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Magnetic Gradient Survey at the M. S. Roberts (41HE8) Site in Henderson County, Texas

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Introduction

The M. S. Roberts site is located in Henderson County, Texas and it represents one of the few known Caddo mound sites in the upper Neches River Basin in northeast Texas (Figure 1). The site is situated along Caddo Creek – an eastward-flowing tributary of the Neches River (Perttula et al. 2016; Perttula 2016; Perttula and Walters 2016). The site is located southeast of Athens, Texas. When first recorded, the single mound at the site was approximately 24 m long and 20 m wide and roughly 1.7 m in height (Pearce and Jackson 1931). Directly west of the mound was a large depression, which has since been mostly filled, and likely represents the borrow pit for mound fill. The mound is situated at the southern end of an elevated alluvial landform.

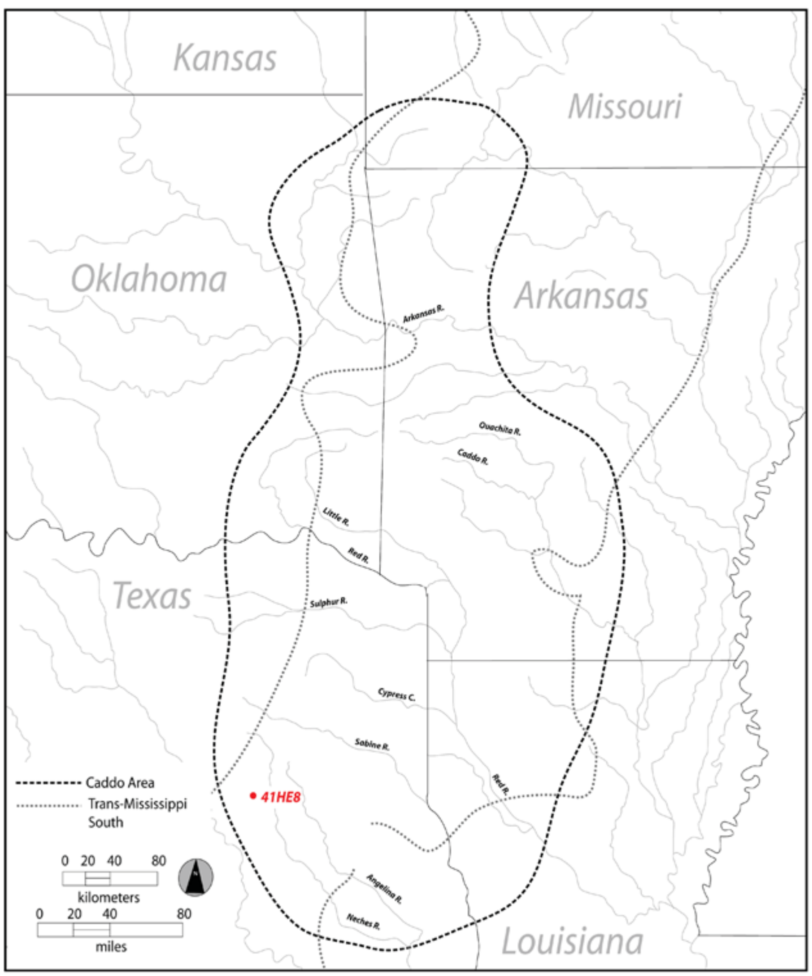

Figure 1. The Caddo Archaeological Area with the location of 41HE8.

The site was first reported to Dr. J. E. Pearce of the University of Texas in September 1931. In October of the same year, archaeologists from the University of Texas began investigating the mound and defining the extent of the associated settlement (Pearce and Jackson 1931). Researchers obtained a surface collection from the site and excavated an unknown number of trenches in the mound where portions of at least one burned and buried Caddo structure was identified. Their excavation notes document that the mound began as a 25 cm deposit of yellow sand constructed on the undisturbed brown sandy loam that defines the alluvial landform. A structure had been built on the yellow sand and then at some point had been burned. The burned structure was then covered with mound fill at least a meter in depth. Materials collected from the surface as part of the 1931 investigations indicate the presence of a Caddo habitation area surrounding the mound and suggest the site was occupied from the fourteenth to the early fifteenth centuries (Perttula et al. 2016; Perttula 2016; Perttula and Walters 2016). At that time, the landscape around the mound was a used as a cotton field and subject to extensive plowing. Today, the landscape is part of a residential ranch development where landowners are stewards of the site with a focus on preservation and research.

In January 2015, with the permission of the landowners, renewed interested in the site began with a surface collection and the examination of the artifact collections from the 1931 work held by the Texas Archeological Research Laboratory (Perttula et al. 2016; Perttula 2016; Perttula and Walters 2016). A series of shovel tests and auger holes were then dug in the mound and surrounding habitation area in mid-2015. Shovel tests and auger holes documented organically-stained and charcoal-rich areas within the mound that were thought to represent the remains of several burned Caddo structures, and also identified non-mound habitation deposits at the site. An initial aerial survey was also conducted to map the landform topography, estimate the extent of the current mound dimensions and borrow pit, and to reconstruct changes in the shape and size of the mound since it was first recorded in 1931 (Perttula et al. 2016). The survey employed a small Unmanned Aerial Vehicle (UAV) to map the roughly 20-acre property surrounding the site at a 2 cm per pixel resolution. The aerial survey of the mound and surrounding landscape and the creation of a high-resolution digital elevation model reveal that the mound dimensions have changed significantly from what was reported in 1931 (Perttula et al. 2016).

For example, aerial data document both the mound and borrow pit features and show that the mound measures 43 m North-South and 26 m East-West, and is roughly 1 meter above the surrounding terrace surface (Perttula et al. 2016). The aerial survey demonstrates that the mound has elongated over the last century since it was first recorded, likely related to historic landscape modification.

In January 2016, the site was again revisited. The purpose of the fieldwork was to better define the spatial extent of archaeological deposits in the non-mounded habitation area and investigate the stratigraphy of mound deposits, identify cultural features in the mound, and hopefully obtain charred plant remains or unburned animal bones from these deposits for AMS dating.

To help evaluate and identify the distribution of cultural features in the mound and the surrounding non-mounded habitation area, an area just over 1 hectare or 2.8 acres was surveyed using magnetic gradient and a second aerial survey was completed to refine the overall landscape topography (Figure 2).

The magnetic gradient results document the subsurface location of at least two interpreted structures within the mound, the possible locations of three 1931 UT trenches, and several possible pit features proximate to the mound. The combination of aerial and geophysical data and the excavation results are revising our understanding of the archaeological remains and preservation conditions of the site.

Magnetic Gradient

The use of magnetic gradient at Caddo sites located throughout the Caddo people's ancestral lands within the current areas of East Texas, Southwest Arkansas, Northwest Louisiana, and eastern Oklahoma

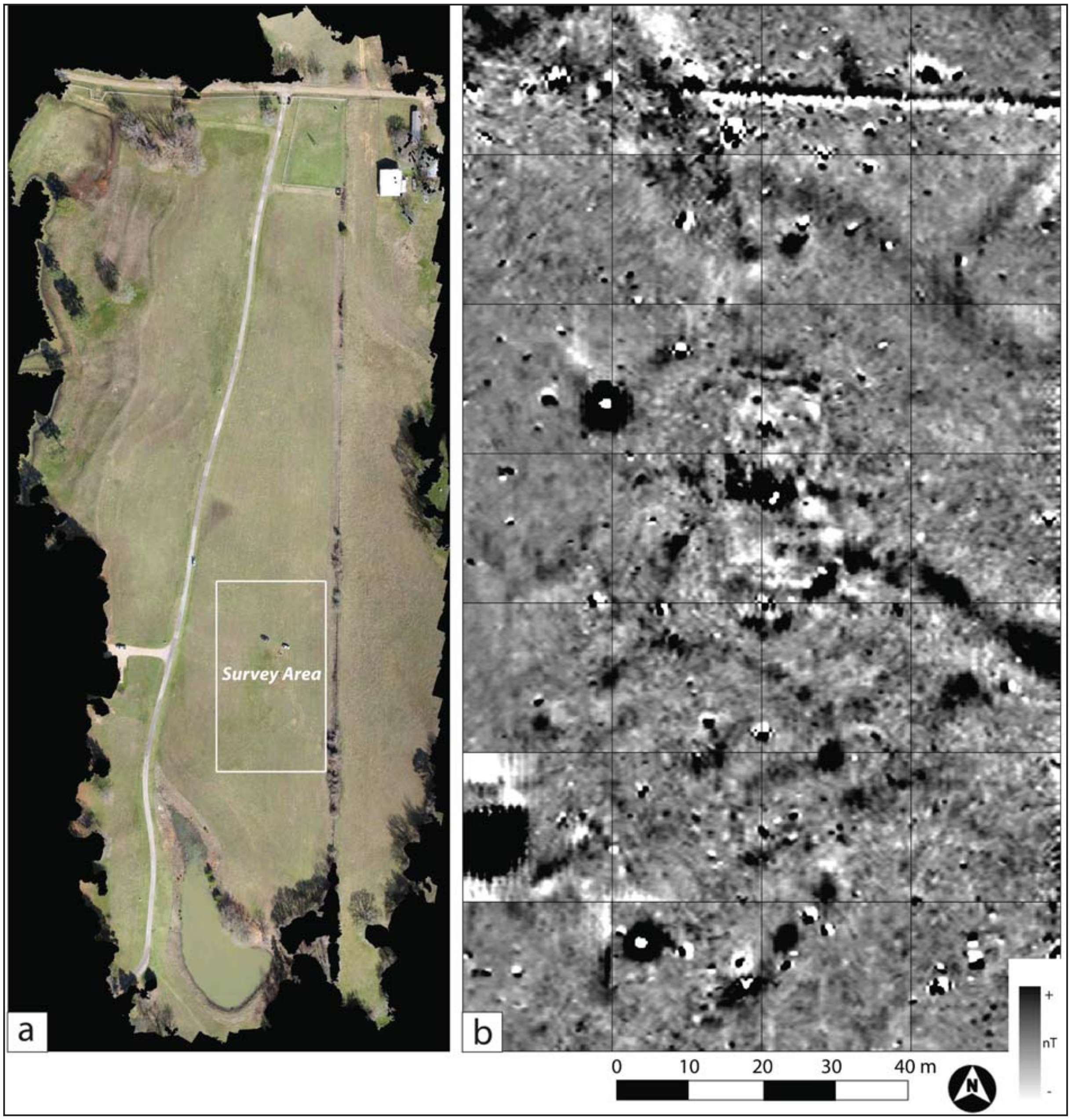

Figure 2. Magnetic gradient survey at the M. S. Robert (41HE8) site: (a) Location of survey area using aerial survey conducted by Arlo McKee (Perttula et al. 2016), (b) magnetic gradient results.

has been very successful in the elucidation and mapping of the distributional characteristics of buried cultural features (see Perttula et al. 2008; Hammerstedt et al. 2010; Walker and McKinnon 2012). Magnetic gradient interpretations discussed herein are developed using a combination of inductive and deductive approaches. An inductive approach has roots in satellite and aerial image interpretation with the recognition that geometric shapes, relative sizes, and systematic repetitions of image objects can form interpretable patterns (Wilson 2000). When anomalies in a geophysical dataset resemble patterns of regular geometric shapes, it can be induced that they are of probable cultural origin.

A deductive approach utilizes known physical properties of the subsurface matrix (artifacts, features, sediments, and soils recorded during excavation) to deduce how instrument sensors might respond and thus certain interpretative deductions can be made about the nature of anomalies revealed in the data. For example, thermoremanent magnetism is the result of burning events, which can produce an anomaly composed of stronger magnetic values (see Kvamme 2006, 2008). Anomalies of medium to high magnetic value may be deduced as being generated by a hearth, kiln, or a quickly burned house. A soil matrix that has been magnetically enriched through pedogenesis (induced magnetism and magnetic susceptibility) can also produce anomalies containing stronger magnetic values than those in the surrounding matrix (see Kvamme 2006, 2008). Several low to medium magnetic signatures identified within or around a structure may be deduced as being pits. Highest magnetic values are typically related to ferrous metal debris buried close to the surface, which can generate anomalies of extreme magnitude. Magnetic values collected by magnetic gradient instruments are recorded in nanotesla (nT; 10^{9} tesla).

The magnetic gradient survey at the M. S. Roberts site was conducted using a Bartington Grad 601-2 fluxgate gradiometer (Bartington and Chapman 2004). The Grad 601-2 is a vertical component fluxgate gradiometer containing two cylindrical sensor assemblies. Each cylindrical sensor assembly contains two mounted sensors with a 1 meter vertical spatial separation that measure the vertical component of the magnetic field. Since magnetic strength decreases with the cube of distance ($1/d^3$), the lower sensor is more sensitive to subsurface readings whereas the opposite upper sensor is more sensitive to Earth's magnetic field (Clark 1996:78). Simple differencing of the two readings removes the effects of the latter. Given that the Bartington instrument offers a vertical sensor separation of 1 meter, the sensitivity of the instrument is greatly increased and subsurface magnetic features more pronounced when compared to gradiometers with a shorter sensor separation (Bartington and Chapman 2004).

Data at the site was collected within established 20 x 20 m grids where a survey tape was pulled taut along each baseline and non-metallic pin flags were placed along baselines to guide the surveyor (Figure 3). White non-metallic pin flags were set at every odd meter with a blue non-metallic pin flag set on every fifth meter. The established non-metallic pin flags were used as transect (Y) collection guidelines in order to maintain 0.5 m spacing along the each grid baseline (X). Collection spacing along each transect (Y) was set to 0.125 m spacing (8 samples per m) and regulated using a focused and practiced walking pace of 1.3 m/second. Data were collected using a zigzag pattern.

A welcomed challenge with magnetic gradient surveys 1 hectare or greater is the significant amount of anomalies detected and the need for an organized way to describe and interpret dimensions, possible function, temporal or cultural affiliation, and origin. In this article, anomalies identified within the survey area are grouped and discussed as (a) those of historic origin (i.e., scattered metallic debris on the surface, unmovable metallic objects on the surface, and buried metallic features); (b) those interpreted to be of archaeological origin (i.e., related to the 1931 University of Texas excavations); and (c) those interpreted to be of Caddo culture origin (i.e., circular structures and associated pits and hearths).

Anomalies of Historic Origin

Landscapes that have a long history of farming and agricultural activities are likely to contain numerous metal objects of varying size randomly scattered throughout the area, such as tractor parts, nuts and bolts, barbs from wire fences, and other metal debris. With a magnetic gradient survey, ferrous metallic debris is recorded as a dipolar anomaly of both extreme high and low values in opposition (see Kvamme 2006). Metallic debris identified in the M. S. Roberts survey is fairly equally distributed, as expected given that the site has a history of cotton cultivation and other forms of farming activities (Figure 4). Three extreme values represent upright t-posts that were unable to be moved prior to the survey. A long single linear magnetic anomaly to the north likely represents a buried utility conduit or irrigation pipe.

Figure 3. Surveying at the M.S. Roberts site

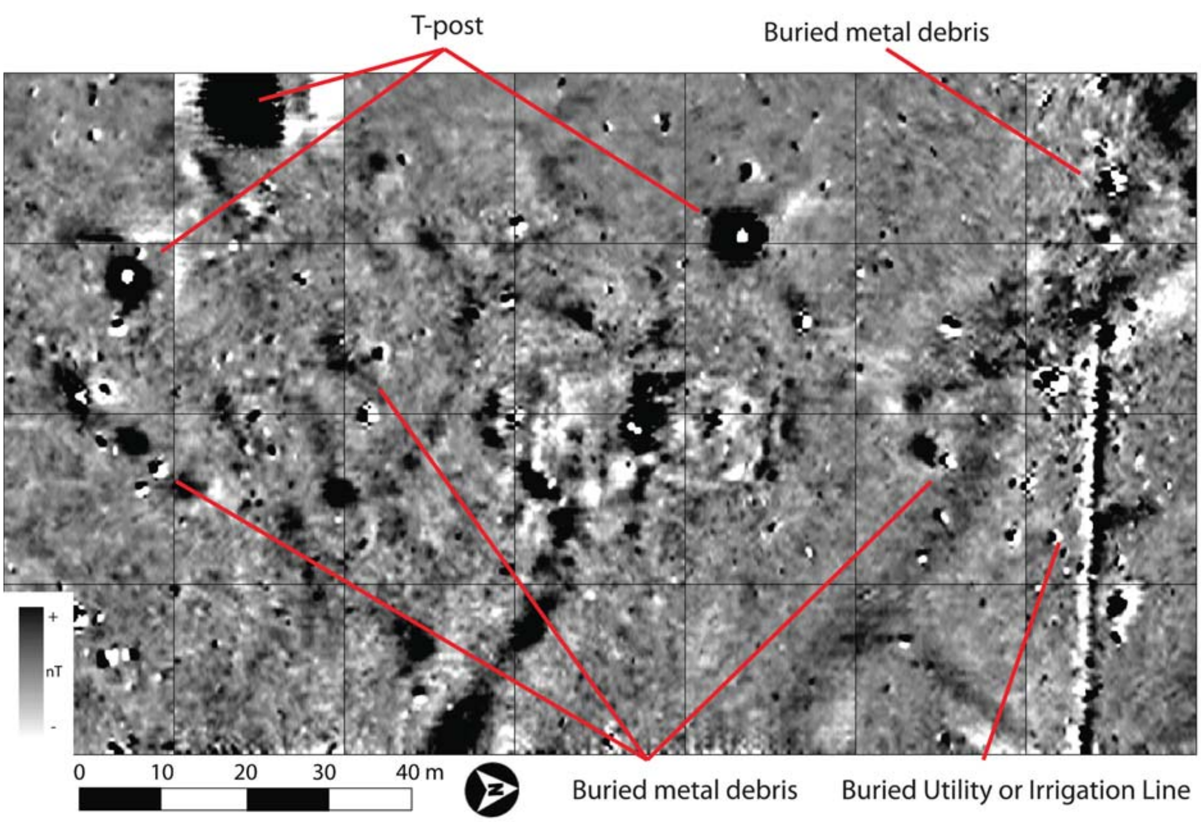

Figure 4. Anomalies of Historic Origin at the M. S. Roberts (41HE8) site. Note change in north arrow direction.

Anomalies of Archaeological Origin

As mentioned, a University of Texas crew excavated several trenches into the mound in the fall of 1931 (Pearce and Jackson 1931). The number, location, size, or extent of the trenches was not recorded during the work. However, magnetic gradient results suggest the location of three possible east-west trenches (Figure 5). The 1931 Pearce and Jackson report suggests that, at a minimum, there was a trench to the north (herein referred to as Trench A) and one to the south (herein referred to as Trench B). A third possible trench is also suggested related to the "east and west portions" of the mound (herein referred to as Trench C). A 1931 photograph of excavations taken by A.T. Jackson indicates digging did occur on the mound summit in the area of the proposed Trench C.

When the proposed trench anomalies are evaluated using an estimated size of the mound, the suggested Trenches B and C coincide with the 1931 mound extent. This arrangement would have been particularly efficient to evaluate mound construction, especially when it was "to be explored with pick and shovel… the only [method] possible with present funds" (Pearce and Jackson 1931). Metallic debris associated with proposed Trenches B and C suggest the presence of trash (broken shovels, lost trowels, metal spikes) that was purposefully or inadvertently deposited into the trenches before backfilling. The proposed Trench A is north of the 1931 recorded mound dimensions and suggests that either the anomaly does not define a trench or the possibility that the mound dimensions recorded in 1931 are inaccurate based on estimations of basal extent or earlier recording technologies.

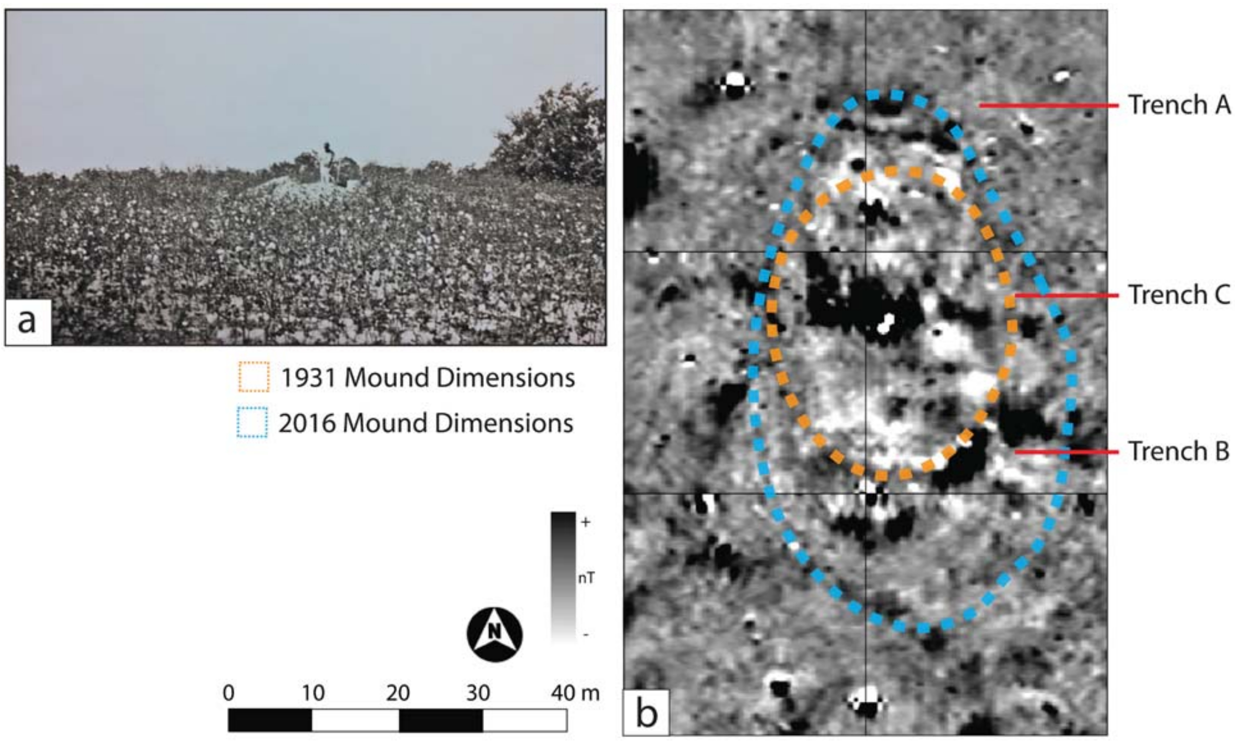

Figure 5. Anomalies of Archaeological Origin at the M. S. Robert (41HE8) site: (a) 1931 excavation on the mound summit, (b) interpreted trenches with estimated extent of the mound highlighted.

Anomalies of Caddo Origin

As recorded in the 1931 excavations and during recent testing at the site, at least one burned structure is present. Shovel tests and auger holes also suggested other structures buried deeper in the mound deposits (Perttula et al. 2016; Perttula 2016; Perttula and Walters 2016). Magnetic gradient survey results reveal the remains of two interpreted circular structures at approximately 10 m in diameter (Figure 6). A series of low magnetic anomalies define the floor of a structure to the north and a second to the south. The concentration of low magnetic anomalies (rather than high magnetic anomalies associated with high heat burning) is likely the result of the inadvertent removal of magnetically enriched topsoil through foot compaction, regular cleaning, and overall use within the house (see also McKinnon 2013). The removal of higher magnetic topsoil as a result of these activities would produce a concentration of the remaining low magnetic soil matrix recorded in the survey. Interestingly, the proposed extent of the north structure overlaps the 1931 mound dimensions, yet is within the recently recorded mound dimensions. This arrangement offers additional consideration regarding the accuracy of the 1931 mound measurements, or it could represent a structure in which the mound was constructed over only a portion.

Three possible hearths are interpreted within the structures (see Figure 6). Two are centrally located within each structure and a third (in the north structure) is situated to the northwest. Additional small high magnetic anomalies within each proposed structure may represent former hearths, internal storage pits, or possible architectural pits. Numerous high magnetic anomalies proximate to each of the three proposed trenches are suggested as the result of soil movement while digging the 1931 trenches.

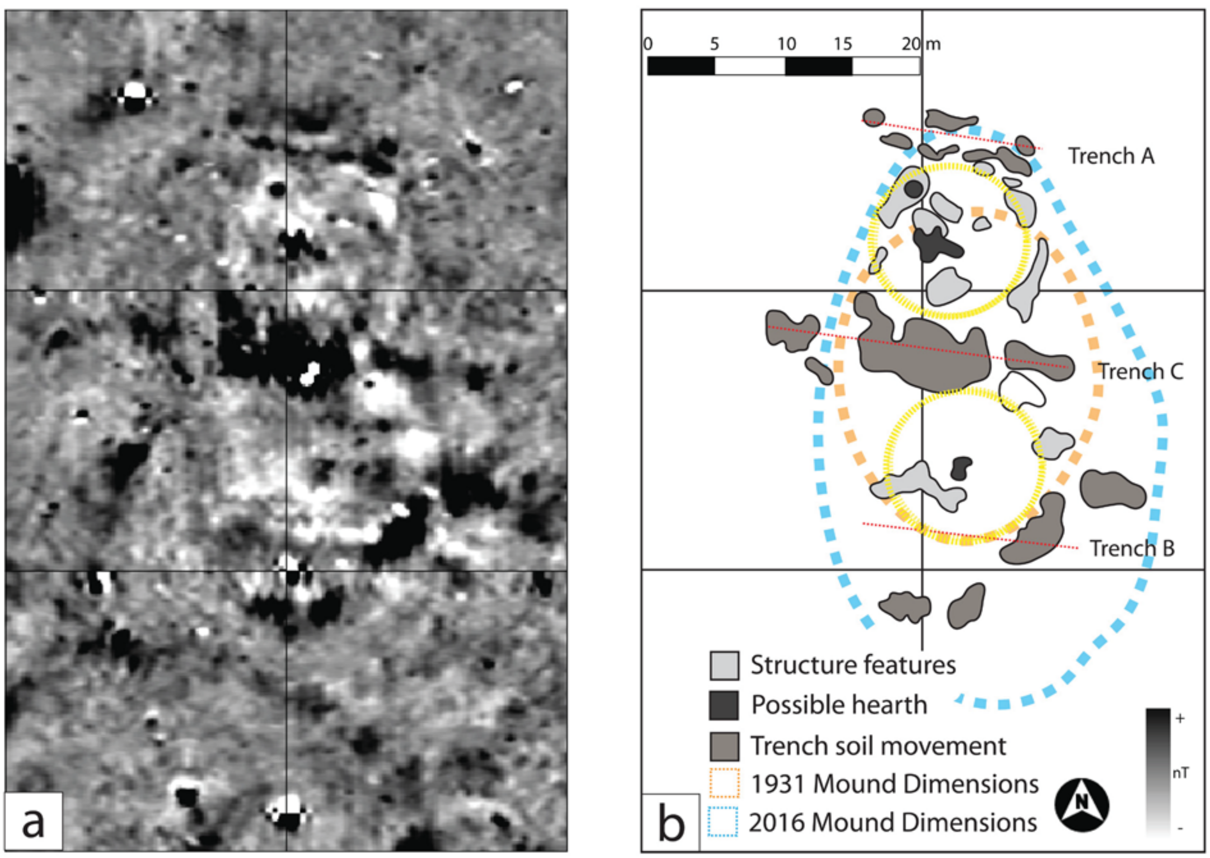

Figure 6. Anomalies of Caddo Origin at the M. S. Robert (41HE8) site: (a) Extent of survey covering mound, (b) interpreted mound structures and associated anomalies.

Recent testing documents the remains of a shallowly buried burned structure on the north portion of the mound (see Perttula et al. article in this volume). The location of the burned structure (Unit 1) is located within the proposed north structure identified in the magnetic gradient data, yet just outside the 1931 mound dimensions. However, a north profile from Unit 1 documents a series of soil layers that define mound composition (Zones 2-6) with the mottled charred remains of the burned structure in Zone 2b. AMS dating of samples of unburned deer teeth from Unit 1 and nutshell from Unit 2 have been obtained. The median 2 sigma calibrated age range of the two samples is A.D. 1294-1405.

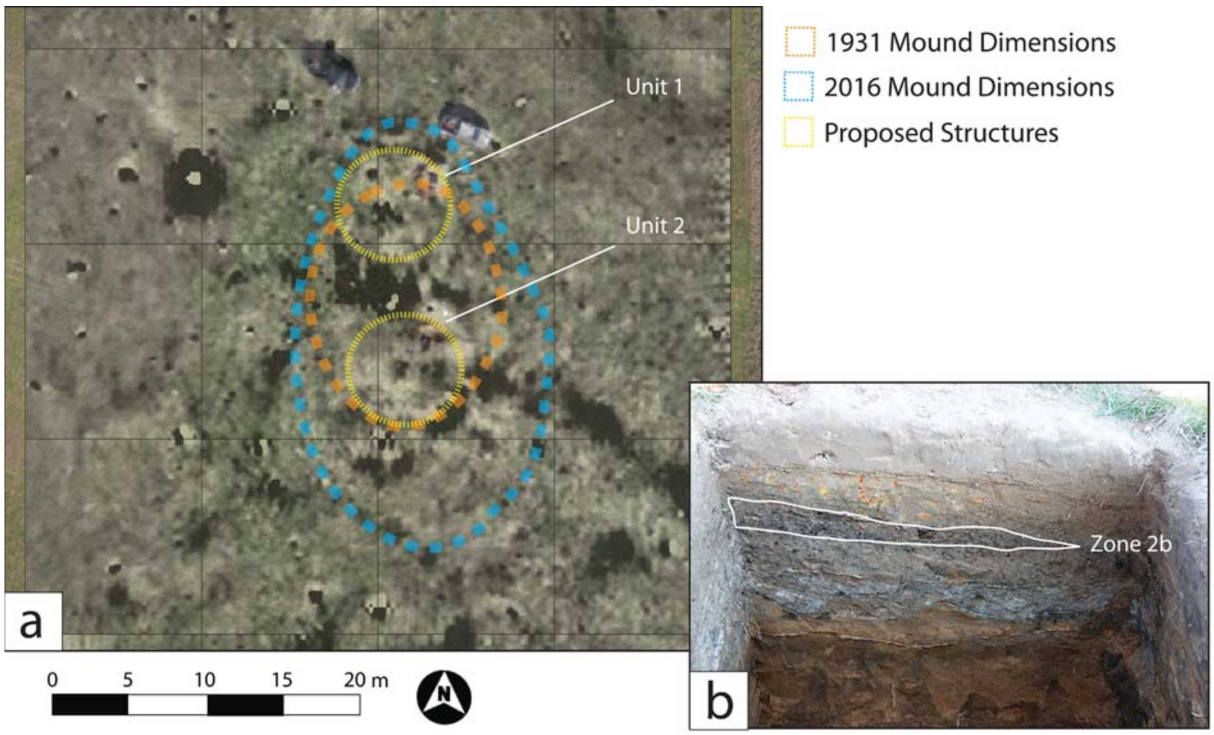

Figure 7. Comparison of magnetic gradient and excavation unit at the M. S. Robert (41HE8) site: (a) Magnetic gradient overlain on aerial survey and showing locations of excavation Units 1 and 2, (b) Profile of the north wall of Unit 1 (Perttula et al. this volume).

While the mottled remains in Unit 1 certainly represent a burned structure, it is worthwhile to note that a significant layer of burned daub does not define the burned structural remains. Instead, Zone 2b is defined by a large piece of burned mud dauber nest and a concentration of charred organic remains. When present, a significant layer of concentrated chunks of daub will produce a high magnetic signature indicative of wattle and daub architecture. The disposal of a wattle and daub structure would have burned at length at a high heat (> 600 degrees Celsius), collapsed, and the high magnetic wattle and daub left to smolder and create a high magnetic signature.

The low magnetic signatures, lack of large chunks of daub, and mottled charred remains associated with the north structure in Unit 1, suggest the structure was a thatch style structure with little or no wattle and daub. Such a structure would burn very rapidly within a short time span of intensive heat and leave little thermoremnant signature (see also McKinnon 2013; Perttula and Skiles 2014). Excavations demonstrate that the thatch structure was burned, but the lack of wattle and daub reduces the potential for higher magnetic readings (see Kvamme 2006).

Conclusions

In closing, recent research at the M. S. Roberts site has provided new insights into one of the few known Caddo mound sites in the upper Neches River Basin in northeast Texas. The combination of aerial, magnetic gradient, and excavation datasets, along with documentation from historic fieldwork, has provided a more informed set of interpretations of mound construction, historic landscape change, and density of off-mound occupations.

Specifically, aerial survey has provided insights into topographic changes in the mound dimensions since the 1931 excavations, which sheds light on the impact of historic landscape modification at the site. The magnetic gradient survey data has revealed the presence of subsurface anomalies that define the mound with the interpretation of at least two structures in or under the mound. Additionally, the possible location of the UT trenches allows for spatiality to be established related to the 1931 excavations and a better analysis of where the UT crew focused their efforts. Magnetic gradient has also provided insight into the distribution of off-mound anomalies and their arrangement relative to the mound. Shovel and auger testing and excavations at the site have corroborated magnetic gradient interpretations associated with the presence and type of mound structures, suggesting thatch-style construction rather than wattle and daub. AMS dates from material collected during excavations demonstrate the site was in use from at least A.D. 1294 to 1405. While still more work is necessary to fully evaluate the relationship of the M. S. Roberts site to contemporaneous sites situated in the upper Neches River Basin, the recent revisit and work at the site is important and certainly past due since its first visit in 1931.

Acknowledgments

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