BIGMAN GEOPHYSICAL

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MAGNETOMETER SURVEY OF FORT MORRIS HISTORIC SITE, MIDWAY, GA

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Introduction

Bigman Geophysical, LLC was contracted by Dr. David Noble of The Sons of the American Revolution to carry out a magnetometer survey at Fort Morris, a revolutionary war era site located in Midway, GA. The goal of the survey was to identify any possible archaeological targets outside of the earthen fort embankment. A previous investigation with ground penetrating radar and excavations conducted by Dan Elliott (2003) recorded a variety of archaeological remains including hearths, rubble piles, refuse pits, and post holes. In addition, the excavations yielded a diversity of artifact types including those made from metal. The results of these investigations indicated that magnetometer might be an appropriate technique based on the soils and the physical properties of the expected targets of interest.

Approximately 1.9 acres were surveyed to the west of the earthen fort enclosure (Figure 1) on July 7, 2017 by Bigman Geophysical, LLC. The magnetometer data contain information on the distribution of possible archaeological remains outside of the earthen fort embankment. Both the locations of metal artifacts and probable features were recorded by the magnetometer and in some cases, a patterned distribution of magnetic anomalies could be inferred. There appear to be many archaeological remains outside the earthen embankment based on the near surface geophysical data.

Figure 1. Aerial photograph of Fort Morris Historic Site. Red line indicates boundary of magnetometer survey.

Survey Methods

Magnetometers measure local variations in the earth magnetic field strength. It is a passive method of prospection in that it records the earth's field rather than generating an artificial field and measuring the earth's response (such as electromagnetic induction). Often the goal of magnetometry in archaeology is to identify short-wavelength variations (anomalies) produced by archaeological sources (Kvamme 2006:206).

There are two basic types of magnetism that produce variations in the earth's local field strength as a result of past human activity: thermoremanent magnetism and magnetic susceptibility (Aspinall et al. 2008). Thermoremanent magnetism occurs when soils or objects are fired above the Curie temperature and the magnetic moments become parallel. Upon cooling, the moments may remain parallel creating a permanent magnetic intensity. Parallel magnetic moments increase the overall field strength of the soil or object and is easily detectable with a magnetometer.

Magnetic susceptibility refers to the ability of a material to become magnetized (Kvamme 2006:208). This primarily depends on the presence of magnetizable minerals, which in soil essentially consists of hematite, magnetite, and maghemite (however, only the last two are significantly magnetic) (Clark 1997). There are four different processes that can enhance the magnetic susceptibility in soils: (1) iron accumulates naturally in topsoils, (2) alternating periods of wetness and dryness can transmutate hematites to maghemites, (3) fires reduce hematite to magnetite, and (4) some colonizing bacteria in organic soils can excrete maghemite (Kvamme 2006). Human activity can exacerbate these processes and enhance the magnetic susceptibility of soils (Dalan 2006).

Thus, magnetometer survey can be an effective tool for investigating historic sites since the instrument can identify possible post holes, pits and other features that contain decayed organic material. The organic decomposed material often emphasizes the positive magnetic pole. Since metal objects generally have their own magnetic field and create a dipolar signature, organic deposits and metal artifacts can often be distinguished. One major drawback of magnetometer investigations of historic sites that have been converted into parks is that it can be difficult to distinguish metal artifacts from modern trash left by tourists. Other feature types were noted during Elliott's (2003) investigations that might yield anomalies that favor the negative magnetic pole. Thus, it is expected that magnetometer data collected at Fort Morris will produce a variety geophysical signatures.

Data Collection and Processing Procedures

This magnetometer survey was carried out using a Bartington 601-4 fluxgate gradiometer with two sensors. The sensors were spaced 1 m apart. The surveyor generally collected data in an east-west direction. The gradiometer data was collected using a Realtime Kinematic Global Navigation Survey System (RTK GNSS) to position the readings. The gradiometer and the GNSS antenna was attached to a two wheeled non-magnetic hand cart (see Figure 2 for a photograph of the set up). Real time data output was stored in a Toughbook H2 field computer and integrated with the GNSS coordinates. A grid projected on the display of the filed computer was used to guide the surveyor across the collection area allowing the surveyor to walk along "virtual" grid lines to ensure complete coverage. The gradiometer data output was 10 Hz and the GNSS was 1 Hz. The data collection software interpolates the GNSS positions for the gradiometer data points that fall between the GNSS readings. A zero mean filter was used to balance the readings from the two sensors.

Figure 2. Photograph of magnetometer and GPS setup.

Results

As expected, the magnetometer recorded a variety of anomalous signatures (Figure 3) consistent with the diversity of features and artifacts identified by Elliott in 2003. Positive, negative, and dipolar anomalies are distributed across the survey area, but a higher concentration exists beginning approximately 20 m from the earthen embankment. There is also variation in the amplitudes of the magnetic anomalies suggesting variation in the sizes and depths of these features and artifacts. These variations might indicate a range of feature sizes and functions from small post holes to larger refuse pits and hearths.

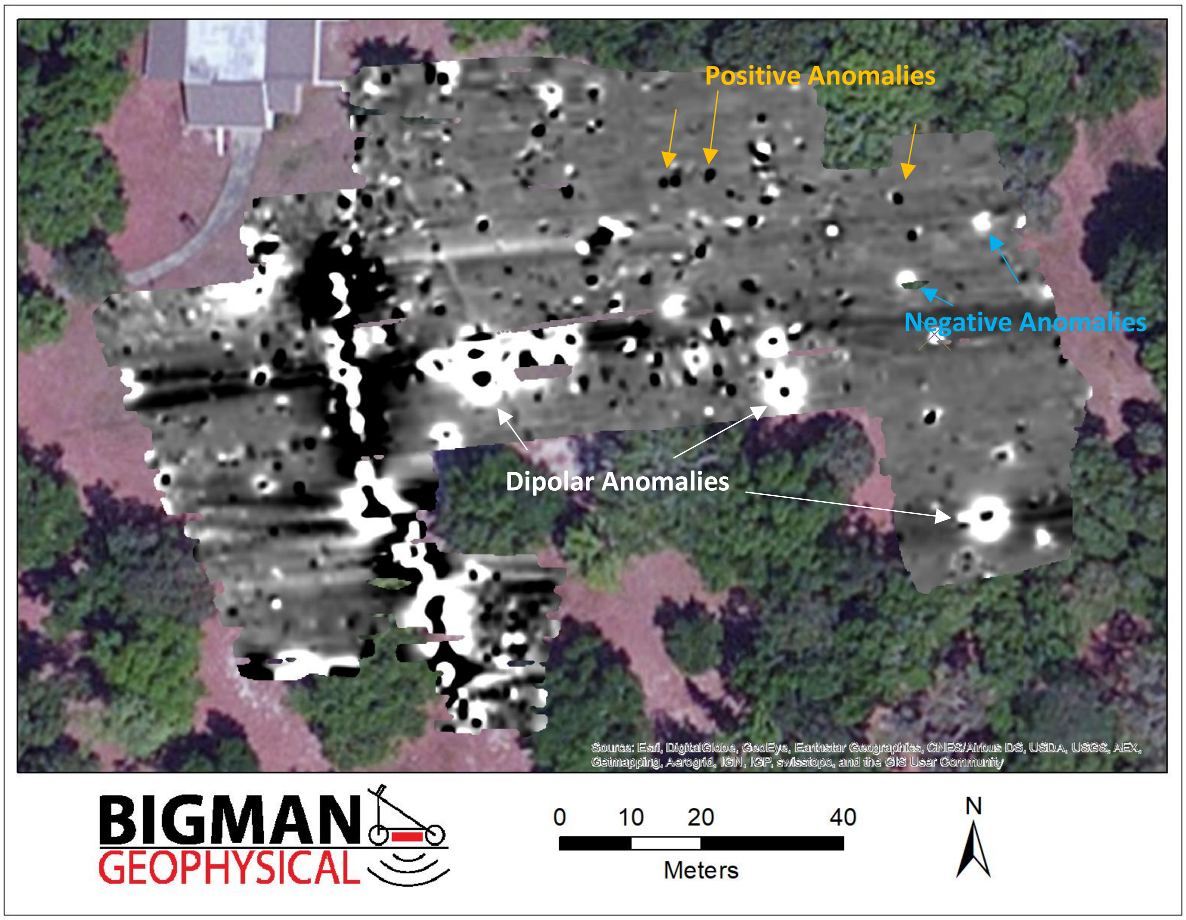

Figure 3. Processed magnetic gradiometer data collected at Fort Morris (+-35 nT; black is positive; white is negative) indicating various magnetic signatures.

There is also some patterning in the distribution of magnetic anomalies indicating the possible locations of architecture (Figure 4). Closely spaced magnetic anomalies oriented in a curvilinear pattern exist in several areas of the site. It is unclear if these are the outlines of buildings or random distributions. One linear anomaly oriented northwest-southeast may suggest a possible location of the fort's wall. The location of the magnetic anomaly appears to be somewhat congruent with early maps and descriptions produced by (Sheftall 1977). However, this conclusion should be viewed as tentative and this feature should be explored through additional investigation.

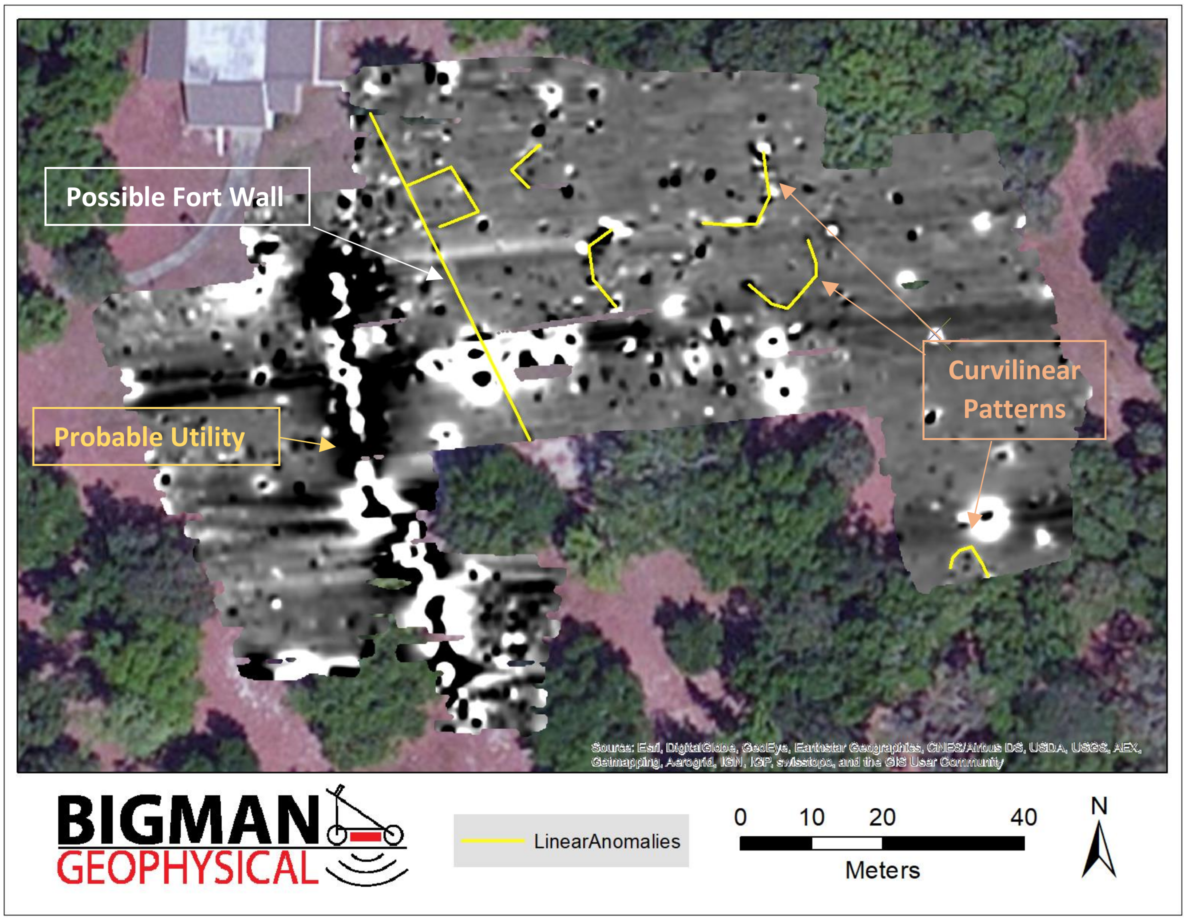

Figure 4. Patterned distributions of magnetic anomalies at Fort Morris (+-35 nT; black is positive; white is negative).

Conclusions

The magnetometer survey results suggest that a high density of archaeological remains are located to the west of the earthen embankment. While much of the previous investigations focused on the interior of the earthen embankment, the current study focused its efforts on the exterior. The diversity of anomalous signatures recorded with the magnetometer is consistent with the variety of features uncovered through excavation by Elliott (2003). Furthermore, a linear magnetic anomaly that may indicate the location of the fort wall was also recorded. Previous GPR work conducted inside the earthen embankment (Elliott 2003) suggests that this would be a helpful follow up technique to use at Fort Morris. My recommendation for future investigations at Fort Morris include collecting a large contiguous grid outside the earthen embankment with GPR that encompassed numerous isolated magnetic anomalies with varying signatures and the linear anomaly that may represent the wall. GPR is a high resolution subsurface imaging technique that will help establish the locations of possible archaeological targets and help characterize the linear anomaly and help determine if future excavations should take place to verify the source of the anomaly.

References

Aspinall A, Gaffney C, Schmidt A (2008) *Magnetometry for Archaeologists.* Alta Mira Press, Lanham.

Clark A (1997) *Seeing Beneath the Soil: Prospecting Methods in Archaeology.* Routledge Press, New York.

Dalan R (2006) A Geophysical Approach to Buried Site Detection Using Down-hole Susceptibility and Soil Magnetic Techniques. *Archaeological Prospection* 13:182-206.

Elliott D (2003) Archaeological Investigations at Fort Morris State Historic Site, Liberty County, Georgia. Report submitted to Georgia Department of Natural Resources. Southern Research, Historic Preservation Consultants, Inc.: Ellerslie.

Kvamme KL (2006) Magnetometry: Nature's Gift to Archaeology. In *Remote Sensing in Archaeology: An Explicitly North American Perspective,* edited by J. K. Johnson, pp. 205-234. University of Alabama Press, Tuscaloosa.

Sheftall, J (1977) *Sunbury on the Medway: A Selective History of the Town, Inhabitants, and Fortifications*. Georgia Department of Natural Resources, Atlanta.