Journal of Archaeological Science 42 (2014) 367–372

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Mapping plow zone soil magnetism to delineate disturbed archaeological site boundaries

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ARTICLE INFO

Article history:
Received 22 May 2013
Received in revised form
22 November 2013
Accepted 24 November 2013

Keywords:
Magnetic susceptibility
Plow zone archaeology
Disturbed archaeological sites
Mississippian
American southeast
Settlement archaeology
Archaeological geophysics

ABSTRACT

This paper presents the results of a magnetic susceptibility survey at Ocmulgee National Monument, a large archaeological site located in central Georgia. Ocmulgee consists of numerous bluffs, each subjected to plowing and erosion. Archaeological remains preserved differentially better on some bluffs, while remains on other bluffs have been obliterated. Magnetic susceptibility readings were recorded in the plow zone on Mound X Ridge, an area of the site that is significantly disturbed. Although the archaeological site is no longer intact, superparamagnetic micro-particles from daub, ceramics, or charcoal have been mixed from 100 years of plowing and remain in the plow zone. The goal of the project was to delineate the northern boundary of this activity area. Thirty posthole tests were excavated and the presence or absence of artifacts from each posthole test was recorded. Magnetic susceptibility values were also recorded in the plow zone following excavation of each test. The positive correlation of high susceptibility values with presence of artifacts indicates this method is useful for mapping disturbed site boundaries of plowed archaeological sites. This method is quicker than more traditional invasive testing and does not further disturb archaeological remains if posthole tests are not excavated below the plow zone.

1. Introduction

This paper presents results from a field magnetic susceptibility survey carried out in 2011 at Ocmulgee National Monument located in central Georgia, USA (Fig. 1). Ocmulgee is the largest Mississippian period site known in Georgia and is located approximately 400 m northeast of the Ocmulgee River. It was excavated in the 1930s as part of a large federal relief program to put people back to work. Following these excavations, the site was preserved as Ocmulgee National Monument. Ocmulgee is one of the largest mound sites in the eastern United States and there is evidence of human occupation from every major historic and pre-historic period over the past 13,500 years.

What makes Ocmulgee special is that the ceramics and spatial layout of its Early Mississippian (AD 900–AD 1200) occupation do not look like anything that came before or after it in central Georgia. The community saw unprecedented population growth and the expansion of its political influence during this time (Bigman, 2012). The Early Mississippian occupation witnessed a major construction effort consisting of at least 8 (possibly 12) earthen pyramids, two extensive ditches, and at least four large earth-embanked council chambers. Hally and Williams (1994) argued that each earthen pyramid formed the nucleus of a neighborhood, and each neighborhood was separated from each other by open space. Following the disintegration of Ocmulgee's centralized political power, and the community's dispersion across the landscape into smaller settlements by AD 1200, there seemed to be a taboo placed on the town's reoccupation (Hally, 1993). This is in stark contrast to numerous other large Mississippian centers where Native Americans reoccupied previous central towns (Anderson, 1994; Hally, 1996; King, 2003). Ocmulgee however, was not reoccupied until about 1680 by historic Creek Indians. A town developed at Ocmulgee when the Creeks began migrating from the Chattahoochee River to the middle Ocmulgee and Oconee rivers to take advantage of the English trading opportunities (Waselkov, 1994: 191). The town surrounded a Carolinian trading house (Mason, 2005) that was discovered by the director of the federal relief program in the 1930s (Kelly, 1938), but was likely abandoned sometime during or just following the Yamasee War of 1715.

This project's objectives were to map the density of occupation near Mound X, a small earthen pyramid in the northern portion of the site, and delineate the northern boundary of a possible activity area surrounding Mound X. The study area includes Mound X Ridge and the wooded area north of Mound X (Fig. 2). This section of the

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http://dx.doi.org/10.1016/j.jas.2013.11.022

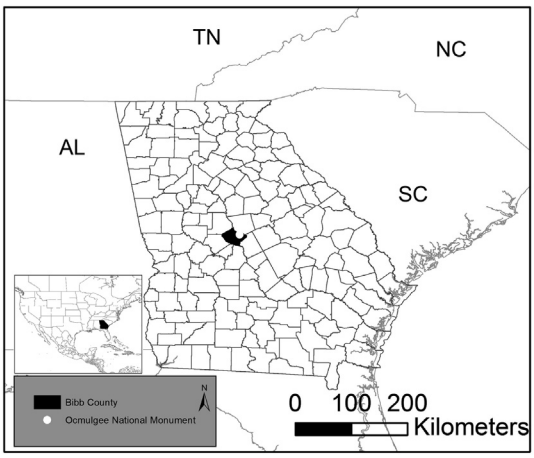

Fig. 1. Map indicating the location of Georgia and Ocmulgee National Monument.

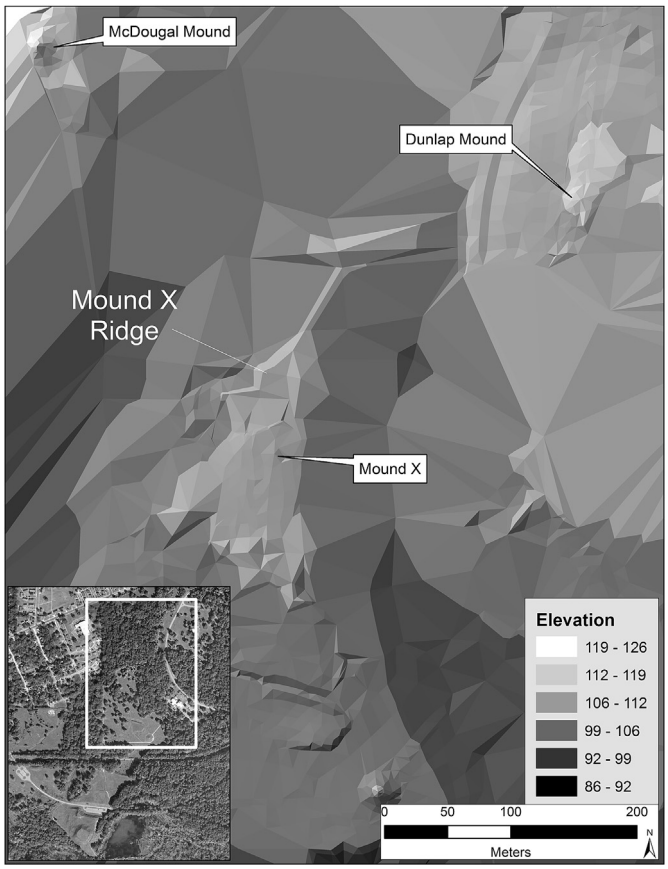

Fig. 2. Topographic map of the study area indicating locations of earthen mounds (Inset shows aerial photograph of Ocmulgee National Monument with the location of the study area outlined in white).

site suffered differentially more disturbance from plowing compared to other pre-historically occupied ridges and bluffs in the park (Bigman and Hurley, 2012) and the purpose of this survey was to develop a field based method to derive archaeologically substantive results from disturbed sites. Despite early recognition of the research potential for plowed sites (Ledbetter, 1988; Lewarch and O'Brien, 1981), explicit methods for meaningful data extraction must continue to be developed.

The woodlands located north of Mound X Ridge are situated between three Pre-Columbian flat-topped earthen pyramids (Fig. 2) dating to the Early Mississippian (Hally and Williams, 1994), and are bounded on the north and east by housing units and the west by a small creek. The study area has an irregular topography where Mound X Ridge extends north into the woodlands and expands into a "T" shape approximately 150 m north of Mound X (Fig. 2). A gentle slope extends east from this T-shaped ridge until it reaches a small creek. A steep gradient extends west from the ridge top, eventually leading into a relatively flat lowland expanse. The flat lowland is disrupted in its northwest corner by a steep hill. The southern portion of Mound X Ridge is an open, mowed grass area with a minimal number of isolated trees randomly dispersed across the ridge. In contrast, the woodlands to the north consist of mixed pine/hardwood forest (consult Woods, 1979; Froeschauer, 1989; Cosner, 1973 for more detailed descriptions of Ocmulgee's geological, ecological, and environmental conditions). The thickness of humus varies between the open grass land (0 cm thick) and the forested context (up to 10 cm thick) and the survey strategy had to account for this difference.

2. Survey methods and data processing

The application of magnetic susceptibility to archaeological problems began almost 50 years ago (Le Borgne, 1965; Tite, 1972; Tite and Mullins, 1971) and many studies continue to use the technique as a supplement to larger resistivity, ground penetrating radar, and magnetic gradiometer surveys (Chianese et al., 2004; Henry, 2011; Lowe and Fogel, 2010; Maillol et al., 2004). Other researchers focused on expanding the technique's utility by exploring new applications such as ceramic sourcing (Glover, 2012; Rasmussen, 2001) and burial detection (Bigman, 2013; Dalan et al., 2010; Linford, 2004). Several excellent studies (Dalan, 2006; Gaffney et al., 2005; Marshall, 2001) documented the effectiveness of magnetic susceptibility in mapping the spatial distribution of architecture and features, identifying functionally discrete activity areas, and delineating site boundaries of well-preserved sites. Preserved sites provide ideal contexts, but many archaeological sites have been subjected to some form of disturbance. Such disturbances include bio-turbation, earthquakes, real-estate development, flooding, and erosion, among others. One of the most destructive processes affecting preservation of cultural heritage around the world is agricultural plowing. Upland activity areas (such as Mound X Ridge) are subject to erosion which maintains thin topsoil cover. This makes archaeological deposits more susceptible to destruction when subjected to prolonged periods of plowing. Information from all sites, including those that are disturbed, is important for understanding larger intra-regional relationships of past human groups. Basic information such as site size and location of site boundaries are critical dimensions of variability archaeologists require to place sites in their regional social context. These basic understandings also help mitigate against future adverse impacts to the archaeological record.

Explicit methodological developments for geophysical survey under these conditions have only recently been explored (Dalan et al., 2011; Roos and Nolan, 2012). One of the most effective studies utilized magnetic susceptibility and soil phosphate analyses to map village layout and community organization at a heavily plowed archaeological site in central Ohio (Roos and Nolan, 2012). Roos and Nolan (2012) collected soil samples in the field on a 20 m $\times$ 10 m grid and measured the geophysical and geochemical properties in the lab. Their survey mapped a U-shaped midden distribution (identified with high susceptibility and phosphate values) on the outer edge of the village and a 30 m $\times$ 40 m plaza (identified with low susceptibility and phosphate readings) located in the center. These results indicate that geophysical and geochemical mapping of plowed sites can yield significant