

# Targeted Near-Surface Geophysical Survey As An Element Of A Multi-Stage Research Design

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## Abstract

Two examples of archaeological fieldwork are presented which incorporate near-surface geophysical survey as an element in a multi-stage research design and not simply in an effort to provide a recognizable image of below ground archaeological remains. Because of this they depart from widely accepted uses for geophysical survey in field archaeology which have tended to stress their ability at times to produce readily comprehensible images of archaeological features.

## Introduction

As used in field archaeology, near-surface geophysical survey using a variety of instrumentation (Johnson 2006) (i.e. magnetometry, ground penetrating radar, resistivity, and earth conductivity) is generally viewed by non-specialists as a way to provide a virtual image of buried cultural features so that they may be identified without excavation. For this reason, near-surface techniques are broadly touted as non-invasive survey techniques because they do not require expensive and destructive manual or machine excavation. This view, which had admittedly not been advanced by geophysical workers, rather by their clients, has tended to be used to evaluate the “success” or “failure” of applications, that is, if the archaeologist is able to identify the geophysical anomalies, the survey has been a success, if not, then a failure. A part of the ambiguous position of geophysics in American archaeology today stems from the fact that, as one can predict, no one technique or combination of techniques can be expected to provide this clarity of imagining consistently.

I take the position that geophysical survey techniques should be embedded in archaeological research design as another data collecting procedure and not be expected to provide “the” image of below-ground archaeology. Viewed from this perspective there are a wide range of applications for near-surface prospecting. Two are discussed below.

## Where it Works it Works

Several cases illustrate the ability of geophysical survey techniques to coherently image archaeological sites and features, in short to be extravagantly successful. They are the sort of field examples that make the use of geophysics in archaeology a victim of its successes. In the first (Figure 1), a near surface magnetic gradient survey provides an immediately recognizable image of what is obviously a prehistoric circle. The resolution also suggests that the circle, which has certainly been rebuilt perhaps four times, was approximately 22 meters across and composed of posts that have perhaps been burned. When this survey is contextualized in what is known of the archaeological record of post circles in North American prehistory, the image accurately portrays a form of feature, a circle of posts, which has a long prehistory beginning perhaps 1000 years B.C. and lasting until the late prehistoric, indeed a version of the post circle was even recorded ethnographically on the east coast by European colonists (Figure 2).

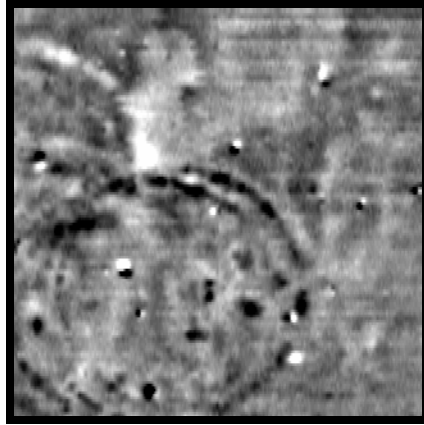


Figure 1. Magnetic Gradient Image of Possible Burned Wood Post Circles, Poverty Point, La.

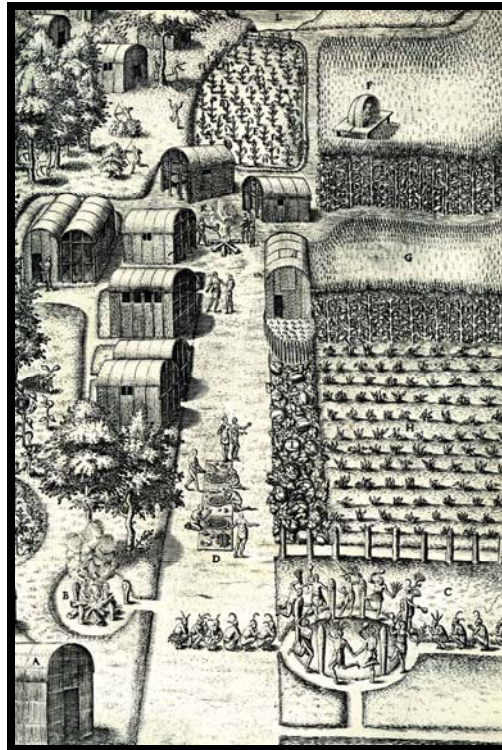
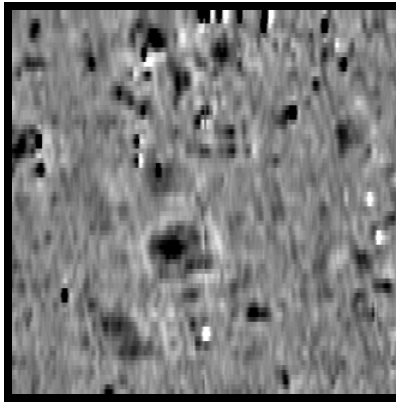


Figure 2. Early (17<sup>th</sup> Century) illustration of Native American Village in Virginia, Note Post Circle in Lower Right (Lorant 1946:265).

The second example is the magnetic image of the floor of a Late Prehistoric Native American house in the Ohio Valley (Figure 3). The below grade floor forms a shallow pit in which are concentrated refuse collected during use and discarded on abandonment. The result is a rectangle of elevated magnetic susceptibility. In the middle is a locus of higher nT probably reflecting the remnant magnetism of a fired clay hearth. Around the perimeter of the floor area is a “halo” of lower nT perhaps imaging the mud which had been used to coat the standing walls. Due to much excavation, the nature of this structure is well known and its correspondence with the archaeological remains. Armed with this information based on the magnetic signature alone, it is possible to inventory large areas for the existence of such structures with no further fieldwork.



*Figure 3. Magnetic Gradient Image of Native American House, Kincaid, Illinois.*

Both surveys would be regarded by non-specialists as spectacular successes. They are the sort of applications which would suggest to one that perhaps he/she should purchase a magnetometer and duplicate them. Depending on the specific application, similar successes are or are not obtained. If they are not immediately forthcoming, interest in the technology lags: if anomalies cannot be immediately identified, the geophysical survey technique by this reasoning cannot be all that good.

#### **Expanding the Search: Targeted Surveys**

I would like to discuss several examples which turn this imaging paradigm somewhat around and use near-surface techniques to inform the archaeologist without assuming that you must recognize the cultural significance of the geophysical image to validate use of the technology. These are from work that Cultural Resource Analysts, Inc. has done for the Missouri Department of Transportation and I appreciate their permission to use them. In both cases the specific survey instruments used have been duplexed, Geoscan Research FM256 fluxgate gradiometers (Figure 4) which have greatly enhanced our ability as a private firm to provide low cost, high-speed, high-density magnetic gradient surveys.



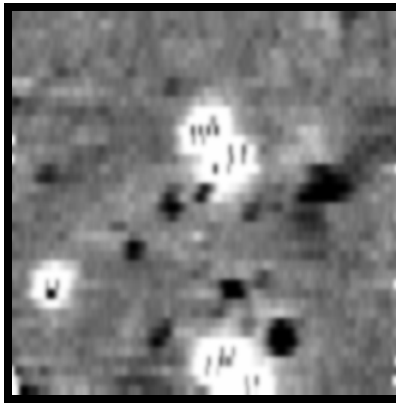
*Figure 4. Duplexed Geoscan Research Fluxgate Gradiometers Used in These Surveys.*

## Inventory and Explain

The survey of the Rohlfing Site (23Fr525) in Franklin County, Missouri was completed in the process of submitting a proposal to perform Phase III data recovery. It covered a 20-meter square judged to form the core of a site in which initial testing had demonstrated the presence of at least one feature, a refuse pit. The magnetic gradient survey is presented in Figure 5 and the magnetic anomalies are identified in Figure 6. The survey revealed several important aspects of the site. First, the locations of earlier hand-excavated test units are clearly evident, marked by iron gutter spikes used to mark their corners. Secondly, there was little evidence from this survey that the site has been recently cultivated because plow or disk cultivation scars were not evident. Finally, and most importantly, these 400 square meters are dominated by a series of positive magnetic anomalies (4-9 nT) (Figure 6). They suggest the presence of further pit-like features. Features were predicted for the site on the strength of the one identified in initial testing. Survey at this point before extensive excavation, suggested a more complete inventory of them and this knowledge was important in our estimation of the work required to excavate them.

These anomalies contrast sharply with the surrounding soil which was close to  $\pm 0$  nT (a feature of a magnetic gradient survey like this is 0 nT in the absence of anomalies). This suggested that the features had been truncated by plowing at some time in the past. An exception is the area around one anomaly, the largest of the set. Here, nT trails off from the major concentration at about 6 nT, to lesser values ca. 2-3 nT. This suggested a distribution of intact midden below plow zone around this anomaly.

A second strata of less magnetically intense anomalies is also indicated (Figure 6 in pink). Limited in diameter, these have magnetic values between 2-3 nT. They suggested a smaller set of features also marked by elevated, positive, magnetic susceptibility.



*Figure 5. Magnetic Gradient Survey of the Rohlfing Site, Franklin County, Mo.*

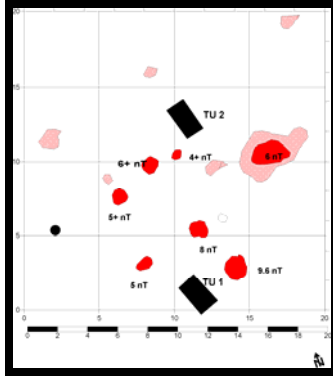


Figure 6. Magnetic Anomalies Detected at the Rohlifing Site.

As the excavated results indicate (Figure 7), the magnetic gradient survey correctly predicted the locations of most the major pit features. Thus, use of the technique proved helpful in excavation planning. But the magnetic images were not all correctly identified. Importantly, the large diffuse feature on excavation proved to be the remains of a burned tree stump. Furthermore, most of the “lesser” magnetic features on excavation proved to be a combination of pottery and fire cracked rocks, that is, artifacts not clearly associated with specific activity areas. Still, identifying them from the magnetic gradient survey made the excavators aware of their existence and this was factored into the excavation strategy, in short they made site features which begged explanation..

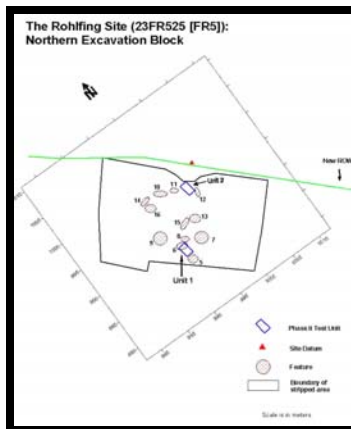


Figure 7. Excavated Anomalies at the Rohlifing Site, Franklin County, Mo.

As a general statement, a magnetic gradient survey rarely identifies all the cultural features that might exist and suggests features which do not have cultural relevance although they are “real” (i.e. the burned tree stump). Other features might be revealed using complementary survey technologies (Clay 2001), for example resistivity or earth conductivity (Clay 2006), however the cost of multiple surveys generally precludes them. Still, this type of targeted geophysical survey, despite its limits in “imaging,” has become routine for our firm. The results become another data set used in the framework of a multi-stage research design to explore the nature of archaeological sites in environmental projects. The point of such a survey is not that it “images” the below-ground archaeology in a recognizable form, but that it provides survey information that informs the structure and cost estimation of further work.

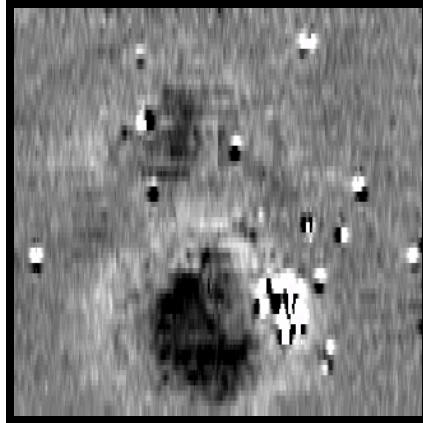
## Working from the Known to the Unknown

The second example also draws on our Missouri experiences. In connection with the Avenue of the Saints (a transportation project) along the Mississippi River, we were asked to evaluate the possibility that at least four Middle Woodland burial mounds existed in possible corridors. In this case we used geophysical survey to develop a model of what *might* exist in a mound with an unknown structure by which to evaluate the possibility that the mounds in the project were Native American structures. This information would then be used in the selection of final alignments to specifically avoid the burial mounds. In earlier times, Native American burial structures were often indiscriminately excavated with little thought for the sensibilities of the descendants of the builders. Current management of such cultural sites under state and Federal laws stresses their identification with as little disturbance as possible and avoidance, and consultation with related Native American nations when human remains are encountered. Our approach was developed in this spirit.

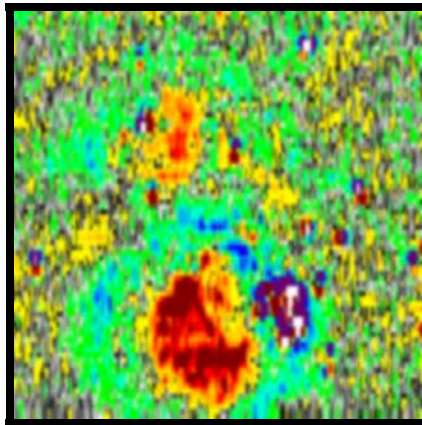


*Figure 8. Middle Woodland Ritual/Burial Mounds at Boulware's Place, Clarke County, Missouri.*

We were fortunate that adjacent to the planning area was a preserved mound group, known as the Boulware Mound Group (Thomas 1985:165-167) identified in the 19<sup>th</sup> Century. Along this portion of the Mississippi Valley during the Middle Woodland Period (ca. 200 B.C.- A.D. 300) small mounds were built as burial structures. Although looting of these sites has produced an assortment of artifacts together with human bones verifying that they were used for burial, there is little information on the structure of features within them, that is how they were used for ritual. Although concentrated at this one mound group where 55 were identified, they also occurred elsewhere nearby. Our approach was to do a non-invasive magnetic gradient survey of two preserved mounds (Figure 8) This suggested that the subsurface below them had a prominent magnetic signature (Figures 9 and 10), a concentrated, circular area of high magnetic susceptibility surrounded by a halo of somewhat lower susceptibility, probably mound wash (against a background of historic scattered iron parts). This strongly suggests a burned activity surface below the mounds that was the focus for ritual activities.



*Figure 9. Magnetic Gradient Survey of Two Mounds at Boulware's Place.*



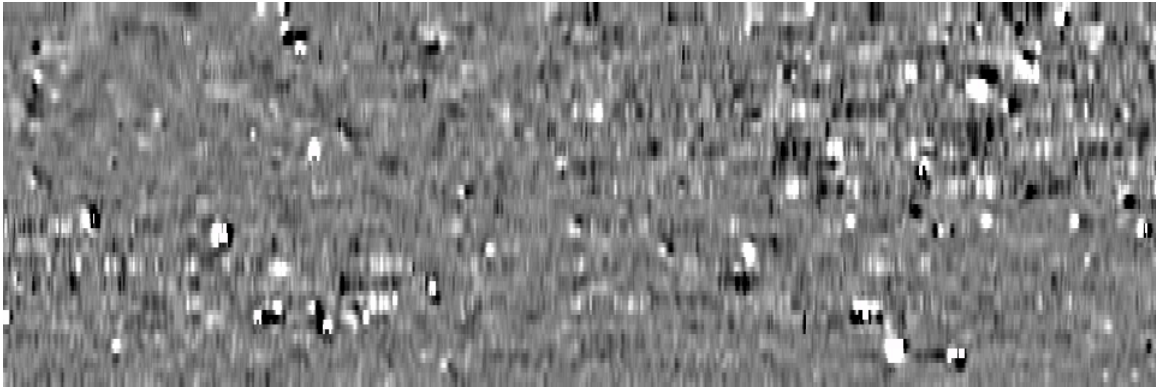
*Figure 10 . Color-emphasized Magnetic Survey of Two Mounds at Boulware's Place.*

Without knowing in any detail what the structures below the mounds were, we elected to use the possibility of a similar “magnetic” structure elsewhere as positive evidence for a burial mound. On the other side of the existing highway from the Boulware Group was 23Ck273 where initial shovel testing suggested the presence of a prehistoric site. Because there was a possibility that the area had actually been part of the mound group, the particular question posed us was “were there degraded mounds in the area which suggested special treatment?” Because of the present topography (Figure 11), there was a suggestion that the land surface had been substantially modified at some point in earlier road construction.

The magnetic gradient survey of the site is presented in Figure 12. There were no clear magnetic anomalies suggesting the sort of structures we had seen from survey of existing mounds. Furthermore, the variable pattern of magnetics we recorded suggested either substantial historic metal or specific geological conditions. Initial hand excavated test units, specifically in the right hand side of the surveyed area where the magnetic signatures were more intense, indicated that they were caused by slightly magnetic rocks and gravels. The magnetic gradient survey, in short, imaged the edge of a terrace which had been graded exposing its Pleistocene gravel sub-strata. Judging that there was little chance that the remains of a burial mound existed, more extensive excavations were pushed forward that fully demonstrated the disturbed nature of the terrace edge.



*Figure 11. Photo of 23Ck273 adjoining Boulware's Place, Clarke County, Mo.*

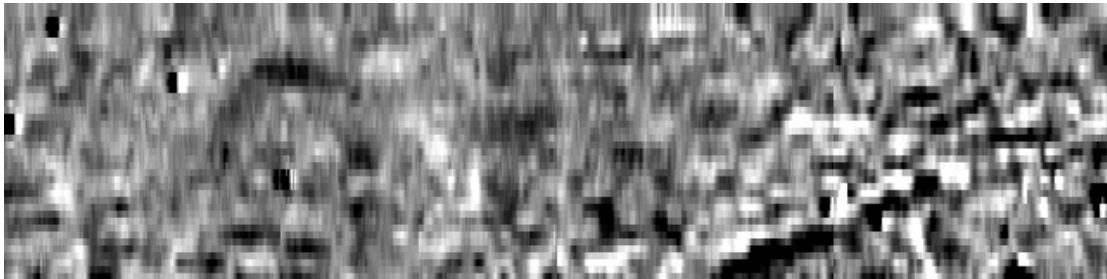


*Figure 12. Magnetic Gradient Survey of 23Ck273, Clark County, Mo.*

The second site, 23Ck273, was some distance from the Boulware Group. Initial testing had suggested the remains of two small mounds, although as the photo indicates (Figure 13), both had been badly degraded by historic agriculture. The magnetic gradient survey (Figure 14) indicated a strong background of minor magnetic disturbance related, again, to the Pleistocene gravel underpinnings of the floodplain terrace. Still, in the southern portion of the survey, an arc of elevated magnetic susceptibility suggested the presence of the sort of "structure" we observed in our magnetic gradient survey of the preserved mounds. The magnetic evidence, therefore, provided important support for the initial, hypothetical identification of a mound, possibly a burial structure.



*Figure 13. Photo of 23Le348, Lewis County, Missouri.*



*Figure 14. Magnetic Gradient Survey of 23Le348, Lewis County, Missouri.*

However, while a mound was hypothesized for the northern end of 23Le348, our survey indicated considerable magnetic disturbance connected with emplacement of an iron water line. This, coupled with magnetic disturbance from Pleistocene gravels, possibly exacerbated by excavation for the utility, suggested that if a mound had existed, it was badly disturbed. These data did not rule out the possible existence of some trace of an earlier mound but they did suggest management information which could be used in verifying that existence. At two other locations in the planning area, our magnetic gradient survey suggested that one mound was the remains of a demolished historic structure (verified when historic records were examined) and that another may have been primarily composed of magnetic gravels, perhaps excavated during stream channel modifications. This information will be used by MODOT in their further evaluation of the project.

In these examples our use of geophysical survey did not solve the question of the identification of Native American burial mounds in the planning area and that is the important point to take away although they did supply strong positive evidence that one mound existed. Together they have provided another level of information to add to the historic and archaeological evidence already collected, which will assist the agency and the archaeologists in their treatment of a sensitive class of prehistoric sites.

## Summary

The extensive use of geophysical survey techniques in North American archaeology is relatively recent in comparison to other countries (most importantly Great Britain): we are just beginning to integrate them into research strategy (Kvamme 2003). In a sense we are now moving past the recognition that these techniques can provide dramatic views of the structure of archaeological sites to the mature realization that they can also be used, in the context of a larger field research strategy, to assist in the understanding of poorly known, often quite small, archaeological sites, those that we cannot immediately recognize. These two examples could be duplicated widely, with variations, in the sort of work that we, and others, are encountering in cultural resource management archaeology today. When this is coupled with high-speed survey technology, here duplexed fluxgate gradiometers, geophysical survey techniques become in addition extremely cost effective in the conduct of archaeology which, because it relies extensively on manual labor, tends to be expensive.

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