LEA COTTAGE FARM, TISSINGTON DERBYSHIRE

Report on geophysical survey conducted in June 2015

Prepared by P. Johnson

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SUMMARY

- Trent & Peak Archaeology was commissioned by Bowler Energy, to conduct a geophysical survey on land at Lea Cottage Farm, Tissington, Derbyshire, centred on NGR SK 19304 51935 at a height of c. 215m OD (Fig. 1).

- The work was carried out on the 11th June in accordance with standard, accepted practices for archaeological geophysical surveys (EH 2008).

- The site is situated on deposits of the Widmerpool Formation, with superficial Till.

- The site was composed of a single area within the field immediately to the west of Lea Cottage Farm, Tissington, Derbyshire.

- Ground conditions for the survey were generally satisfactory, the land had been in use as pasture but had become overgrown prior to the survey.

- Geophysical survey demonstrated the presence of potential buried archaeological features, these comprised:

    - Probable archaeological features indicating past agricultural activities, possible ridge/furrow, ([7], [8], [9]); ([17], [19], [21], [22], [28], [30], [31], [32], [34]); ([36], [38], [39], [41]).
    - Possible boundary/enclosure ditches [57], [56], [55].
    - Possible pits or post-holes [44], [61].

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NGR SK 19304 51935

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ACKNOWLEDGEMENTS

The Project Manager for the work undertaken was Paul Johnson. The Project advisor was Lee Elliott. The Project Team comprised Tom Hooley and Povilas Cepauskas.

1. INTRODUCTION

1.1. Trent & Peak Archaeology was commissioned by Bowler Energy, to conduct a geophysical survey on land at Lea Cottage Farm, Tissington, Derbyshire, centred on NGR SK 19287 51938 at a height of c. 215m OD (Fig. 1).

1.2. The fieldwork was conducted in June of 2015 on an approximately 1.5 hectare area of land to the west of Lea Cottage Farm, Tissington, Derbyshire.

1.3. The site is located on deposits of Widmerpool Formation; Sedimentary Bedrock formed approximately 326–335 million years ago in the Carboniferous period. Superficial deposits of Till, formed up to 2 million years ago in the Quarternary period, are recorded overlying the bedrock (British Geological Survey).

1.4. Topographically the site lays immediately to the west of Lea Cottage Farm. The site is bounded by agricultural fencing and comprised of land currently used for pasture, although the area was overgrown at time of survey. The site displays notable topographical variation, sloping upwards by c. 10m from east to west.

1.5. Archaeological remains are known within the site of the survey, and the area of survey is adjacent to the Scheduled Ancient Monument of Lee by Bradburne Deserted Mediaeval Settlement (RSM 29942).

2. PROJECT BACKGROUND

2.1. Potential Remains

2.1.1. The archaeological potential of the site is considered to be high.

- *Prehistoric*
  No prehistoric remains are recorded within the survey area.

- *Roman*
  No Romano-British remains or finds are recorded as being located within the site, or a 1Km radius thereof.

- *Mediaeval*
  The Deserted Mediaeval Settlement of Lee by Bradburne (RSM 29942) is located adjacent to the site. Additionally, mediaeval earthworks are visible in the fields surrounding the survey area.

- *Post-Mediaeval*
  No Post Medieval or Modern heritage assets are recorded as being within the survey area. However, Lea Hall Farmhouse, located to the southeast of the survey area, is itself a Grade 2 listed building (List No. 1109395).

2.2. Proposed Fieldwork

2.2.1. In order to evaluate the potential archaeological remains in this area, the following fieldwork investigation was proposed:

- Geophysics – Geomagnetic survey at standard (1m x 0.25m) sampling density across an area totalling c. 1.4 ha.

3. OBJECTIVES

3.1. In light of the archaeological potential of the site, the Senior Conservation Archaeologist for the Peak District National Park Authority recommended a scheme of archaeological evaluation by geophysical survey to be carried out.

3.2 The aim of the present work is to provide an evaluation and understanding of any potential archaeological remains through an evaluation by geophysical survey (geomagnetic) to determine the presence and location of any sub-surface remains, in accordance with NPPF para' 128, prior to submission and determination of a planning application for installation of a 50KW photovoltaic array on the site (ref: NP/DD/0515/0389).

3.3. The archaeological work undertaken through this project aims to provide information that will enable the remains to be placed within their local, regional, and national context, and for their significance to be assessed.

3.4. The survey results will be used to inform the planning application and the necessity or otherwise of any further archaeological conditions.

4. METHODOLOGY

4.1. Geophysical Survey: Geomagnetic

4.1.1. The decision to use magnetic gradiometry to survey the site was based on its efficiency as a survey technique suitable for detecting the buried remains of a range of materials based on differences in their magnetic characteristics as compared to the geological background of the area (Gaffney et al. 1991, 6; 2003).

4.1.2. The results of this method are, however, severely restricted in areas of modern disturbance and by the presence of ferrous material (Scollar et al. 1990, 362ff). Because of the presence of metal fencing within the field boundaries, these features were given a wide-berth with an average distance of 3m being allowed to limit their effect on the archaeological data. Although a number of alternative geophysical survey techniques could be applied to the site (Appendix B), magnetometry represented the best compromise between speed and quality of data retrieval for an initial investigation.

4.1.3. The magnetometer survey was undertaken, within the guidelines advocated by English Heritage (David et al. 2008), by a two-person team using a Bartington Instruments Grad 601-2 fluxgate gradiometer. This equipment allowed the survey to be conducted rapidly as the area was relatively free of obstructions. Readings were taken at 0.25m intervals along traverses of 1m spacing walking east. This enabled a sufficiently high density of data for the purposes of archaeological evaluation to be collected across the site in the relatively short time allotted for the survey to be completed.

4.1.4. The geophysical survey grids of 30m by 30m were set out using a Leica GS15 GPS with SmartNet, in the Ordnance Survey National Grid coordinate system. The use of a north-south orientation for the survey grids was employed in the expectation that any surviving remains would be intersected by the survey traverses at an angle of approximately 30°.

4.1.5. The geophysical survey data were processed in Geoplot 3.0 software to remove any environmental disturbances or variations produced in the course of the survey. Firstly data were manipulated to remove any distorting 'spikes' from the survey results. A high-pass filter was then also used to reduce the effect of geological anomalies in the data-set. Low-pass filtering was then used to improve the resolution of larger archaeologically derived anomalies. Finally the data were interpolated to produce uniform data-densities equivalent to 0.25m x 0.25m.

4.1.6. The results were exported as greyscale, raster images and inserted into the AutoCAD plan of the site, generated from Ordnance Survey data, for georeferencing and production of a descriptive, vector overlay. The anomalies presented here were identified visually and manually digitised to produce the vectorised plans which are discussed in the results section of this report. The final print-versions of these plans were elaborated and prepared for printing in Adobe Illustrator CS6.

Ground Conditions

4.1.7. Ground conditions for the survey were satisfactory. The site had been used as pasture, but was overgrown at the time of the survey.

5. RESULTS
(Figures 2-4)

5.1. Geomagnetic Survey
5.1.1. Within the area surveyed, the site exhibited a generally good response to the geomagnetic survey. Geophysical anomalies can be observed across the whole area surveyed, and buried features can be clearly discerned against the geological background. There is some noise in the dataset, particularly to the east of the site. The overall magnetic response is low, although spikes within the dataset extend the range of unfiltered values to $^{+}/_{-}$ 90nT the standard deviation of the raw-data remained within c. 5nT of the mean. Any cut features are likely to show against this background as areas of positive magnetism. Positively magnetic anomalies are likely to result from the presence of settlement activity and deposition of thermo-remanent, or depositionally-remanent magnetised material.

5.1.2. The results are presented below as a greyscale image of the processed data (Fig. 2), and a complementary numbered interpretative plan to which the following description relates (Fig. 3). This description is organised broadly from west to east. Unprocessed survey data are also presented below (Fig. 5). These data are unfiltered and hence show striping resulting from slight but consistent imbalances between the two sensors used for the survey.

5.1.3. The western end of the survey area contains a number of discrete anomalies. Adjacent to the northern edge of the survey is a c. 2.8m-diameter, magnetically positive anomaly [1]. Approximately 20m from the southern edge of the survey is a c. 4.5m-diameter strongly-positive macula [2]. Due south of this feature, at a distance of c.3m is a 2.5m-diameter, strongly negative macula [3]. To the south of this feature, and beginning adjacent to the southern edge of the area surveyed are three strongly-positive maculae [4], [5], and [6], which may be associated with each other. The first two of these have diameters of approximately 3.5m, while the latter is smaller at c.1.5m in diameter.

5.1.4. Also located within the western part of the survey area are broadly linear, weakly positive anomalies [7], [8], and [9]. Of these, [7] appears to be the longest, running for approximately 62m east-southeast–west-northwest. Anomaly [8], parallels [7] for approximately 46.5m, c. 3m to the north of it. Anomaly [9] is located a further 3m to the north and runs for c. 36m, parallel to the two previously discussed anomalies. Approximately 3m to the north of [9], are three positive maculae [10], which appear to define a linear alignment paralleling [9], before deviating to the northwest.

5.1.5. The southern edge of the western end of the survey area is characterised by a number of small, discrete anomalies. A 2.5m-diameter dipolar macula [11], is located adjacent to the southern edge of the survey. Approximately 7.5m to the north of this feature is a pair of positive maculae [12], neither of which exceeds 2m in diameter. Aligned with the [11] and [12], is another dipolar macula [13], of approximately 2m diameter. Approximately 17m to the southeast of this feature is a similar dipolar macula [14]. Approximately 16m to the southwest of [14], is a small, but strongly-magnetic, 1.5m-diameter, positive macula [15]. An extremely weak, positively magnetic band, appears to link this feature to a pair of c.1.5m-diameter, strongly-positive maculae [16], located adjacent to the southern edge of the survey.

5.1.6. The central part of the survey area exhibits the highest concentration of geophysical anomalies. The clearest of these appear to relate to a series of linear, positive anomalies parallel to the three discussed above (Paragraph 5.1.4.). Approximately 12m from the southern edge of the survey area is a c. 17.5m-long, positively magnetic, linear anomaly [17]. Adjacent to the western end of this feature is a c. 2.5m-diameter, dipolar macula [18]. Approximately 3m to the north of [17], and running parallel to it, is a c. 15.5m-long, positive, linear, anomaly [19]. The alignment of this anomaly appears to be continued by a 1.5m-diameter, positive macula [20], which is located c. 8m to the west of [19]. A further 3m to the north of [19], is a 21.5m-long, positive, linear anomaly [21]. The line of which, is continued c.2m from its eastern terminus by a c. 14m-long, positive, linear anomaly [22]. Immediately to the south of [22], is a c. 11m-diameter, strongly dipolar macula [23]. Approximately 5m to the southwest of this feature, and adjacent to the southern edge of the survey area, is an irregular dipolar macula [24], which occupies an area of approximately 37m^2. Approximately 12.5m to the east of this feature is a smaller, weaker, c. 3m-diameter, dipolar anomaly [25]. Immediately adjacent to the southern edge of the survey area, c. 3.5m to the west of [24], is a strongly-magnetic, positive linear anomaly [26]. This feature appears to run for c. 6m (intersecting with the edge of the survey area), on a parallel alignment to [17], but its position makes this alignment difficult to ascertain reliably. To the south of [25] is a group of two, probably associated, c. 2m-diameter, strongly-magnetic, positive maculae [27].

5.1.7. The northern half of the central part of the site also exhibits a large number of densely distributed anomalies. Approximately 2.5m to the north of, and parallel to [21], is a 31.5m-long linear, positively magnetic anomaly [28]. The alignment of this feature appears to be continued to the east by a positive macula of 2.5m-diameter [29], and an 8.5m-long, linear, positive anomaly [30]. Approximately 3m to the north of [28] is another linear, positive anomaly [31], running parallel to [28] for c.18m. The line of this feature appears to be continued to the east by a pair of positive maculae [32], which appear to be associated with a c. 1.5m-diameter negatively-magnetic macula [33], and by a small, c.1.5m-diameter positive macula [34]. Approximately 2.5m to the north of [31], is a group of three positively-magnetic maculae [35], each of approximately 2m diameter. Approximately 3.5m to the east of these maculae is an irregular positive anomaly [36]. Immediately to the north of [36], is a 10.5m^2 negative macula [37]. Approximately 7m to the east of [36] is a 2m-diameter, positive macula [38]. Features [35], [36], and [38] appear to possibly continue the alignment of [7].

5.1.8. Immediately to the east of the long, linear anomaly [9] discussed above (see Paragraph 5.1.4), is a group of irregular positive and negative anomalies [39]. To the southeast of this group is a 6.5m-long, linear, negatively-magnetic anomaly [40]. This last anomaly appears to offset/parallel the line of [9], which itself is picked up c. 5m to the east by the c. 13.5m-long positive, linear anomaly [41]. Immediately to the north of [41] is a 3m-diameter strongly-dipolar macula [42]. To the north of this feature is a group of three, c. 2m-diameter, positive maculae [43]. Approximately 14m to the west of [43] is a group of similarly-sized positive maculae [44], which appear to define an arc, open to the northeast, of approximately 6m radius. Adjacent to the northern edge of the survey, north of [43], are two strongly-dipolar maculae [45], the larger of which is of 4.5m diameter.

5.1.9. The area to the east of these previously discussed anomalies exhibits a much lower density of responses to the survey. Approximately 16m to the east of [42], is a group of three, positively-magnetic maculae [46], which appear to be arranged in a triangular pattern. Approximately 15m to the south of these is a cluster of strongly-dipolar maculae [47], spaced across a total area of approximately 148m^2. Approximately 20m to the southeast of these anomalies is a 4.5m-diameter, strongly-dipolar macula [48]. Approximately 12m to the southwest of this anomaly is a 2.5m-diameter positive macula [49], which appears to respect the alignment of [17] discussed previously (see Paragraph 5.1.6).

5.1.10. The southeastern and eastern edges of the survey appear to be characterised by anomalies which appear to be largely the result of "noise" in the dataset. A pair of dipolar/positive c. 1.5m-diameter, maculae [50], are located in the southeastern corner of the survey area. Approximately 14m to the northeast of these, a series of positive maculae [51], [52] are located within a few metres of the eastern edge of the area surveyed. A c. 22m-long, positively-magnetic, linear anomaly [53] runs north–south from a point c. 2m to the north of [52]. The remainder of the eastern edge of the survey area exhibits a number of irregular positive anomalies [54].

5.1.11. The northeastern part of the area surveyed also exhibits a number of discrete magnetic anomalies. Approximately 6.5m to the west of the northern end of [53], is a c. 17m-long, curvilinear, positively-magnetic anomaly [55]. Possibly continuing the alignment of this previous anomaly to the north, is an irregular, c. 10m-long, broadly linear, positively-magnetic anomaly [56]. Approximately 10m further to the northwest of [56], is an irregular positively-magnetic macula of c. 15.5m^2 [57], which intersects the northern edge of the survey and appears to respect the alignment of [55]/[56]. Approximately 6m to the northeast of this alignment of features are a negatively-magnetic macula [58], positively-magnetic macula [59], and c. 6m-diameter dipolar macula [60], which appear to parallel the previously discussed anomalies. Approximately 14m to the east of [60] is a group of c. 2.5m-diameter positive maculae [61], which appear to be arrayed in two parallel rows c. 5.5m apart and aligned east-northeast–west-southwest.

6. DISCUSSION

6.1. Geomagnetic Survey

6.1.1. The geomagnetic response to the survey revealed a high density of anomalies across the majority of the survey area, several features with archaeological potential could be clearly recognised within the dataset. The scale of these features is varied, with some possible evidence for agricultural activity. Likely archaeological features were generally represented by positive magnetic anomalies. The overall character of the geophysical anomalies revealed by the survey suggests a possibility for the presence of archaeological remains within the area surveyed.

6.1.2. The group of features [7], [8], and [9] appear to suggest the possible presence of buried evidence of ridge/furrow agriculture.

6.1.4. The group of features [17], [19], [21], [22], [28], [30], [31], [32], and [34] appear to suggest the possible presence of buried evidence of ridge/furrow agriculture.

6.1.5. The group of features [36], [38], [39], and [41] appear to suggest the possible presence of buried evidence of ridge/furrow agriculture.

6.1.6. Feature [44] may represent some form of enclosure or pit-alignment.

6.1.7. Features [57], [56], and [55] appear to represent a stratigraphically negative alignment or feature such as a ditch.

6.1.8. Feature [61] appears to represent a series of stratigraphically negative features such as pits/ post-holes.

6.1.9. Feature [53] is likely to be an artefact of the survey and should probably considered of little or no significance in the interpretation of these results.

7. CONCLUSION

7.1. Geophysical survey suggested the presence of potential buried archaeological features.

These comprised:

- Probable archaeological features indicating past agricultural activities, possible ridge/furrow, ([7], [8], [9]); ([17], [19], [21], [22], [28], [30], [31], [32], [34]); ([36], [38], [39], [41]).
- Possible boundary/enclosure ditches [57], [56], [55].
- Possible pits or post-holes [44], [61].

7.2. The distribution of geophysical anomalies across the areas surveyed should probably be seen as representative of the presence of archaeological features within the survey area and no significant biases in survival/detection of these remains appear to be present within the dataset.

8. BIBLIOGRAPHY

David, et al. (2008) *Geophysical Survey in Archaeological Field Evaluation*. English Heritage

Gaffney, C., Gater, J. & Ovendon, S. 1991. *The Use of Geophysical Survey Techniques in Archaeological Evaluations*. Institute of Field Archaeologists Technical Paper No. 9.

Scollar et al. (1990) *Archaeological Prospecting and Remote Sensing*. Cambridge: Cambridge University Press.

Cartographic references

BGS British Geological Survey: England and Wales (online) Solid and Drift Geology: 1: 50,000

OS Ordnance Survey 1: 50,000 Landranger Map

Ordnance Survey Maps: All editions 1859-1992

Appendix A: Details of Survey Strategy
Date of Survey: 11th June 2015
Site: LFT – Lea Cottage Farm, Tissington (Derbyshire)
Region: Derbyshire
Grid Reference: NGR SK 19304 51935
Surveyor: Trent and Peak Archaeology
Personnel: Tom Hooley, Povilas Cepauskas
Geology: Widmerpool Formation/Till
Survey Type 1: Geomagnetic, fluxgate gradiometry
Approximate area: 1.4 hectares
Grid size: 30m
Traverse Interval: 1m
Reading Interval: 0.25m
Instrument: Bartington Instruments Grad 601-2
Resolution: 0.1nT
Traverse mode: Zig-zag

Appendix B: Geophysical Prospection Methods

Magnetic Survey

Magnetic prospection of soils is based on the measurement of differences in magnitudes of the earth's magnetic field at points over a specific area. The iron content of a soil provides the principal basis for its magnetic properties. Presence of magnetite, maghaematite and haematite iron oxides all affect the magnetic properties of soils.

Although variations in the earth's magnetic field which are associated with archaeological features are weak, especially considering the overall strength of the magnetic field of around 48,000 nano-Tesla (nT), they can be detected using specific instruments (Gaffney et al. 1991).

Three basic types of magnetometer are available to the archaeologist; proton magnetometers, fluxgate gradiometers, and alkali vapour magnetometers (also known as caesium magnetometers, or optically pumped magnetometers).

Fluxgate Gradiometer

Fluxgate instruments are based around a highly permeable nickel iron alloy core (Scollar et al. 1990, 456), which is magnetised by the earth's magnetic field, together with an alternating field applied via a primary winding. Due to the fluxgate's directional method of functioning, a single fluxgate cannot be utilised on its own, as it cannot be held at a constant angle to the earth's magnetic field. Gradiometers therefore have two fluxgates positioned vertically to one another on a rigid staff. This reduces the effects of instrument orientation on readings.

Fluxgate gradiometers are sensitive to 0.5nT or below depending on the instrument. However, they can rarely detect features which are located deeper than 1m below the surface of the ground.

Archaeological features such as brick walls, hearths, kilns and disturbed building material will be represented in the results, as well as more ephemeral changes in soil, allowing location of foundation trenches, pits and ditches. The results are however extremely dependent on the geology of the particular area, and whether the archaeological remains are derived from the same materials.

FIGURES

Fig. 1: Site location

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Fig. 2: Greyscale plot of geomagnetic survey results

Fig. 3: Vectorised plan of geomagnetic survey results

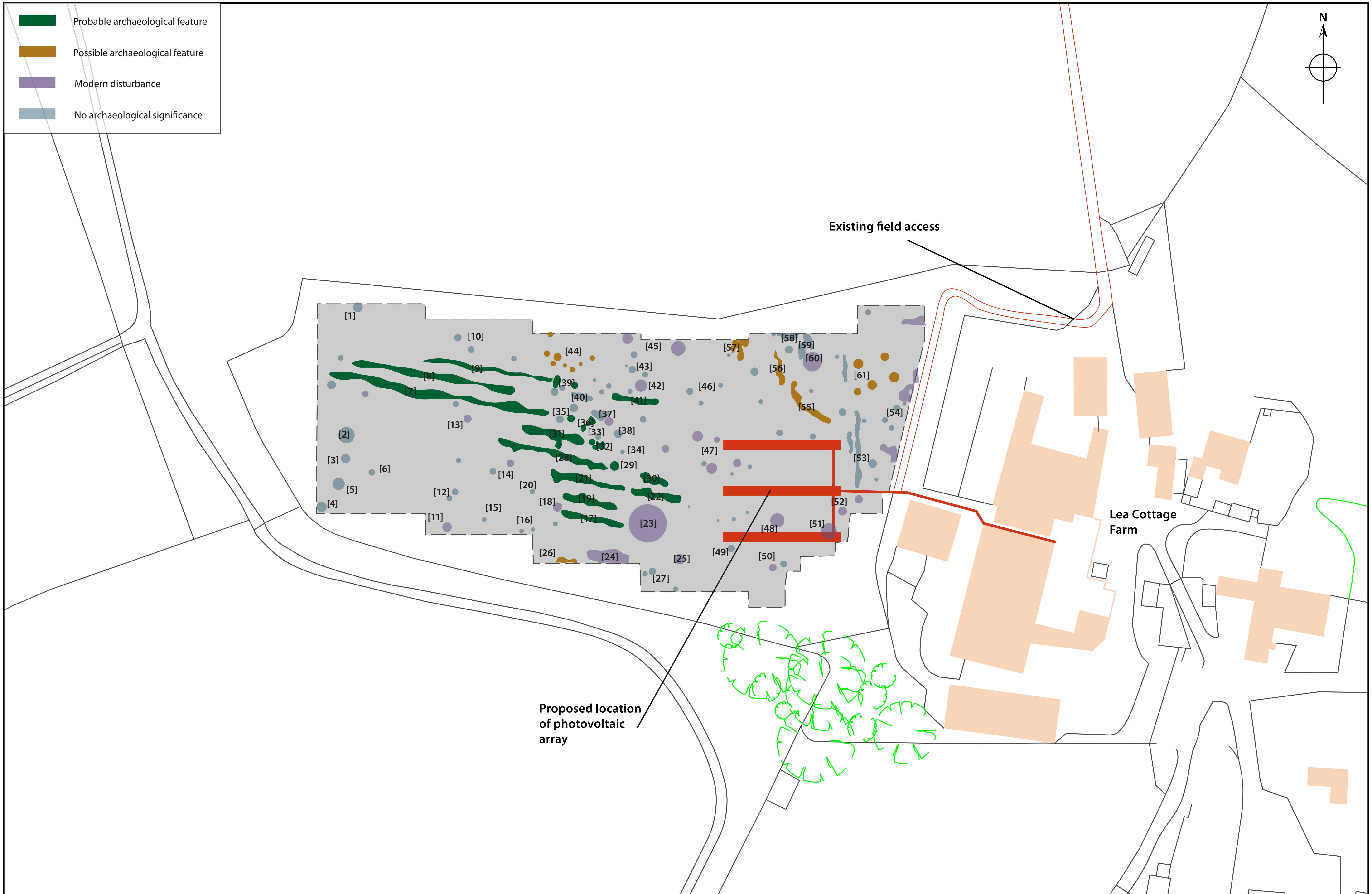

Fig. 4: Archaeological interpretation of geomagnetic survey results

Fig. 5: Unfiltered greyscale plot of geomagnetic survey results