Archaeological Services
University of Durham

Oaklands, Nosterfield, North Yorkshire

geophysical surveys

on behalf of

On-Site Archaeology

ASUD Report 1273
June 2005
(revised August 2005)

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Contents

1. Summary

Revised text (3rd August 2005) shown in bold

The project

1.1 This report presents the results of geophysical surveys conducted in advance of a possible extension to Nosterfield Quarry near Thornborough, North Yorkshire.

1.2 The works were commissioned by On-Site Archaeology, on behalf of Mike Griffiths Associates, and conducted by Archaeological Services University of Durham in accordance with instructions provided by On-Site Archaeology.

Results

1.3 Geomagnetic surveys were carried out on four sample areas to the north of Nosterfield Quarry with electrical resistance survey also being conducted over one of those areas.

1.4 Upon completion of the resistance survey it appeared that the technique had been particularly effective and had recorded evidence for a multi-phase system of ditched enclosures and associated features. Two trial trenches were subsequently excavated by On-Site Archaeology across two of these features. The excavators have interpreted the features as being the result of natural processes (ice wedges).

1.5 Geomagnetic surveys over the same area failed to detect these features, implying that gradiometer surveys are not well suited to detecting features of this type in the soil conditions found in here.

1.6 Geomagnetic surveys in other areas at Oaklands detected evidence for later field systems, including ridge and furrow remains and old field boundaries, probably post-medieval in date.

2. Project background

Location (Figure 1)

2.1 The study area is located on land to the north of Nosterfield in North Yorkshire (NGR centre: SE 275 815) and measures approximately 49ha divided into six parts, Areas A-F. A sample of 6ha has been surveyed, with surveys located in Areas A, D, E and F.

Development proposal

2.2 The surveys have been carried out in advance of a proposal to extend Nosterfield Quarry to the north of its present site.

Brief

2.3 The surveys have been undertaken in accordance with instructions provided by On-Site Archaeology.

Objective

2.4 The principal aim of the surveys was to determine the extent and nature of any sub-surface features of likely archaeological interest, including cut, built and fired features, which would assist the client and the planning authority in determining appropriate mitigation strategies should archaeological deposits be found to survive within the study area.

Dates

2.5 Fieldwork was undertaken between 12th and 18th May 2005. This report was prepared between 19th May and 2nd June 2005. **This revised version of the report was prepared on 3rd August 2005, subsequent to the results of a trial trench evaluation by On-Site Archaeology.**

Personnel

2.6 Fieldwork was conducted by Sam Roberts (Supervisor), Graeme Attwood and Lorne Elliot. This report was prepared by Sam Roberts and Duncan Hale, with illustrations by Janine Fisher. The Project Manager was Duncan Hale.

Archive/OASIS

2.7 The site code is **OFT05**, for **O**aklands **F**arm, **T**hornborough 20**05**. The paper and data archive is currently held at Archaeological Services, University of Durham. It is anticipated that the data archive will be transferred to the Archaeology Data Service in due course. Archaeological Services University of Durham is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (OASIS). The OASIS ID number for this project is archaeol3-8460.

3. Archaeological and historical background

3.1 Aerial photography has previously recorded a cropmarked enclosure in Area A; this was subject to both geomagnetic and electrical resistance survey techniques.

3.2 The area under investigation lies to the north of the early Neolithic complex of monuments known as the Thornborough Henges, consisting of three main circular henges, associated with an earlier cursus monument and later pit alignments. Although some distance away from our investigation area, the scale of this monumental complex requires the landscape to be interpreted with these in mind. These monuments were a centre of ritual activity throughout the Neolithic, and acted as a focal point for later activity demarcating and dividing the prehistoric landscape, with domestic settlement only being found some distance away from the henges.

3.3 Their importance in the landscape continued into the Bronze Age, seemingly acting as a hub for burial activity, with both inhumations and cremations having been discovered in the vicinity. Although an integral part of the ritual landscape of the Bronze Age, there is little evidence for domestic settlement, implying that landscape divisions formed in the Neolithic continued to be a factor in the Bronze Age.

3.4 There is little evidence so far for Iron Age activity in the area, however, burials and pit alignments discovered to the north of the henges (south of the current investigation area) have shown that this area was in use through this period, and seemingly with a similar focus on ritual activity. Evidence for a number of pit alignments dug during this period suggests that there may have been a restructuring of landscape divisions during the Iron Age.

3.5 There is more evidence for settlement in the surrounding area during the Roman period. One of the main arterial Roman roads, Dere Street, lies to the east of the investigation area, with forts situated at regular intervals along its course. Villa complexes discovered in the area attest to a Romanisation of the surrounding landscape. A Roman bath-house discovered at Well, just 0.5km to the north-west, together with a portion of tesselated pavement suggest that a villa complex of fairly high status would have been situated here. A corn-drying oven found just to the south in Nosterfield Quarry further illustrates that this landscape was utilised for agricultural purposes during the Roman period.

3.6 Little evidence is available regarding the post-Roman and early medieval period. The nearby settlement of Well has a church with features dating from the 12th century, and the surrounding land, including the investigation area, is likely to have been agricultural land, either as strip fields or common land. Most of this strip-field farming system would have been lost during the post-medieval period, as more and more land was taken by the Enclosure acts. These enclosed areas have in turn been replaced by more open fields as hedgerows have been removed during the 20th century to facilitate arable farming and larger grazing herds.

4. Landuse, topography and geology

4.1 At the time of survey the study area comprised fields of pasture and young arable crops, as follows:
Area A (17.5ha): arable/rough grassland

Area B (3.2ha): pasture
Area C (1.6ha): pasture
Area D (12.3ha): improved grassland
Area E (7.7ha): pasture
Area F (8.1ha): pasture

4.2 The survey area was predominantly level at a mean elevation of *c*.45m AOD.

4.3 The underlying solid geology of the area comprises Magnesian Limestone, which is overlain by sands, gravels and peat deposits.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage (1995) Research and Professional Services Guideline No.1, *Geophysical survey in archaeological field evaluation*; the Institute of Field Archaeologists (2002) Paper No.6, *The use of geophysical techniques in archaeological evaluations*; and the Archaeology Data Service (2001) *Geophysical Data in Archaeology: A Guide to Good Practice*.

Technique selection

5.2 Geophysical surveying enables the relatively rapid and non-invasive identification of potential archaeological features within landscapes and can involve a variety of complementary techniques such as magnetometry, electrical resistance, ground-penetrating radar and electromagnetic survey. Some techniques are more suitable than others in particular situations, depending on a variety of site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, based on existing aerial photographic cropmark evidence identifying an enclosure in Area A and previous work carried out in and around Nosterfield Quarry, it was considered likely that cut features, such as ditches and pits, would be present on the site, and that other types of feature such as trackways and fired structures (for example kilns and hearths) might also be present.

5.4 Given the anticipated shallowness of the targets and the non-igneous geological environment of the study area a geomagnetic technique, fluxgate gradiometry, was considered appropriate for detecting each of the types of feature mentioned above. This technique has previously been shown to be effective in the general area. The technique involves the use of hand-held magnetometers to detect and record minute perturbations, or ‘anomalies’, in the vertical component (i.e. gradient) of the Earth’s magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect the presence of archaeological features.

5.5 A 1ha sample was also surveyed over the previously identified cropmark in Area A using an earth electrical resistance technique. This technique is particularly well-suited to surveying cropmark sites since the soil properties which give rise to cropmarks/parchmarks (principally contrasts in soil moisture content) are essentially the same as are measured in an electrical resistance survey.

Field methods

5.6 A 30m grid was established across each survey area except Area A, where the resistance equipment necessitated use of a 20m grid. The survey grids were tied-in to known, mapped Ordnance Survey points by On-Site Archaeology using a GPS total survey station instrument and datalogger.

5.7 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad-601 fluxgate gradiometers with automatic datalogging facilities. A zig-zag traverse scheme was employed and data were logged in 30m grid units (20m in Area A). The instrument sensitivity was set to 0.1nT, the sample interval to 0.25m and the traverse interval to 1.0m, thus providing 3600 sample measurements per 30m grid unit, or 1600 measurements per 20m grid unit.

5.8 Measurements of electrical resistance were determined using a Geoscan RM15A resistance meter with automatic logging of the data. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was set to 0.1 ohms, the sample interval to 0.5m and the traverse interval to 1.0m, thus providing 800 sample measurements per 20m grid unit.

5.9 Data were downloaded on-site into laptop computers for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.10 Geoplot v3 and Archeo Surveyor v1 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw data. The greyscale images and interpretations are presented in Figures 2-14; a general location plan is shown in Figure 1; the trace plots are provided in Appendix I. In the greyscale images, positive magnetic and high resistance anomalies are displayed as dark grey and negative magnetic and low resistance anomalies as light grey. A palette bar relates each greyscale intensity to anomaly values in nanoTesla or ohms.

5.11 The following basic processing functions have been applied to the datasets (G denotes their use on gradiometer survey data, R on resistance survey data):

Clip (G) – clips, or limits data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic.

Zero mean traverse (G) – sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities.

Despike (G, R) – locates and suppresses localised spikes in gradiometer data caused by near-surface ferrous litter and poor contact resistance in resistance data.

Interpolate (G, R)– increases the number of data points in a survey; to match sample and traverse intervals and so create a smoother appearance to the data. In this instance the data have been interpolated to 0.5 x 0.25m intervals.

Destagger (G)– corrects for displacement of anomalies recorded along zig-zag traverses.

Add (R)- used in resistance surveys to add a set value to all readings within a defined area; used in this instance to adjust data values acquired when surveying in different weather conditions.

Interpretation: anomaly types

5.12 Colour-coded geophysical interpretation plans are provided for each survey area. Three types of geomagnetic anomaly have been distinguished in the data:

positive magnetic — regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches.

negative magnetic — regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids.

dipolar magnetic — paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths.

Two types of resistance anomaly have been distinguished in the data:

high resistance — regions of anomalously high resistance, which may reflect foundations, tracks, paths and other concentrations of stone or brick rubble.

low resistance — regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches.

Interpretation: features (Figures 2-14)

5.13 Gradiometer surveys were carried out in Areas A, D, E and F. A 2ha survey in Area A was located over a previously recorded cropmark enclosure. Another

2ha survey in Area D was located to determine if any sub-surface features were present, whilst surveys measuring 1ha in Areas E and F were located in an attempt to determine the nature of earthworks observed in these areas. A 1ha electrical resistance survey was also completed in Area A to complement and test the gradiometer survey results in the area of the cropmark.

5.14 Colour-coded archaeological interpretation plans are provided for each survey area.

Area A: *Gradiometer survey* (Figures 2, 4 & 5)

5.15 The gradiometer survey over this area detected modern and landscape features but only scant evidence for the cropmark identified by aerial photography. Two weak linear positive magnetic anomalies aligned broadly east-west in the eastern part of the area, within an area of possible peat deposits, reflect soil-filled features, possibly ditches associated with the cropmark enclosure.

5.16 In the south-western corner of the survey area, a chain of small dipolar magnetic anomalies marks the boundary between a ploughed area and an area of rough grassland. Immediately to the south of this boundary closely spaced weak positive and negative linear magnetic anomalies reflect the modern plough regime, orientated north-west/south-east.

5.17 A strong positive linear magnetic anomaly aligned north-east/south-west traversing the area of rough grassland corresponds to a cropmark of darker grass observed during the survey, and almost certainly reflects the location of a grubbed-out field boundary. A weak linear positive magnetic anomaly to the west on a parallel alignment also reflects a soil-filled feature, and may represent a field drain or other field boundary.

5.18 A change in the background magnetic texture in the northern part of the survey corresponds to a change in surface vegetation observed during the survey, possibly relating to the presence of underlying peat deposits.

5.19 The only other anomalies detected here are small, discrete dipolar magnetic anomalies. These almost certainly reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments. A sample of these is highlighted in Figure 4.

Area A: *Resistance survey* (Figures 3-5)

5.20 The location of the 1ha resistance survey was to be informed by the results of the gradiometer survey, and was to elaborate on any features of interest detected inside or outside the enclosure. In the light of the gradiometer results, the survey was located based on the aerial photographic evidence.

5.21 The resistance technique successfully detected a complex of linear and curvilinear features, including possible discrete features, the majority of which were not detected by the gradiometer survey. It seems that although the soil conditions were suitable for distinguishing a crop/parchmark from the air, there was insufficient magnetic susceptibility contrast between the fill of the ditches and the surrounding subsoil. The lack of magnetically-susceptible material in the fill of the enclosure ditch could indicate that it may have been back-filled with the same material shortly after excavation, or that the enclosure was not directly associated with stock or human occupation, **or indeed that the features were formed by natural processes**.

5.22 In the resistance survey the features detected are set against a background of varying resistance, reflecting broad variations in moisture content and pore volume of the underlying geology. Whilst not having any archaeological significance *per se*, it is possible that these fluctuations mask archaeological features, as well as denoting areas of better/poorer drainage, which may in turn have influenced the situation of any features present.

5.23 A linear low resistance anomaly aligned north-east/south-west in the north-western corner of the survey corresponds to the location of the possible field boundary noted on the ground and identified in the gradiometer survey. This anomaly cuts across the eastern end of the complex of rectilinear and curvilinear low resistance anomalies, part of which corresponds to the cropmark identified by aerial photography. These anomalies arise from soil-filled features and appear to form part of a multi-phase system of ditched enclosures, possibly of late prehistoric/Romano-British date. A series of discrete low resistance anomalies detected within the probable enclosures may reflect soil-filled features such as pits. **Subsequent trial trench evaluation by On-Site Archaeology has indicated that the features were created by natural processes (ice wedges).**

Area D (Figures 6-8)

5.24 Three evenly spaced linear dipolar magnetic anomalies orientated north-east/south-west in the southern half of the survey area are likely to reflect land drains, as informed by the farmer. These anomalies start where the land begins to slope away to the south towards an area of peat deposits. The break of slope seems to be demarcated by a change and increase in noise in the magnetic background visible on the greyscale image (Figure 6).

5.25 The only other anomalies detected are small dipolar magnetic anomalies reflecting soil litter in the form of fired/ferrous debris. A sample of these is highlighted in the geophysical interpretation.

Area E (Figures 9-11)

5.26 An irregular linear positive magnetic anomaly traversing the survey area orientated north-west/south-east corresponds to a ditch visible on the ground. This feature is likely to represent a grubbed out field boundary. Further linear positive magnetic anomalies leading off this anomaly to the north and south are also likely to represent former field boundaries.

5.27 To the north of this irregular anomaly are a series of weak linear positive magnetic anomalies, orientated broadly north-south. These may reflect the remains of ridge and furrow.

5.28 The irregular anomaly seems to end in an area showing a concentration of small dipolar magnetic anomalies; anomalies such as this are often indicative of disturbed ground. Close to the eastern terminus of the irregular anomaly, a relict tree-line still stands, orientated north-south.

5.29 A linear positive magnetic anomaly orientated north-south to the west of the tree-line reflects a soil-filled feature. Traces of a ditch running alongside the tree-line still exist as a shallow earthwork.

5.30 To the east and west of the ditch and tree-line a series of weak positive and negative magnetic anomalies orientated north-south are likely to reflect ridge and furrow remains.

5.31 A region of diffuse positive and negative magnetic anomalies in the south-western corner of the survey area are likely to reflect subsurface geological variation.

Area F (Figures 12-14)

5.32 A broad, weakly negative magnetic linear anomaly, flanked by two positive magnetic anomalies, which was detected traversing the survey area aligned east-west, corresponds to an earthwork visible on the ground similar in form to a hollow-way or trackway. A linear positive magnetic anomaly heading south from the track probably represents a former boundary ditch. Weak positive and negative linear magnetic anomalies on the same alignment may reflect traces of ridge and furrow cultivation.

5.33 Two weak linear positive magnetic anomalies to the north of the track reflect soil-filled features, possibly ditch remains or ridge and furrow.

6. Conclusions

6.1 Geophysical surveys have been carried out on land to the north of Nosterfield Quarry, Nosterfield, North Yorkshire.

6.2 Upon completion of the resistance survey it appeared that the technique had been particularly effective and had recorded evidence for a multi-phase system of ditched enclosures and associated features. Two trial trenches were subsequently excavated by On-Site Archaeology across two of these features. The excavators have interpreted the features as being the result of natural processes (ice wedges).

6.3 Gradiometer surveys over the same area did not detect most of these features. Although the soil moisture conditions were suitable for distinguishing a crop/parchmark from the air, and by electrical resistance survey, there was insufficient magnetic susceptibility contrast for the gradiometers between the fill of the features and the surrounding subsoil.

6.4 Surveys in the other areas found evidence for later field systems (probably post-medieval), including ridge and furrow and old field boundaries.

7. References

Archaeology Data Service (2001) *Geophysical Data in Archaeology: A Guide to Good Practice*. Arts and Humanities Data Service.

English Heritage (1995) Research and Professional Services Guideline No.1, *Geophysical survey in archaeological field evaluation*. London.

Institute of Field Archaeologists (1991) Technical Paper No.9, *The use of geophysical techniques in archaeological evaluations*. Birmingham.

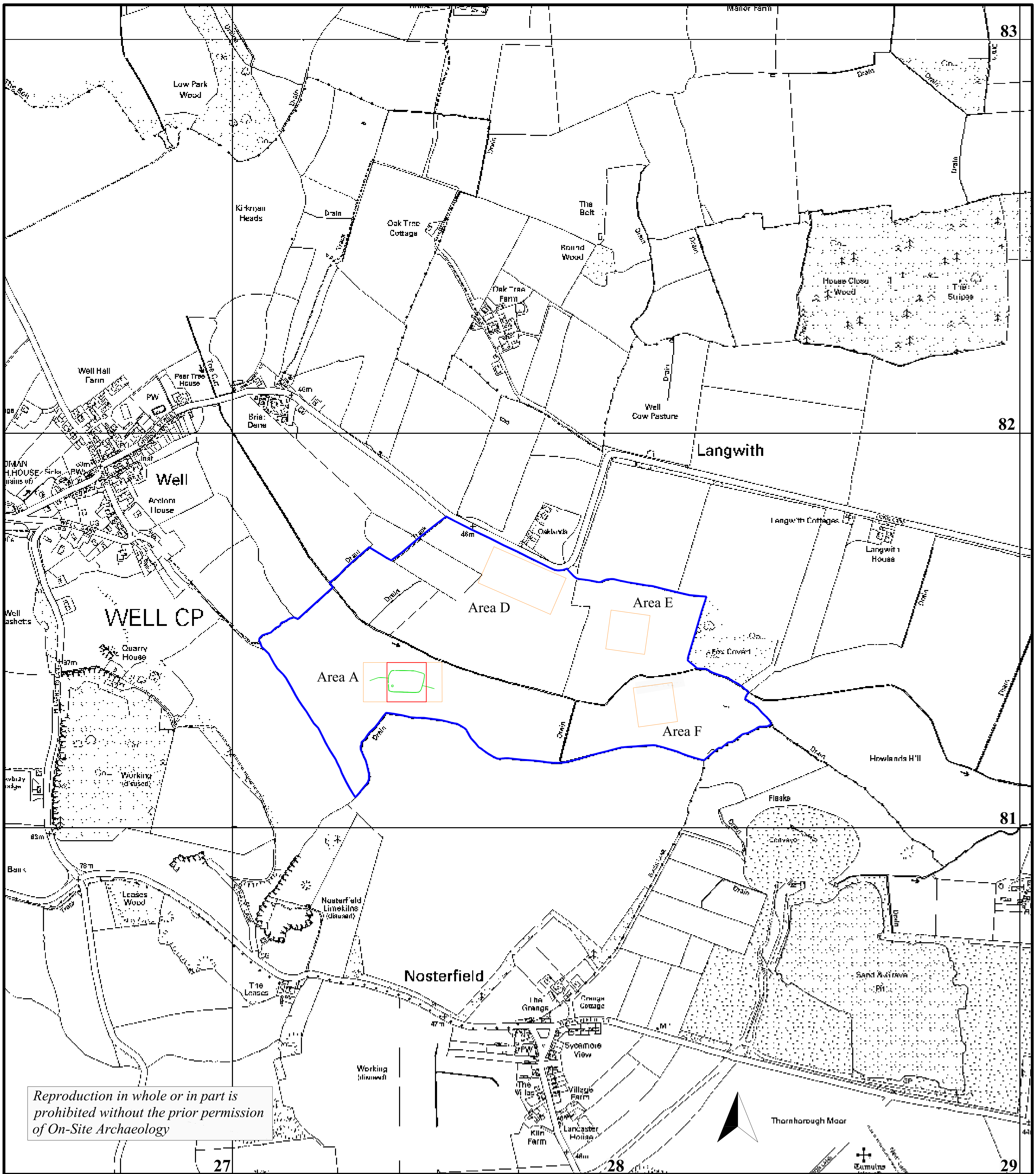

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Figure 1

Location map

on behalf of

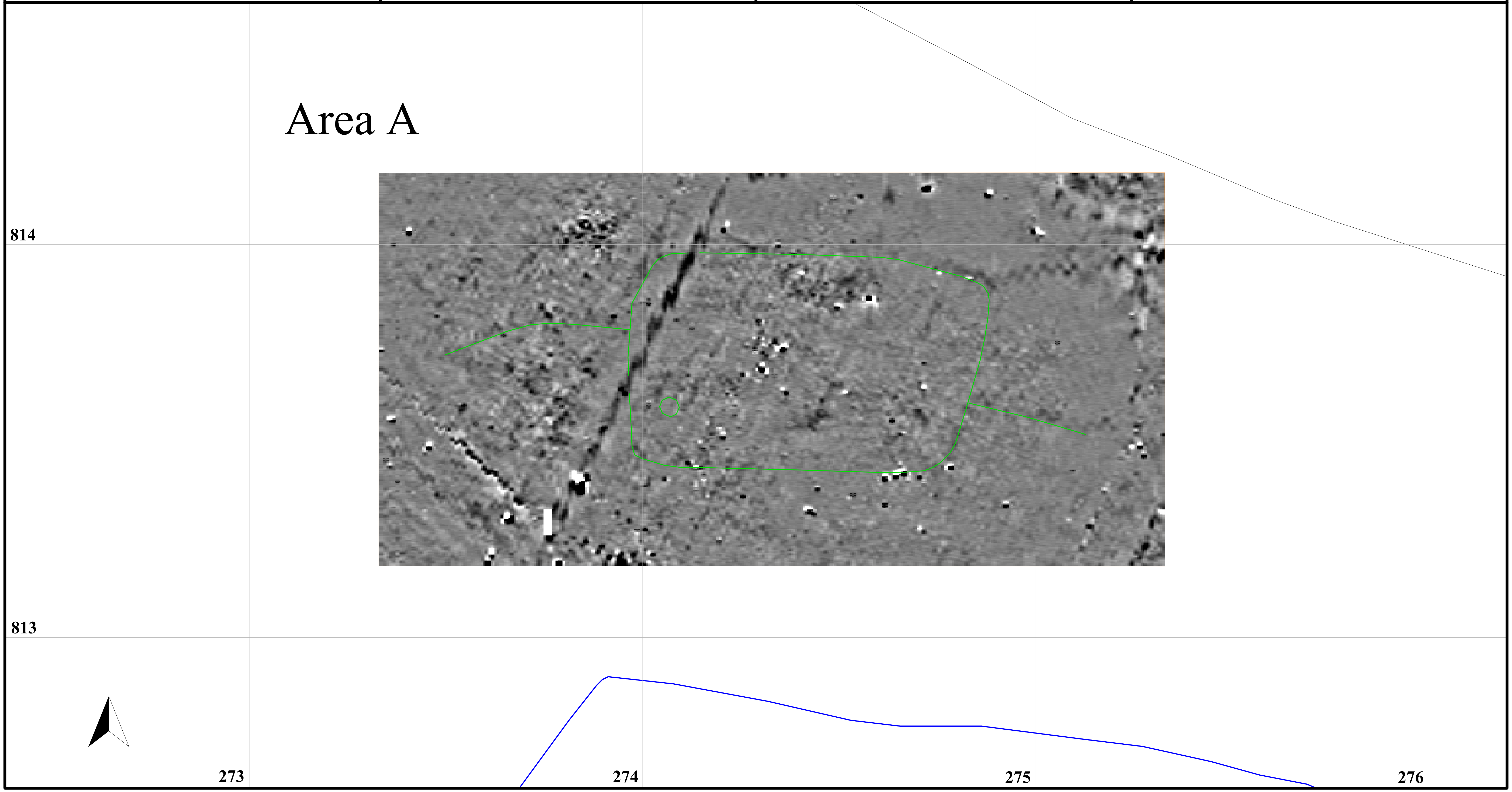
On-Site Archaeology

0 500m

scale 1:10 000 - for A3 plot

blue line	area of interest
orange line	magnetic survey outline
red line	resistance survey outline
green line	crop marks from aerial photographs

Archaeological Services University of Durham	on behalf of **On-Site Archaeology** 0 50m *scale 1:1000 - for A3 plot*	5.00 4.17 3.33 2.50 1.67 0.83 0 -0.83 -1.67 -2.50 -3.33 -4.17 -5.00 nT crop marks from aerial photographs area of interest field boundary	**Oaklands, Nosterfield, North Yorkshire geophysical surveys** **ASUD Report 1273** Figure 2 *Area A geomagnetic survey*



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0 50m
scale 1:1000 - for A3 plot

95.44
89.66
83.89
78.12
72.35
66.57
60.80
55.03
49.48
43.48
37.71
31.94
26.17 ohm

crop marks from aerial photographs
area of interest
field boundary

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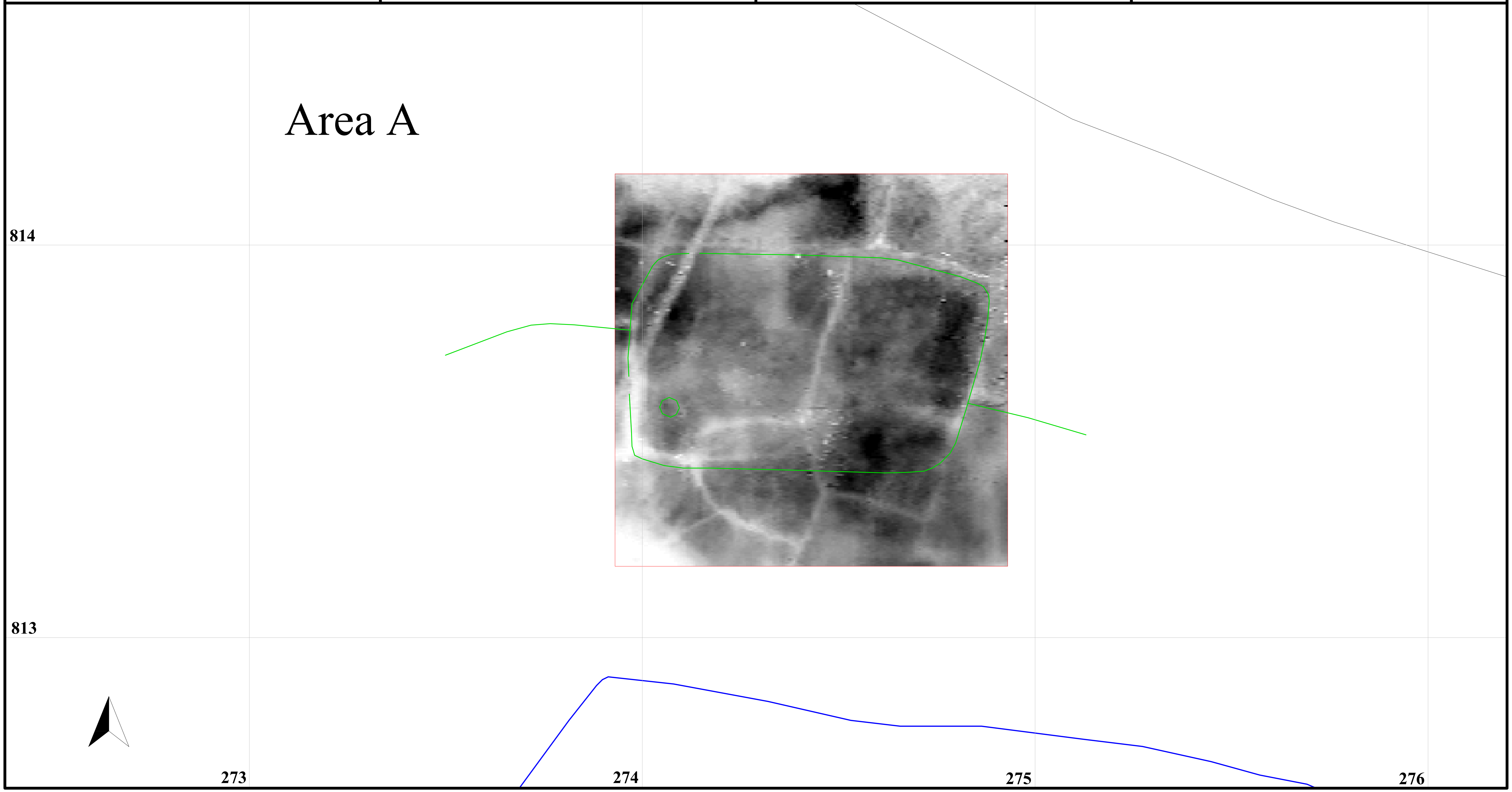
Figure 3

Area A resistance survey



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0 50m
scale 1:1000 - for A3 plot

- outline of magnetic survey area
- outline of resistance survey area
- positive magnetic anomalies
- dipolar magnetic anomalies
- low resistance anomalies
- region of uniform magnetisation

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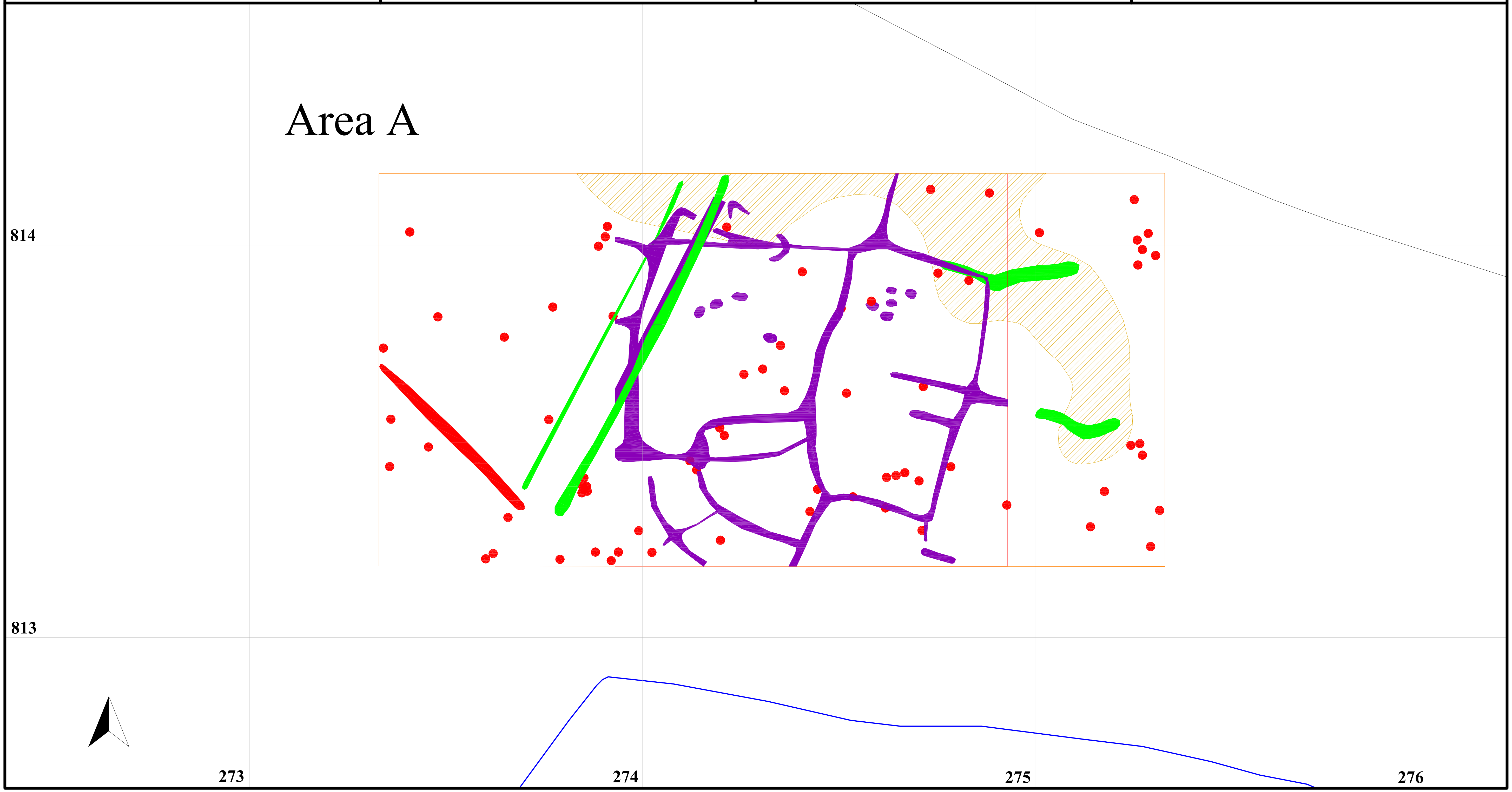
Figure 4

Area A geophysical interpretation



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0 50m
scale 1:1000 - for A3 plot

outline of magnetic survey area
outline of resistance survey area
system of ditches
possible pits
other soil-filled features
possible peat deposits

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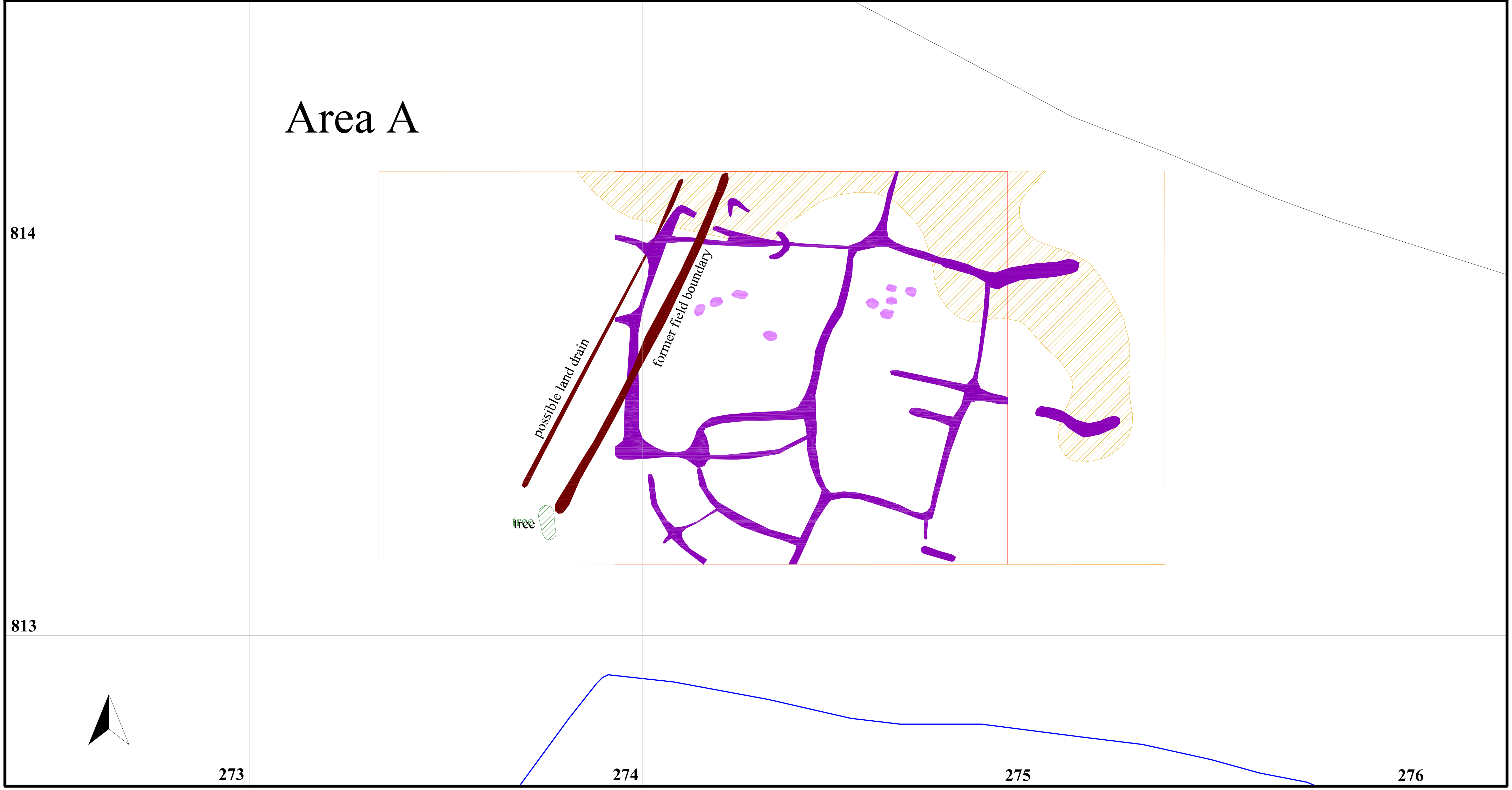
Figure 5

Area A archaeological interpretation



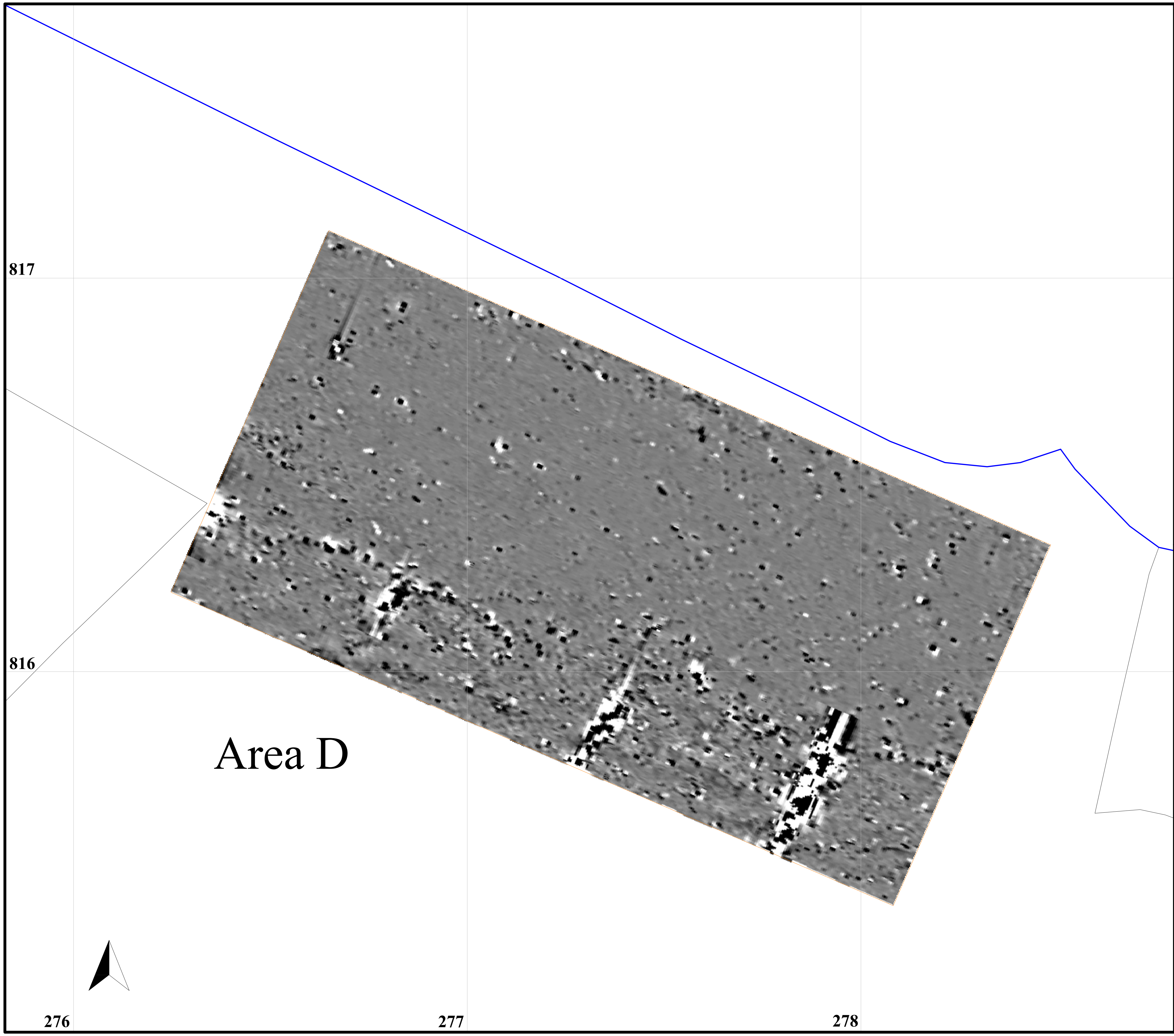


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Figure 6

Area D geomagnetic survey

on behalf of
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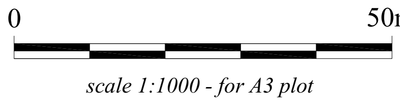

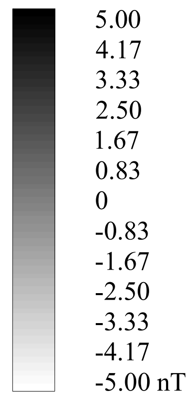

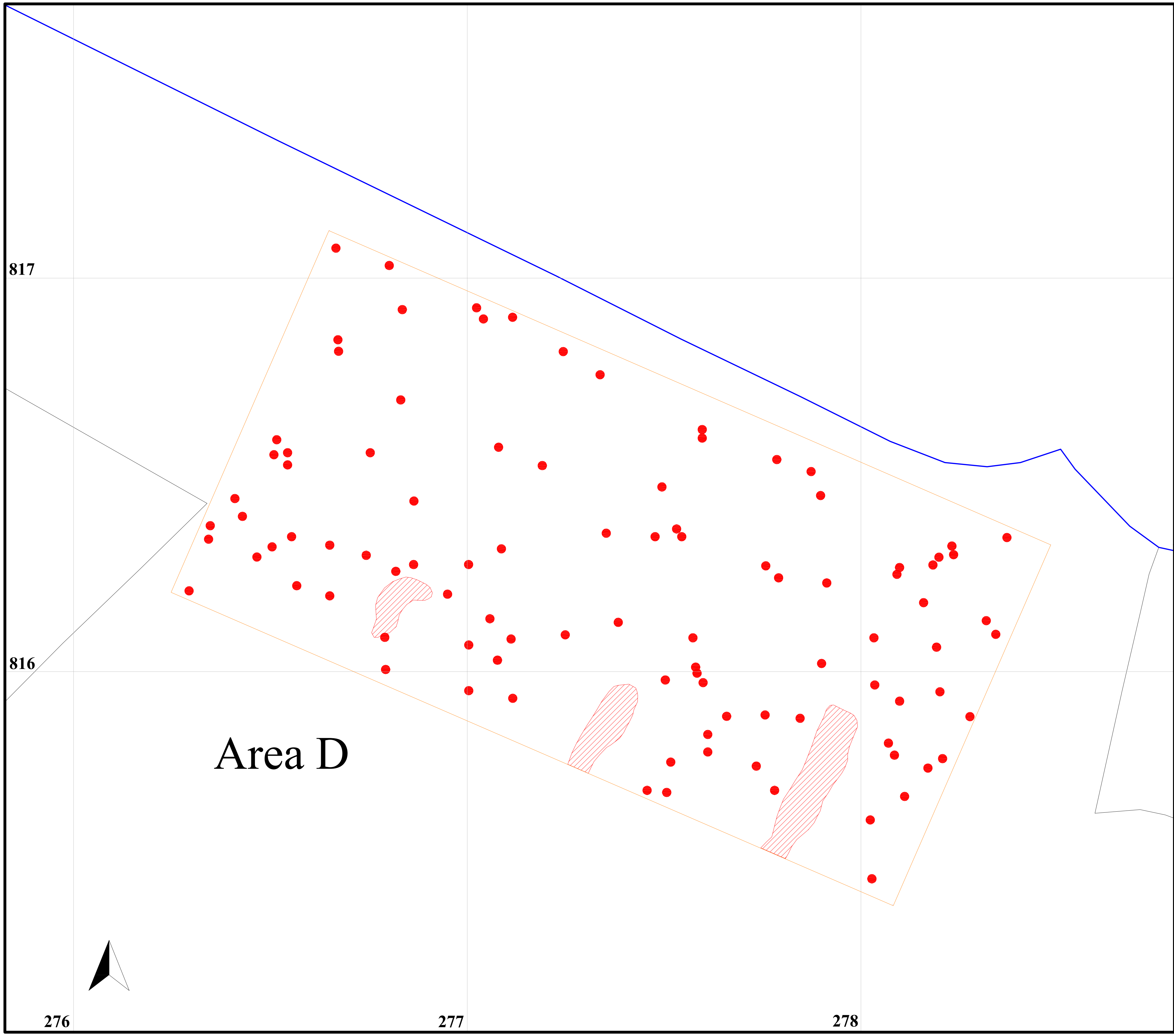

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Figure 7

Area D geophysical interpretation

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0 50m

scale 1:1000 - for A3 plot

outline of survey area

dipolar magnetic anomalies

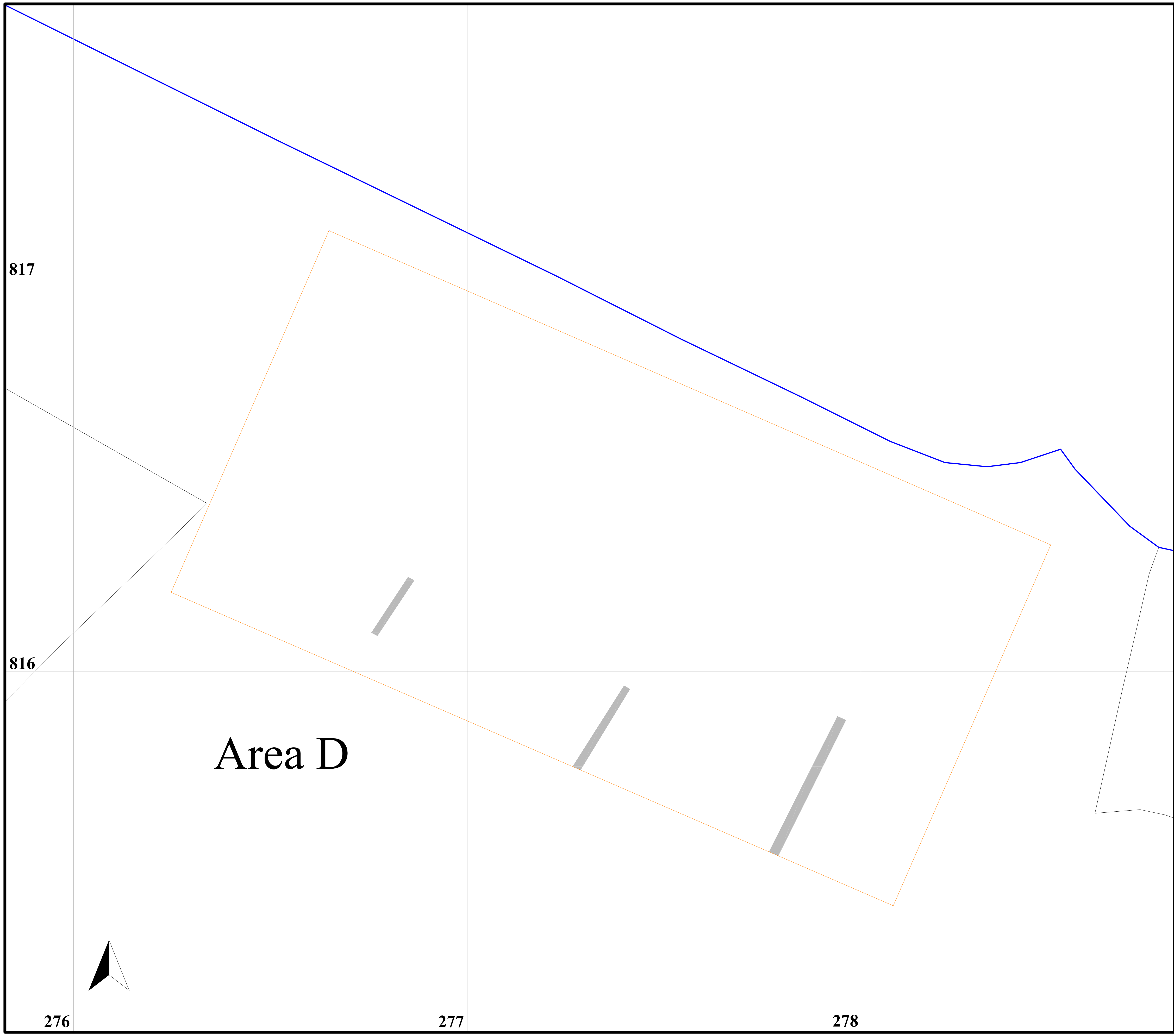

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Figure 8

Area D archaeological interpretation

on behalf of
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0 50m
scale 1:1000 - for A3 plot

outline of survey area

possible land drains

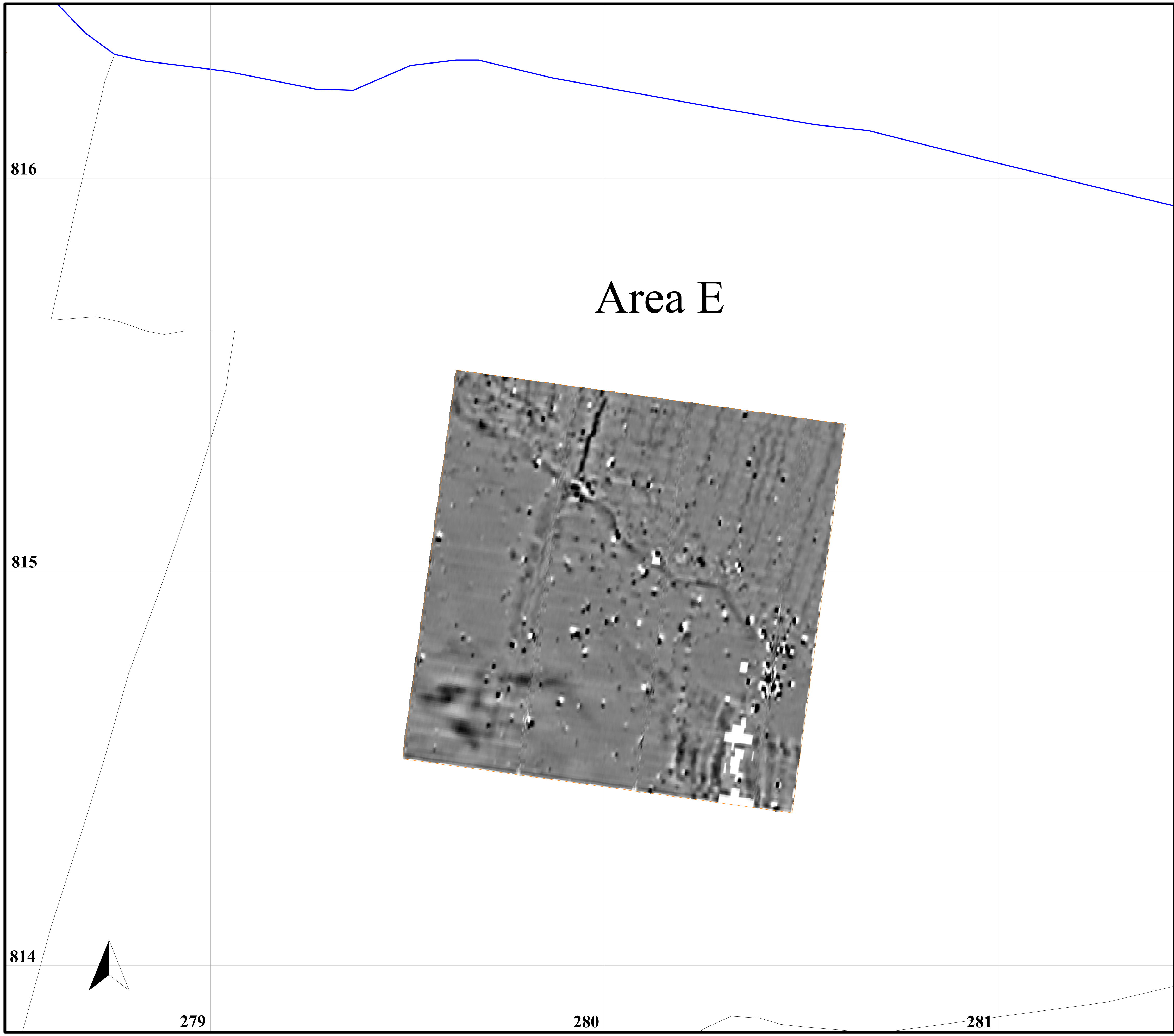

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Figure 9

Area E geomagnetic survey

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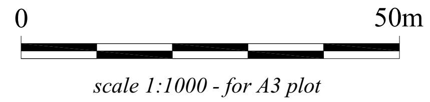

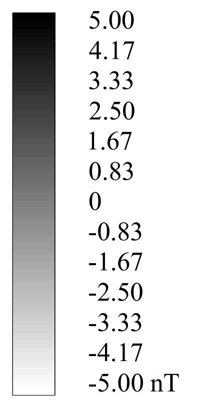

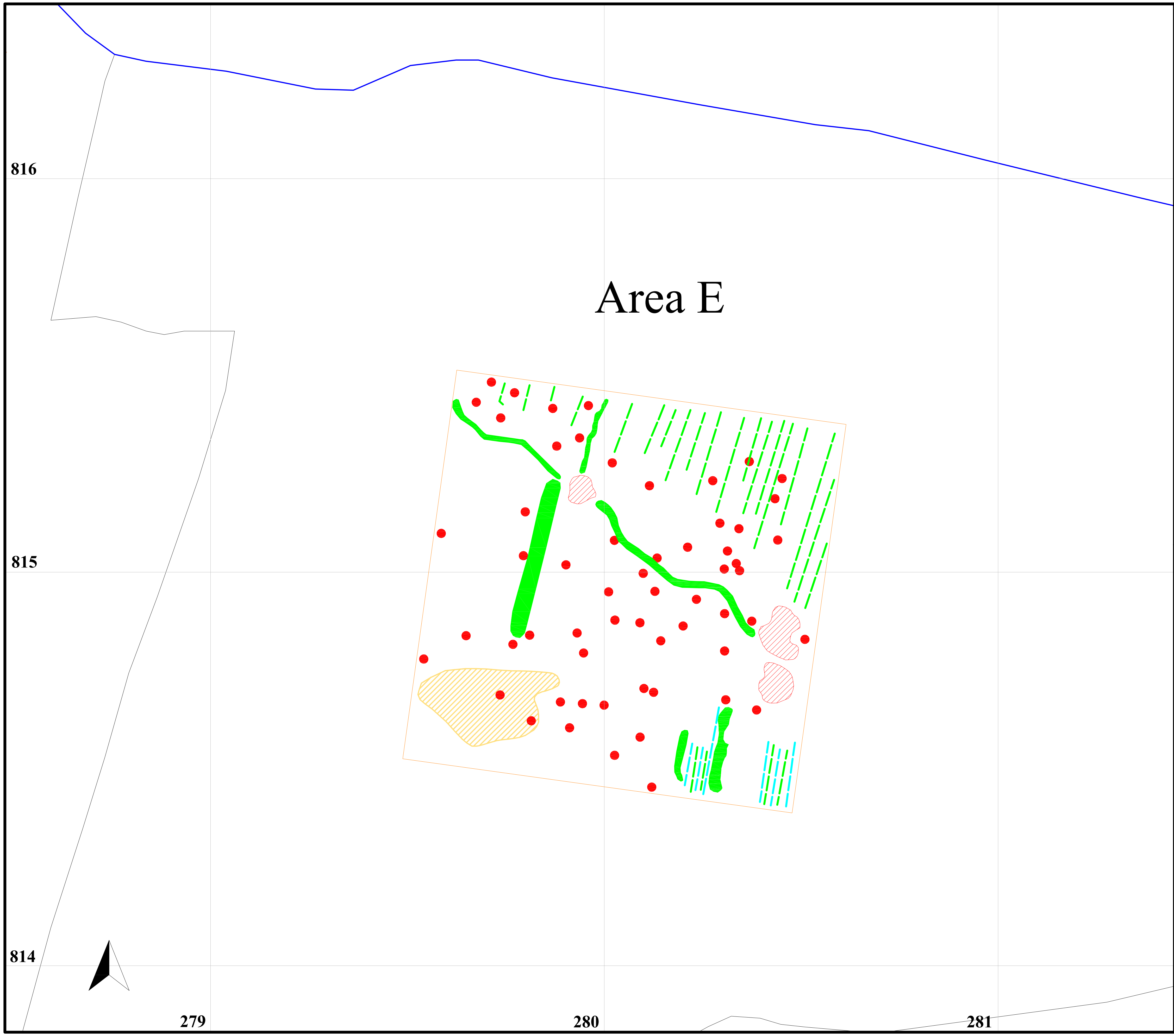

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Figure 10

Area E geophysical interpretation

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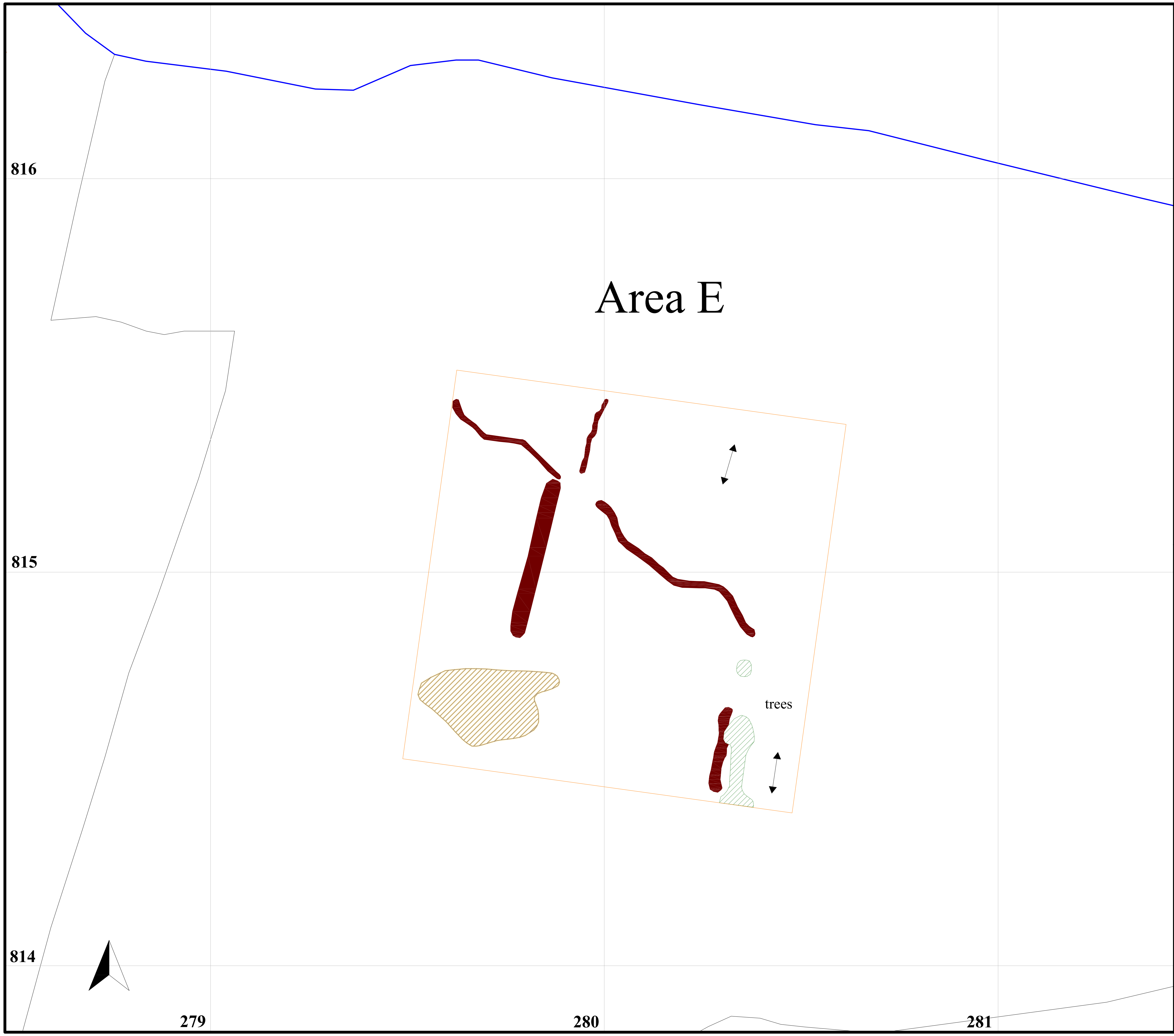

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Figure 11

Area E archaeological interpretation

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0 50m

scale 1:1000 - for A3 plot

outline of survey area
soil-filled features
?underlying geology
trees
orientation of ridge and furrow

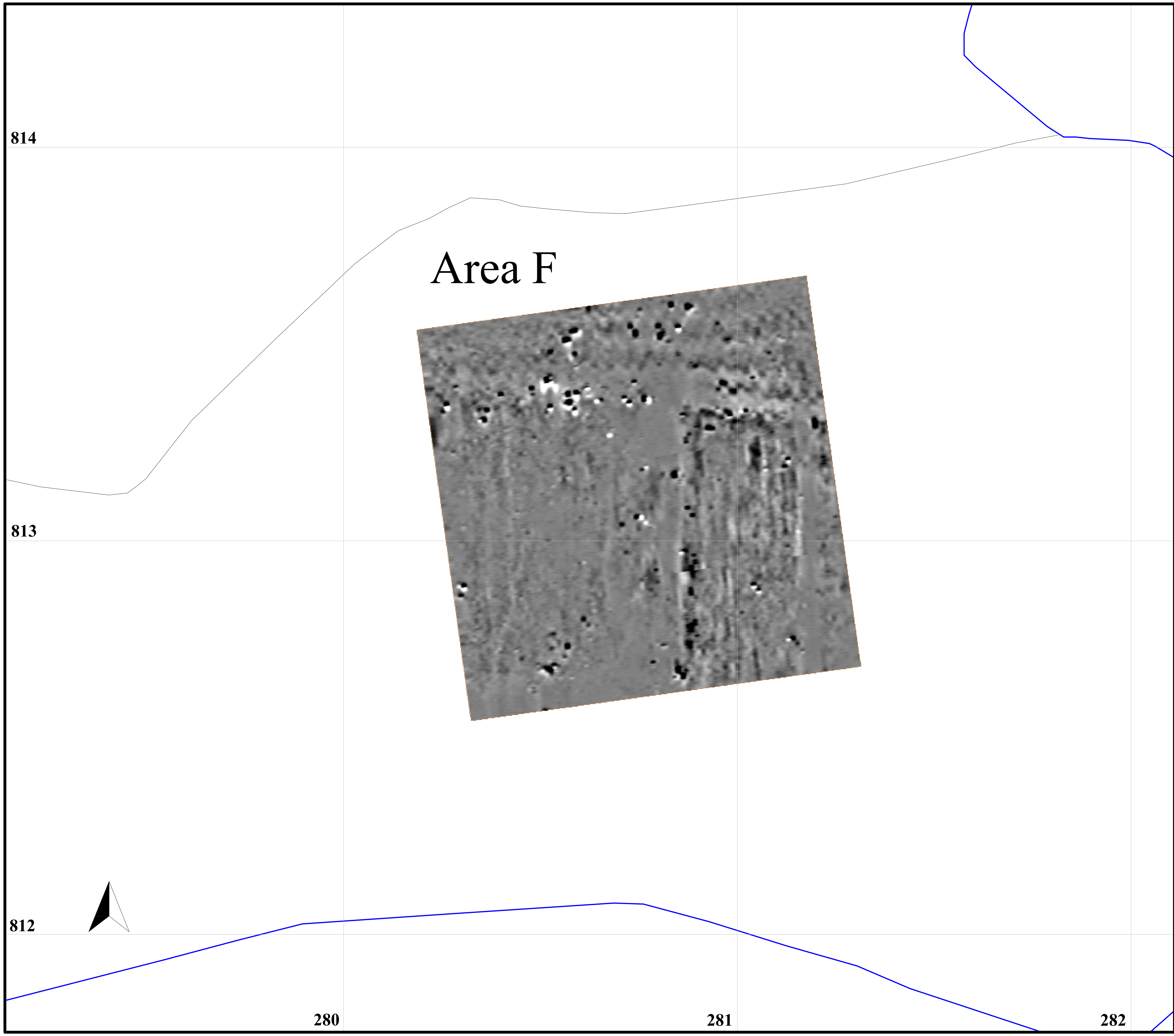

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Figure 12

Area F geomagnetic survey

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0 50m

scale 1:1000 - for A3 plot

5.00
4.17
3.33
2.50
1.67
0.83
0
-0.83
-1.67
-2.50
-3.33
-4.17
-5.00 nT

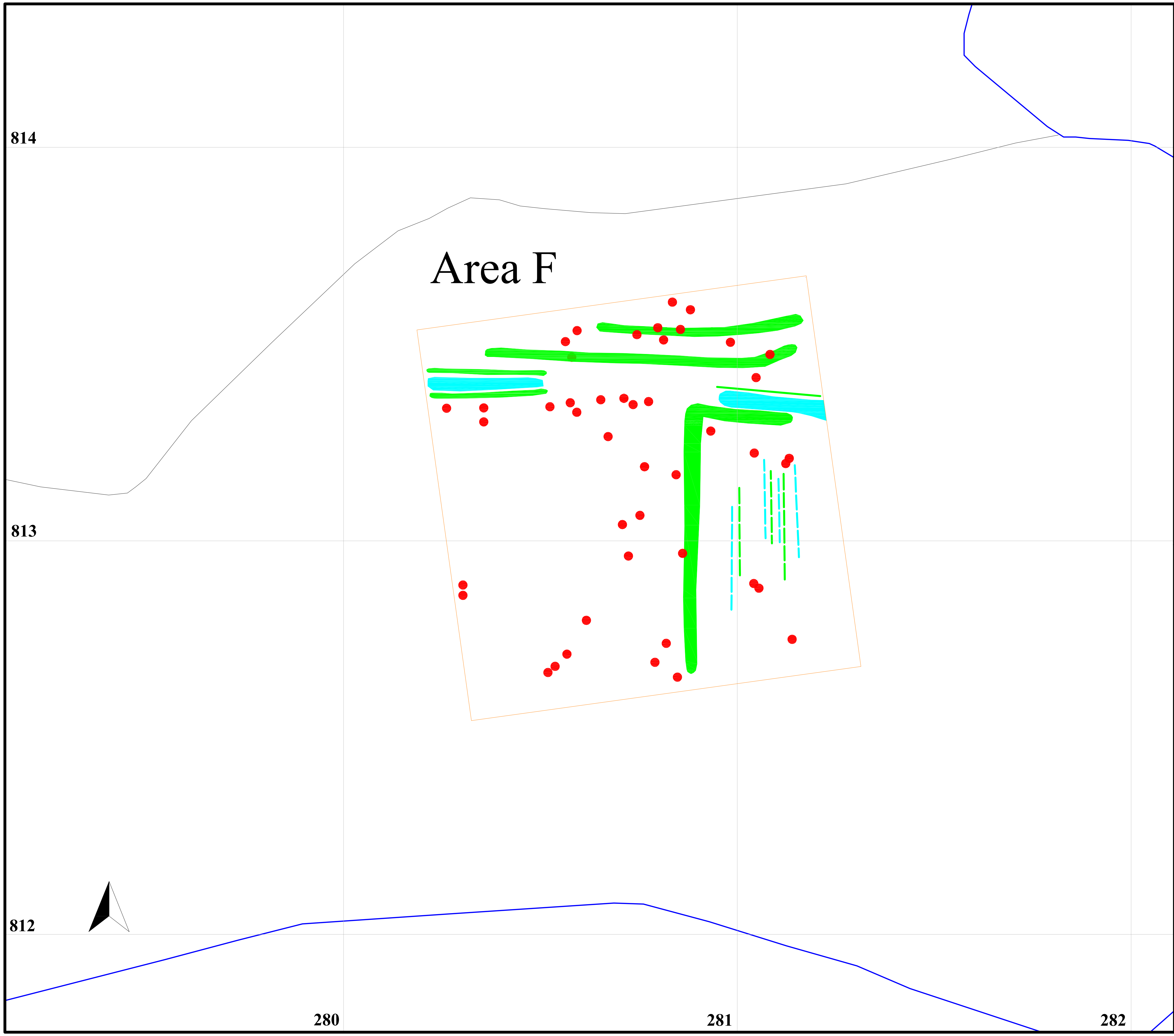

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Figure 13

Area F geophysical interpretation

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0 50m

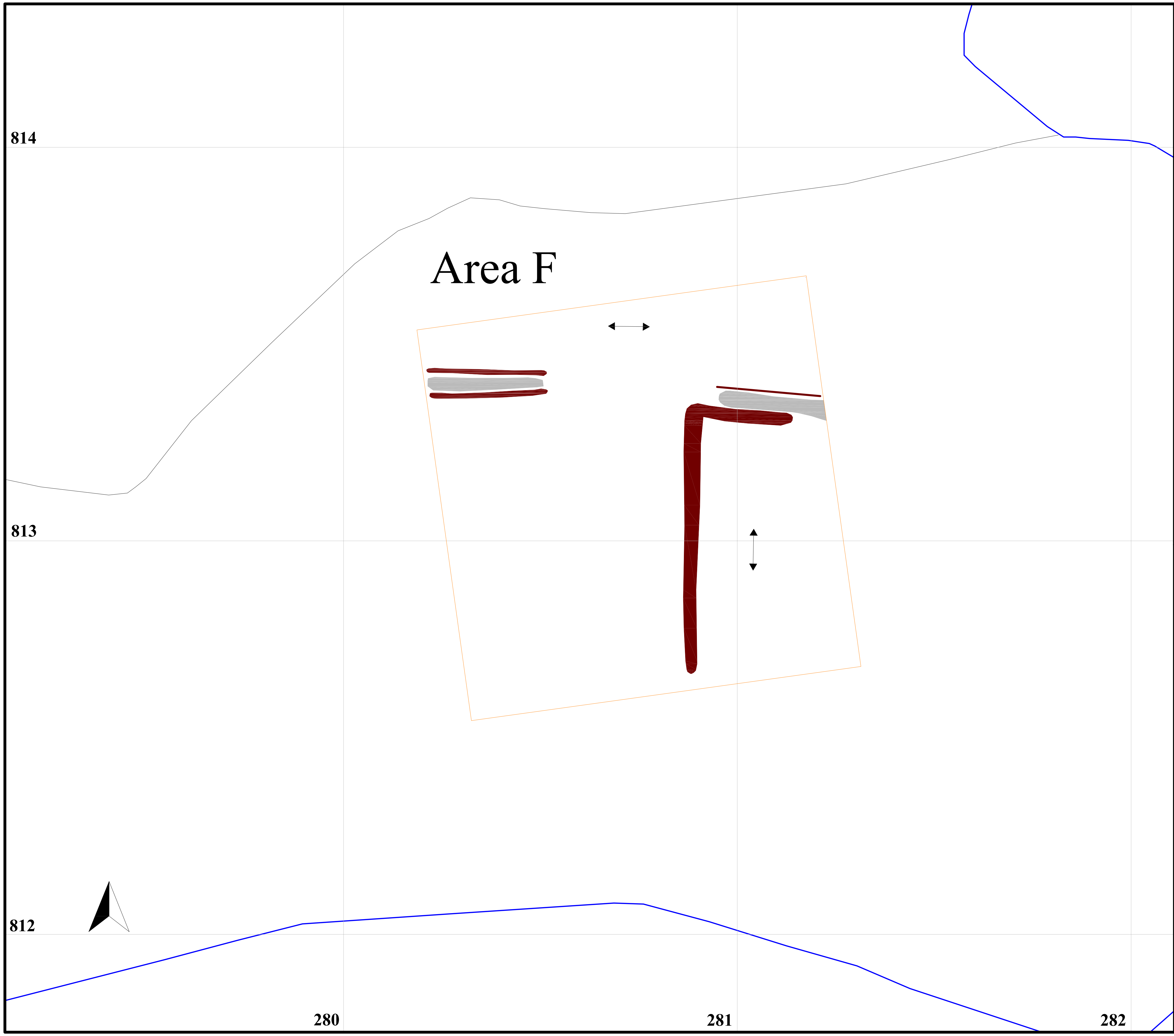
scale 1:1000 - for A3 plot

outline of survey area

positive magnetic anomalies

negative magnetic anomalies

dipolar magnetic anomalies



Archaeological Services University of Durham

Oaklands, Nosterfield, North Yorkshire geophysical surveys

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Figure 14

Area F archaeological interpretation

on behalf of
On-Site Archaeology

0 50m
scale 1:1000 - for A3 plot

outline of survey area

ditch

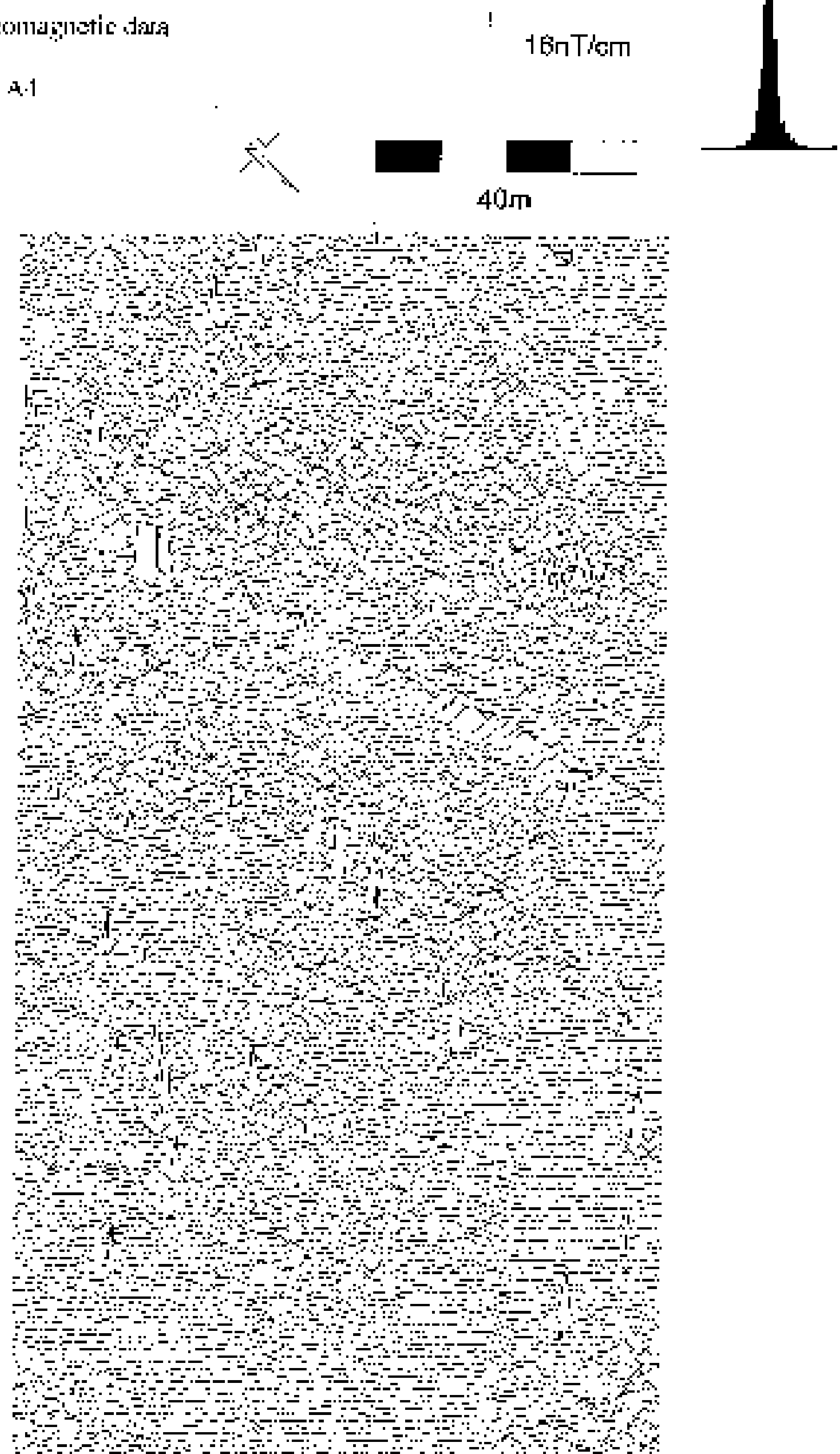
hollow way

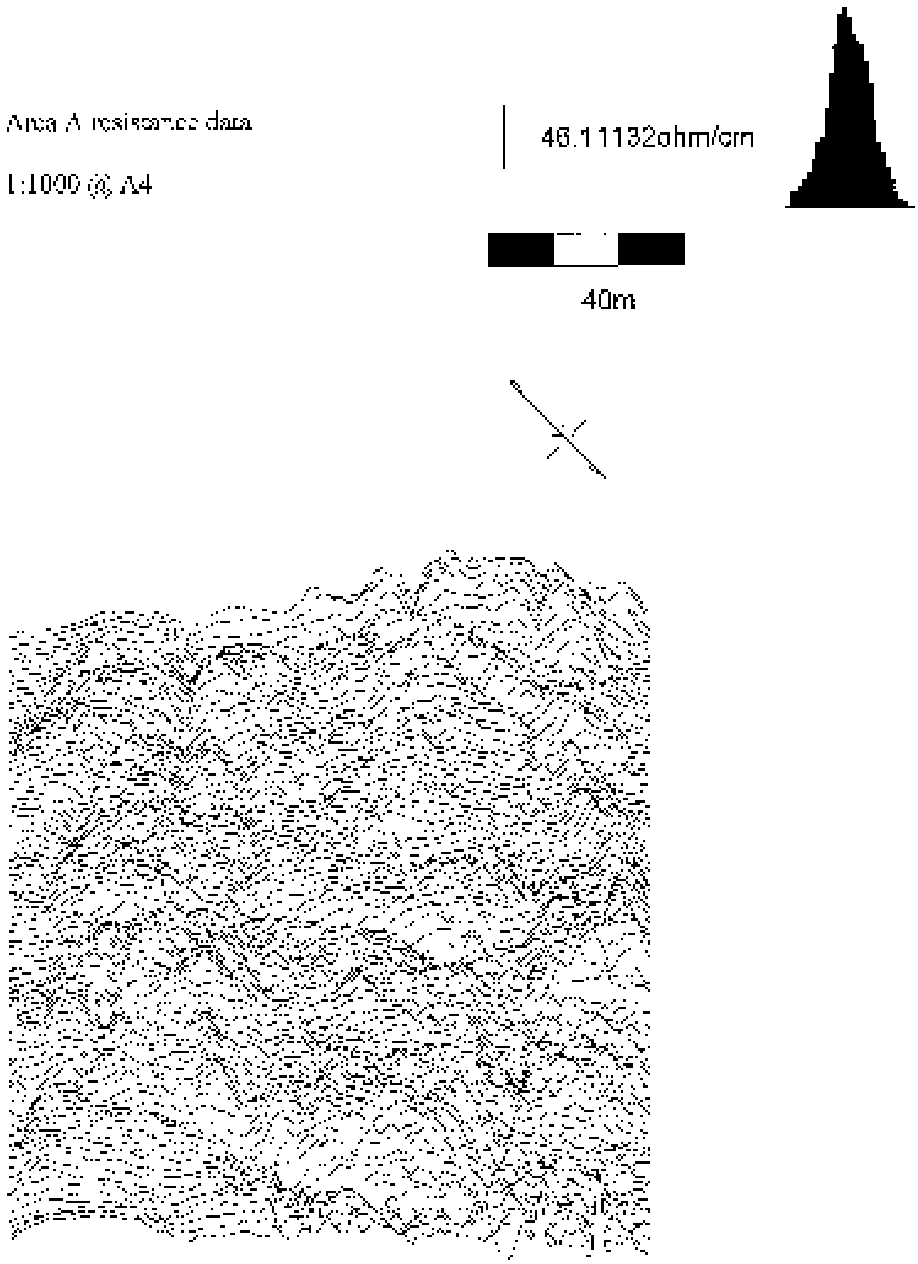
orientation of ?ridge and furrow

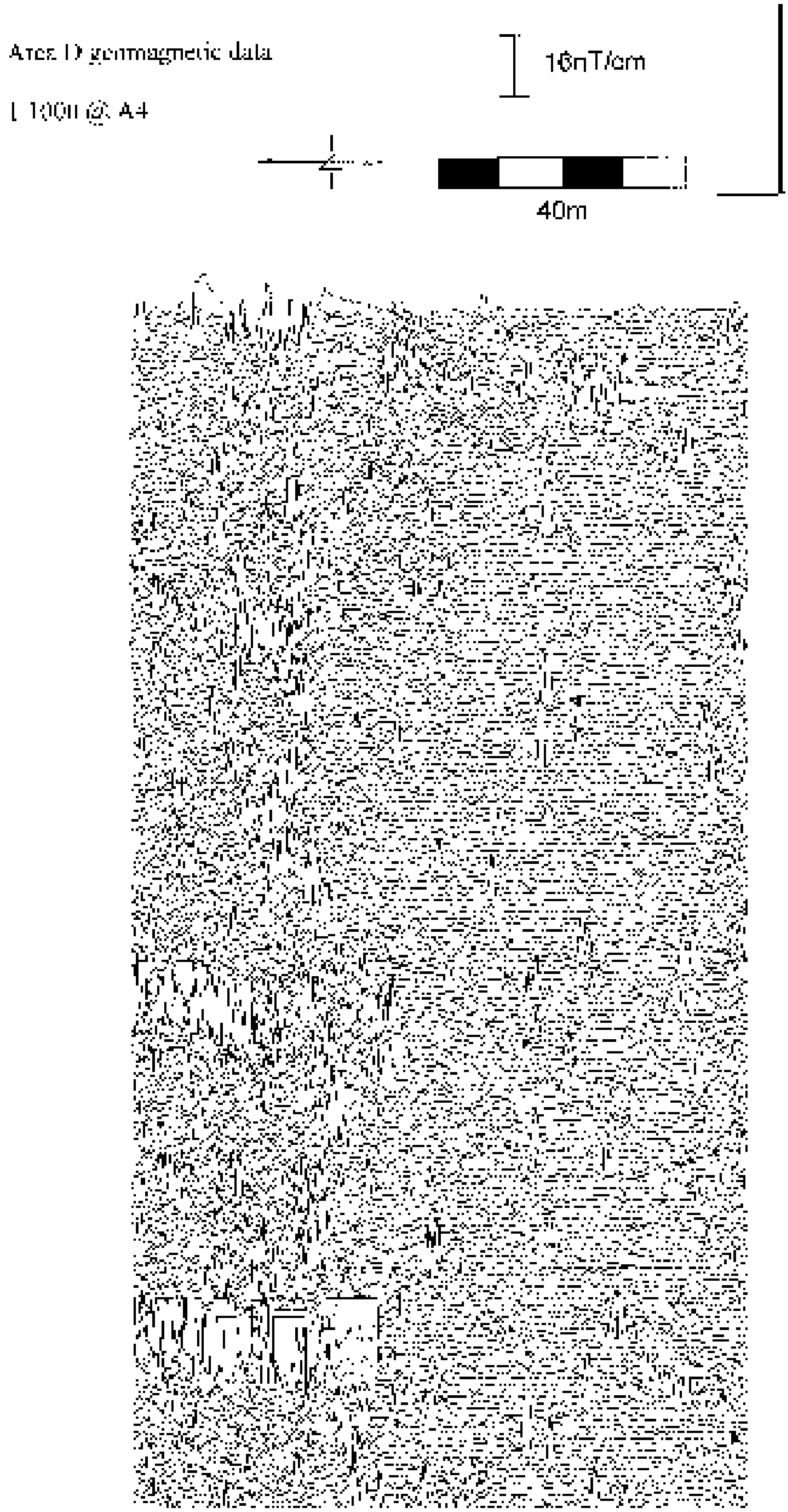
Appendix I: trace plots of geophysical data

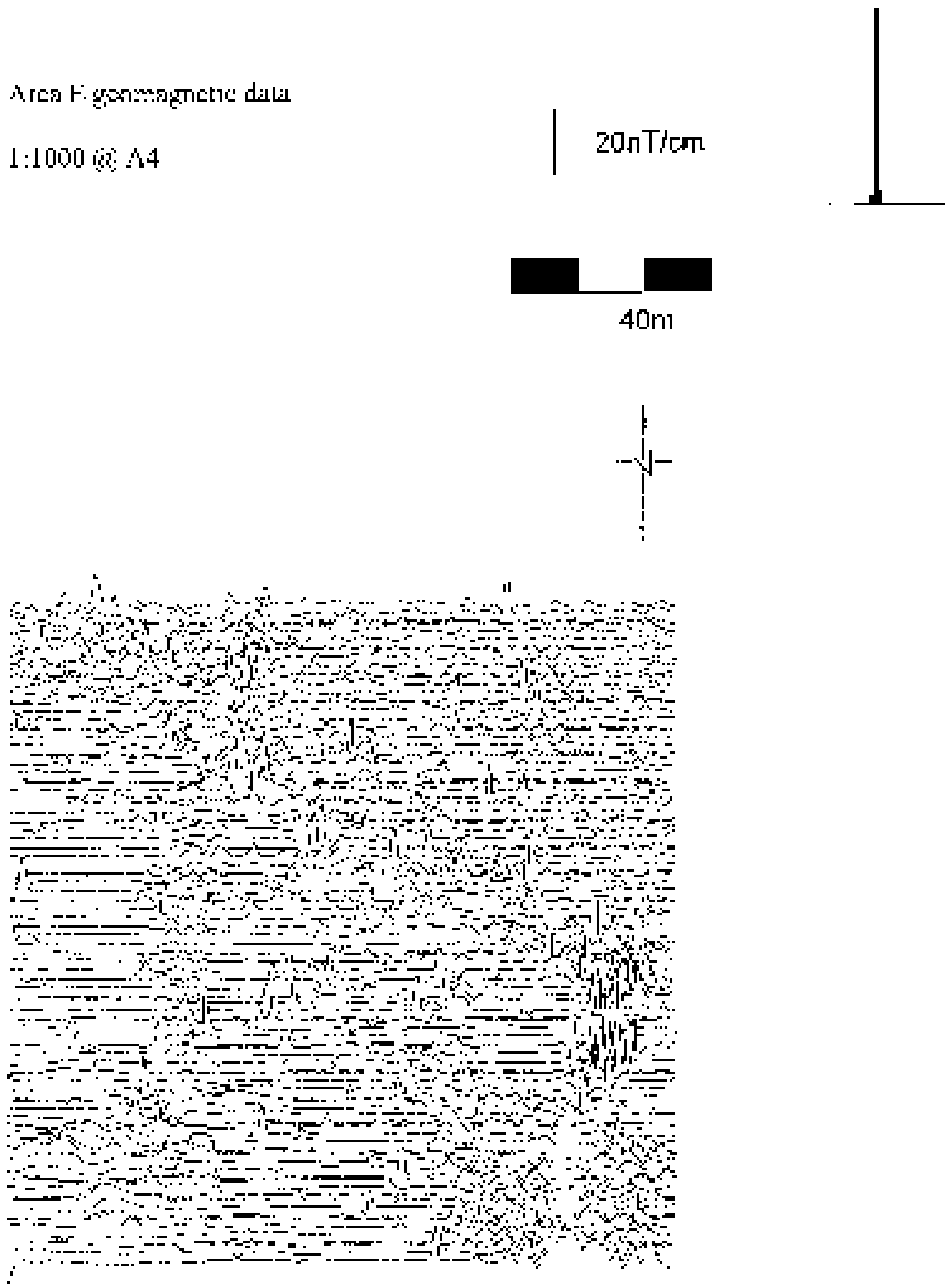
Area A geomagnetic data

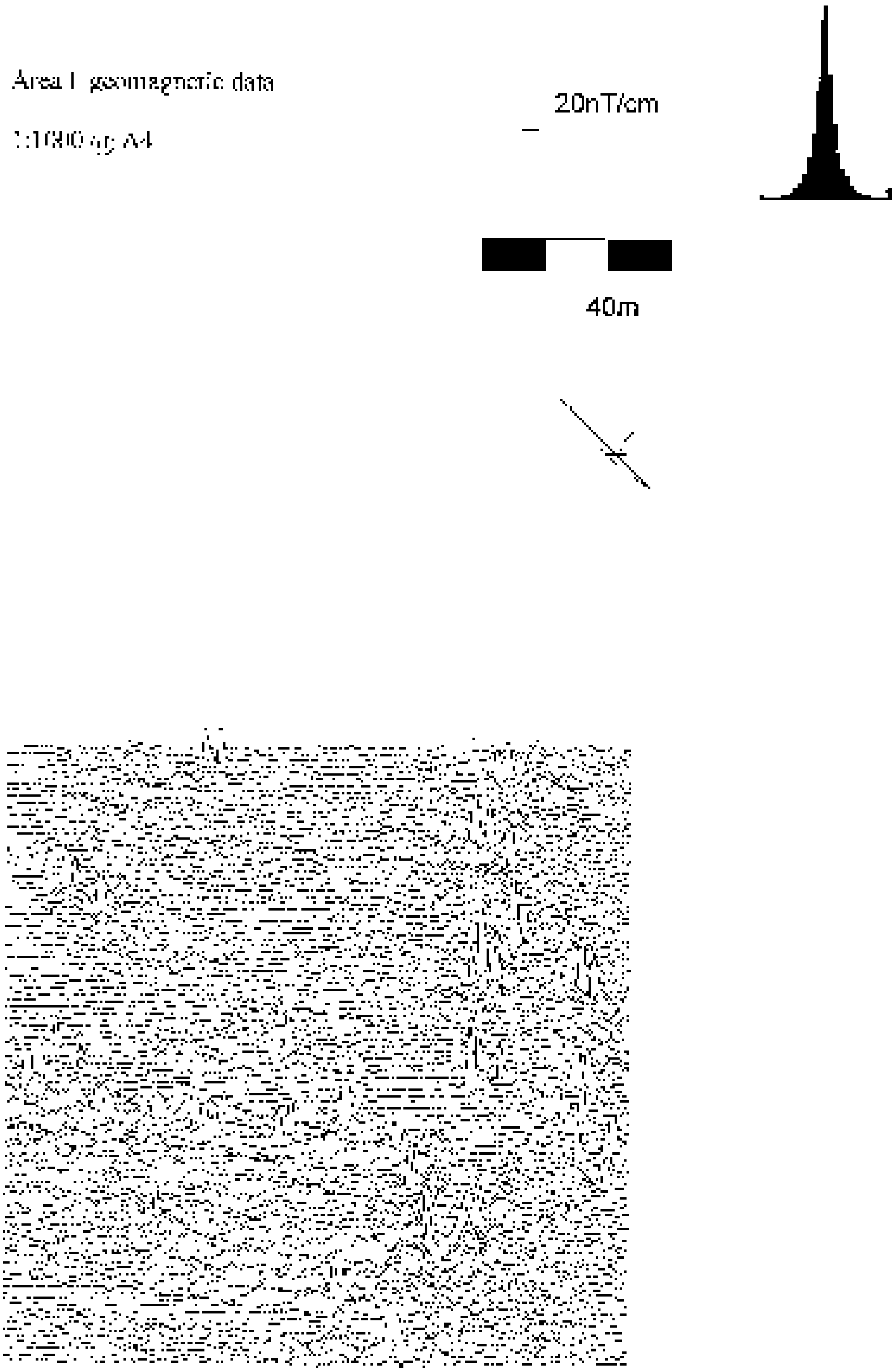
1:1000 @ A4




Area A resistance data
1:1000 @ A4
46.11132ohm/cm
40m


Area D geomagnetic data
10nT/cm
40m


Area F geomagnetic data
1:1000 @ A4
20nT/cm
40m


Area 1 geomagnetic data
20nT/cm
40m