Using Magnetometry to Identify Late Woodland Pit and House Features

Claire L. Hankla (Smith College), Jacob Lulewicz (Washington University in St. Louis), and Jason L. King (Center for American Archeology)

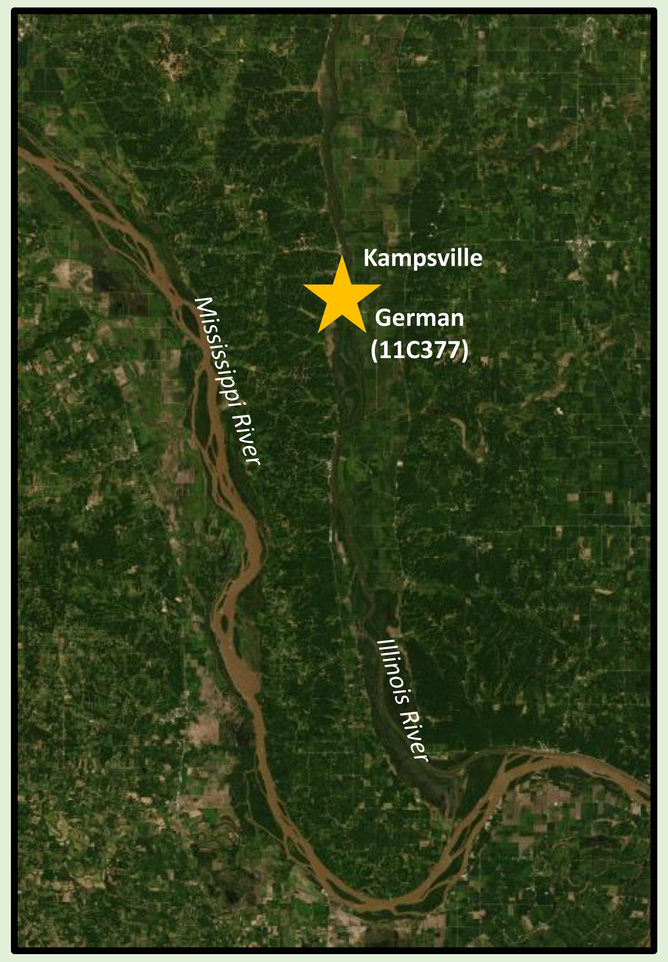


Figure 1. Map of the Lower Illinois River Valley. Star indicates site location.

Introduction

Common excavation methods are slow and destructive. Geophysical survey facilitates the understanding of sites, though interpretation of this data may be difficult or vague. By excavating at a few magnetic anomalies in the Late Woodland German site (11C377), Calhoun County, IL, we hope to understand, in more complexity, how anomalies in magnetic gradiometry data reflect and predict the presence of house and pit features uncovered during excavation. An increased understanding of geophysical survey data can contribute to a field-wide turn toward minimally invasive archaeological method and will allow future excavators at the German site to determine relevant positions for future excavation units.

Methods

Before excavation, the field crew conducted geophysical survey beginning in summer 2019. A two-probe Bartington 601 magnetometer was used to measure magnetic gradiometry. Magnetic anomalies were then used to guide excavation unit placement in a small, central portion of the site. Following the initiation of excavation, the magnetogram was processed and the nanotesla (nT) values of excavated features were recorded using TerraSurveyor. With QGIS, the excavated feature outlines were geo-referenced and overlain on the magnetogram of German. The nanoteslas, areas, and shape factors of intriguing anomalies were recorded and run through statistics programs in R to analyze patterns and similarities between excavated and unexcavated anomalies.

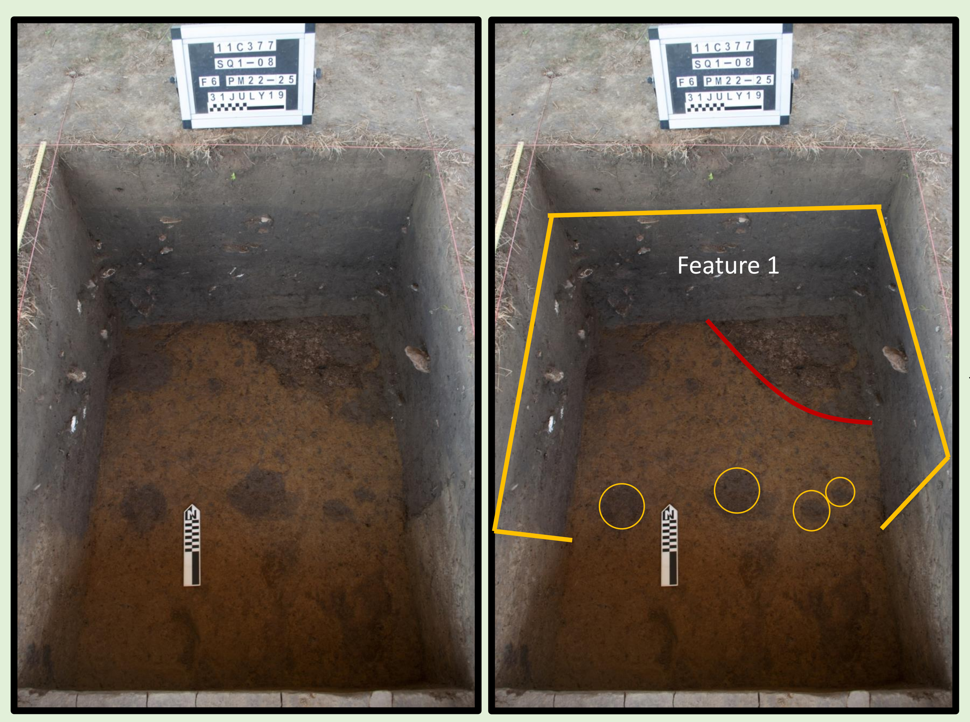


Figure 2.

Plan view of Square 1 (see Figure 3). The northern half of this 1x2m unit overlaps with the large magnetic anomaly designated Feature 1 after excavation. The photographs show the bottom of Feature 1. The fill of the probable house basin can be seen in profile as a rich, dark layer full of artifacts. A row of post-molds can be seen just along the southern edge of Feature 1. A probable hearth filled with burnt limestone can be seen in the northeast corner.

Results

- ❖ Excavated features visually confirm the spatial representation of the magnetometry as compared to the physical ground (**Figure 3**).
- ❖ Excavation at the center of the site has revealed the presence of a house (Feature 1) with an interior hearth on the west side and a pit feature (Feature 2) just under 9 meters to the northwest. Additionally, a possible midden (Feature 3) and a possible pit (Feature 4) are present; however, further analysis must be done to confidently identify them.
- ❖ The magnetometry reading reveals a difference in the positive nT values between Feature 1, mean 4.69nT, and Feature 2, mean 2.09nT.
- ❖ Based on similar shapes, areas, and nT values in the magnetogram, seven potential houses and 19 potential pit features have been identified.

Discussion

- ❖ Analysis of anomalies representing potential pits shows how magnetometry facilitates the identification of features before breaking ground. All points in **Figure 4** were marked based on visual criteria determined by similarity to Feature 2. Blue points are indicative of potential pits with similar mean nanotesla values to the excavated pit. While all points are similar, the blue points are more closely clustered, indicating a stronger relationship with the pit.
- ❖ When put through a Principal Component Analysis (PCA) including mean [nT], min [nT], max [nT], median [nT], standard deviation [nT], area [m^2], perimeter [m], circularity, aspect ratio, roundness, and solidity, the potential house anomalies indicate similarity to each other and a difference in relation to the excavated house (**Figure 5**). Further, if the range of nT values is not considered in the PCA, this separation is maintained (**Figure 6**). This is because, while the mean nanoteslas is similar, Feature 1 has a significantly larger nanotesla range. However, if range *and* size factors are ignored, Feature 1 proves to be very similar to the potential houses in terms of shape and mean magnetism (**Figure 7**). The similarity in terms of all other criteria suggests they are not separate structure types, despite the difference in nT ranges and size. Comparison with other Jersey (Late) Bluff habitation sites suggests that the presence of an interior hearth may not be correlated with house size, as originally suspected, thus indicating the inclusion of a hearth may not be the primary cause of extreme nT range differences.[1] The feature is surrounded by three distinct dipoles that may obscure the reading as well.
- ❖ If a selection of these anomalies is, in fact, representative of houses, then this site fits smoothly into the characteristics of a Jersey Bluff habitation site as defined by Studenmund.[2]

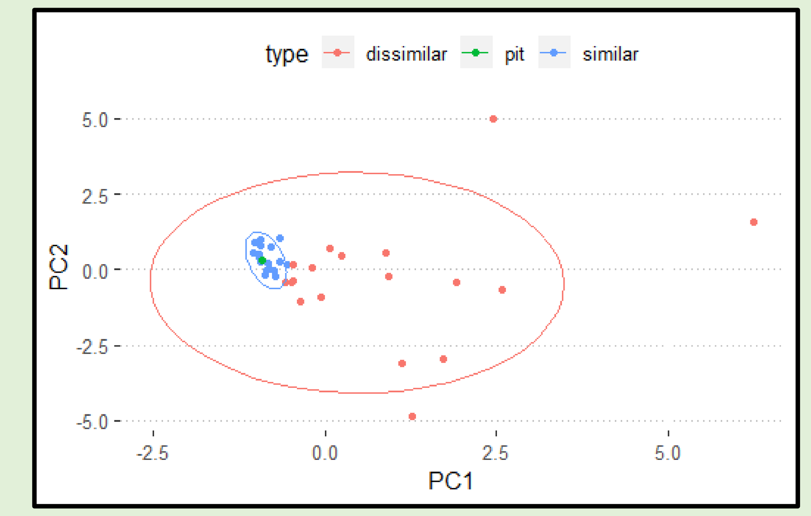


Figure 4. Principal component analysis of Feature 2 and potential pits by relative dimensions and average nT values.

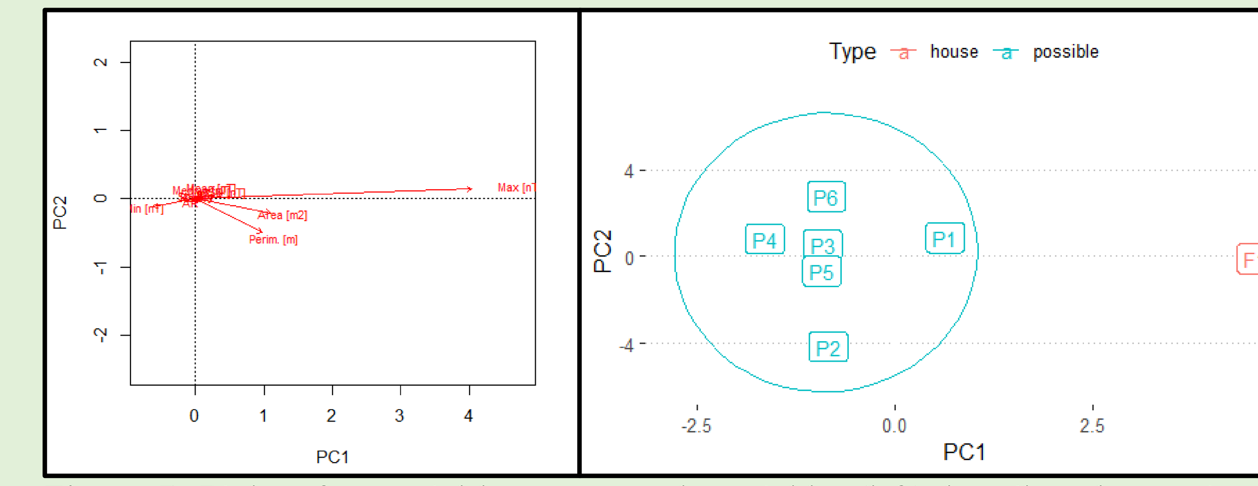


Figure 5. Biplot of potential house anomaly variables (left) describes the maximum nT value as the variable that contributes most to variation. PCA of possible house anomalies (right) shows the similarity between potential and excavated houses.

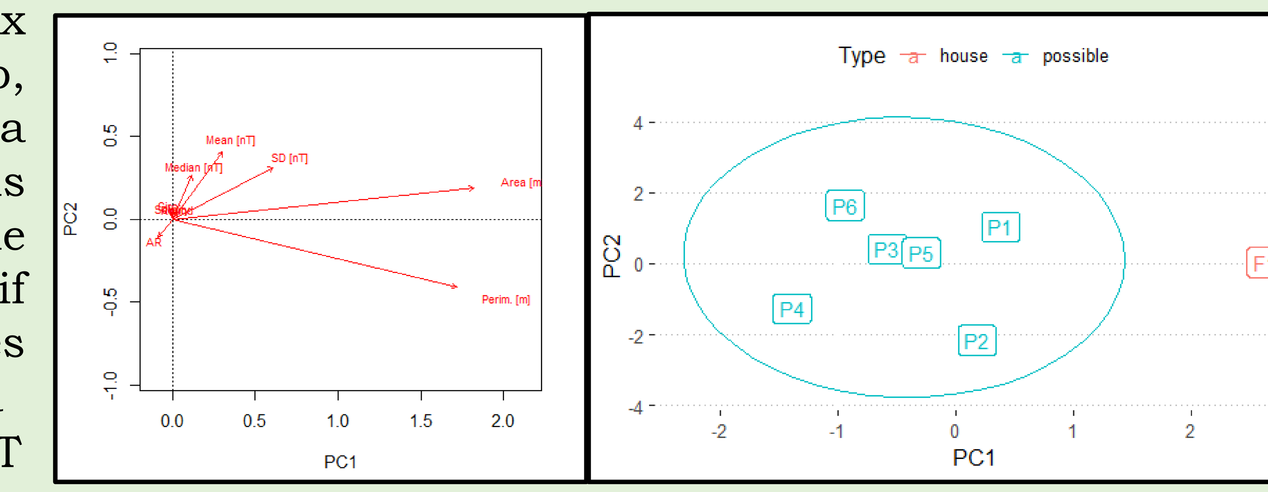


Figure 6. Biplot of all potential house anomaly variables excluding nT range (left) describes size as responsible for most variation. PCA of possible house anomalies (right) shows the similarity between all potential and excavated houses.

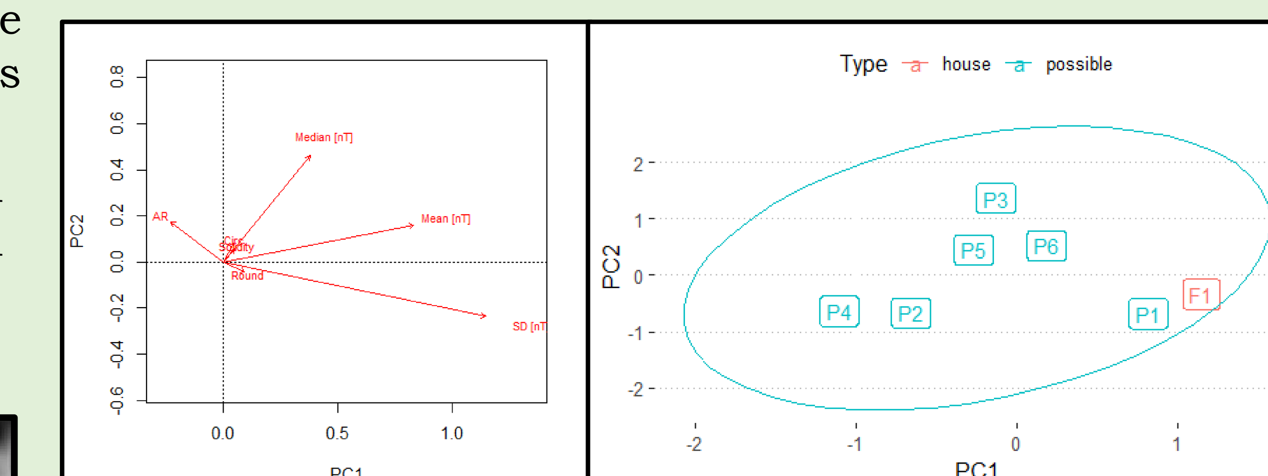
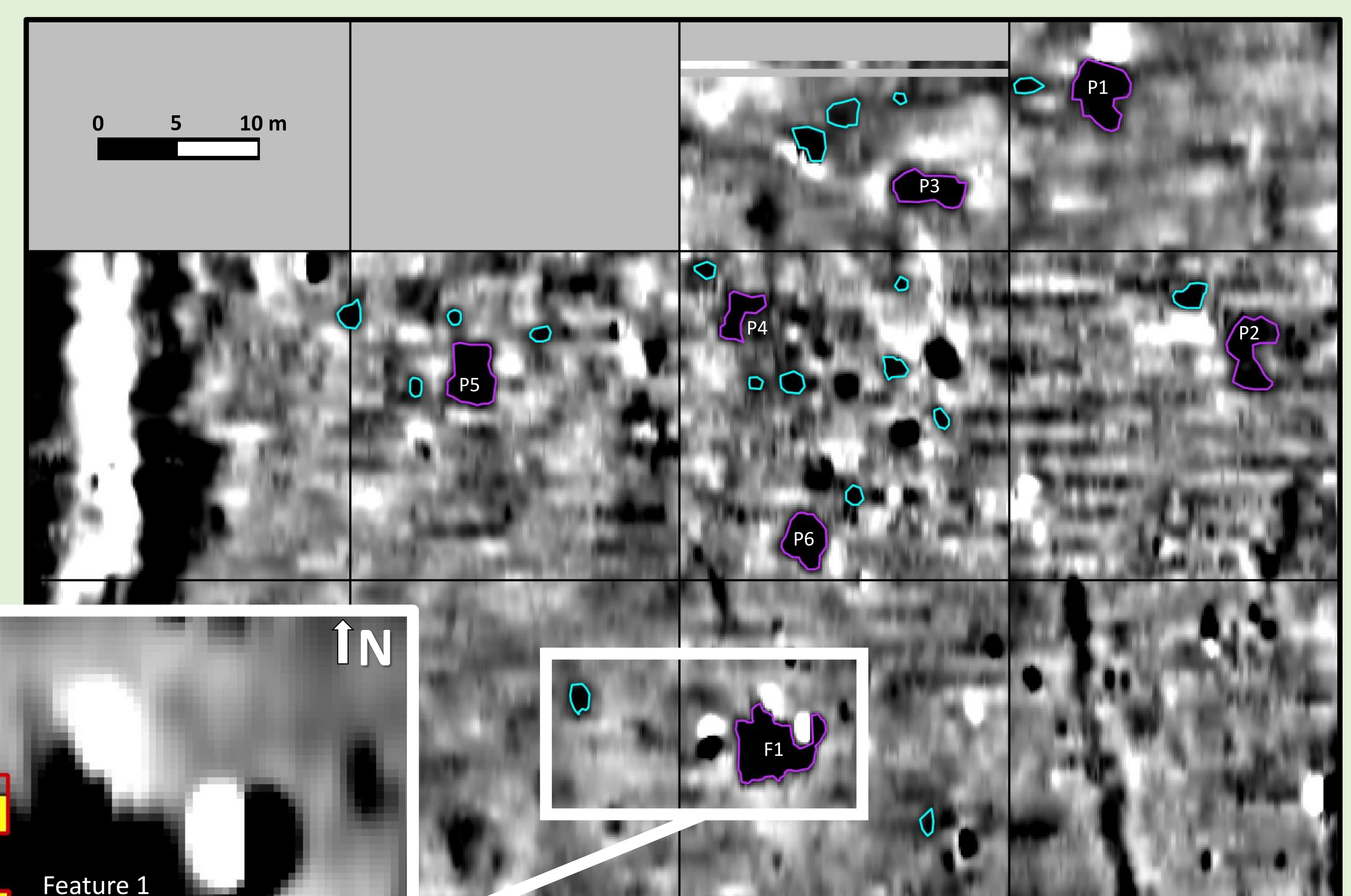


Figure 7. Biplot of all potential house anomaly variables excluding nT range, area, and perimeter (left) describes a relatively even distribution of variables contributing to variation. PCA of possible house anomalies (right) shows similarity between all possible houses and the excavated house Locations of potential houses are labelled in Figure 3.



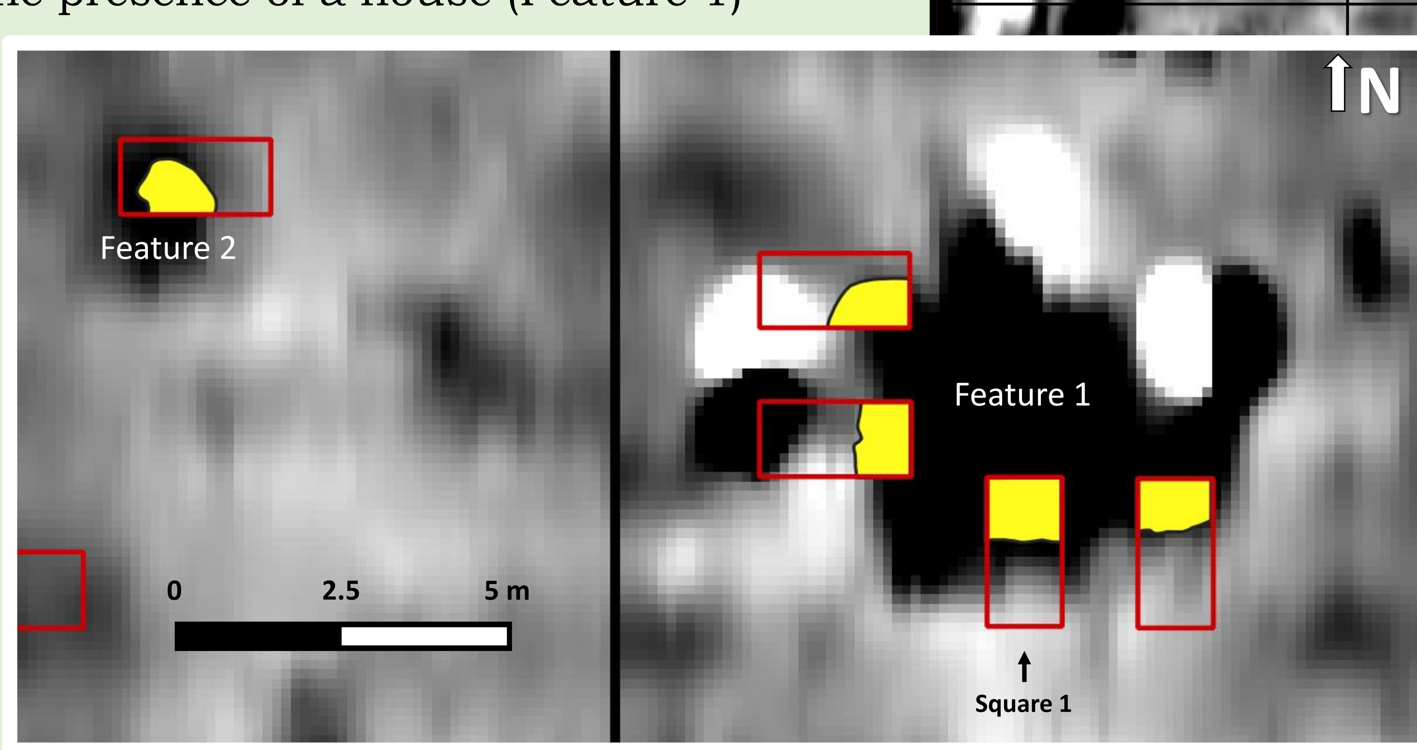


Figure 3.

Left: A magnified view of the magnetogram focuses on the excavated house (Feature 1) and the excavated pit (Feature 2). Red rectangles indicate the placement of excavation units. Yellow fills represent excavated features.

Right: A magnetogram of a portion of the German site includes all potential house anomalies (purple outlines) and proximal potential pit anomalies as determined visually by shape (blue outlines).

Future Directions

- ❖ Future excavations of suspected pits and houses may confirm, deny, or focus prediction criteria and allow for an investigation into the spatial organization of features at the site. Additionally, future work may reveal criteria for anomalies that are not associated with physical features.
- ❖ The comparison of PCAs for anomalies that are not thought to be houses or pits with those that are potential houses as determined by this study may provide a clearer view of how to interpret geophysical data.
- ❖ Magnetometry anomalies and excavation features at other Late Woodland sites can be compared, taking differences in magnetic orientation and soil type into account, to calibrate prediction criteria for Late Woodland features.
- ❖ This project could be expanded to include GPR and ERT data into prediction criteria and to allow for a more 3D and minimally invasive understanding of site contents.

Acknowledgements I would like to thank the Center for American Archeology and the National Science Foundation for giving me the opportunity to conduct this research. Many thanks to Jason L. King, Daniel Williams, Jacob Lulewicz, and Natalie G. Mueller for guidance with this project and to the field crew members and my fellow REU students.

References 1 Wettersten, V. (1983). A Study of Late Woodland Cultural Change in the Lower Illinois River Valley. Northwestern University. 2 Studenmund, S. (2000). Late Woodland Occupations in the Lower Illinois Valley: Research Questions and Data Sets. In *Late Woodland Societies* (pp. 301–344). University of Nebraska Press.