

**Large Area Magnetic Gradient Survey
In Lee County, Iowa
By Heartland Research Group
February 2021**

By

**Richard D. Moats, Archaeologist, Archaeoastronomer
Calvin J. Hamilton, GIS, Computer, & Image Specialist**

Prepared for:

**Heartland Research Group
Dr. John Lefgren, Ph.D., CEO/HRG**

February 2021

Executive Summary:

In December 2020, a preliminary report was released of the large-area magnetic gradient surveys from multiple areas scanned in Lee County Iowa. Over 223 acres were scanned from November 8, 2020 to November 20, 2020. The survey was conducted by the Heartland Research Group using a Sensys MV X3,16-foot-wide, 16 sensor, fluxgate gradiometer. This is a revolutionary array which was designed to scan large areas at a rate of approximately 8 miles per hour, depending on terrain surface conditions, and provide high resolution plot maps of the magnetic gradient.

Thousands of magnetic anomalies of archaeological interest were detected by the Iowa expedition. They are georeferenced to within 25cm. This level of accuracy provides a means where anomalies can be pinpointed on the ground to within ¼ of an inch. Among the anomalies are fire pits, henges, storage pits, cultural activity clusters, and dwelling structures believed to be from the middle to late Woodland cultures. Two features appear to be a destroyed mounds or circular earthworks. Carbon 14 carbon will determine the age of the cultural activities. Modern activities such as farming and areas with ferrous metal can be distinguished from cultural activity to focus only on pre-Columbian cultures.

After the initial publication in December, a core team was organized to retrieve datable samples from many of the potential fire and storage pits discovered in the survey. The core team discovered datable materials below three feet under the surfaces of the fields. The samples were sent to Vilnius Radiocarbon Laboratory in Lithuania for Carbon 14 testing. Additional filtering and analysis of the magnetometric data revealed more information than the first analysis and provided greater in-depth interpretation. For these reasons, it was decided to wait on the C14 data and additional magnetometric evidence before publishing the final reports on the December 2020 Iowa expedition.

The primary reference source for this type of remote sensing technology is from a paper published by one of the leading geophysical survey specialists in the country, Dr. Jarrod Burks. His paper sets the standard for magnetometry as applied to Woodland Culture Archaeology. (Burks 2013).

A geomagnetic survey reveals anomalies and provides a range of probabilities for their cause by measuring the values of each anomaly in nanotesla values, (nT). Magnetometry cannot provide definitive causation for every signature. Ground-truthing can be performed with C14 sampling, minimal excavation, as well as historic and multi-spectral imagery.

What follows is the currently available data from the December 2020 magnetometry expedition. This report only involves the magnetometry analysis. Other data such as infrared aerial imaging, archaeological excavation results, and Carbon 14 results is not included in this paper.

Table of Contents:

Section	Page
Introduction.....	1
Method.....	4
Interpreting Survey Results.....	5
Field Locations	7
Magnetometry Surveys and Analysis:	
Field 1.....	8
Field 2.....	12
Field 3.....	14
Field 4 North and South.....	15
Field 5.....	16
Field 6.....	18
Field 7 & 8.....	19
Field 9.....	20
Field 10.....	22
Field 11.....	23
Fields 12 & 13.....	26
Field 14.....	27
Field 15.....	28
Total Cultural Features Discovered.....	29
Conclusions.....	30
Summary.....	32
References.....	33

Figures:

Figures	Page
1. The array pulled by an ATV.....	1
2. Suspension system of the MV X3.....	2
3. The SENSYS MV X3 magnetometry array.....	3
4. Reference legend for nT values by color.....	3
5. Legend for cause based on color assigned to nT values.....	4
6. Standard aerial image of a field.....	4
7. The field by magnetic deviations.....	5
8. Artist concept of a round house structure.....	5
9. A round house signature in the magnetic field.....	6
10. Georeferenced field numbers.....	7
11. Field 1 Survey.....	8
12. Field 1, anomaly 15.....	9
13. Field 1, anomaly 16.....	9
14. Field 1, three circular post molds patterns.....	10
15. Field 1, Possible Round House destroyed by fire.....	10
16. Field 1, Round House or Henge.....	11
17. Field 2 Survey.....	12
17E. Field 2, Possible rectangular pit.....	13
18. Field 3 Survey.....	14
19N. & 19S. Field 4 test scans.....	15
20. Field 5 Survey.....	16
20E. Field 5, Enlarge area with Round Houses.....	17
21. Field 6 Survey.....	18
22. Field 7 & 8 Survey.....	19
23. Field 9 Survey.....	20
23E. Field 9 Enlarged.....	21

24. Field 10 Survey.....	22
25. Wide view of lower terrain between sites 9 and 10.....	23
26. Field 11 Survey.....	23
26 NE. North End of Field 11 enlarged.....	24
26 SE. South End of Field 11 enlarged.....	25
27. Fields 12 & 13 Survey.....	26
28. Field 14 Survey.....	27
29. Field 15 Survey.....	28
30. Enlargement of feature seen in field 14.....	29
31. Enlargement of feature seen in field 15.....	29
32. Acreage covered by field number.....	30
33. Lowland areas projected for scanning.....	31
34. Highland areas projected for scanning.....	31

Introduction:

This report details the results of large-area magnetic survey done in 15 different locations in Lee County, Iowa. It is prepared for Mr. John Lefgren, Ph. D., CEO of Heartland Research Group. One objective was to demonstrate the capabilities of the MV X3 array from SENSYS of Germany. In only 7 days, 223.451 acres of land were successfully scanned. The primary objective was to search for and find Native American occupation sites in the area along the West bank of the Mississippi River, North of the town of Montrose, Iowa. This area is believed to have been occupied by all native American cultures to include the Woodland Period cultures of the Adena and Hopewell. There is evidence that suggests there was a large population in the area between 1000 BC to 600 AD but the location of a large village site is yet to be identified.

A GPS responder attached to the MV X3 array provides precise recording of the coordinates of each sensor. With this system, any location can be identified to within 25cm for the purpose of core sampling, surface, and sub-surface investigation. (Figure 1).



Figure 1. The 16-sensor array with the GPS responder atop the array.

The SENSYS 16 probe array was pulled over the terrain with an ATV at an average rate of 8 mph. The unique design of the MV X3 reduces vertical oscillations, caused by rolling over bumpy terrain at relatively high speed, by using proprietary “shock absorbers”. (Figure 2).



Figure 2. The shock absorption system of the device minimizes vertical oscillations.

The data is recorded in the on-board computer sitting on the front of the ATV. It is downloaded and sent wirelessly to a GIS technician for processing. After filtering and enhancements, the data is then sent to an interpreter. The result is a geospatially registered image of the variations in the magnetic field of the terrain covered. The prime objective of a geophysical survey is to use non-intrusive methods and remote sensing to locate sites of ancient human occupation which are not previously known or define known Native American sites.

The SENSYS MV X3 Flux Gate Gradiometer

The SENSYS MV X3 Flux Gate Gradiometer was designed to be pulled over the terrain at a much higher speed than has ever been done by older technologies. Its original application was to search for un-exploded munitions in Germany and adjoining countries resulting from World Wars 1 and 2. For this application, the machine performs exceedingly well.

It was soon realized that the technology works very well in detecting anomalies in the magnetic field of the earth caused by human activity both modern and prehistoric. Many unknown pre-historic sites have been discovered in Europe, Great Britton, France, Portugal, Spain, and Italy. Unknown earthworks were discovered around and near Stonehenge. Roman Villas have been discovered in Germany. The Heartland Research Group, (HRG), using the MV X3, discovered multiple Round House signatures dating as far back as 2000 BC constructed by early Woodland people named the Adena in Ohio.

The next image shows the 16 sensors in place on the array carriage. The top of each tube measures the magnetic field about 4 feet above ground surface. The bottom of each tube measures the magnetic field in the ground up to a depth up to 10 feet depending on soil types. Any difference between the two fields is recorded by the onboard computer mounted on the front of the ATV as an anomaly. The data is processed, filtered, and analyzed. (Figure 3).

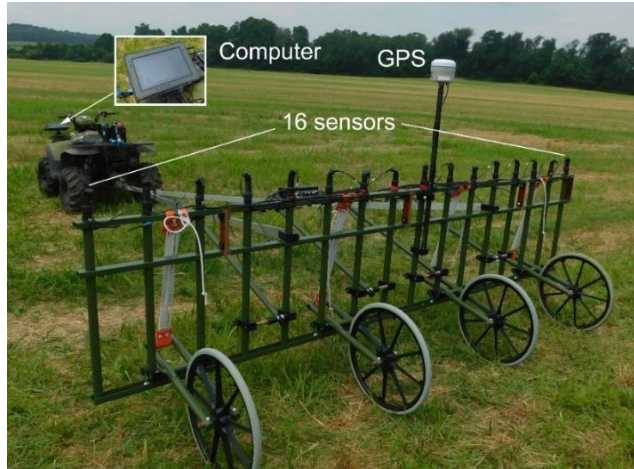


Figure 3. The SENSYS MV X3 Magnetometer array.

“To prepare the magnetometer data for analysis, the magnetic responses generated by the sensors are averaged together and then gridded and converted into an image where each pixel value represents the average magnetic response from the nearest sensor. Because the sensors are extremely sensitive, the data is noisy so averaging helps to produce a better overall magnetic reading. To visualize the image for analysis, the floating-point values in the image are converted to a gray scale image with +6 nanotesla (nT) value assigned to black and -6 nT to white with other values in that range taking on some grayscale value. Because values outside of +6nT often indicate pits, fire pits, trenches, or iron implements, colors were assigned to represent these different ranges. The magnetic signatures in Iowa seem to be slightly less than in Ohio. The soil in South Eastern Iowa is very sandy compared to Ohio. In sandy soils, magnetic signatures can be reduced by 1nT to 5nT. If there is an extremely high sand ratio or an area is pure sand, magnetic signatures may only be detectable if they are recent. When visualizing the magnetometry data in Ohio, it was scaled +/- 8 nT. A legend was created to increase the probability of selecting targets for core sampling based on the nT values of a given anomaly”. (Figure 4). (2020 Hamilton).

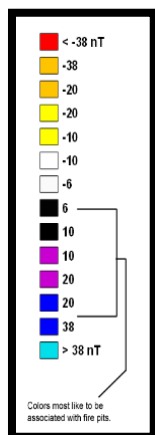


Figure 4. Reference legend for nT value ranges based on color.

A second legend was created to associate cause with color combinations of nT values. The causes are listed with the highest probability first followed by ever decreasing cause

probabilities. Hence, anomalies which are black with a purple center or black with purple and a blue center are more likely to be manmade pits, subsurface intrusions, or small fires. Anomalies which are black, purple, blue, and turquoise may have some association with ferrous metal objects. If there is any association with yellow, orange, or red, the feature is highly likely to be modern ferrous metal. (Figure 5).

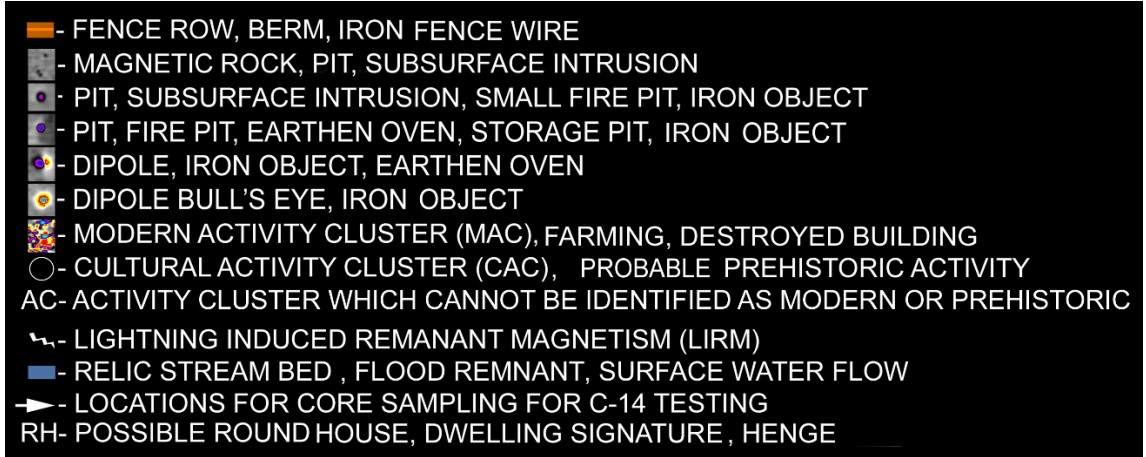


Figure 5. Legend for causes of anomalies based on color combinations which indicate nT values. Most cause is listed first followed by decreasing probability causes.

Note: All aerial and magnetometry images are oriented so the top is true north.

Figure 6 is a standard color aerial photograph of a field. Figure 7 is the same field consisting of the magnetic gradient. It can be overlaid with a ¼ inch grid for georeferencing.



Figure 6. Standard aerial photo of a field.



Figure 7. The same field by a georeferenced magnetic gradient.

Interpreting Survey Results

Interpretation of a magnetometry results is determining the cause of deviations in the magnetic field. It is much easier to say than to perform. Archaeologists have been using magnetometry for several years. Interpretation of magnetometric data from the perspective of an archaeologist requires an understanding of various practices of the cultures. This is particularly so with the Adena and Hopewell cultures in the Woodland period. The Adena constructed circular dwellings called round houses. They have been dated as far back as 2000 BC and varied in size from 10 feet up 90 feet in diameter. They were constructed by placing posts in the earth about 2 feet apart in a circular pattern and then weaving lighter branches between the posts. Up to 4 large posts were set in the middle of the structure to support a conical roof made of tree bark shingles. (Figure 8).



Figure 8. Artist concept of a Woodland Culture round house.

The walls were likely covered with wood branches and mud. The perimeter of a round house can sometimes be detected by a curvilinear line linking the post molds together. The round house tradition is also seen in the later Hopewell culture. They are displayed in the magnetic data by a complete or partial ring of black dots in a circular formation with up to four larger black spots in the middle. Round, ovoid, and rectangular dwelling signatures may be seen in the late Hopewell culture of the late Woodland period. (Figure 9).

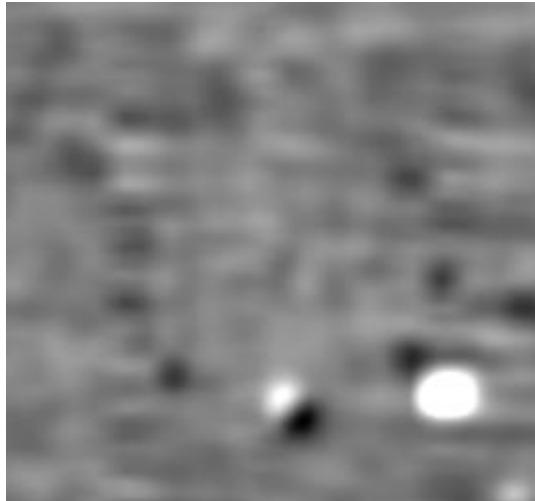


Figure 9. Signature of a round house in the magnetic survey.

Dwelling structures are the primary evidence of Woodland and subsequent Cultural activity. Another possible cause for circular, curvilinear, and straight-line post mold patterns is a henge. Henges were constructed in similar manner as round houses, but their purposes are not fully understood. Sometimes henges were partial circular structures, straight line arrangements, and even a single large post. It is believed that circular henges were used as yearly “clocks” to determine seasons. Some were used to determine the Solstices and Equinoxes and the Metonic Cycle. Only excavation can definitively differentiate round houses from henges. Therefore, circular post arrangements will be labeled RH’s meaning either round houses or henges depending on the configuration and elements of the anomaly. Other features such as fire pits, storage pits, ditches, earthworks, walls, roadways, post molds, crematory pits, destroyed mounds, and general cultural related activities can present anomalies in the magnetometric data.

Not all black spots, circular, geometric, or irregularly shapes are the result of cultural activity. Magnetized stones make up the great majority of irregularities in the magnetic data. They generally have no detectable negative polarity. Either the negative pole is too far away from the sensor or the intensity of the negative pole is too weak to be detected. If a black area has an elevated nT value at its center represented by a shift toward blue colors, there is an increased probability the cause or the anomaly is fire or an ancient sub-surface intrusion. Small ferrous metal objects will cause the negative nT value to elevate at the center of a positively poled area. Negative polarities represented by a shift toward the yellow, orange, and red are caused by ferrous metal. Therefore, only coring can objectively determine the cause for any given anomaly. A pattern of a cluster of anomalies without ferrous metals suggests cultural activity. Geometric arrangements can be very definitive as

to culture and cause such as a “medicine wheel”, destroyed fence line, building corners, and geometric arrangements such as those seen in the Ohio Valley.

Each field analysis will be presented in the order of field number. Each analysis will involve the magnetometry survey georeferenced to modern imagery. Specific locations of high interest will be studied and addressed with full resolution close-up images and text. If analysis of a feature presents a probability of 85% or higher for cause probability, it will be labeled as probable. If the probability for cause is lower than 85%, the anomaly will be labeled as “possible”. If the cause of an anomaly is unknown it will be labeled with a (?). Clusters of anomalies fall into three generalized activity classes. A Cultural Activity Cluster, (CAC), relates to pre-historic human activity. Post Columbian activity will be labeled Modern Activity Cluster, (MAC). And clusters of activity that cannot be determined as to the general time of activity will be labeled (AC) for Activity Cluster.

The full resolution scans are too large to print in this paper. The scans are at 300 ppi, (pixels/inch), and range in dimensions depending on the size of the field. Each field s scaled to fit the page dimensions at 72 ppi. Areas of interest in selected fields are printed at 300ppi. The original full resolution images are maintained by HRG.

Field Locations

Fifteen fields were scanned in South East Iowa North West of the city of Montrose on the Western shore of the upper Mississippi River. The fields are addressed by the order in which they were scanned. The names of each landowner have been omitted to protect their privacy. Below is an aerial view of the scanned areas by field number. Each scan is georeferenced. (Figure 10).

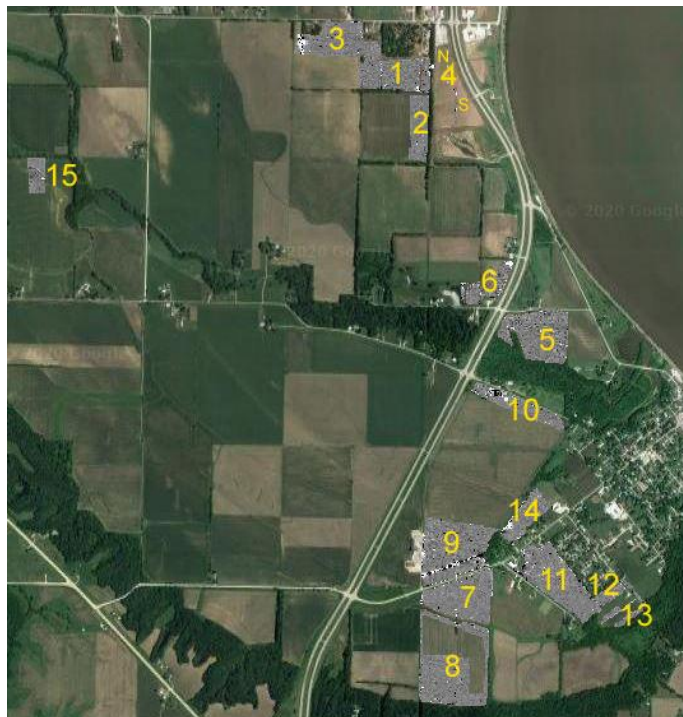


Figure 10. Fields scanned by number. Image by C. Hamilton

Field 1 Magnetometry Survey

Below is the magnetic gradient of field 1. Incorporated are the legends for anomaly causation and the color assignments to nanotesla values, (nT). (Figure 11).

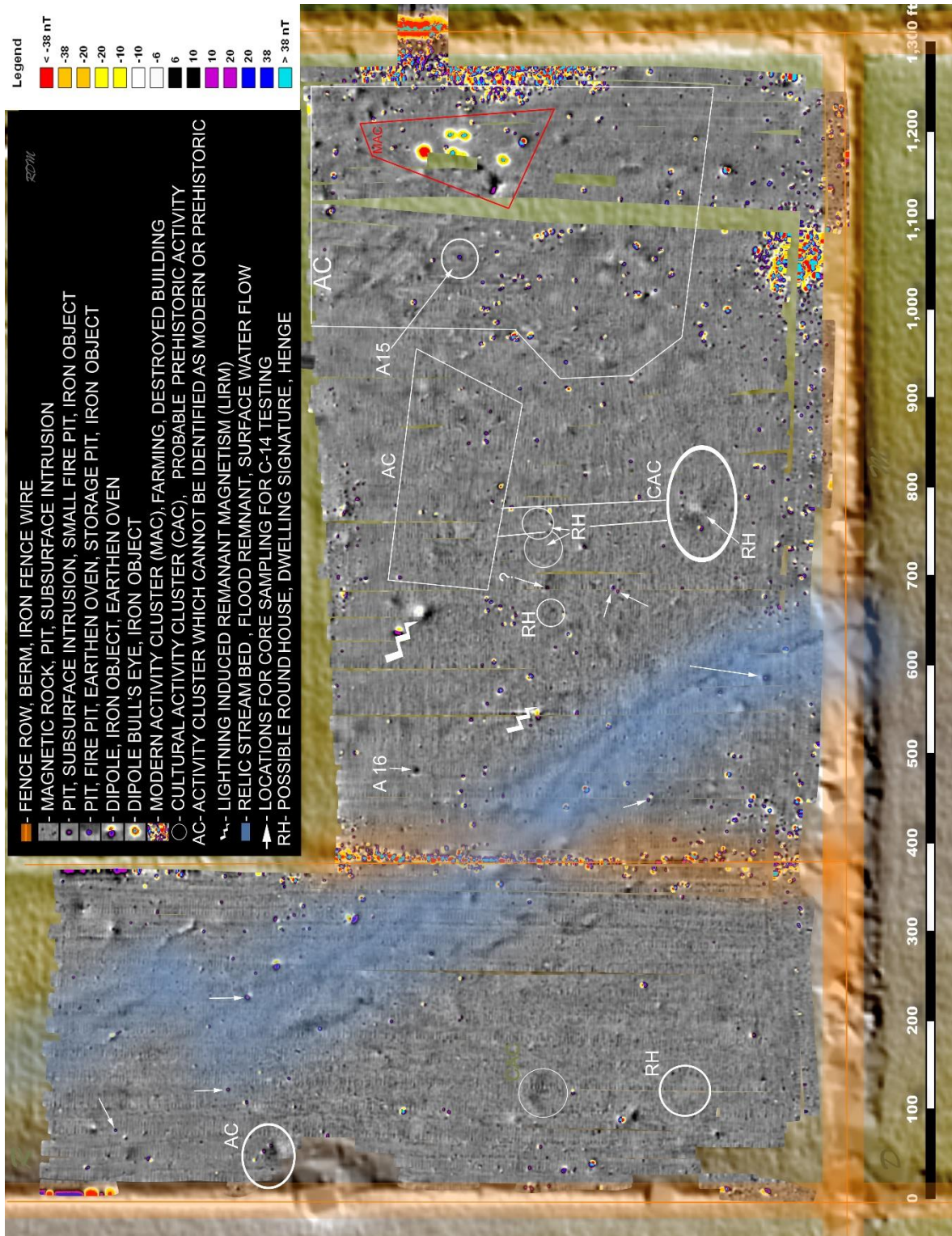


Figure 11. The magnetic survey of field 1 with legends.

The magnetometry gradient of field 1 shows multiple cultural features. There are two areas marked AC, (activity cluster) which could be either recent or ancient activity. It is known that a large area on the East end of the field has been disturbed by archaeological investigations. The presence of ferrous metal within this area is modern. The surface disturbances are consistent with the expedition and cannot be separated from what may be cultural activity. The area outlined in red is undoubtedly the archaeological expedition activity and is contaminated by the presence of large ferrous metals. The fence rows are highlighted in orange to indicate they are naturally raised elevations due to wind-blown soil piling up in the foliage. The process is similar to how a snow fence collects snow. (1961 Davidson).

One anomaly inside the large area of AC does not appear to be caused by modern activity. This anomaly is labeled A15 and appears to be a firepit with a ring of heat proximity changes to the magnetic field in the soil surrounding the pit. The ring of change that encircles the central pit suggests multiple events over a long period of time and/or involved large fire events.

A magnification of this feature shows the nT values to be between +20 and +38 which is consistent with a firepit. The diameter of the central pit is 6 feet. The diameter of the heat proximity changes to the soil extend out to 13.5 feet radius. (Figure 12). The unilateral heat changes to the soil are consistent with fire events in many different wind directions.

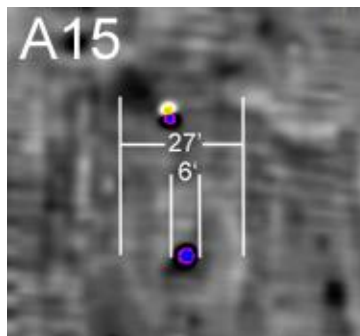


Figure 12. A15 Magnified.

Another similar feature to A15 is A16. The central pit is 6 feet in diameter with heat changes extending to 10 feet in diameter. A heat proximity change to the soil on the South West side suggests the wind was out of the North East when the fire event occurred. The one-sided heat plume and absence of nT values in the +20 to +38 range suggests this fire pit was not used as often as A15.

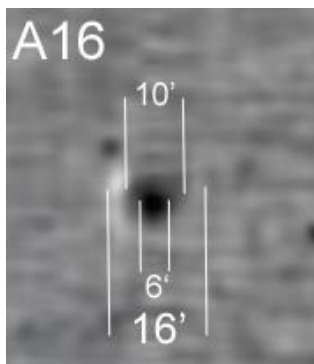


Figure 13. A16 Magnified.

In the center of the field 1 are three areas marked as RH. Magnified views of these three features are consistent with the signatures of round houses of 18.5 feet, 29 feet, and 26.9 feet in diameter, respectively. The absence of internal post molds in the two larger features suggest they could be henges but the percent of probability for henges is low. The probability for round house structures is 85% plus.. These are most likely partial signatures of round house structures. There is a feature which could be a fire pit between the RH on the left and the RH in the center. (Figure 14).

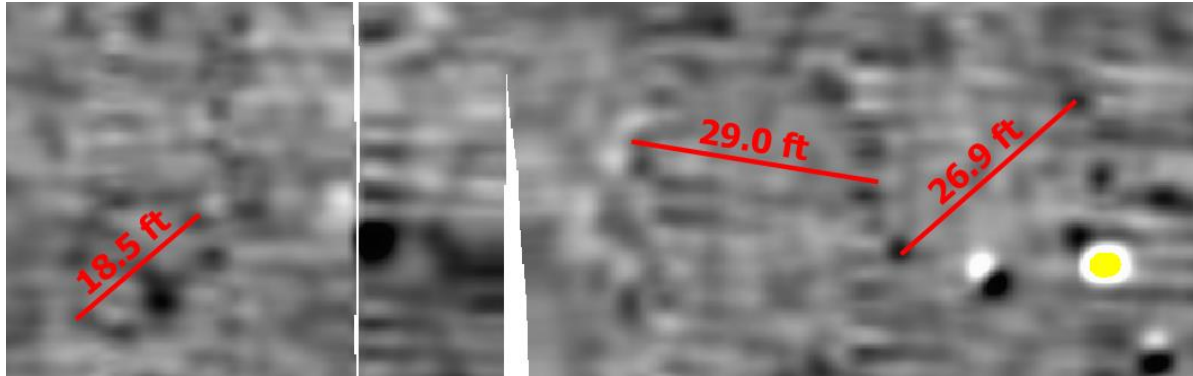


Figure 14. Three circular post mold structures and a fire pit in the center of field 1.

In the south-central part of the field is a cluster of Cultural Activity, “CAC”. This area contains the signature of what appears to be a 24.3-foot diameter round house which was been destroyed by a fire. (Figure 15).

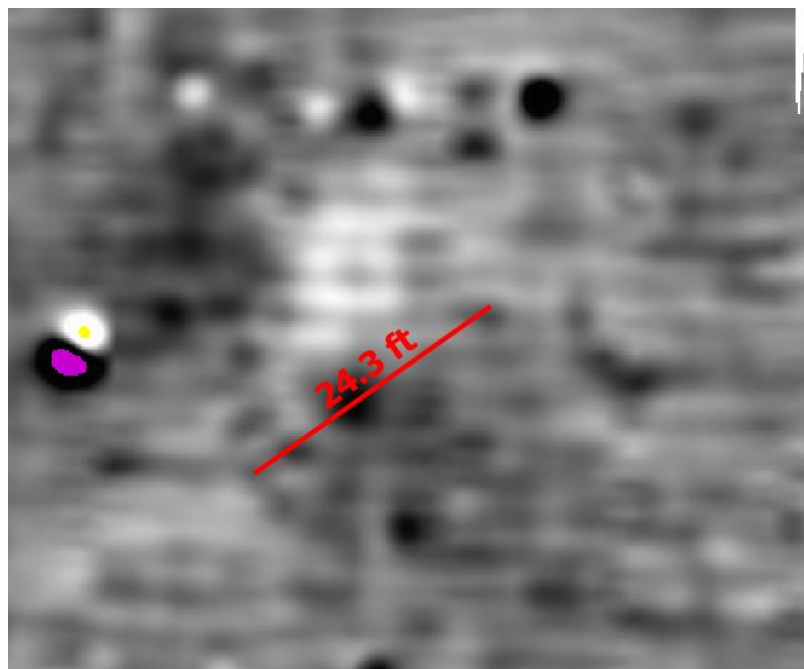


Figure 15. Area of cultural activity with a possible round house destroyed by fire.

The features addressed in figures 13 and 14 are linked by what appears to be a pathway. (Figure 11). This suggests all of these structures existed at the same point time. There are several locations

in field one marked with arrows indicating probable fire pits. On the west end of the field there are two areas of activity, one cultural and one which is not decidedly cultural or modern. There is a RH in the south-west corner of field 1. This is probably a large round house but could be a henge arrangement. (Figure 16).

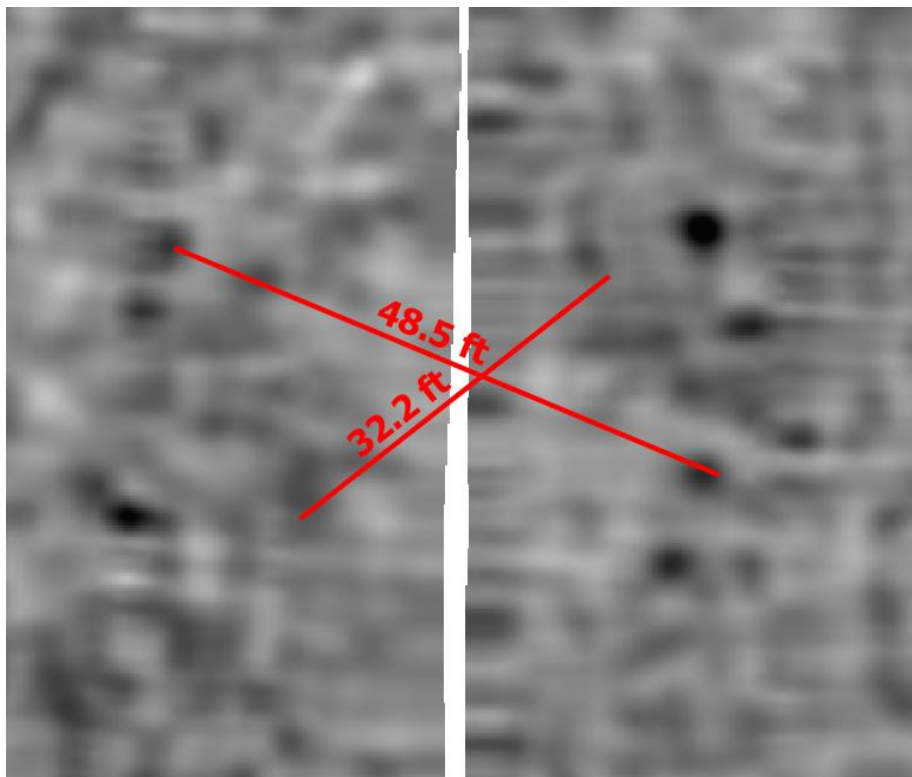


Figure 16. Round house or henge, south-east corner field 1.

Summary of Field 1 Analysis

The magnetometry of field 1 reveals both cultural and modern human activity. The east end of the field has been disturbed by recent surface and sub-surface modern activity. Anomalies A15 and A16 appear to be large cultural fire pits.

There are four locations of probable round house signatures. One of these appears to have been destroyed by fire. An area in the south center of the field has an area of disturbance which could be either a fifth-round-house or a henge. There is a number of what appear to be fire pits scattered about the landscape and are consistent with use by pre-historic human activity.

It is suggested that A15, A16, and the areas around the suspected round houses be cored for C14 samples.

Field 1 Features:

Probable Round Houses 4.

Possible Round Houses or Henge 1.

CACs 2.

ACs 3.

Large Fire Pits 2.

“?” Unknown Features 0.

Field 2 Magnetometry Survey

Field 2 is South and adjacent to field 1. Below is the magnetometry scan of field 2. (Figure 17).

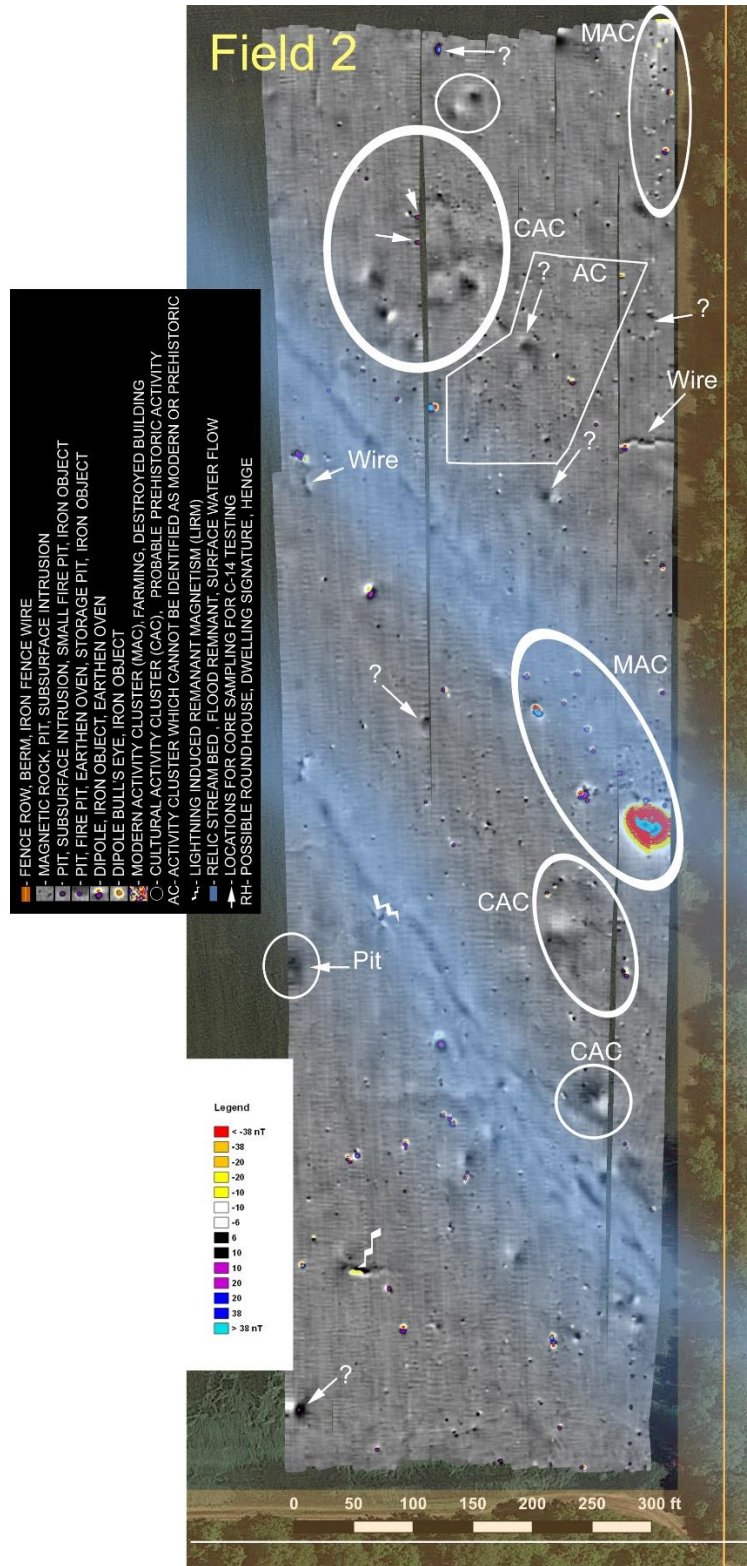


Figure 17. Field 2 Survey.

There are two areas of MAC in which we have no interest. There are three areas of what appear to be CAC. These areas have no high nT values which suggest they are not fire pits. These areas of CAC should be investigated and cored to determine their cause and age. The features marked with a “?” should also be cored. The most interesting feature in F2 is a partial scan of a what may be a rectangular or square pit. The North/South dimension is about 16ft. This feature should be re-scanned and cored to determine its characteristics and cause. (Figure 17E).

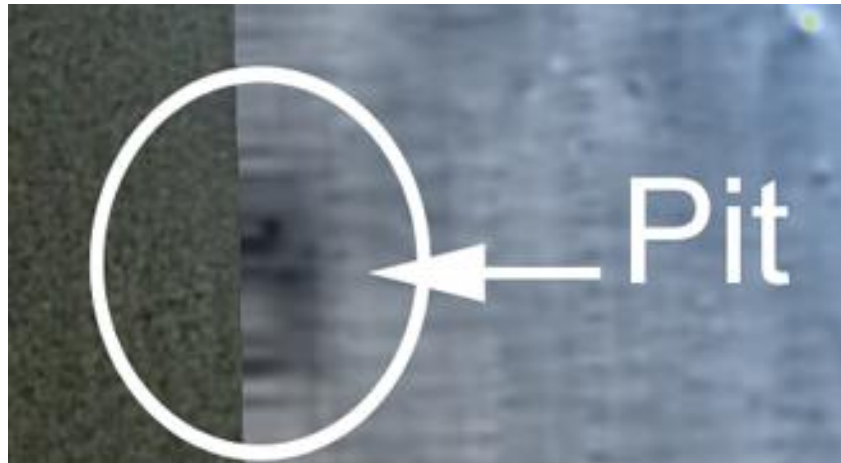


Figure 17E. Enlarged Partial scan of a possible rectangular pit.

Summary of Field 2 Analysis

Field 2 contains some features which have some interest in this investigation. The CACs and locations marked with arrows could be cored or excavated for more definitive causations. However, the probability of these locations adding significant data for the presence of a large pre-historic village is low.

The one exception is the area on the West side of the scan marked with an arrow and question mark. This area should be thoroughly investigated as to its characteristics and causes.

Field 2 Features:

Probable Round Houses 0.

Possible Round Houses or Henge 0.

CACs 3.

ACs 3.

Large Fire Pits 0.

Rectangular Pit 1.

“?” Unknown Features 3.

Field 3 Magnetometry Survey

Field 3 is West and adjacent to field 1. Below is the magnetometry scan of field 3. (Figure 18).

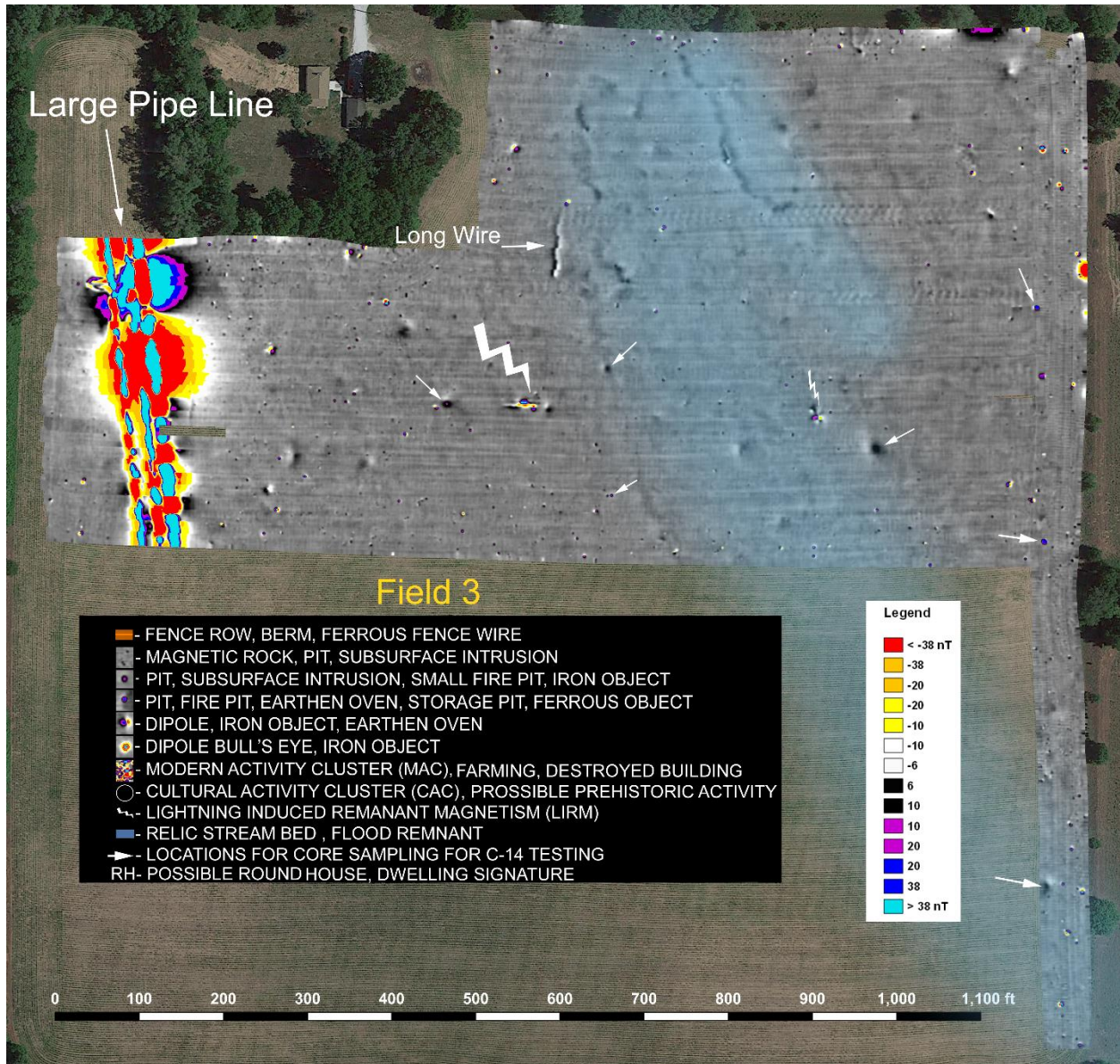


Figure 18. Field 3 magnetometry survey.

Summary of Field 3 Analysis:

Field three contains multiple locations indicated by arrows which could be features caused by cultural activity. The obvious Large Pipeline is of no interest nor is the LIRM in the center of the field. There are no geometric patterns which would suggest dwellings. The locations marked with arrows should be cored for the purpose of determining cause and age but is not likely to be of any value.

Field 3 Features:

Possible large fire pits 4. CACs or ACs 0.

Field 4 Magnetometry Survey

Field four is East and adjacent to field 1. Two test scans were performed in this field, see figure 10, one on the North side and one on the South side. (Figure 19 N & 19 S).

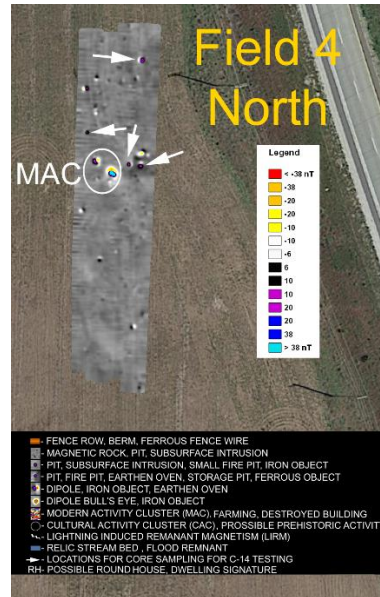


Figure 19 N.

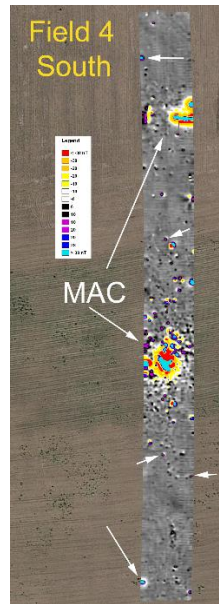


Figure 19 S.

Summary of Field 4 Analysis

Field 4 has no geometric or CACs. Areas of MAC can be ignored. Locations marked by arrows could be sub-surface intrusions such as a fire pit. This field presents no obvious areas for additional investigation. The terrain is sloped down toward the East and is not conducive to long term ancient occupation such as dwellings or large areas of CAC.

Field 5 Magnetometry Survey

Field 5 presents many potential locations which appear to be of cultural interest. (Figure 20).

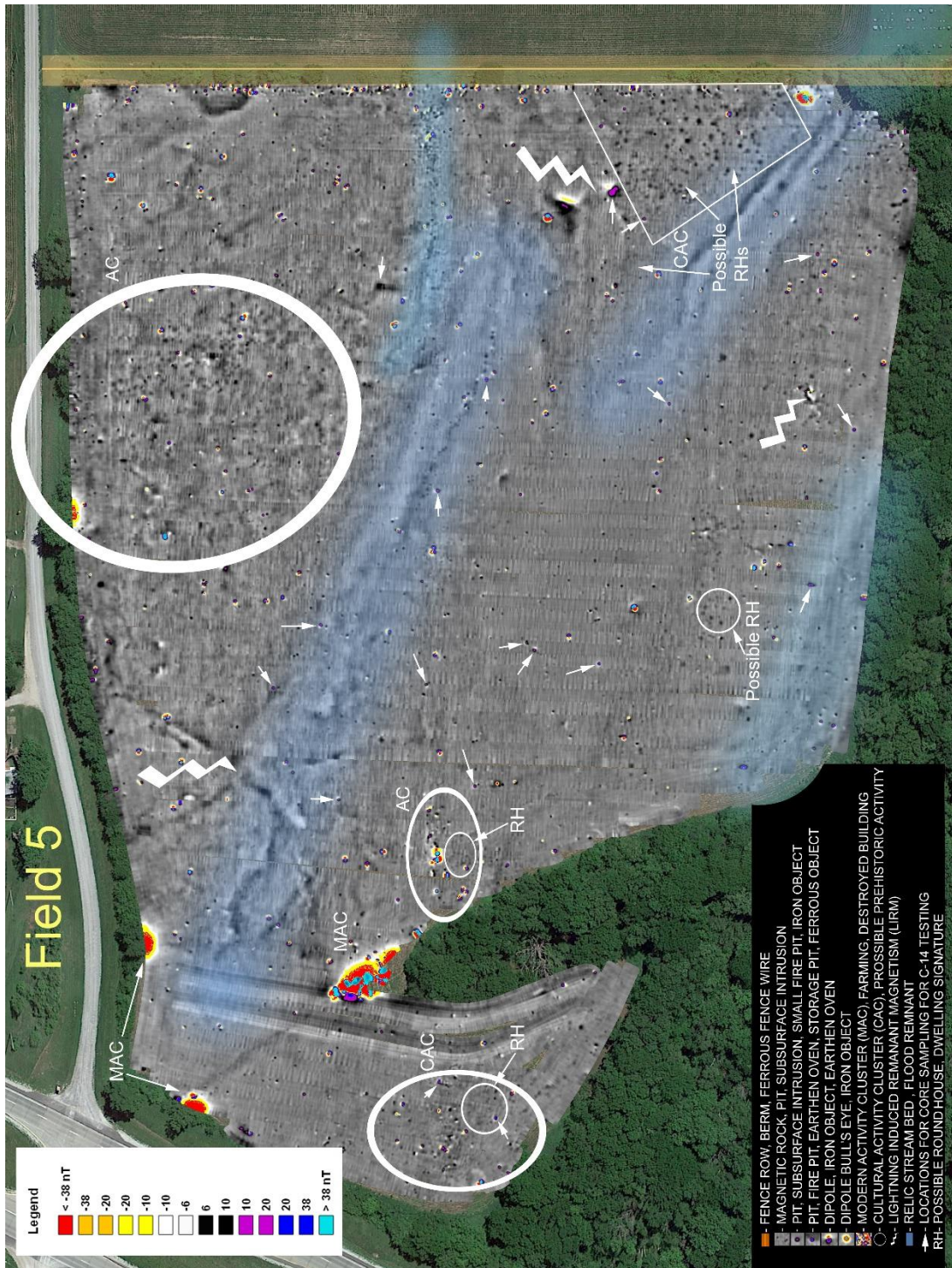


Figure 20. Field 5 magnetometry scan.

A large area in field 5, marked AC, is close to the road and therefore could be modern or cultural. The uncertainty is due to the absence of metal, or elevated nT returns consistent with modern activity. The large number of dark spots are likely magnetized rocks. The modeling of the soil in the area suggests human activity but its age is not certain.

The CAC on the West side of the ravine with a probable round house configuration is a strong indication of ancient activity as well as the AC on the East side of the ravine. Ravine head locations were typically selected for modern dump sites for the purpose of disposing of trash and debris and to control erosion. The presence of round houses at ravine heads is also typical for having early Native American activity close to lowland hunting and gathering terrain.

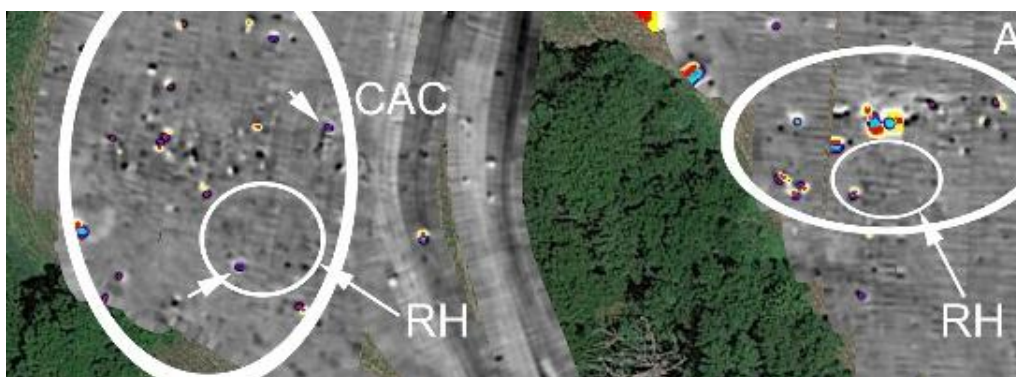


Figure 20E. Enlarged area of F5.

The presence of two other possible round houses in the southeast corner of this field suggests the area was occupied by as many as four family units and associated activities. Samples for coring here should be spread out over the widest possible area.

Summary of Field 5 Analysis

Field 5 is far to the South and East of fields 1 through 4. Field 1 through 4 are in a location where the soil has a high sand to biomass ratio. The soil composition in the region of fields 5 through 15 is more conducive to holding the signatures of early human activity as opposed to the sandy soils farther North. This could be the reason for what appears to be a generalized increase in ancient activity in this region as opposed to the Northern fields. An increase in early population density and activity in the region could also be the cause of increased signatures per square meter as opposed to the more Northern fields.

Population density based on an increased number of CACs, fire pits, storage pits, and round houses per cubic meter is valid. However, it is dependent upon ground truthing by excavation, coring, and C14 dating.

Note the increased number of low nT value black spots clustered along the flow of creek and flood water. This is typical of the clustering of magnetic stones by the flow of water and is not necessarily related to human activity.

Field 5 Features:

Probable Round Houses 2. Possible Round Houses or Henges 2. CAC 2. ACs 2.

Field 6 Magnetometry Survey

Field six is greatly deficient in CA. Two areas are labeled as AC could be modern or cultural. Disturbances in the magnetic field caused by recent activity are obvious. The area running East/West was suspected as CA but with the use of historic imagery it was determined it was the remnant of an old farm lane. (Figure 21).

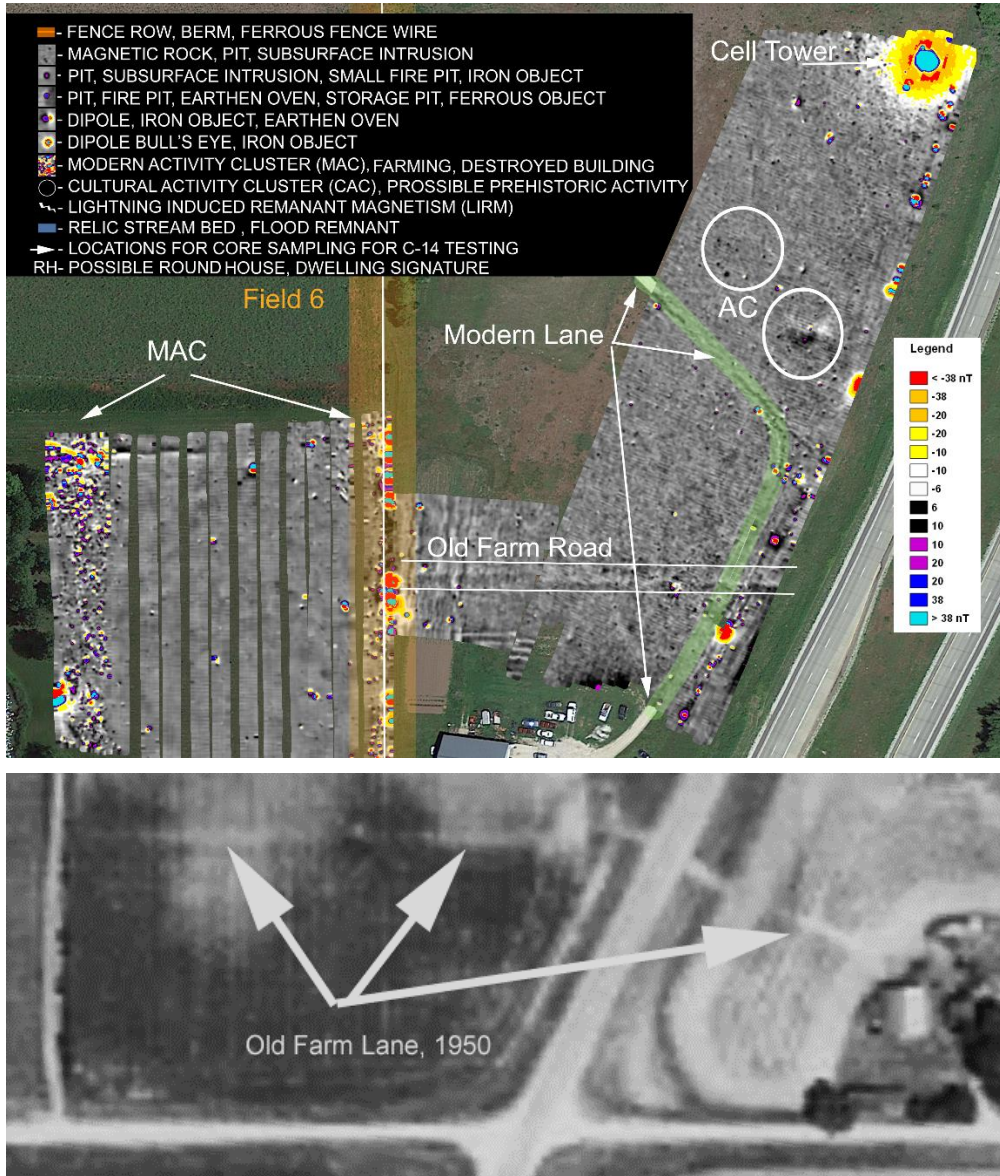


Figure 21 Field 6 showing old farm road or lane.

Summary Field 6 Analysis

Field 6 has two areas of possible cultural interest. Otherwise, this area is unremarkable.

Fields 7 & 8 Magnetometry Survey

The magnetometry scan of fields 7 & 8 are shown in figure 22.

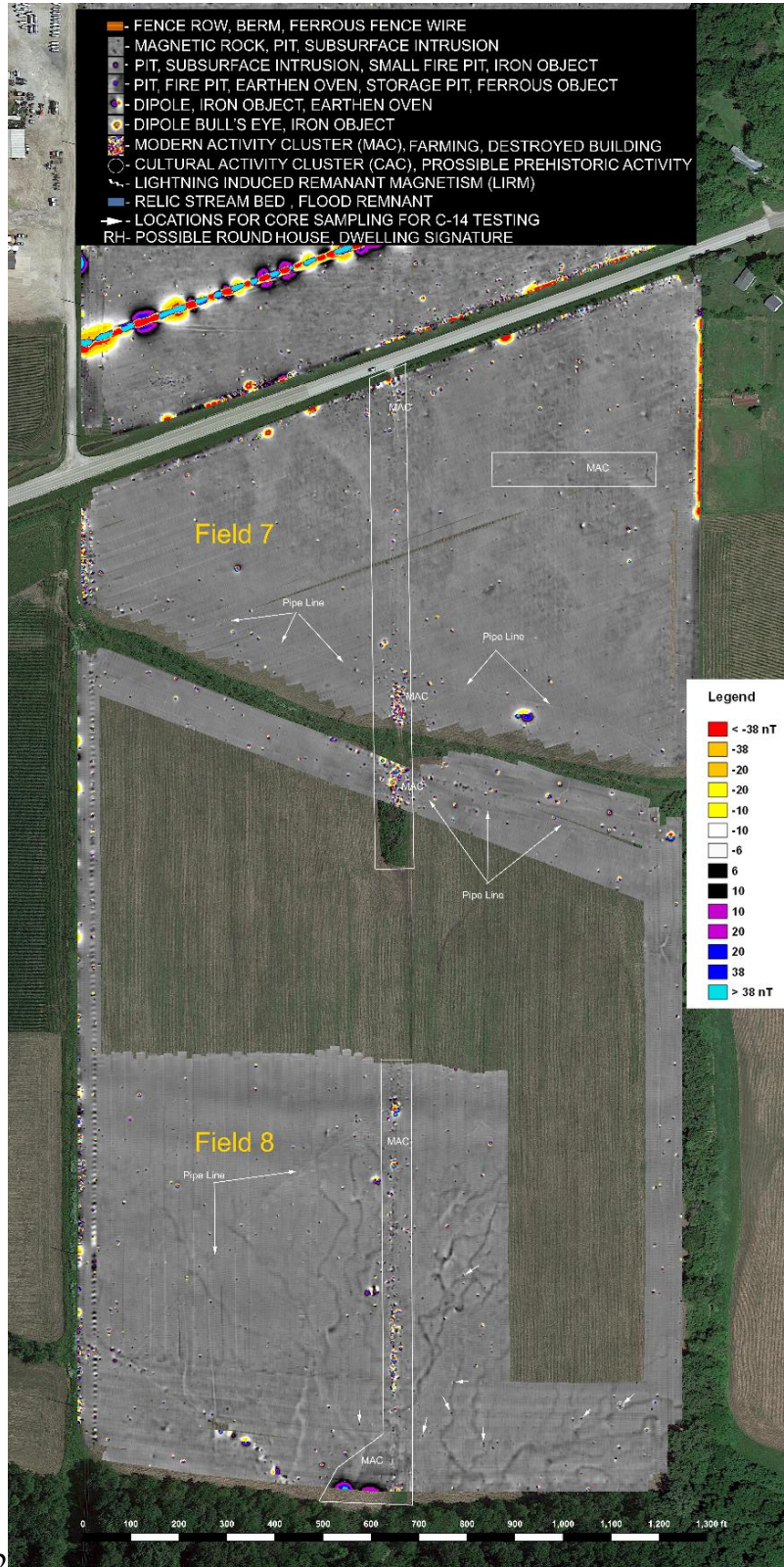


Figure 22

Summary Fields 7 & 8 Analysis

Fields 7 & 8 have very minimal areas of interest. The area running North and South in the middle of the fields appears to be a remnant of a long lane or fence row. The MAC in the middle is the remnants of house. Fragments of brick are scattered along the entire pathway. The irregular dark areas are due to increased moisture concentrating positive signatures.

The area of high nT value in the South East corner of field 7 is probably a metal object. There are no locations in field seven which I would recommend for coring. There is an area in the South East corner of field 8 that could contain some CA. They are designated with arrows.

Overall, fields 7 & 8 are of little interest except to demonstrate the arrays ability to detect a pipeline that is below the plow zone and likely made of tile or PVC pipe.

Field 9 Magnetometry Survey

Field 9 is to the North of field 7 & 8 and is seen on the next page. This area has a high proliferation of possible CACs and signatures consistent with fire pits, sub-surface intrusions, and possible round houses, and what appears to be a destroyed mound or circular earthen enclosure. (Figure 23)

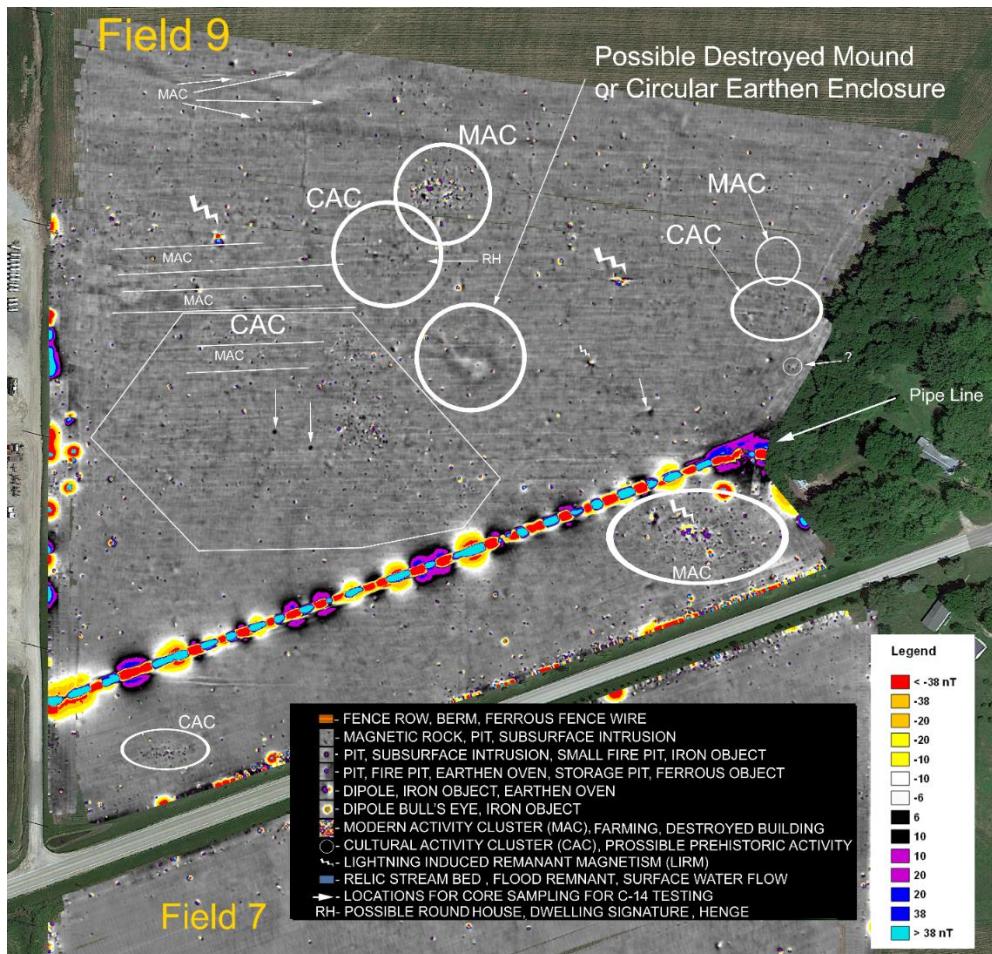


Figure 23. Field 9 with multiple locations of probable CA.

Five areas stand out as being of great interest; the three CACs, the possible round house with associated AC, and the feature which is suspected of being the result of a destroyed mound or circular earthwork. These areas are enlarged for greater clarity. (Figures 23E).

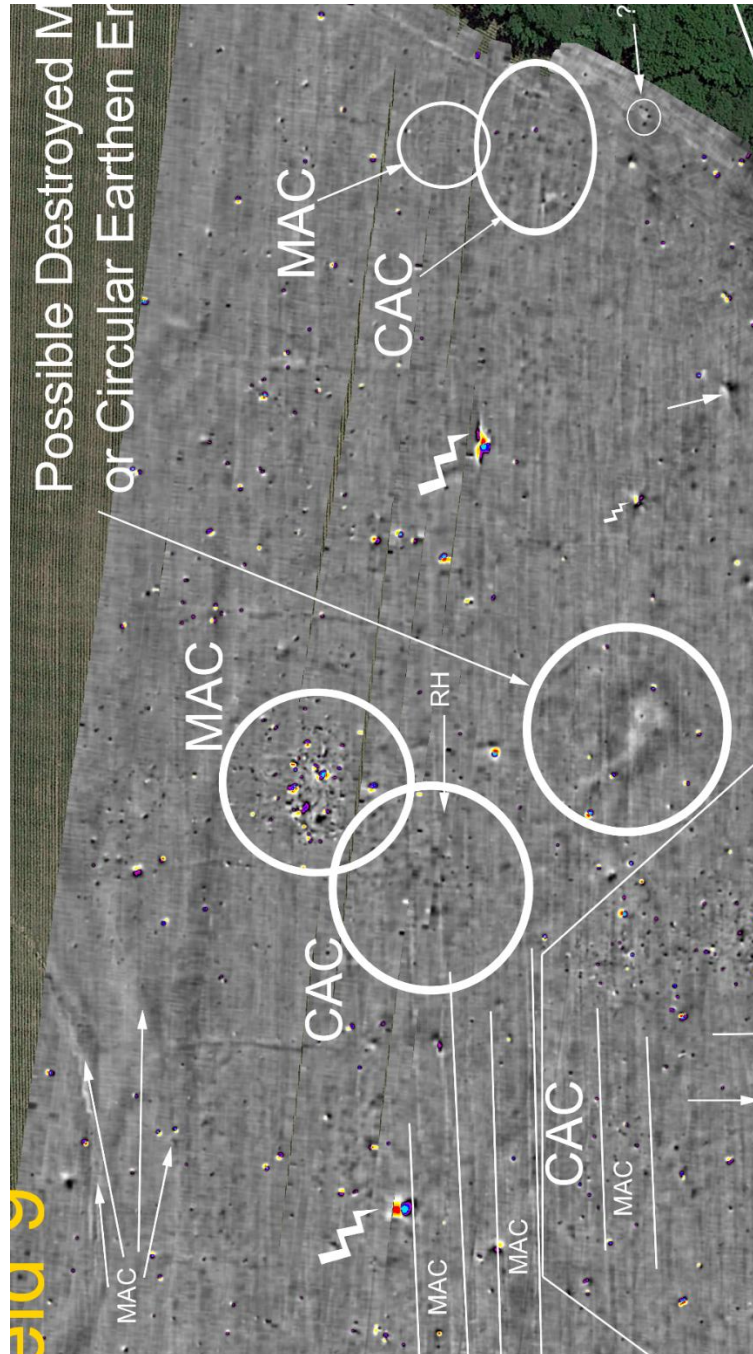


Figure 23E. Enlarged area of field 9.

Summary of Field 9 Analysis

Field 9 appears to have significantly more areas of CA than field 7 or 8. One explanation for this is this area of field 9 is on the edge of a small ridge. Elevated terraces above lowlands are known to generally have more Native American activity than other landforms. Native Americans of the Woodland period chose elevated areas above flood plains and lowlands for long-term living areas. (Converse 2003).

Burial mounds of the Adena and the early Hopewell are often found on ridges that have a distant view of the landscape. This location fits this pattern of behavior of selecting an elevated ridge with a view of many miles to the Northeast for long term occupation and mound building.

This field has three areas of probable CAC and two areas of high interest. The area marked as a possible destroyed mound or earthwork should be investigated by coring and sub-surface excavation.

The area identified as a possible round house should be thoroughly investigated. Long term occupation could be proven with conformation of round house dwellings. In general, this field has potential for discovery of a large NA population in the areas to the North, East and West.

Field 9 features: Round House 1. CACs 4. Possible destroyed cultural work 1. Unknown 1.

Field 10 Magnetic Survey

Field 10 is the North end of field 9. This field is exceptionally large. Scans 9 and 10 are separated by nearly ½ of a mile. (Figure 24).

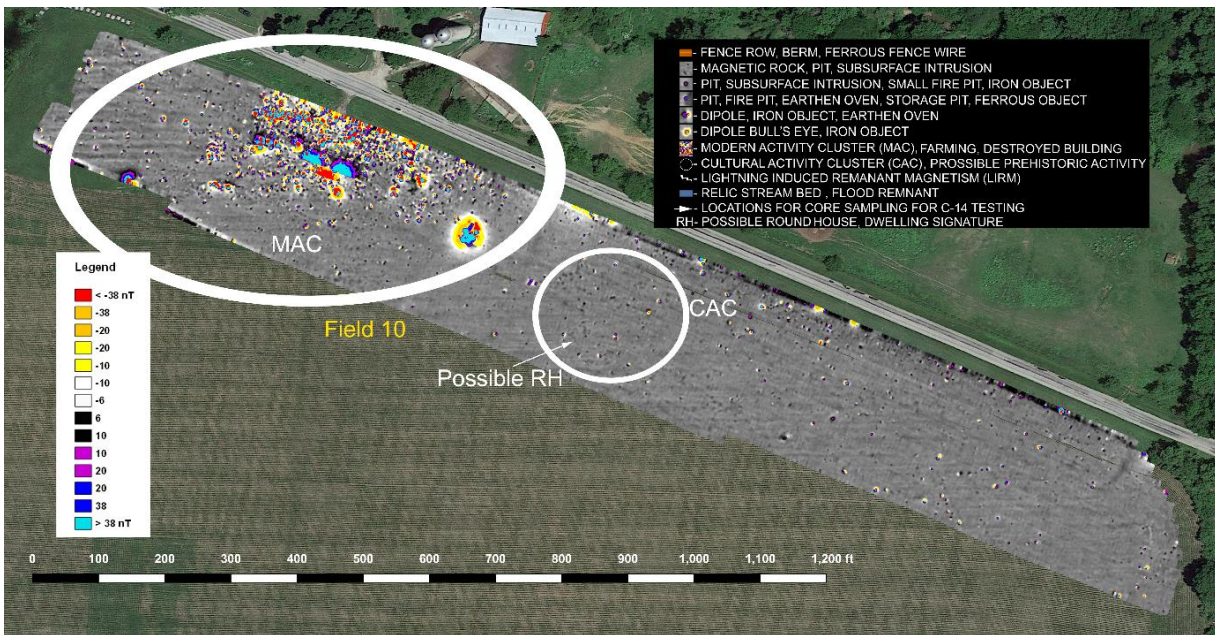


Figure 24. The North end of field 9.

Summary of Field 10 Analysis

The area of MAC is a destroyed barn. The profusion of small metallic objects, (in red), range from the size of a nail to large pieces metal such as hinges, straps, latches, and pieces of farming equipment. The area of CAC contains the possible signature of a round house.

Field 10, or area 10, is also higher in elevation than the portion between this and the ridge of field 9. The view in the photograph below shows the large separation of areas 9 and 10. (figures 10 & 25).



Figure 25. A wide-angle view of the entire field containing site 10 on the left and 9 on the right.

Field 10 features: Round House or Henge 1. CAC 1. The ridge overlooks an exceptionally large field of lower elevation to the North and East. This area had all the necessary resources to sustain a large population including the Mississippi River. This entire field should be scanned for evidence of a pre-historic village.

Field 11 Magnetometry Survey

Below is the scan of field 11. (Figure 26).

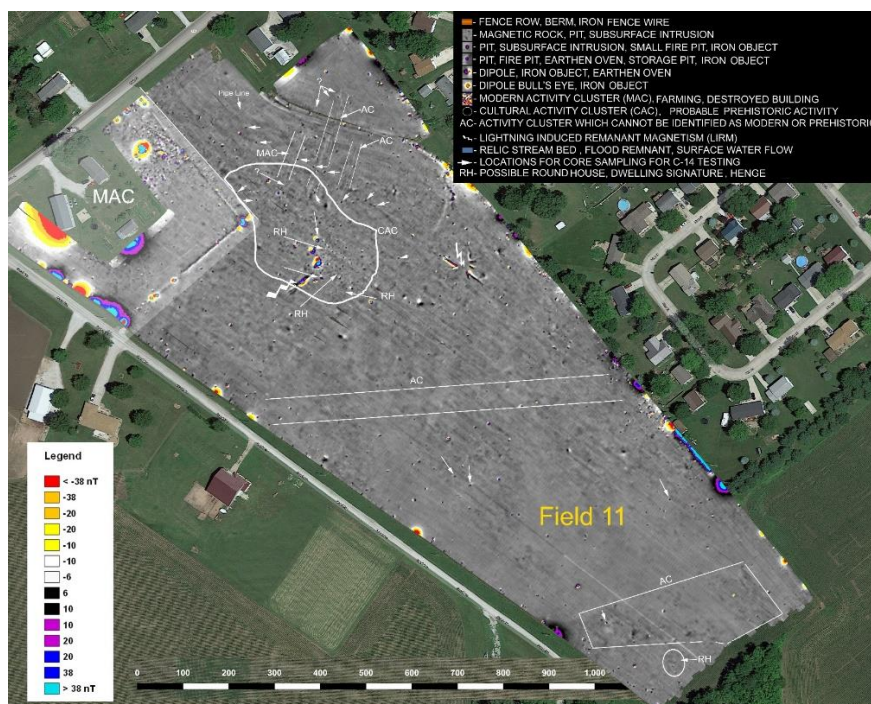


Figure 26. The magnetometry scan of field 11.

Below is an enlargement of the North end of the field. (Figure 26NE).

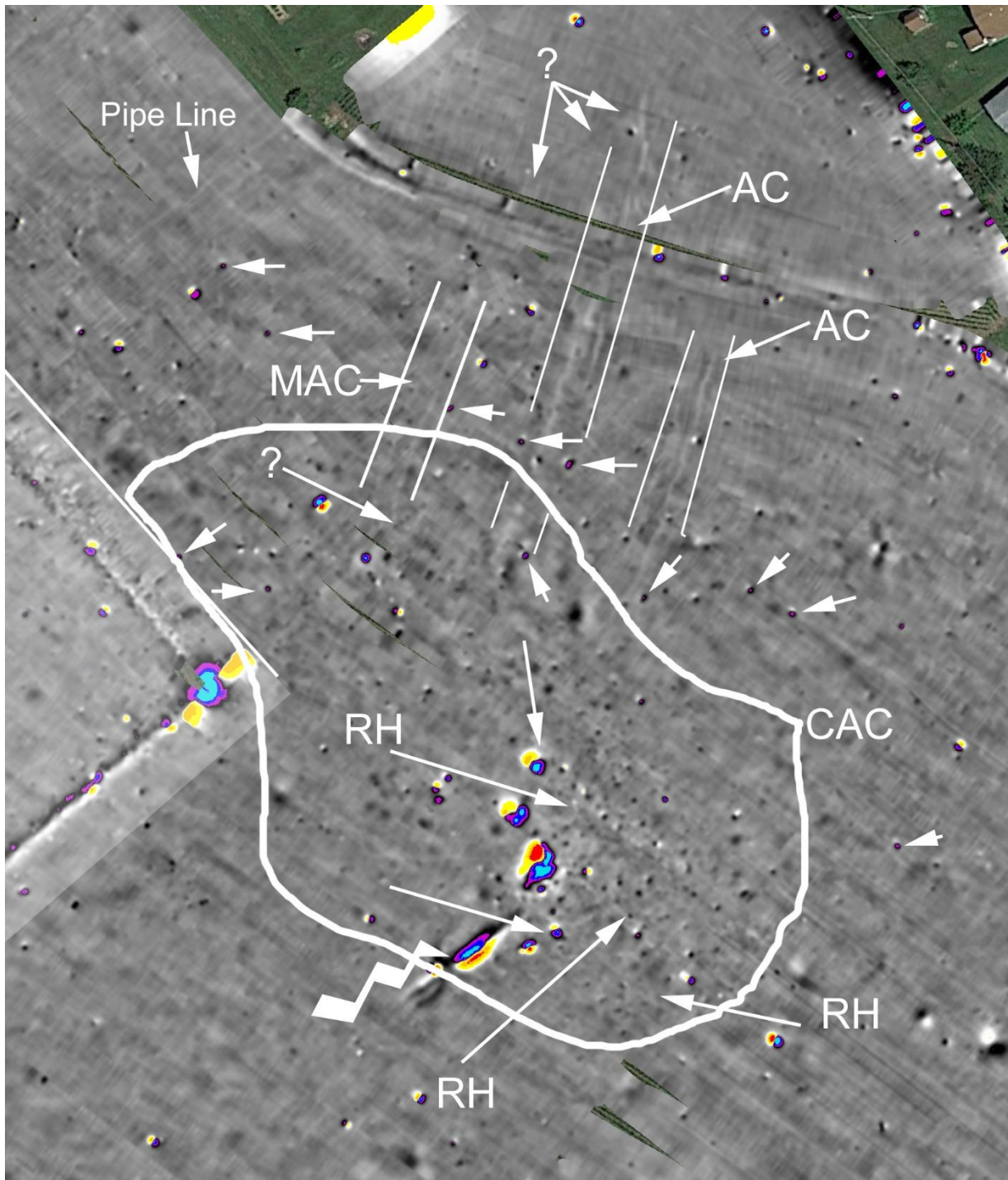


Figure 26NE. Enlarged North end of field 11.

This scan shows a large area of CAC with at least three possible round houses embedded in the CAC. At the top middle is a dark line which could be an ancient pathway. There is a feature inside the CAC perimeter, (?), which cannot be identified but appears to be a row of post molds. Arrows point to features which could be fire pits or sub-surface intrusions.

Below is an enlarged view of the South end of field 11. (Figure 26 SE).

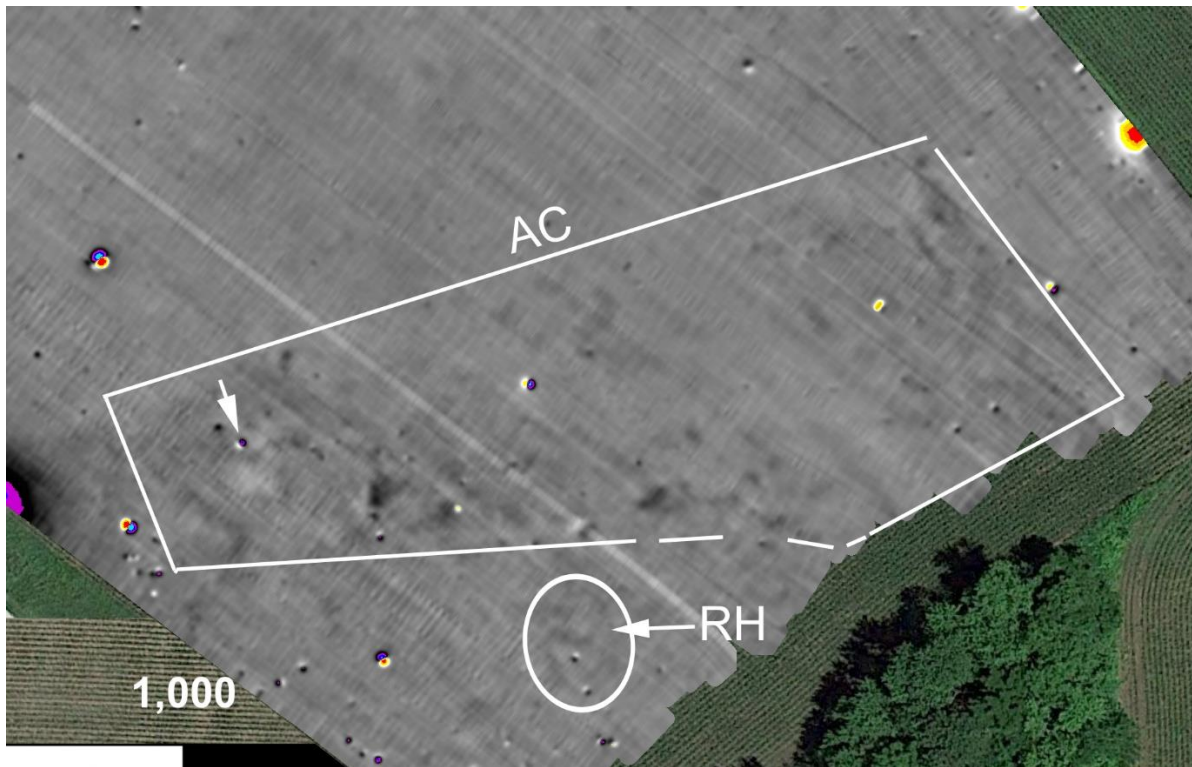


Figure 26 SE.. The South end of field 11.

The features inside the area labeled AC appear to be both modern and cultural. Features having straight edges and 90-degree corners is the result of farming. The amorphous shaped areas are likely CA. The feature circled and marked “RH” appears to be a possible oval shaped dwelling signature. An ovoid house is not impossible in the late Hopewell culture. However, it is probable this anomaly is the result of farming but should be investigated.

Summary of Field 11 Analysis

Field 11 contains multiple features which appear to be CA. CACs and the presence of two or more round house signatures suggests this area was used by Native Americans long before contamination and destruction by the encroachment of modern culture. The features marked with arrows, particularly those in or near round house signatures should be cored and investigated. It appears that as scanning moved toward the city of Montrose not only does the “junk” of society increase, but so does the number of possible Native Americans and activities.

Field 11 Features:

Probable Round Houses 4. Possible House structure 1. CAC 1. Multiple ACs.

Fields 12 & 13 Magnetometry Survey

Below is the magnetometry scan of fields 12 & 13. (Figure 27).

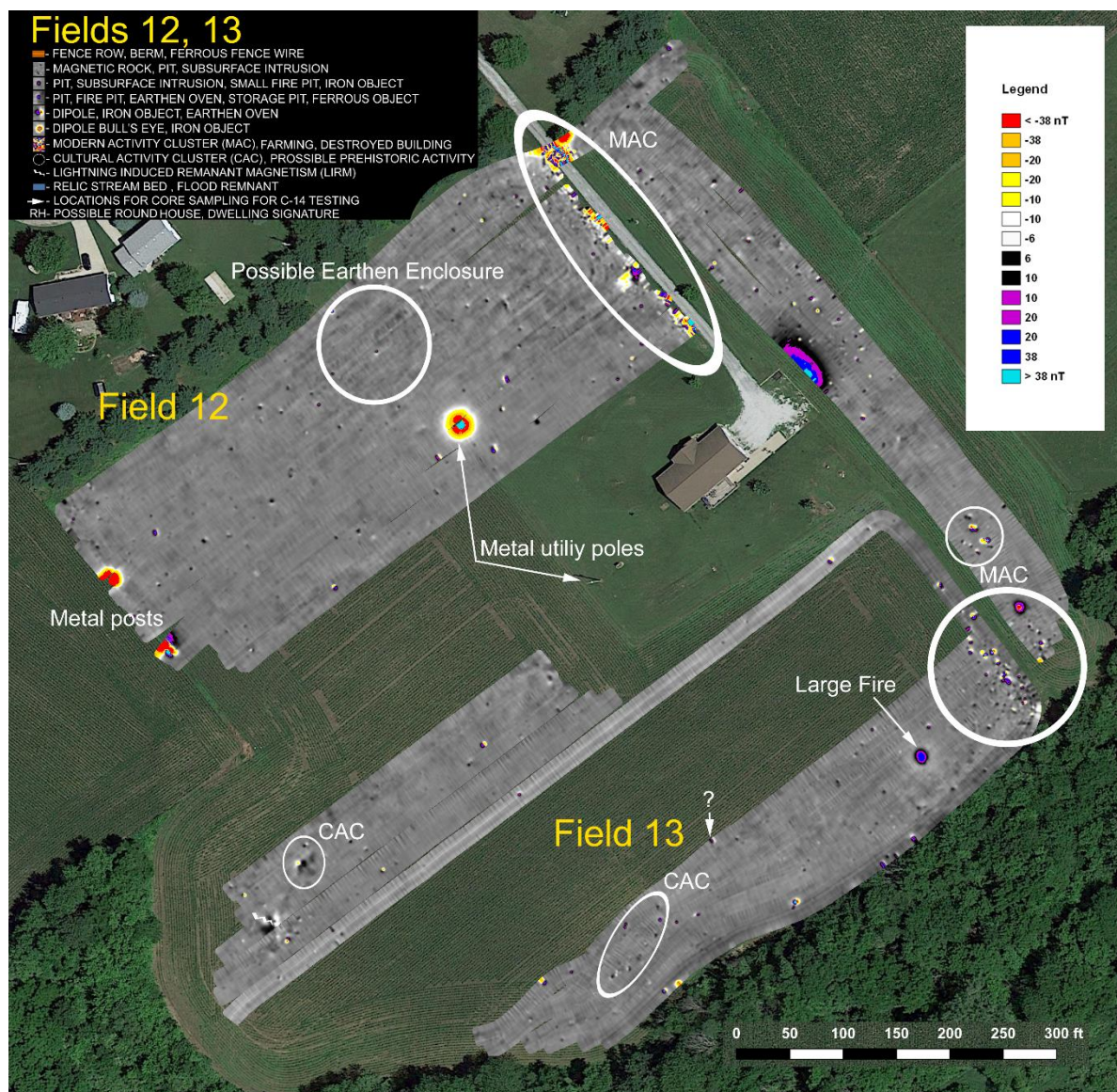


Figure 27. Fields 12 and 13.

Summary 12 & 13 Analysis

There are two areas of possible CA and a possible remnant of a circular enclosure. The “Large Fire” area at the bottom right corner is definitely a fire pit. Coring should determine its age.

Fields 12 & 13 features:

CACs 2. Possible Cultural work 1. Large fire pit 1. Unknown Feature 1.

Field 14 Magnetometry Survey

Below is the magnetometry scan of field 14. (Figure 28).

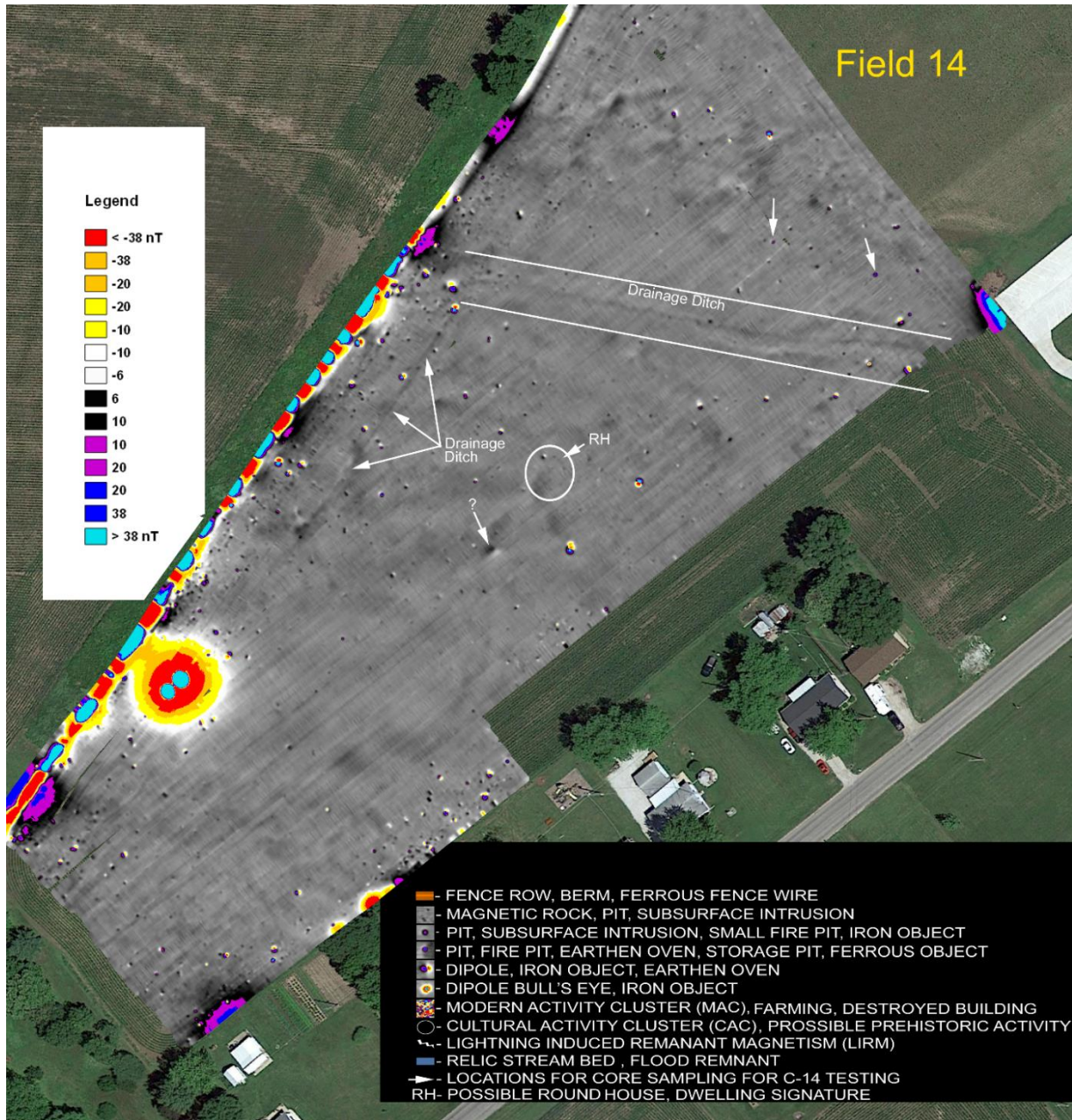


Figure 28. Field 14.

Summary of field 14 Analysis

The feature marked RH should be investigated for cause. It appears to be the partial signature of a round house but could be caused by farming activity. The linear feature between the lines and the dark line pointed out by the arrows is a drainage ditch. The single feature marked with “?” appears to be cultural and should be investigated.

Field 1 features: Possible Round House or Henge 1. Unknown features 1.

Field 15 Magnetometry Survey

Below is the magnetometry scan of field 15. (Figure 29).

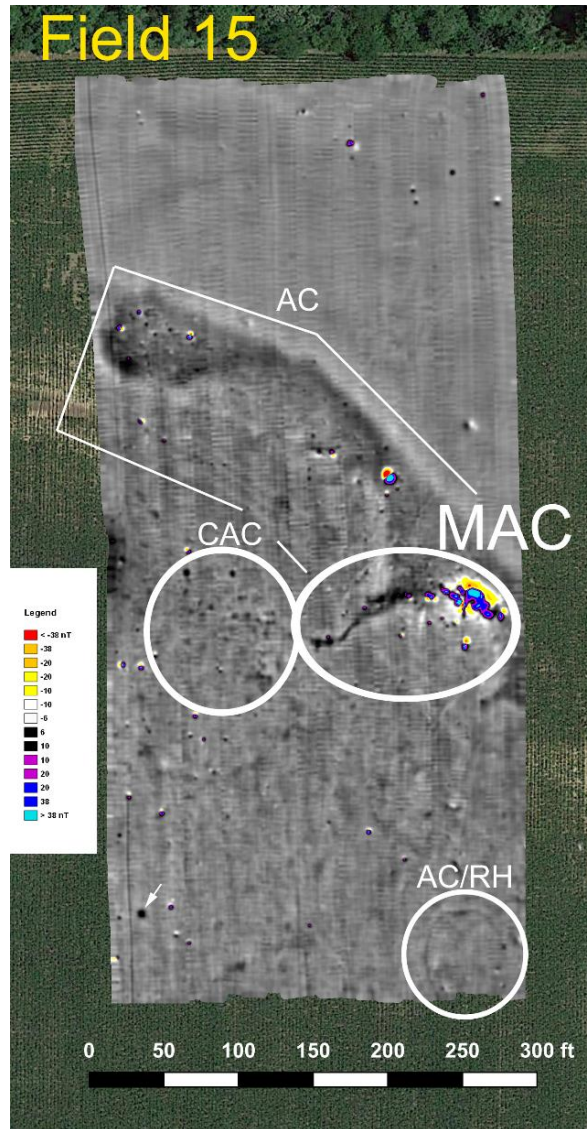


Figure 29. Magnetometry scan of field 15.

Summary of Field 15 Analysis

The areas labeled AC and MAC are most likely modern. The presence of metal is indicative of modern activity. The curvilinear dark area at the top of the image is a sandy ridge. The black area inside the MAC circle is a waterway.

The only features of interest in this field are the signature of what may be an ovoid house structure and the area of CAC. If this is an “oval house”, then it should have post molds in the perimeter. The absence of post molds in the perimeter and middle suggests this is not a dwelling structure. (Figure 29). The ovoid structure in field 14 has what are likely post molds in the perimeter and internal roof supports consistent with RHs.

Field 15 is far to the North West of fields 9 through 14. See the field number image. (Figure 10). Figures 30 & 31 show the differences between the two anomalies. The feature in field 14, figure 30, appears to be a round shaped “pole structure” with internal roof support. The feature in field 15, figure 31, appears to be the remnant of an ovoid earthwork with an external ditch. The width of the external ring is 5.54 feet. This is consistent with the wheelbase of many modern tractors. The absence of post molds in the perimeter and its ovoid shape suggests this feature in field 15, figure 31, is most likely where a tractor turned around.

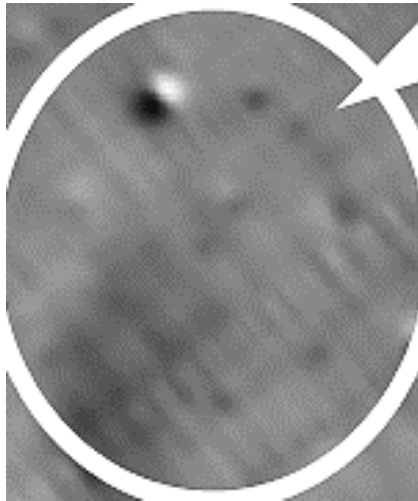


Figure 30. Ovoid feature field 14.

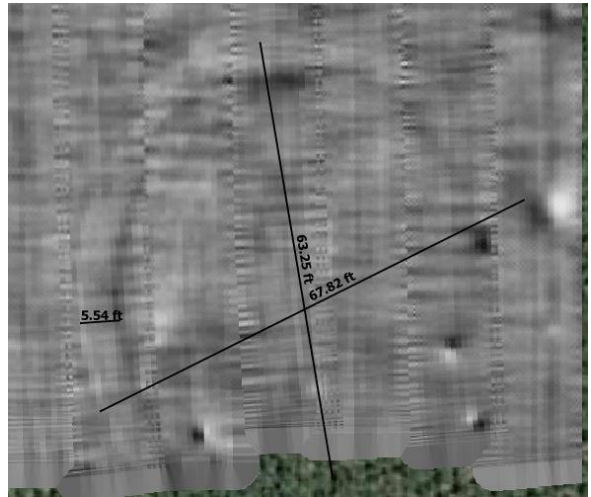


Figure 31. Ovoid feature field 15.

These anomalies should be investigated. There is a possibility they are both “ovoid houses”. Oval shaped structures in the late Woodland Period would be a unique discovery but not impossible. Many NA cultures which came after the Hopewell florescence constructed round, ovoid, square, and rectangular dwelling structures. The Algonquin people, found in the North East, particularly in New York State, built Long Houses. They were rectangular. These two structures, figures 29 and 30, could be a transition from round to ovoid structures.

Field 15 features: CAC 1. ACs 2.

Total Features Fields 1 through 15

Round House or Dwellings	11	Unknown Features	8
Possible Dwellings or Henges	5	Rectangular Pit	1
CACs	15	Destroyed Cultural Structure	1
ACs	10		

Possible cultural anomalies number in the thousands and require ground truthing.

Conclusions

The SENSYS magnetometry array and electronics is a cutting-edge system. It is capable of scanning exceptionally large areas of terrain in a fraction of the time of “walk behind arrays”. The resulting magnetometry data is as good or better as the results of slow-moving arrays. It is certainly much more efficient in terms of field time. It appears the sensitivity of the SENSYS array can detect anomalies at a greater depth than other near ground magnetometry technologies.

The total number of acres scanned in the 7 “scan-days” is 223.451. (Figure 32).

#	Day	Hectors	Acres
1	Day 1	8.001	19.770
2	Day 1	3.841	9.490
3	Day 1	0.136	0.335
4	Day 3	8.677	21.440
5	Day 3	1.520	3.755
6	Day 4	6.224	15.379
7	Day 4	8.235	20.348
8	Day 5	1.343	3.319
9	Day 5	18.750	46.331
10	Day 8	11.196	27.665
11	Day 8	3.913	9.670
12	Day 9	1.618	3.998
0	Day 10	0.873	2.157
13	Day 10	2.730	6.745
14	Day 10	3.618	8.939
15	Day 10	9.757	24.110
	Total Scanned	90.429	223.451

Figure 32. Acreage Scanned.

The fields available for scanning were determined by crop harvesting and permissions from landowners. The intent was to scan multiple fields in a wide pattern and follow the evidence for NA activity by evaluating the data on site within 12 hours of scanning. This was done by sending the data to Maryland for processing and filtering to remove noise and enhance the layered results. The data was then sent back to Iowa where it was analyzed and used to determine the following days scanning locations. By spreading the scans over a wide area, the probability of locating a large occupation site of Native Americans in the region was increased.

The total acreage scanned is a fraction of the possible locations for a large NA concentration. Scans 9 & 10 were on opposite sides of an exceptionally large field. **This lowland fields highlighted in figure 33 should be scanned for a high concentration of NA activity. (Figure 33).** Scanning inside the city limits of Montrose is not an option. It would be fruitless because of modern activity and the limited available open ground. However, there are outlying rural residences on the highest terrain elevation in the area to the South above and adjacent to the main part of Montrose proper. **The highland plots of open grass on top of the bluff would be ideal locations to search for a large NA hilltop settlement. (Figure 34).**



Figure 33. Lowland search area.



Figure 34. Highland search areas.

Summary:

The expedition in Iowa was a success on several fronts. The SENSYS MV X3 magnetometry array functioned very well in detecting variations in the magnetic field of the earth. The speed at which it can be moved over terrain is multiple times faster than other magnetometry systems available to archaeologists. This offers archaeologists and researchers the ability for high resolution magnetometry to be accomplished over large terrain areas and to obtain high quality results in a fraction of time as opposed to older systems.

The discoveries of NA features near the town of Montrose suggest there may have been a high population center on which the modern city of Montrose was constructed. Future expeditions applying this technology to other fields in this area could locate a high concentration of NA occupation. A large cluster of dwellings, pits, and CA in this area would be an important discovery. The NA complex near Saint Louis, MO named Cahokia is thought to be the largest NA village in North America. Its fluorescence was in the Mississippian period 800AD to 1600AD. The discovery of a comparable size NA population center in SE Iowa predating Cahokia would be of great importance to North American archaeology and history.

Multiple signatures representing dwellings, pits, hundreds of fire pits, storage pits, and cultural activities were discovered. The core team found much charred wood and other datable material between 3 feet and 10 feet below field surfaces. This suggests there was human activity in this area long before Colonial settlers arrived. The C14 analysis will definitively determine the time period of occupations. We now know the locations where a high concentration of Native American occupation is likely not. But the search should go forward.

Note: Quoting astronomer Carl Sagan; “*The absence of evidence is not the evidence of absence*”.

The “absence of evidence”, as applied to this project, only means that the area where there was a large NA concentration of dwellings and activity was not scanned **or**, if it was scanned, it is undetectable with this magnetometry device. The SENSYS MV X3 magnetometer works exceedingly well and is proven to locate human activity several feet below the terrain surface.

Therefore, HRG should continue to scan this area of Iowa. Future investigations will narrow the possibilities. If there is a large Native American dwelling site or pre-historic “city” that predates Cahokia in Missouri, a future expedition by HRG will likely locate it.

Acknowledgements:

Special thanks to the HRG team who deployed to Iowa. You know who you are. Thank you.

Special recognition to Calvin J. Hamilton for his Graphic Imaging work. Your contributions to HRG were indispensable.

Much thanks to Gorden Konieczek, Applications Engineer for SENSYS for working in the middle of his nighttime in Germany. His assistance was critical to the success of this expedition.

References Cited:

Burks, Jarrod, Ph. D., Archaeologist, Geophysical Survey

2013, Large Area Magnetic Gradient Survey at Hopewell Mound Group Unit. Hopewell Culture National Historic Park, Ross County, Ohio.

Hamilton, Calvin J., GIS, Computer, & Image Specialist

2020, Verbal communication.

Davidson, D. T., Professor, Civil Engineering

1961, Geologic and Engineering Properties of Pleistocene Materials in Iowa. Iowa State University Bulletin, page 4

Converse, Robert N., Founder Archaeological Society of Ohio

2003, The Archaeology of Ohio.

Moats, Richard D., Avocational Archaeologist, Archaeoastronomer, Remote Image Analyst

2018, A Magnetometry Survey of Fort Glenford

2020, Surface observations and investigation of South East Iowa.