



Wind Turbine at Site 10505 Rhosbeirio, Anglesey

Detailed Gradiometer Survey Report

Prepared for:

Stephenson Halliday
32 Lowther Street
Kendal Cumbria
LA9 4DH

Prepared by:

Wessex Archaeology
Portway House
Old Sarum Park
Salisbury SP4
6EB

www.wessexarch.co.uk

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Detailed Gradiometer Survey Report

Summary

A detailed gradiometer survey was conducted over land at Rhosbeirio Farm, Rhosgoch, near Llanfechell and Amlwch on Anglesey. The project was commissioned by Stephenson Halliday with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of a proposed wind turbine and associated cable route. The geophysical survey forms part of a programme of on-going archaeological work at the Site.

The site comprises three agricultural fields to the south of Rhosbeirio Farm, approximately 2km east of the village of Llanfechell and some 5km southwest of Amlwch. The site occupies relatively flat land within the Afon Wygyr valley, and was under pasture at the time of survey. The gradiometer survey covered 3.2 ha and has demonstrated the presence of anomalies of definite, probable and possible archaeological interest within the survey area, along with a region of increased magnetic response associated with near-surface geological changes.

The majority of the anomalies of likely archaeological interest are grouped towards the eastern extent of the cable route and comprise a series of ditches oriented approximately NW-SE; they are consistent with the remnants of part of a field system or enclosure, or perhaps a former track. It is difficult to determine the relationship between these anomalies or their likely date; whilst a Bronze Age barrow lies to the northwest, the orientation of the ditches is similar to that of existing boundaries nearby and their projected course passes close to Rhosbeirio Farm. Near the complex of ditches, other anomalies are apparent that are more irregular in plan; whilst these are not characteristically archaeological in origin, this interpretation cannot be excluded entirely.

The dataset over the central portion of the cable route exhibits a relatively quiet magnetic background, and several anomalies are visible. A weakly defined sub-circular anomaly appears to the west of the eastern field boundary, although it is poorly defined from the magnetic background and may represent a chance alignment in the data, although an archaeological interpretation cannot be ruled out. Elsewhere, a rectilinear region of increased magnetic response and an isolated pit-like anomaly are of uncertain origin.

The westernmost portion of the dataset is dominated by strong geological responses, which are consistent with an intrusive geological feature. Strong ploughing trends in the vicinity suggest that this geological material is being disturbed through ploughing, leading to the strong enhancements seen throughout that part of the dataset. It has been possible to identify tentatively some anomalies as being of possible archaeological interest; however, a linear ditch a short distance to the east is likely to indicate the presence of a former field system or enclosure oriented parallel with existing boundaries.

Numerous ferrous responses and weak magnetic trends have been identified throughout the survey area, although the majority of these are likely to be modern or agricultural in origin.



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Acknowledgements

The detailed gradiometer survey was commissioned by Stephenson Halliday. The assistance of Nick Edwards is gratefully acknowledged in this regard.

The fieldwork was directed by Phil Roberts and assisted by Jonathon Buttery and Chris Hirst. Ben Urmston processed and interpreted the geophysical data in addition to writing this report. The geophysical work was quality controlled by Dr. Paul Baggaley. Illustrations were prepared by Linda Coleman. The project was managed on behalf of Wessex Archaeology by Chloe Hunnisett and Ben Urmston.



Wind Turbine at Site 10505 Rhosbeirio, Anglesey

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

- 1.1.1 Wessex Archaeology was commissioned by Stephenson Halliday, to carry out a geophysical survey of land at Rhosbeirio on Anglesey in north Wales (**Figure 1**), hereafter “the Site” (centred on NGR 239270 390360).
- 1.1.2 Gwynedd Archaeological Planning Service (GAPS), acting as an archaeological advisor to the Isle of Anglesey County Council (IACC), had been requested to provide a screening opinion on the development. GAPS advised that as part of the archaeological assessment, geophysical survey was required in order to provide an assessment of impacts of the development upon the historic environment resource (Ref. 0823je02/D1701).
- 1.1.3 Previous work includes a desk-based assessment and walkover survey (WA 2013) as part of the assessment to support a planning application for the construction of a single wind turbine within the Site to be submitted to IACC.
- 1.1.4 The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the survey area.
- 1.1.5 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 The Site

- 1.2.1 The survey area comprises three pasture fields to the south of Rhosbeirio Farm, 2.3 km east of Llanfechell and some 5km southwest of Amlwch (**Figure 1**). Detailed gradiometer survey was undertaken over all accessible parts of the Site, a total of 3.2 ha. The Site is relatively flat, lying at c. 35m above Ordnance Datum in the Afon Wygyr valley, and is surrounded on all sides by agricultural land.
- 1.2.2 The survey area was located to investigate a corridor 30m wide centred upon the proposed cable route to the wind turbine, which is to be situated within a mircositing area. A wider area was surveyed around the turbine location in order to mitigate against the effects of magnetic disturbance associated with the proposed turbine.
- 1.2.3 The underlying geology is mapped as Neoproterozoic mica schist and psammite of the New Harbour Group, overlain by Quaternary superficial sediment comprising Devensian diamicton (British Geological Survey, WA 2013). Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey, although given Anglesey’s relatively complex geological composition, localised variations can be expected.



2 METHODOLOGY

2.1 Introduction

- 2.1.1 The detailed magnetometer survey was conducted using a Bartington Grad601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (2008).
- 2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team on 3rd and 4th June 2013. Field conditions at the time of the survey were good, with the survey area being under pasture.

2.2 Method

- 2.2.1 Individual survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02m and therefore exceeds English Heritage recommendations (2008).
- 2.2.2 The magnetometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1m between sensors. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with EH guidelines (2008). Data were collected in the zigzag method.
- 2.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (± 5 nT thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied to all survey areas, with no interpolation applied.
- 2.2.4 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

3 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

3.1 Introduction

- 3.1.1 The gradiometer survey has been successful in identifying anomalies of definite, probable and possible archaeological interest across the Site, along with regions of geological changes. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:2,000 (**Figures 2 and 3**). The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and 25nT per cm for the XY trace plots.
- 3.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figure 4**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.
- 3.1.3 Numerous ferrous anomalies are visible throughout the detailed survey dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

3.2 Gradiometer Survey Results and Interpretation

- 3.2.1 The western extent of the survey is dominated by strong geological responses, although some anomalies are discernible within the variable magnetic background. At the western extent of the survey area, narrow linear anomaly **4000** extends NNE from the western



border to meet larger and stronger anomaly **4001** extending NW-SE across the western portion of the dataset. It is possible that **4000** represents part of a field system, although little of the anomaly is visible within the survey area. The strength and irregularity of **4001** suggests that it relates to a geological intrusion, although an archaeological interpretation cannot be excluded entirely.

- 3.2.2 Sub-annular anomaly **4002** lies to the south of **4001** and is considered to be of possible archaeological interest given its form in plan; its response is comparable with that of **4001** and it may therefore be associated with geology. Similarly curvilinear anomaly **4003** may be of archaeological interest, although it is possible that it relates to a geological intrusion.
- 3.2.3 Across the northern portion of the proposed turbine lease area, linear and curvilinear anomalies **4004** and **4005** are considered to be of possible archaeological interest due to their linear form in plan. However, this interpretation is tempered by the proximity of strong ploughing trends on the same orientation; it is possible that the general enhancement in the magnetic background across this part of the Site is the result of geological material having been disturbed through agricultural activity. Typically plough strikes are ephemeral features and their appearance within the data indicates they have been augmented by some process.
- 3.2.4 Ditch **4006** extends NE-SW across the southeastern corner of the lease area and is consistent with a former field boundary or perhaps part of an enclosure. It is interesting to note that the geological responses do not appear to extend to the east of **4006**, lending weight to the interpretation of the enhancement as being associated with agriculture.
- 3.2.5 It is likely that **4006** extends further to the northeast to **4007**, where there is an apparent spur towards the southeast. Several pit-like anomalies are seen in close proximity, although no direct relationship can be demonstrated. Nearby to the east, linear anomaly **4008** is oriented approximately E-W and appears to bifurcate with a spur towards the northwest; it is possible that it represents part of the same system of fields or enclosures as **4007**.
- 3.2.6 The track extending N-S across the survey area from Rhosbeirio farm to the north is apparent as region of magnetic disturbance **4009**, the extended nature of which probably relates to its construction.
- 3.2.7 Further to the east, within the cable route corridor, pit-like anomaly **4010** may be of archaeological interest, although it is isolated and not characteristically anthropogenic in nature.
- 3.2.8 To the west of the field boundary, rectilinear region of increased response **4011** may indicate the presence of a ploughed-out field boundary, although it exhibits only weak contrast with the magnetic background. Close by, sub-annular anomaly **4012** has been interpreted as being of possible archaeological interest based upon its form in plan alone; it is very poorly defined from the magnetic background and an archaeological interpretation is necessarily tentative.
- 3.2.9 To the east of the field boundary, linear anomalies **4013** and **4014** are consistent with ditches and may relate to a former field system, enclosure or track; **4014** appears as a pair of parallel linears and trends to the south of **4013** suggest that this may also comprise parallel ditches.



- 3.2.10 Curvilinear anomaly **4015** is irregular in plan, although its clearly defined nature and dissimilarity to geological anomalies elsewhere within the dataset suggests that it is probably of archaeological interest.
- 3.2.11 Faint linear anomaly **4016** extends NE-SW across the northeastern portion of the dataset, intersecting more clearly defined rectilinear ditch **4017**; their relationship is unclear due to the difference in magnitude of response, however. Towards the very northeastern extent of the survey area, amorphous anomalies **4018** are considered to be of possible archaeological interest, although their lack of clear definition and apparently random distribution within the survey area suggests they may be agricultural or geological in origin.

4 CONCLUSION

- 4.1.1 The detailed gradiometer survey has been successful in detecting anomalies of definite, probable and possible archaeological interest within the Site, in addition to regions of increased magnetic response relating to near-surface geological changes.
- 4.1.2 The main concentration of anomalies of likely archaeological interest is at the eastern extent of the cable route. This cluster of anomalies is consistent with the remnants of a former field system or possible network of enclosures. It is difficult to assess the possible periods from which these anomalies date and although a Bronze Age barrow (WA13, WA 2013) lies a short distance to the northwest, the orientation of the ditches is similar to that of extant field boundaries, consistent with a historic origin for these anomalies; the projected line of these ditches also passes close to Rhosbeirio Farm further to the northwest.
- 4.1.3 Within the central portion of the survey area, sub-annular anomaly **4012** is c. 17 m in diameter and the weakly magnetic response is consistent with the heavily truncated remnants of a barrow or hut circle. However, other anomalies within the survey area interpreted as being of archaeological interest exhibit more clearly defined responses and, given the lack of clear ploughing trends nearby, it is considered likely that surviving archaeological remains would have produced more obviously detectable anomalies.
- 4.1.4 At the western extent of the survey area, strong geological responses have complicated the interpretation, although it has been possible to identify a number of linear anomalies of possible archaeological within these stronger responses. The similarity between the orientations of these anomalies (e.g. **4006**, **4007** and **4008**) with nearby extant boundaries suggests that they may represent a former field system of uncertain date.
- 4.1.5 The strong linear and curvilinear responses noted at the southwestern extent of the survey area are consistent with intrusive geology, although elements of these anomalies may be archaeological in origin.
- 4.1.6 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of magnetometers. It may therefore be the case that more archaeological features may be encountered than have been identified through geophysical survey.



5 REFERENCES

English Heritage, 2008. Geophysical Survey in Archaeological Field Evaluation. Research and Professional Service Guideline No 1, 2nd edition.

Wessex Archaeology, 2013. Wind Turbine at Site 10505, Rhosbeirio, Anglesey: Archaeological Desk-Based Assessment. Unpublished report 88940.02



APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a ± 100 nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. Both types depend upon the establishment of an accurate 20m or 30m site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25m intervals along transects spaced 10m apart, acquiring a minimum of 80 data points per transect. Due to the relatively coarse transect interval, scanning surveys should only be expected to detect extended regions of archaeological anomalies, when there is a greater likelihood of distinguishing such responses from the background magnetic field.

The detailed surveys consist of 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m grid respectively, and are the recommended methodologies for archaeological surveys of this type (EH, 2008).

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125m intervals along traverses spaced up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by English Heritage (2008) for characterisation surveys.



Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

Typical data and image processing steps may include:

- Destripe – Applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- Destagger – Shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Despiking – Filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data)

Typical displays of the data used during processing and analysis:

- XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.



APPENDIX 2: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by Wessex Archaeology separates the anomalies into two main categories: archaeological and unidentified responses.

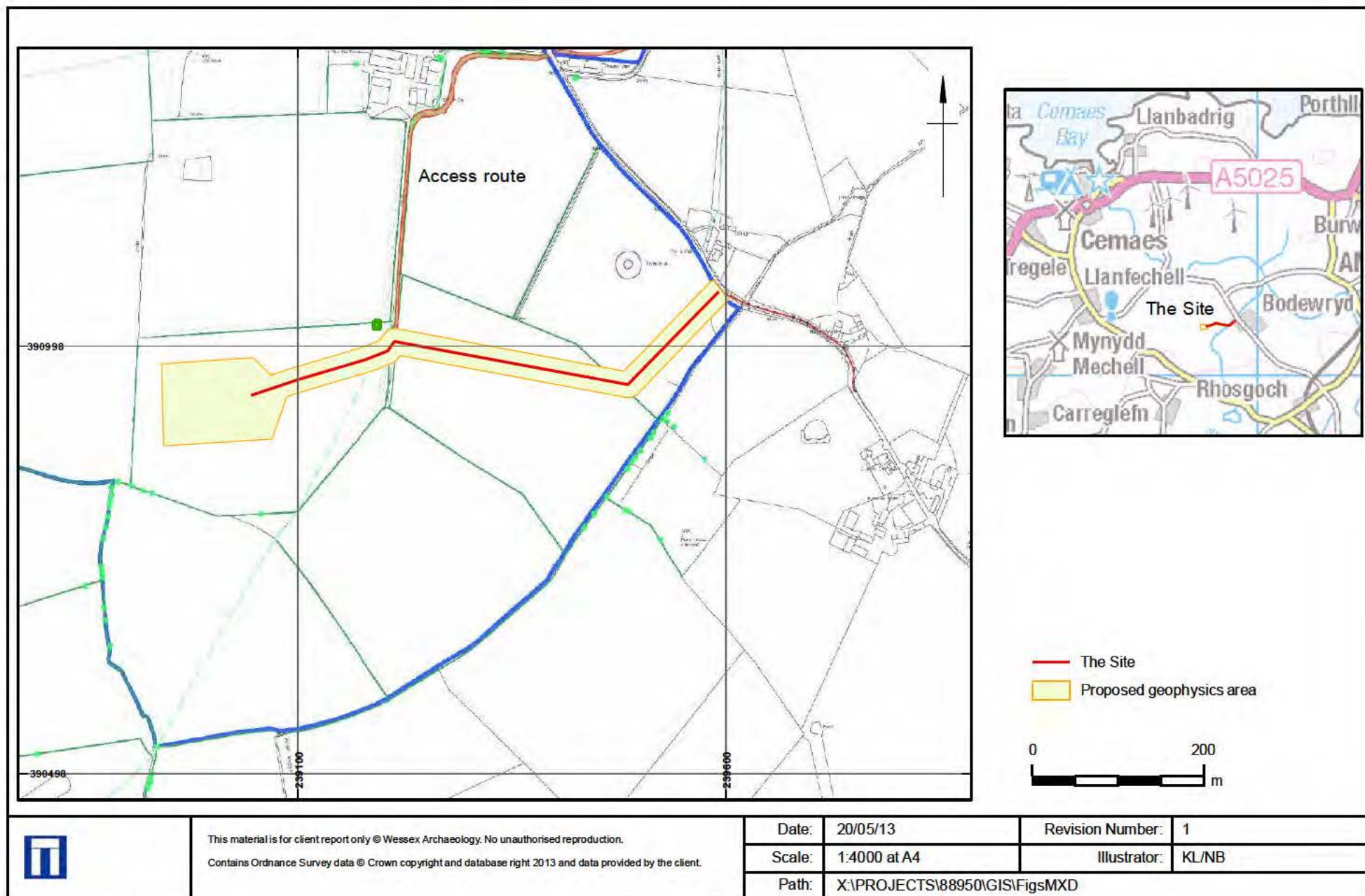
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.
- Possible archaeology – used for features which give a response but which form no discernible pattern or trend.

The unidentified category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

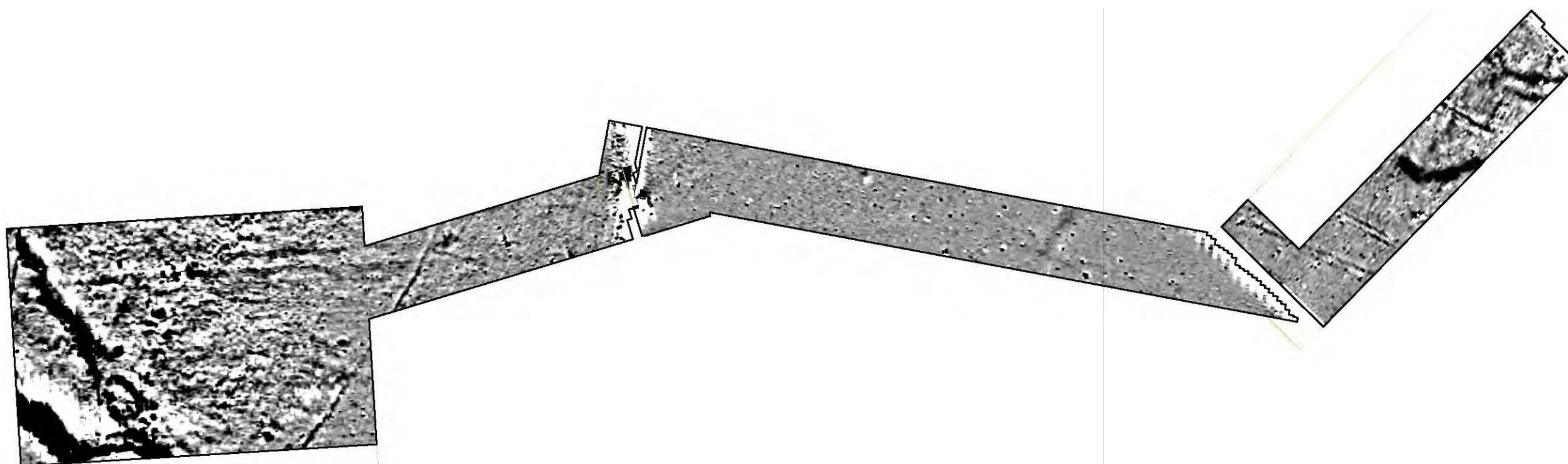
- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend – used for low amplitude or indistinct linear anomalies.
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.

Finally, services such as water pipes are marked where they have been identified.



Site location and survey extents

Figure 1

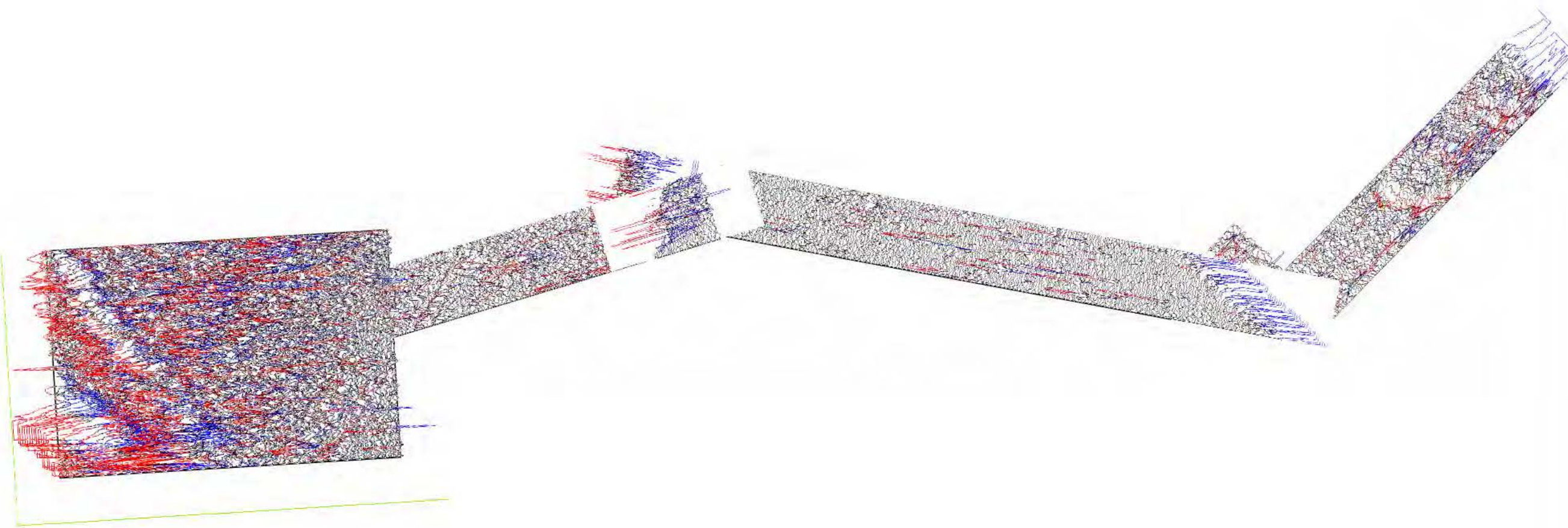


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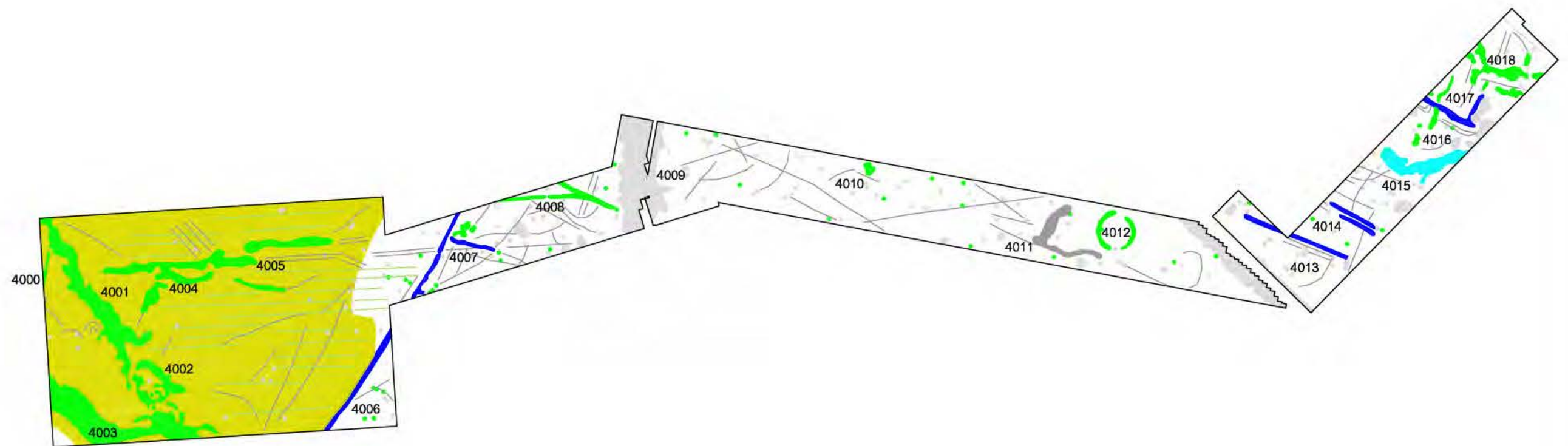
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Definite Archaeology	Increased magnetic response	Superficial Geology
Probable Archaeology	Trend	
Possible Archaeology	Ploughing	Ferrous

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