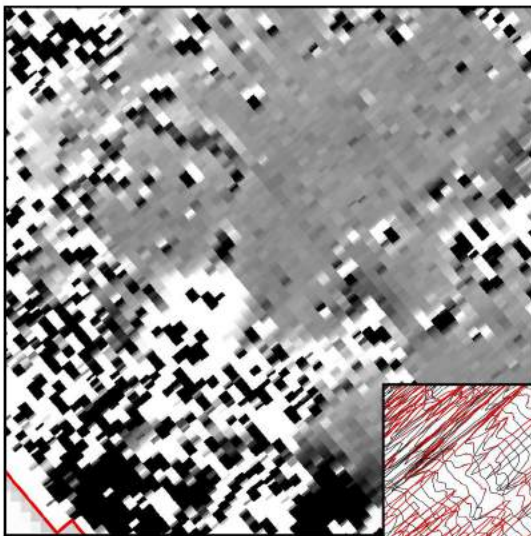


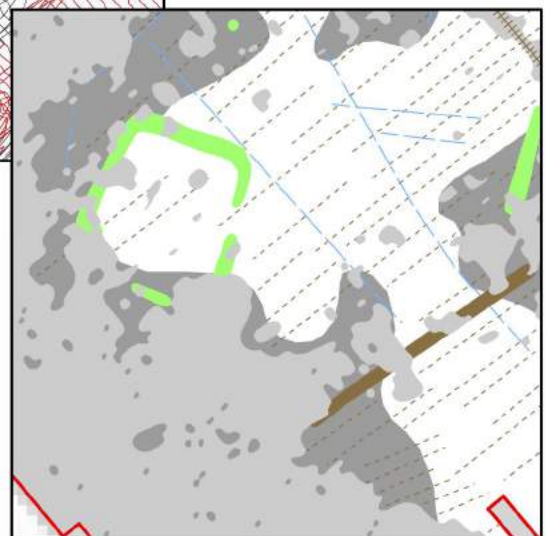
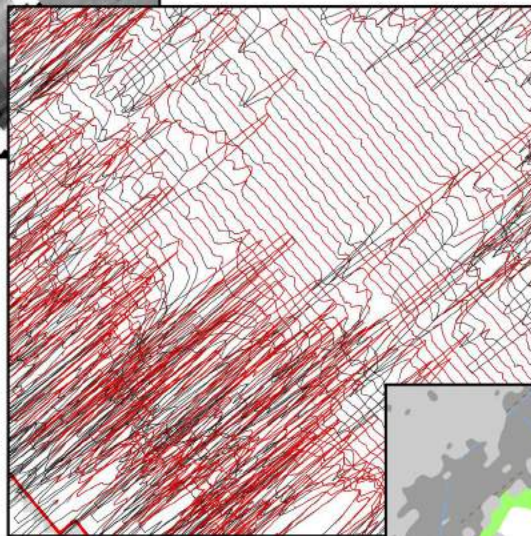


LEFORT GEOPHYSICS



Land off Southampton Road (Wagtails) Alderbury, Wiltshire

Gradiometer Survey Report



Report Ref: 19-0012.01

May 2019



**Land off Southampton Road (Wagtails),
Alderbury, Wiltshire**

Gradiometer Survey Report

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Gradiometer Survey Report

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Land off Southampton Road (Wagtails), Alderbury, Wiltshire

Gradiometer Survey Report

Summary

A gradiometer survey was conducted over land off Southampton Road, close to the centre of Alderbury, Wiltshire. The project was commissioned by AC Archaeology with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of proposed development.

The site is located on an east facing slope close to the northeast edge of Alderbury, some 5.5km southeast of the centre of Salisbury. The site occupies a formerly wooded area. The survey area measures approximately 1.17ha and of this a total of 0.82ha has been covered by geophysical survey.

A sub-rectangular feature has been detected along with similarly aligned ditch sections which may constitute an earlier field system. Other detected features include agricultural remnants and numerous trends of uncertain origin.

The survey was undertaken by the Lefort Geophysics survey team on 7th May 2019.

Acknowledgements

The gradiometer survey was commissioned by AC Archaeology. The assistance of Peter Cox and Kevin Trott is gratefully acknowledged in this regard.

The fieldwork was undertaken by Ross Lefort who processed and interpreted the geophysical data in addition to producing this report.



Land off Southampton Road (Wagtails), Alderbury, Wiltshire

Gradiometer Survey Report

1. Introduction

1.1. Project Background and Survey Objectives

- 1.1.1. Lefort Geophysics was commissioned by AC Archaeology to carry out a geophysical survey over land off Southampton Road, towards the northeast side of Alderbury, Wiltshire. The survey is centred on NGR 419075, 127025 (**Figure 1**).
- 1.1.2. This survey forms part of a wider scheme of works being undertaken in advance of proposed development at the site. The area selected for geophysical survey measures approximately 1.17ha.
- 1.1.3. The following aims have been set out for the geophysical survey:
 - *To conduct a gradiometer survey that covers as much of the specified area as possible, allowing for surface obstructions.*
 - *To determine the presence or absence of archaeological features, as far as the technique and site conditions will allow, and to map the extent of any features that may be present.*
 - *To clarify the general nature and possible significance of the detected features.*
 - *To produce a report of the survey results in sufficient detail to support an informed decision as to the site's archaeological potential.*
- 1.1.4. This report sets out details of the site's location, the methodology followed, the survey results and the archaeological interpretation of the geophysical data.

1.2. Site Location and Topography

- 1.2.1. The site is located close to the centre of Alderbury and some 5.5km southeast of the centre of Salisbury, Wiltshire. The site comprises a single field that was partially wooded until recently. The site limits are defined by field boundaries on all sides (**Figure 1**).
- 1.2.2. The site occupies an east facing slope with the land at a height around 75m above Ordnance Datum. A number of streams are located to the south of the site, these flow west to join the River Avon. A lake or large pond lies to the southeast and this lies within the line of an old canal.

1.3. Geology and Soils

- 1.3.1. The bedrock geology under the site is recorded as sand, silt and clay deposits of the Wittering Formation that dates to the Palaeogene Period. No superficial deposits have been recorded under the site (BGS).
- 1.3.2. The soils underlying the site are recorded as typical gley-podzols of the 641b (Sollum 2) association (SSEW 1983).



- 1.3.3. It is considered that soils derived from the parent material outlined above can produce contrasts suitable for the detection of archaeological features through geophysical survey.

1.4. Archaeological and Historical Background

- 1.4.1. The following information has been obtained from a Historic Environment Assessment (HEA) carried out by AC Archaeology (2019). The information considered to be of greatest relevance to the geophysical survey and its results will be summarized below.
- 1.4.2. The HEA revealed no designated heritage assets within the site with 26 designated and 11 non-designated assets identified within 1km of the site. Assessment of air photographs and historic maps revealed only two 19th century former field boundaries. The site was concluded to have a low potential for the presence of significant archaeological deposits.



2. Methodology

2.1. Introduction

- 2.1.1. Magnetometer survey was selected for the investigation of this site as this was deemed to be the most appropriate technique for the rapid assessment of a site in this geological setting. The survey was carried out using a Bartington Grad601-2 dual fluxgate gradiometer and was conducted in accordance with Historic England's guidelines (2008).
- 2.1.2. The survey was undertaken by the Lefort Geophysics survey team on 7th May 2019. Site conditions were variable with an even surface temperature but uneven and waterlogged ground in places. Of the proposed 1.17ha area a total of 0.82ha was covered by geophysical survey. The shortfall in coverage is due to felled trees that covered parts of the site.

2.2. Method

- 2.2.1. The survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS instrument. Positional corrections are provided for this system by SmartNet which gives a precision of approximately 0.03m and therefore exceeds the Historic England minimum requirements for geophysical survey (2008).
- 2.2.2. The Bartington Grad601-2 gradiometer system has two sensor tubes set at a horizontal separation of 1m; this allows for two lines of data to be collected simultaneously. The upgraded system has an effective sensitivity of 0.03nT. Data were collected at 0.25m intervals along transects spaced 1m apart using the zigzag method. This survey strategy is in accordance with Historic England's minimum requirements for geophysical survey.
- 2.2.3. The survey data were subject to minimal correction processes using Geoplot and in-house software. The processing functions used include:
- Group Zero Median Traverse (GZMT): This was applied to remove minor variations between the two Bartington sensors. This method of processing prevents the removal of archaeological features that run in-line with the traverse direction. Thresholds of $\pm 5\text{nT}$ were applied.
 - Zero Median Traverse (ZMedT): This was applied to all grids to remove minute variations between the two Bartington sensors left behind by GZMT. Thresholds of $\pm 1\text{nT}$ were applied.
 - Zero Mean Traverse (ZMT): This was applied to grids dominated by ferrous responses where GZMT failed to remove sensor variations. Thresholds of $\pm 5\text{nT}$ were applied.
 - Deslope: This was used on selected grids to correct minor grid edge discontinuities introduced by earlier processing steps.
 - Destagger: This corrects small errors in traverse position introduced by varying topography and ground cover.
- 2.2.4. Further details of the survey equipment, fieldwork procedures and methods of processing are described in **Appendix 1**.



3. Results and Interpretation

3.1. Introduction

- 3.1.1. The gradiometer survey has been successful in identifying a few anomalies of possible archaeological interest. A number of other features have been detected including agricultural features and trends of uncertain origin. Results are presented as a series of greyscale plots, XY trace plots and archaeological interpretations at a scale of 1:1000 (**Figures 2 to 3**). The greyscale plots are displayed from -2nT (white) to +3nT (black) and the XY trace plots are displayed at $\pm 25\text{nT}$ at 25nT per cm.
- 3.1.2. The interpretation of the dataset highlights the presence of potential archaeological features, modern features, geological responses, agricultural features and anomalies of uncertain origin (**Figure 3**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.
- 3.1.3. Numerous ferrous responses have been observed throughout the gradiometer dataset. These are presumed to be modern and are not referred to, unless they are considered relevant to an archaeological interpretation.

3.2. Gradiometer Survey Results and Interpretation

- 3.2.1. The clearest response is a small sub-rectangular enclosure around **1001**; this measures approximately 15m x 12m. This feature is closely associated with ferrous/ceramic responses which could either indicate it is a ditch filled with magnetic debris or is potentially the remains of a brick wall. A couple of ditches at **1002** and **1003** run on a similar NNE-SSW alignment and may be related. These features do not follow the modern scheme of field division and may form part of an earlier field system and have been classed as possible archaeology.
- 3.2.2. A number of isolated small pit-like responses are scattered across the dataset, such as at **1004**. These could prove to be archaeological but could equally prove to be natural or modern responses. They have been classed as possible archaeology.
- 3.2.3. A former field boundary marked on the 1926 Ordnance Survey map runs through the data at **1005** and possible land drains are visible around **1006**.
- 3.2.4. Trends of uncertain origin run through the data; some, such as at **1007**, could prove to be archaeological but others, such as around **1008**, look likely to relate to past agricultural activity.

3.3. Gradiometer Survey Results and Interpretation: Modern Services

- 3.3.1. No clear modern services have been identified within the dataset.
- 3.3.2. It should be noted that gradiometer data will not be able to detect all services on site. Services made from non-ferrous material are unlikely to generate the distinctive response that would allow for a classification as a service. Plastic pipes are particularly hard to detect for example.



- 3.3.3. This report and accompanying illustrations should not be used as the sole source for service locations. Service maps should be consulted in addition to employing appropriate equipment (e.g. CAT and Genny) to confirm service locations before any invasive activities are carried out on site.

4. Conclusions

- 4.1.1. The gradiometer survey has been successful in identifying a few anomalies of possible archaeological interest. A number of other features have been detected including agricultural features and trends of uncertain origin. The survey and this report are considered to have addressed all of the aims set out for the project.
- 4.1.2. The sub-rectangular enclosure and associated ditch sections represents the clearest response and its differing alignment from the surrounding modern and earlier mapped boundaries suggest it may have some archaeological significance. The ditches look to define a fragmentary field system but it is possible that the rectangular feature proves to be formed by ceramic bricks rather than being defined by a ditch.
- 4.1.3. The majority of detected responses attest to this area serving a largely agricultural function in recent centuries.
- 4.1.4. Gradiometer survey has a proven track record of identifying a wide range of archaeological features in a diverse range of geological settings. It is however a possibility that other archaeological features may exist that are not detectable through gradiometer survey. Stone walls composed of a sedimentary rock, for example, may not be visible on a site with similar underlying geology as there is no measurable magnetic contrast between the wall and the surrounding soil.

5. References

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APPENDIX 1: THEORY, SURVEY STRATEGY AND DATA PROCESSING

Basic Theory

Introduction

The two geophysical survey techniques carried out by Lefort Geophysics are magnetometer and earth resistance survey. Magnetometer survey is routinely used for archaeology due to the rapid area coverage achievable, in addition to its successful track record in many different geological settings. Earth resistance survey is slower by contrast, but can reveal archaeological features that may be missed by a magnetometer survey.

Magnetometer Survey

This technique involves measuring minor variations in the Earth's magnetic field; these variations are caused by a number of human induced and natural phenomenon. Humans can enhance the magnetic properties of soils in a number of ways; such as through the creation of ceramic/metallic objects, deposition of settlement waste and through burning. The resulting enhanced soils that fill pits and ditches make these features detectable.

Some natural phenomenon, like underlying geology and the sun, create large scale magnetic variations that can mask weaker archaeological features. A common way of filtering out these large scale effects is to collect data using two magnetometer sensors, one mounted at a fixed distance above the other. The lower sensor is closer to the ground and is therefore more sensitive to shallow, small scale changes; both sensors measure the large scale variations to a similar degree. When data from one sensor is subtracted from the other, the effect is to remove the large scale variations to reveal a clear picture of potential archaeological features. This configuration is known as a gradiometer and the system used by Lefort Geophysics works in this way.

There are several different types of magnetometer sensor available but the two most commonly used for archaeology are fluxgate and caesium vapour. The basic difference between the two is that caesium vapour measures the total strength of the magnetic field whereas fluxgate only measures a component of the field in a particular direction.

The advantages of the fluxgate sensors are their robust and lightweight design coupled with a lower power consumption; these factors make for an excellent piece of field equipment. Caesium vapour magnetometers are considered to be more sensitive with a lower noise level. In most cases this difference in sensitivity and noise is not enough to warrant use of caesium vapour over fluxgate sensors. Use of caesium vapour sensors is considered most advantageous when searching for deeply buried archaeological features.

Earth Resistance Survey

Earth resistance survey works, in simple terms, by passing a weak electrical current through the soil and measuring variations in electrical resistance. Resistance varies according to differences in soil moisture content and by the presence of materials of varying resistivity. A wall, for instance, is likely to be dry and composed of poor conducting materials; this results in a high measured resistance value. A ditch filled with wetter, better conducting material will register a lower resistance value by contrast.

Four electrodes are used to measure resistance, two pass a fixed electric current through the ground (current probes) and the other two sample the voltage required to drive this current (voltage probes). The variations in voltage required to drive the current are indicative of the varying electrical resistance. The four electrodes can be arranged in a



variety of different configurations, the twin-probe array is the widest used of these. The twin-probe involves grouping the four electrodes into two pairs, with a current and voltage probe in each pair. The pairs are separated by a large distance with one set in a fixed position and the other moved across the survey area to sample the varying resistance.

In general terms, the wider the electrode spacing, the deeper the technique can penetrate. The catch is that a wider electrode spacing increases the volume of soil sampled. This can result in smaller features, such as internal walls, being less detectable when investigating to greater depths. The standard probe separation used for commercial archaeology is 0.5m and this is considered suitable for the investigation of most rural sites in Britain.

The main weakness of earth resistance survey is that the quality of results are dependent on climatic conditions on the day and in the weeks running up to the survey. If the site is waterlogged then there is little contrast, the same is true if the site is too dry. This constraint puts the technique at a disadvantage in the commercial sector where waiting for the right conditions is not always possible.

Detailed Survey Methodology

Magnetometer data is collected using a Bartington Grad601-2 dual fluxgate gradiometer system. This has two sensor tubes mounted at a horizontal separation of 1m which allows for the simultaneous collection of two transects of data. Each sensor tube contains two fluxgate sensors arranged as a vertical gradiometer at a separation of 1m. This system can suppress large scale variations that might obscure potential archaeological features.

The Bartington Grad601-2 has an effective sensitivity of 0.03nT when set at a range of ± 100 nT in grid mode. The standard resolution for a geophysical survey is to collect readings at 0.25m intervals along transects spaced 1m apart. Data is collected in grids measuring 30m x 30m and at the resolution outlined above results in 3600 readings per grid. Higher sample density surveys can be carried out at a 0.125m separation along transects spaced 0.25m apart. This results in 28800 readings per 30m grid.

Magnetometer data can also be collected on the Lendiniae cart system. On this system multiple Bartington Grad601-2 can be mounted with positions logged by a Trimble 4800 base and rover GPS system. The advantage of using this system is that each reading has greater positional accuracy compared to grid based data collection. The Trimble 4800 system is capable of a horizontal accuracy of ± 1 cm and a vertical accuracy of ± 2 cm.

The earth resistance data is collected using a Geoscan Research RM15 system using the twin-probe array. The mobile electrodes are mounted on a fixed bar with a multiplexer (MPX15) used to allow two transects of data to be collected simultaneously. A probe separation of 0.5m is typically used with data collected at 1m intervals along transects spaced 1m apart, in line with English Heritage minimum requirements.

The 30m x 30m survey grid nodes and base points for the Trimble 4800 system are accurately established in the field using a Leica Viva series RTK GNSS instrument. This system achieves a high level of precision thanks to a network of reference stations operated by the Ordnance Survey and Leica Geosystems, known as SmartNet. These reference stations provide positional corrections that are fed to the system via a mobile internet connection. This enables the system to achieve an accuracy of 0.03m which exceeds the English Heritage minimum requirements (2008).



Data Processing Methodology

The collected gridded gradiometer data are downloaded from the Bartington system using the software provided. Data are saved in a Z format with a separate header file generated for survey parameters. Data are then imported into the processing software Geoplot to correct minor errors. These corrections aim to enhance the results for greater clarity. The processing applied is minimal with no filtering or interpolation used.

The processing steps for gridded data include Group Zero Median Traverse (GZMT) followed by a narrow threshold Zero Median Traverse (ZMedT). This method of processing allows variations between the Bartington sensors to be removed while minimising the potential loss of features that run in line with traverse direction. Other processing steps include deslope, and destagger with Zero Mean Traverse (ZMT) applied to selected ferrous dominated grids.

GZMT works by grouping the 30 traverses of data into four groups according to the sensor used and its orientation during data collection. The median values of each line of data are calculated and from these results an overall median value for each of the four groups is calculated. These four values are used to correct each of the 30 traverses. This is then followed up with ZMedT; this removes minor variations that are a result of instrument drift and preserves archaeological features thanks to a very narrow threshold.

The ungridded magnetometer cart data are downloaded from the acquisition software Nav601 and positions for each reading are calculated in Trackmaker601. This results in an XYZ file of the magnetometer data that can be processed. Gridded data is processed in MagPick to remove variations between Bartington sensors. The most common processing applied is a linear filter to remove variations between sensors.

The earth resistance data are downloaded in Geoplot in the .grd file format. Minor data corrections are then applied in Geoplot. The main difference from the processing of gradiometer data is that filtering is applied to earth resistance data.

The typical processing steps applied to earth resistance data are as follows:

- **Despike:** Removes anomalous data points that can arise during data collection.
- **Edge Match:** Corrects for differences between grids that arise when survey is carried out on different days or through the movement of the fixed probes.
- **Multiply:** This multiplies data in a selected area by a specified positive or negative value and alongside edge match is useful for the correction of grid differences.
- **Low Pass Filter:** This is used to remove small scale spatial detail and is useful for enhancing broad, weak anomalies.
- **High Pass Filter:** This removes large scale spatial detail and is useful for filtering out broad geological responses that could obscure archaeological features.

Two methods of data display are used to show gradiometer data: greyscales and XY trace plots. For the display of earth resistance data greyscale plots are used only.

- **Greyscale:** Presents the data in plan view with a shade of white, grey or black assigned to each reading according to its magnetic or resistance value. At the standard survey resolution each rectangular pixel corresponds to a reading.
- **XY Trace:** Presents each line of the magnetic data as a graph line with multiple lines overlapping to produce a stack of profiles. The graph running upwards signifies a positive anomaly (red) and running down (black) indicates a negative. This is of help in further characterising a magnetic anomaly as either archaeological or ferrous.



APPENDIX 2: INTERPRETATION CATEGORIES

The interpretation methodology used by Lefort Geophysics divides anomalies into five main categories: archaeological, agricultural, modern, geological and uncertain origin.

The archaeological category is used where a detected anomaly presents a shape or configuration that looks to be indicative of a buried archaeological feature. Further sources of information including aerial photography and historic maps may be incorporated into the final interpretation. This category is sub-divided into two groups based on levels of confidence in the interpretation.

- Archaeology – this is used to classify anomalies with a clear anthropogenic pattern that do not appear to relate to modern or agricultural features.
- Possible Archaeology – this is used for anomalies that give a fairly regular pattern but cannot be discounted as relating to modern, agricultural or geological features.

The modern category is used for anomalies that are presumed to be relatively recent in date. Modern is sub-divided into two categories as follows:

- Ferrous – used for anomalies characterised by a dipolar or bipolar response. Such anomalies can be caused by the presence of iron and ceramic material and are assumed to be modern in origin.
- Modern Service – used for responses considered to correspond to buried pipes and cables. Most detectable services are made from ferrous or ceramic materials.

The agricultural category is sub-divided into five categories as follows:

- Former Field Boundary – used for anomalies that are shown to correspond to the positions of field boundaries marked on historic maps.
- Agricultural – used for anomalies that follow known agricultural features or run parallel to them but do not appear on historic mapping.
- Ridge and Furrow – these are defined by broad and diffuse linear positive and negative anomalies. Ridge and furrow are broad strips of raised ground with parallel ditches that were cultivated during the medieval and post-medieval periods.
- Ploughing – used to define narrow linear trends running through the data created by ploughing scars in the soil.
- Drainage – used to define ceramic field drains or ditches running through a field that are used to keep the soil well drained. Ceramic drains are identified by their distinctive anomaly form whereas ditched drains are identified more by their layout.

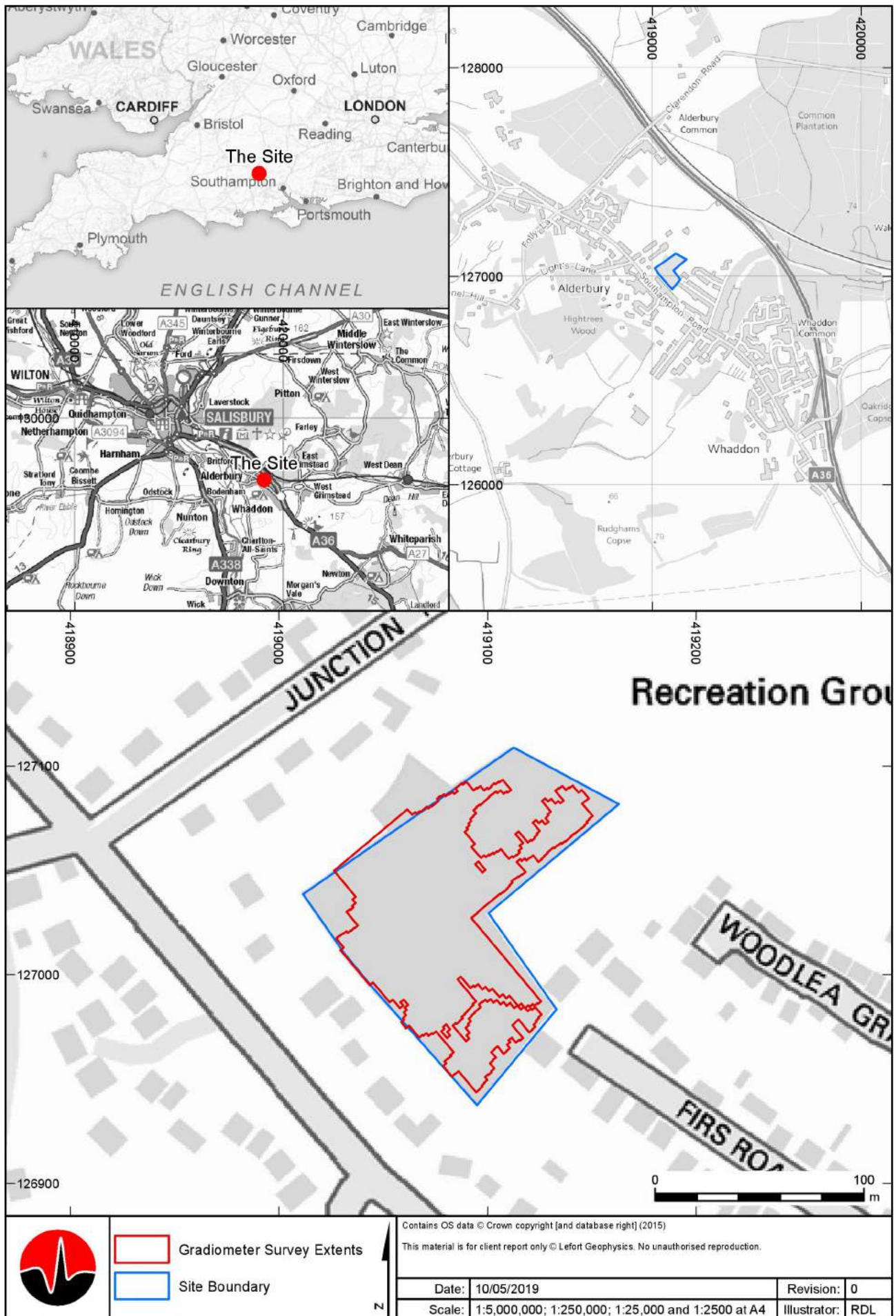
The geological category defines areas of broad and diffuse responses that are not considered to be archaeological. There are two sub-divisions of this category:

- Superficial Geology – used to define broad spreads of responses considered to relate to shallow geological deposits.
- Palaeochannel – used to define linear and curvilinear anomalies that are considered to represent former watercourses.

The uncertain origin category is used for anomalies that cannot be classified confidently in any of the four categories outlined above. There are two sub-divisions of this category:

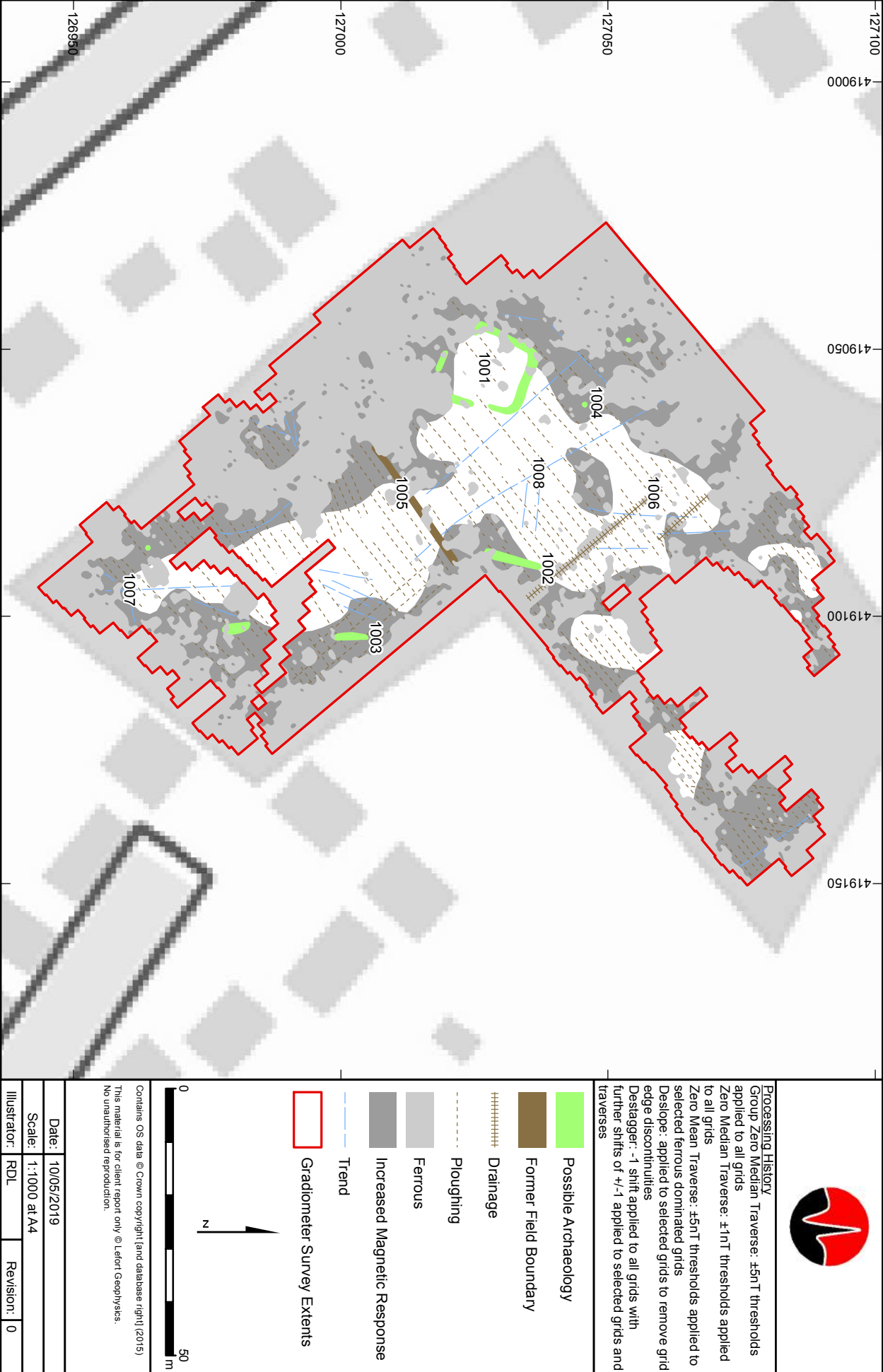
- Increased Magnetic Response – used to define areas of varying magnetic responses.
- Trend – weak narrow linear responses that do not seem to relate to ploughing.

Other categories may be added in some instances to account for unusual features or where a project specification requires more detailed interpretation. Any additions will be outlined in the introduction of the results section of the survey report.



Site location and gradiometer survey extents

Figure 1



Interpretation

Figure 3

