far as can be judged based on the magnetic data. In the following section we examine each of the new enclosures more closely.

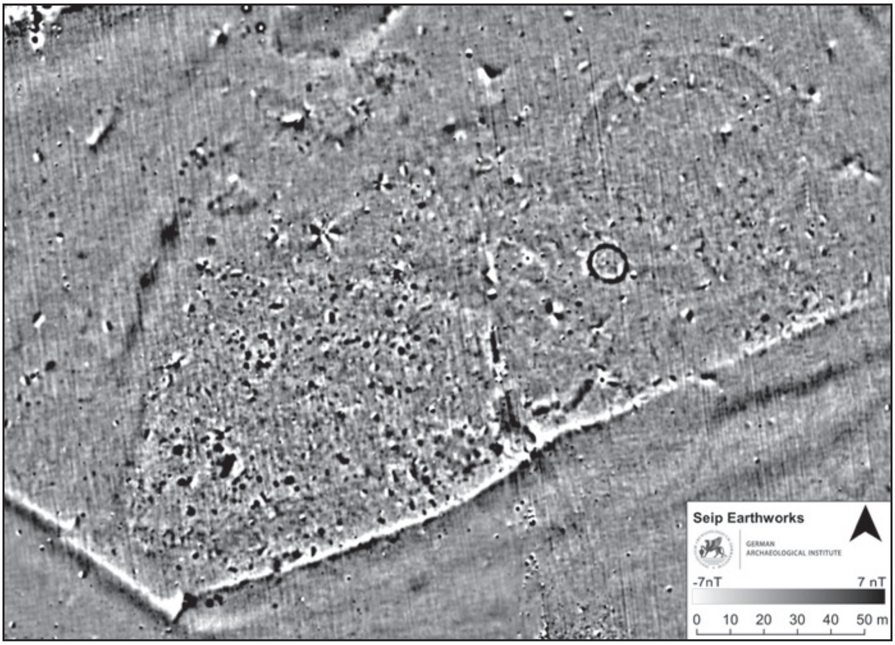

Figure 6. Seip Earthworks. Mound A and pit cluster.

Enclosure A. Enclosure A is a small (8.6 m diameter) circular feature located 45 m off the northeast corner of the Square Enclosure. While the signature of the ditch is relatively fuzzy, some peculiar spots (0.5–1.7 m in diameter) follow its line (Figure 7A). Two of these are slightly bigger and may flank the edges of a 1.8 m wide gateway. A dozen or more pits can be seen in the vicinity towards the west and a probable borrow pit is located 10 m to the east.

Enclosure B. The most northern visible enclosure has a square shape with slightly rounded corners. The magnetic signature is notably distinct in the northwest part, while the southeast edge is weaker (Figure 7B). The one-meter wide ditch encloses an area about 11.5 m north-south by 12.1 m east-west. At its east side is a gap, a probable gate, providing a pass-through about 1.5 meters wide. Almost in the center are four small posts arranged as a square with a distance of two meters to each other.

There is a large possible pit, three meters in diameter, located about two meters off the southeast corner. A number of similar anomalies are scattered across this area of the site, some ranging up to five to seven meters in diameter. These may be

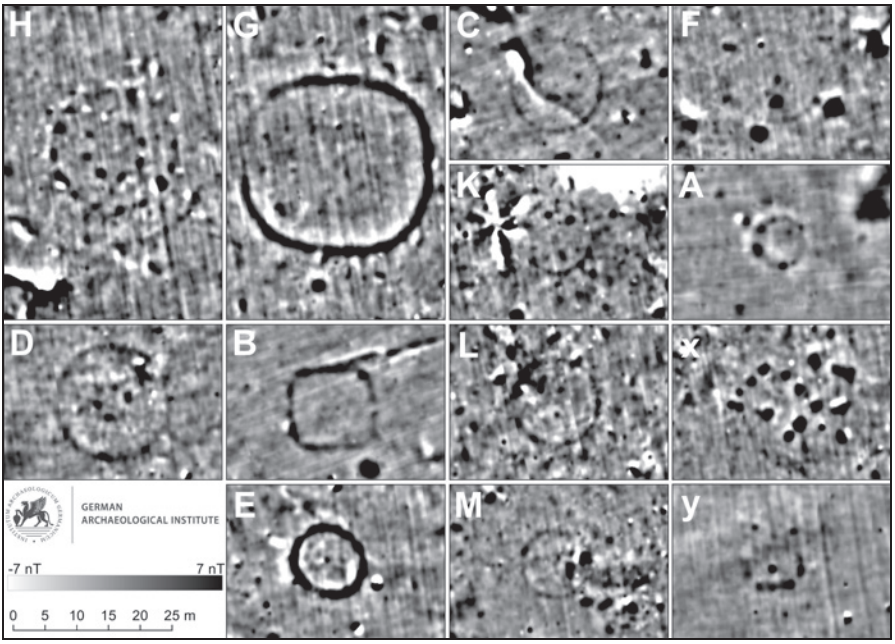

Figure 7. Seip Earthworks. Compilation of enclosures.

more small borrow pits, or they could be extremely large cooking pits. How these relate to the enclosures in time is not known.

Enclosure C. This circular enclosure, slightly obscured by traces of a lightning strike, is 15 m in diameter (Figure 7C). Two small anomalies (0.8 m diameter), may be interior postholes. These are nearly east-west aligned and spaced 6.5 m apart, and each is set 2.9 m inside the enclosure wall. No gateway can be distinguished. To the east are two large probable pit features, each about three meters wide.

Enclosure D. Enclosure D is located 150 m north of the Seip-Pricer Mound and 200 m west of the Seip-Conjoined Mound. This location is about 30 m southwest of the cluster of seven rectangular buildings excavated by the Ohio Historical Society in the 1970s (Baby and Langlois 1979; Greber 2009). Enclosure D is a circle, 19 m in diameter, with six clear pits of one-meter diameter each arranged around its center (Figure 7D). The distance between the pits is about three meters in one direction and about 1.5 m in the other. There is a three-meter-wide gateway opening to the northeast.

Enclosure E. As mentioned previously, Enclosure E is circular and is located just at the edge of Mound/Enclosure A. This probably corresponds to the mound marked "e" in the Squier and Davis map (1848:58, pl. XXI no. 2). They in turn relate it to Atwater, who described a "very singular mound, five feet high, thirty feet in diameter" (1820:143), a feature which had already vanished by the time Squier and Davis made their observations.

Now, the structure is indeed striking. The anomaly is strongly magnetic and gives a detailed shape (Figure 7E). The inner diameter is exactly 10 m as reported. In the center a magnetic anomaly may match the description of Squier and Davis, in that they found it "to contain an altar"—their descriptor for prepared clay basins that are often intensely burned. Moreover, a gateway can be identified opening to the southwest with an obvious post in the middle of the 1.5 m wide opening. Several magnetic dipoles in the vicinity most probably are related to modern iron objects.

Atwater (1820) described the mound as "composed entirely of red ocher," while Squier and Davis (1848) identified the composition as a "clayey loam." The different impressions of the material by the surveyors may reveal the effects of erosion over time. Hypothetically, the small mound was built using the material excavated from a surrounding trench: the volume of the soil, reasonably loam in this floodplain area, would easily have filled up the mound to the mentioned height of 1.5 m as stated by Atwater, which would make a volume of about 30 m^3—based on the recognizable ditch size of 1.5 m width and even less depth. The top was then covered with red ochre. Atwater describes that the big mounds, in contrast, were covered over with a layer of stones.

Enclosure F. Enclosure F is a small circle, 15 m in diameter, and located near the opening between the Small Circle and the Great Circle. Two pits (one and two meters in diameter) are located in the southern half of the enclosure; outside are two larger pits, up to three meters in diameter (Figure 7F). Given the large number of pits in this area, it is hard to know if these pits are of the same age as the enclosure.

Enclosure G. In the middle of the Small Circle's eastern half, Enclosure G is one of the most distinctive of the newly discovered enclosures at Seip. Its shape is best described as a *superellipse*, the shape Danish poet and architect Piet Hein famously designed to harmonize the elliptical and rectangular spaces in the post-WWII redevelopment of Stockholm's city center, Sergels Torg (see Gardner 1965). The enclosure measures 25.5 m east-west and 28 m north-south. The magnetic signature of this ditch (1.2 m wide) is distinctive, like that of Enclosure E, suggesting that it is deep and filled with sediment that contrasts sharply in magnetism with its surrounding matrix (Figure 7G). The weakly magnetic area along the enclosure's west edge could be a gateway feature or an area where the ditch is very shallow. There are two possible posts near the west side that could mark the edges of the enclosure gateway. A faint linear feature parallels the southern portion of the enclosure, along its inside edge. This might be related to posts or some other earthen component of the enclosure that is too damaged to fully understand. The small pit located outside the southern edge of the enclosure may be an unrelated feature.

Enclosure H. Located west of center in the Small Circle, Enclosure H is one of the more sophisticated constructions detected in the magnetic survey. It consists of two concentric circles of probable postholes. The inner circle, nine meters in diameter, consists of eight posts spaced at 2.5 m intervals. The outer circle has 16 posts with the same interval spacing and measures 19 m in diameter (Figure 7H). The posthole-related anomalies have different shapes and sizes, mostly circular with a diameter of one to two meters. This may be related to the sizes of the posts and/or the type of fill within the post, as well as whether there is burning. A third concentric circle appears at a distance of five meters beyond the post circles, this time as a continuous line (most visible on the southeast side). This likely is a ditch or trench feature. Together, the total diameter of this enclosure complex is about 29 meters. Interestingly, Atwater's description of the Small Circle includes this observation: "In its center is another circle, whose walls are now about four feet high, and this lesser circle is six rods in diameter" (1820:147). This corresponds to an earthwork 30 m in diameter and 1.25 m high. Based on the outer diameter of the three-ring complex, it is likely that Atwater was referring to Enclosure H, though our magnetic data reveal far more internal complexity.

Enclosure K. Several similar enclosures are located in the southwestern part of the Small Circle. Southwest of a former power pole and with traces of a lightning strike at its west side is a circular, slightly elongated enclosure ditch. Its diameter is about 12 meters, and the ditch appears to be interrupted on the east and west side, most probably destroyed by plowing (Figure 7K). Two pits of 1 and 1.3 m in diameter are located inside near the north side of the ditch; another two subtle anomalies in the south may represent corresponding features. A slight magnetic anomaly in the center is conspicuous in its positioning. A large probable earth oven is located eight meters to the southwest of the enclosure.

Enclosure L. Enclosure L is a perfect circle situated to the southeast of Enclosure K. It is 14 m in diameter and appears to have a 2.7 m wide gateway at its west side (Figure 7L). In the center two probable postholes (diameter 0.5 m) occur in a north-south line with a spacing of four meters, while a larger pit of about one meter in diameter is in the northwest quarter.

Enclosure M. Forty meters to the south is another circle measuring 11 m in diameter. Two large pits, up to 2.5 m in length, are situated inside, and more can be found outside (Figure 7 M). The enclosure intersects at least one of these pits in a manner that suggests multiple episodes of occupation.

Uncertain Enclosures N, O, P. No doubt there were more enclosures once present on the site. That said, those enclosures that were detected are quite clear, despite intensive agriculture for almost 200 years. Though not immediately obvious, at least three more findings in the southwest portion of the Small Circle are worth further discussion:

N) A fairly circular construction of posts or stones is 18 m in diameter. At its center are large dipolar magnetic anomalies about two to three meters in diameter. These may be burned features;

O) At the west border of the survey field, within the Small Circle in the area with a large concentration of enclosures, there is a suspicious half-circular-shaped feature along the field edge approximately 12 meters in diameter with a possible ditch about two meters wide. Its magnetic signature is quite strong, like that of enclosure E. Additional survey to the west would no doubt reveal this to be another enclosure;

P) This is a subtle, circular ditch feature, located 30 m west of enclosure L, and about 10 meters in diameter. Only the northeast part is visible. There is a pit feature in the data along the inner edge of its southern side and two small (0.5 m) pits opposite in the northern edge of the ditch. More two-meter-long, oblong shaped pits are present inside.

PIT CLUSTERS

Our magnetic survey identified three noteworthy pit clusters. They are characterized by conspicuous concentrations of pits accompanied by traces of possible structures. All three pit clusters are situated outside of the main enclosures. This distribution may be analogous to observations at the Hopeton and Liberty earthworks where systematic surface surveys have been conducted; at both these sites evidence for Hopewellian activities is concentrated outside the enclosure walls (Burks and Gagliano 2009; Coughlin and Seeman 1997; Ruby and Lynott 2009). All three of these pit clusters correspond to significant surface concentrations of Hopewell-related ceramics, bladelets, and stone tools recorded by N'omi Greber (1995, 1997). Here we provide additional details about each of the three clusters.

Pit Cluster 1. Located west of Mound/Enclosure A. The pits are one to two meters in size (Figure 6). There is a nearly rectangular structure, 10 x 12 m with two features on the inside; posts may be visible in data at the structure walls. This general area corresponds to Greber's Locality 4 and Locality 20 where notable concentrations of fire-cracked rock, animal bone, and organic soils were associated with Hopewellian diagnostics including bladelets, blade cores, bifaces, simple stamped ceramics, and mica. Two features were radiocarbon dated to the fourth and fifth centuries AD (Greber 1995:13, 25).

Pit Cluster 2. South of the Seip-Pricer Mound and close to the northwest corner of the Square Enclosure, there is a cluster of pits on a low terrace that has been sculpted by the meandering creek. At least two possible structures are evident: a 5 x 6 m anomaly in the center of the cluster and a 9 x 10 m feature with a roundish pit in its southwest corner. This general location may correspond to Greber's Locality 60 where Hopewellian diagnostics including bladelets and zoned rocker stamped ceramics were recorded (Greber 1995:56).

Pit Cluster 3. This cluster is located along the banks of Paint Creek at the southern edge of the survey area, and it is the most striking of the pit clusters. The magnetic signatures of these pits range from one to three meters, suggesting the presence of typical pits and pits filled with burned material (e.g., earth ovens). A few lightning strikes and iron-related anomalies add to the mix in this cluster. This location likely corresponds to Greber's Locality 29. Shetrone lived in a fishing camp near here while directing the Seip-Pricer excavations. He collected materials from a "village site near creek" including Hopewellian cores and bladelets, at least one Middle Woodland biface, and rocker-stamped and sand tempered ceramics. Fort Ancient ceramics were present as well (Greber 1995:33).

In addition to the pit clusters there is a unique arrangement of pits—possibly a building—visible in the data in the southwest area of the Small Circle (Figure 7X). There a rectangular outline is indicated by a series of mostly large pits (one to two meters in diameter). In the center of the southeast front side, which otherwise has no pits, a separate pit is present. The whole setting measures 12 x 9 m.

Another structure to be mentioned here is located in the south-west area of Pit Cluster 2. Several probable postholes outline a rectangular area about 10 x 9 m in size (Figure 7Y). A perfect round pit of 1.3 m in diameter can be seen in the lower half of the pattern.

CONCLUSION

Large-scale geomagnetic surveys at Hopewell earthwork sites, such as those in Hopewell Culture National Historical Park, are very productive endeavors (e.g., Burks 2010, 2013a, b, c; Burks and Cook 2011; examples in Lynott 2015). The case of the Seip Earthworks survey presented here is perhaps one of the most productive to date for identifying new features of many types. In part this is due to the scale of the survey, but it is also a function of the higher resolution of the survey—many more readings were collected per square meter during the Seip survey as compared to other large-scale survey efforts.

Some of the most distinctive new discoveries include the identification of more than a dozen new enclosures both within and outside of the main enclosures; documentation of a distinctive reentrant gateway configuration in the Great Enclosure northeast of the Seip-Conjoined mound; and evidence of enclosures surrounding the site's two largest mounds. Some of these findings confirm obscure features from the nineteenth-century maps of Atwater (1820) and Squier and Davis (1848), others are new to our understanding of Seip.

We think the most important of the new set of discoveries at Seip include the small enclosures located all across the site, but in high concentration within the Small Circle. These new enclosures occur with several designs, and they can be classified into three basic types:

1) Squircles (squares with rounded corners),
2) Perfect circles, shaped by ditches, and
3) Concentric post circles

With some variability, the sizes of all of these new enclosures are quite similar, with diameters ranging between 9 and 14 m. There are two exceptions that range up to 29 m across (i.e., enclosure G and H). Many of these have interior features, including pit-type features and probable postholes. Some have features (likely posts) that appear to be set up in concentric rings, but the majority are defined by circular and squircle-shaped ditches. Frequently, there are small areas within the ditches that produce slightly higher readings. These could be posts or pits within the ditches, or they might simply be areas of the ditch fill with elevated magnetic susceptibility. Though it is hard to conclusively say this with magnetic data, there is some indication that the enclosures and possible buildings have been modified through time, with the dismantling of wooden post circles and the erection of covering mantles. Possible indications of this may be evident at enclosure E, which has a ditch that looks to have been filled with some highly magnetic sediment. Perhaps at some point this area of the site was highlighted at the surface with a strongly red sediment containing hematite (i.e., red ochre).

Most of the new enclosures feature some kind of gateway. While at first glance there does not appear to be any obvious reason for the various gateway orientations, astronomical considerations and cultural symbolism should be examined (Greber 2015; Romain 2015, 186).

Ultimately, the magnetic survey at Seip shows a nearly unmanageable amount of magnetic anomalies caused by different cultures at different times. Some areas are packed full of features indicating the repeated and overlapping use of the space, with evidence for pits, structures, and earthen enclosures.

Finally, the three pit clusters discovered during the survey hold great potential for future studies aimed at developing a richly detailed understanding of the human use of this remarkable landscape through time. Although the search for the everyday habitations of the earthwork builders is one of the oldest and most troublesome problems in Ohio Hopewell archaeology, the recent technological advances that are making geophysical surveys possible on a truly landscape-scale are opening a new window on the problem. For the first time, we are able to generate something approaching a comprehensive inventory of the subsurface features related to cooking, storage, craft production, refuse disposal, and other activities in the vicinity of the enclosures (or at least the magnetic component of this inventory). Direct interpretation of the magnetic maps is not likely to allow us to sort out the palimpsest of activity areas laid down during the Hopewell episode, let alone the residue of several millennia of human activity on these ancient landforms. Nor will it allow us to distinguish between the domestic hamlets, transient housing, ritual camps, craft workshops, or other activity areas we might expect to be directly related to the construction and use of the earthworks. But surely, landscape-scale geophysics will provide us our best guide yet to the targeted excavations that will be necessary to resolve these vexing questions of chronology, function, and meaning at a range of different scales.

This detailed examination of the spaces "between the monuments" has opened new vistas with tremendous potential to further our understanding of this extraordinary landscape. The detailed work of data processing, comparative analysis, and ground-truthing is barely begun. Yet already, the survey results provide a new baseline for understanding the integrity and state of conservation of the site, and establish a firm foundation for the future management of the property. And certainly, we need to reimage our vision of the landscape to include not just the static mounds and earthworks, but also a pageant of living occupants—building and using a rich array of ditched enclosures, post circles, and wooden buildings.

NOTES

1. Now the Ohio History Connection.

2. Members of the team in the field were: Rainer Komp, Friedrich Lüth, Sebastian Messal, Bret Ruby, Timothy Everhart, and Jarrod Burks. Lukas Goldmann joined the team for data processing and illustrations. SENSYS Sensorik & Systemtechnologie GmbH generously provided equipment and support. Special thanks to the maintenance team at Hopewell Culture National Historical Park, and Tim Winland, Lewis Ewry, and Greg Pennington of Paint Valley Local Schools for logistical support in the field.

3. All measurements given here are approximate only, since the appearance of a magnetic anomaly is subject to several impacts (e.g., the depth of the object, or the displacement of soil by plowing, all making the detected magnetic signature more or less bigger than the object itself).

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