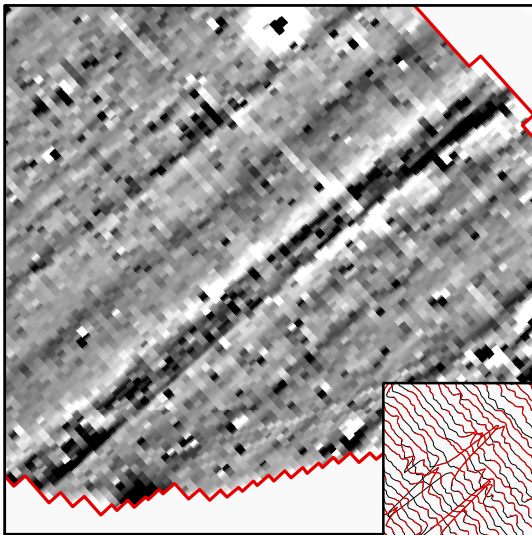


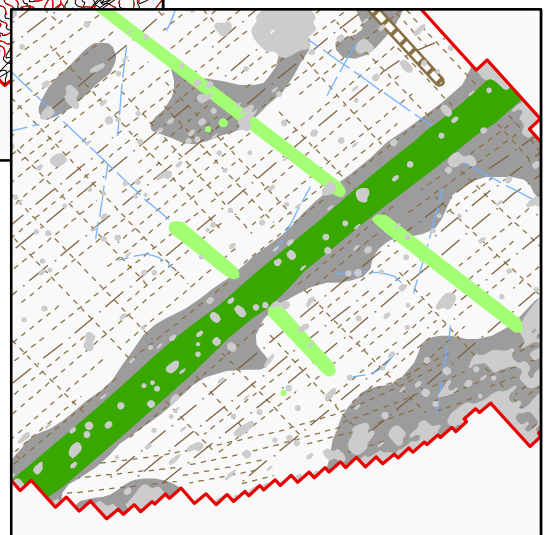
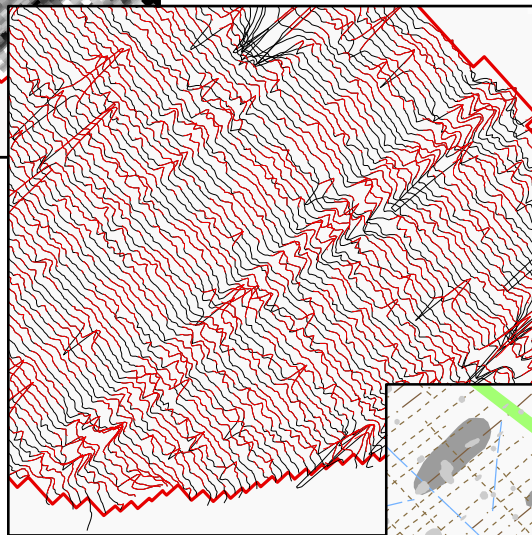


LEFORT GEOPHYSICS



Land Northwest of White Street West Lavington, Wiltshire

Gradiometer Survey Report



Report Ref: 24-0022.01

September 2024



**Land Northwest of White Street,
West Lavington, Wiltshire**

Gradiometer Survey Report

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Land Northwest of White Street, West Lavington, Wiltshire

Gradiometer Survey Report

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Land Northwest of White Street, West Lavington, Wiltshire

Gradiometer Survey Report

Summary

A gradiometer survey was conducted over land off White Street, some 0.25km northwest of the centre of West Lavington, Wiltshire. The project was commissioned by Landgag Heritage 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 a gentle east facing slope on the northern edge of West Lavington, some 7.75km south of the centre of Devizes. The survey area measures approximately 2.16ha and of this a total of 1.69ha has been covered by geophysical survey.

A probable track or road has been detected along with a few undated possible agricultural features. Other responses detected include numerous agricultural features, trends of uncertain origin and at least one modern service.

The survey was undertaken by the Lefort Geophysics survey team on the 18th of September 2024.

Acknowledgements

The gradiometer survey was commissioned by Landgag Heritage. The assistance of Isobelle Ward 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 Northwest of White Street, West Lavington, Wiltshire

Gradiometer Survey Report

1. Introduction

1.1. Project Background and Survey Objectives

- 1.1.1. Lefort Geophysics was commissioned by Landgage Heritage to carry out a geophysical survey over land off White Street, to the northwest of West Lavington, Wiltshire. The survey area is centred on NGR 400425, 153250 (**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 2.16ha.
- 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 approximately 0.25km northwest of the centre of West Lavington and some 7.75km south of the centre of Devizes, Wiltshire. The site comprises two pasture fields with the survey extents defined by surrounding field boundaries on all sides (**Figure 1**).
- 1.2.2. The site spans a gentle east facing slope. The land in the western corner of the site is over 90m above Ordnance Datum (aOD) and falls to under 85m aOD in the eastern corner. An unnamed stream flows north, past the east of the site; this watercourse flows northeast to eventually join the River Avon between Trowbridge and Melksham.

1.3. Geology and Soils

- 1.3.1. The bedrock geology under the site is recorded as glauconitic sandstone deposits of the Upper Greensand Formation that dates to the Cretaceous Period. No superficial deposits have been recorded under the site (BGS).



- 1.3.2. The soils underlying the majority of the site are recorded as typical argillic brown earths of the 571h (Ardington) association. The soils underlying the western edge are recorded as typical brown calcareous earths of the 511d (Blewbury) 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.



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 guidelines set by Historic England (2008) and the Europae Archaeologiae Consilium (EAC 2016).
- 2.1.2. The survey was undertaken by the Lefort Geophysics survey team on the 18th of September 2024. Site conditions were good with firm ground under foot, low vegetation and an even surface temperature throughout the survey. Of the proposed 2.16ha area a total of 1.69ha was covered by geophysical survey. The shortfall in coverage is due largely to a heavily vegetated strip along the western edge 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 and EAC minimum requirements for geophysical survey (English Heritage 2008 and EAC 2016).
- 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 and conforms to a Level 1 (prospection) survey, as defined by the EAC (2016).
- 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 likely and possible archaeological interest. A number of other features have been detected including numerous agricultural features and at least one modern service. 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 -4nT (white) to +6nT (black) and the XY trace plots are displayed at ± 50 nT at 50nT per cm.
- 3.1.2. A greyscale plot of the raw data is included as an appendix figure which is displayed from -5nT to +5nT (**Figure 3b**).
- 3.1.3. The interpretation of the dataset highlights the presence of potential archaeological features, modern features, geological responses, agricultural features and anomalies of uncertain origin (**Figure 3a**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.
- 3.1.4. 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 most noteworthy feature detected is a broad positive linear response at **1001** to **1002**. This runs on a rough northeast to southwest alignment and runs roughly perpendicular to the nearby High Street. The response measures 5m in width and has variable magnetic values along its length and across its width. This response is considered to represent a metalled trackway or road; this does not feature on the historic mapping consulted and may have gone out of use before the late 19th century. This feature is classed as archaeology.
- 3.2.2. Linear features cross this area at **1003** to **1004** and **1005** to **1006**; the former is a positive response with the latter negative. These could prove to be agricultural features of unknown date and are classed as possible archaeology.
- 3.2.3. A further linear feature at **1007** is closely associated with ferrous responses. This could prove to be archaeological but could also relate to the allotments recorded in this area. Due to this uncertainty in identification this feature is classed as possible archaeology.
- 3.2.4. Small pit-like responses are observed within the dataset such as at **1008**. These responses could prove to be archaeological features such as postholes or small pits but could equally prove to be natural features or are deeply buried ferrous or ceramic objects. Due to this uncertainty these responses are classed as possible archaeology.
- 3.2.5. Two former field boundaries are visible at **1009** and **1010** to **1011**. The former is visible on the 1889 edition Ordnance Survey map with the latter not visible until the 1926 edition. Unmapped ditches running along the northeast edge at **1012** and **1013** are classed as agricultural.



- 3.2.6. Ridge and furrow is visible across much of the dataset with particularly well-defined responses visible around **1014**.
- 3.2.7. A modern service and possible second short service are visible at **1015** and **1016**. These will be discussed in the next section of the report.
- 3.2.8. The remaining responses are trends of uncertain origin. Some, such as at **1017**, may prove to be of archaeological interest whereas others, such as at **1018**, may prove to be agricultural in origin.

3.3. Gradiometer Survey Results and Interpretation: Modern Services

- 3.3.1. A clear modern service crosses the dataset at **1015** with a shorter possible second service visible at **1016**.
- 3.3.2. It is not clear if any of the detected services are in active use. It should also 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 likely and possible archaeological interest. A number of other features have been detected including numerous agricultural features and at least one modern service. The survey and this report are considered to have addressed all of the aims set out for the project.
- 4.1.2. The most noteworthy feature detected is the probable track or road. This does not feature on the historic mapping consulted. This could either be due to the route going out of use prior to any mapping exercise or this may simply be a path that served the allotments once located within this area.
- 4.1.3. The linear positive and negative features crossing the southern field may relate to undated agricultural features such as former boundaries or drainage features.
- 4.1.4. The small pit-like responses scattered across the dataset are considered to have a low archaeological potential. This is as many could prove to be natural features such as tree throws or may even relate to deeply buried ferrous/ceramic objects.
- 4.1.5. The majority of detected features attest to this area serving an agricultural function in recent centuries.
- 4.1.6. 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. Inhumation burials are also difficult to identify at times as the backfill of the grave is largely unchanged, in terms of its magnetic properties, during the burial process.
- 4.1.7. The dimensions of the modern services in the gradiometer data are indicative of the strength of their magnetic response; this varies according to the materials used in their construction. The physical extents of the services may therefore differ in the ground from that depicted in the geophysical data. It is not possible to accurately determine the depth of burial of these services through gradiometer survey.



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 using a cart system. On this system multiple Bartington Grad601-2 can be mounted with positions logged by a Trimble 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 5800 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 5800 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.

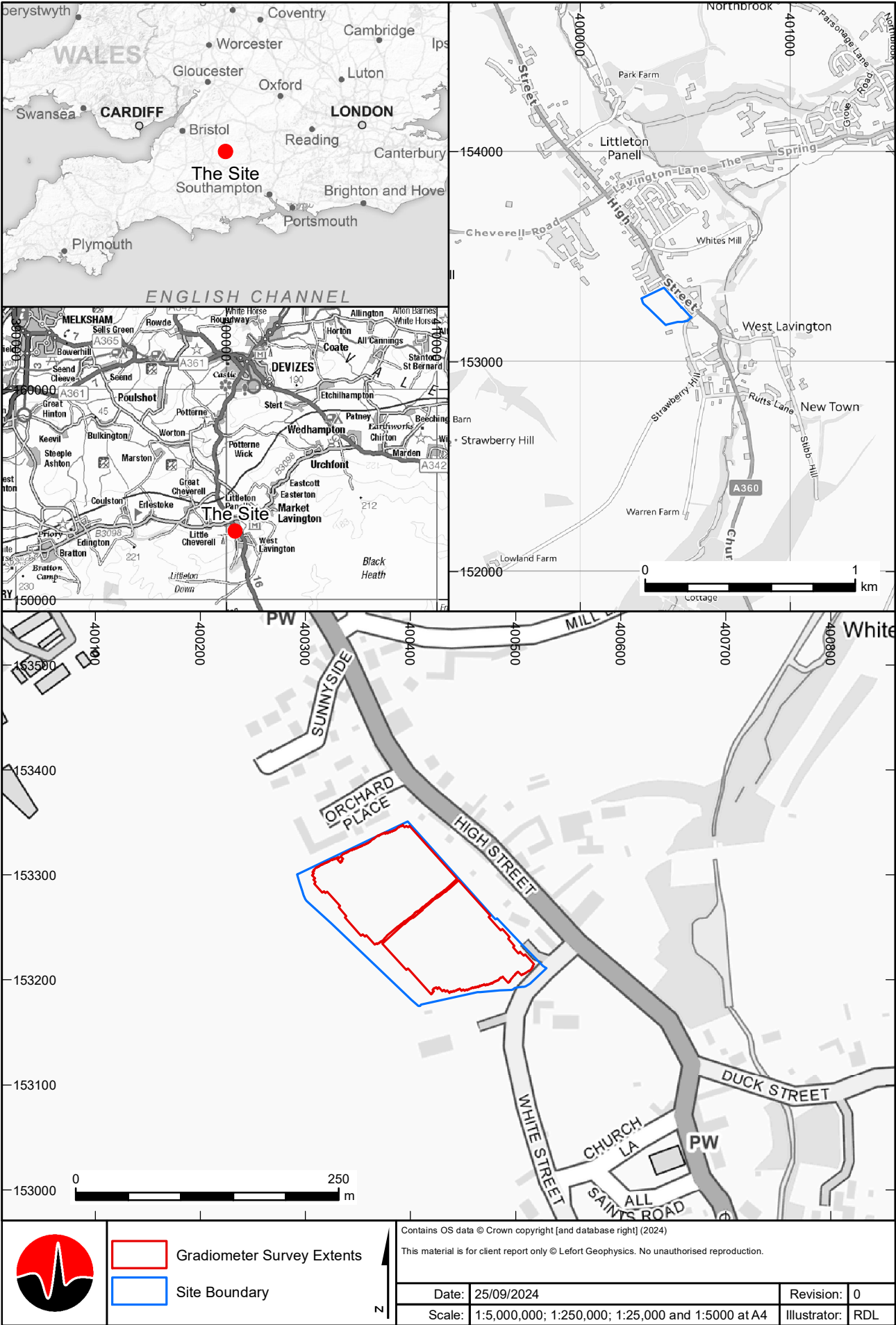
The geological category defines areas of broad and diffuse responses that are not considered to be archaeological. There are two sub-divisions of this category:

- 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:

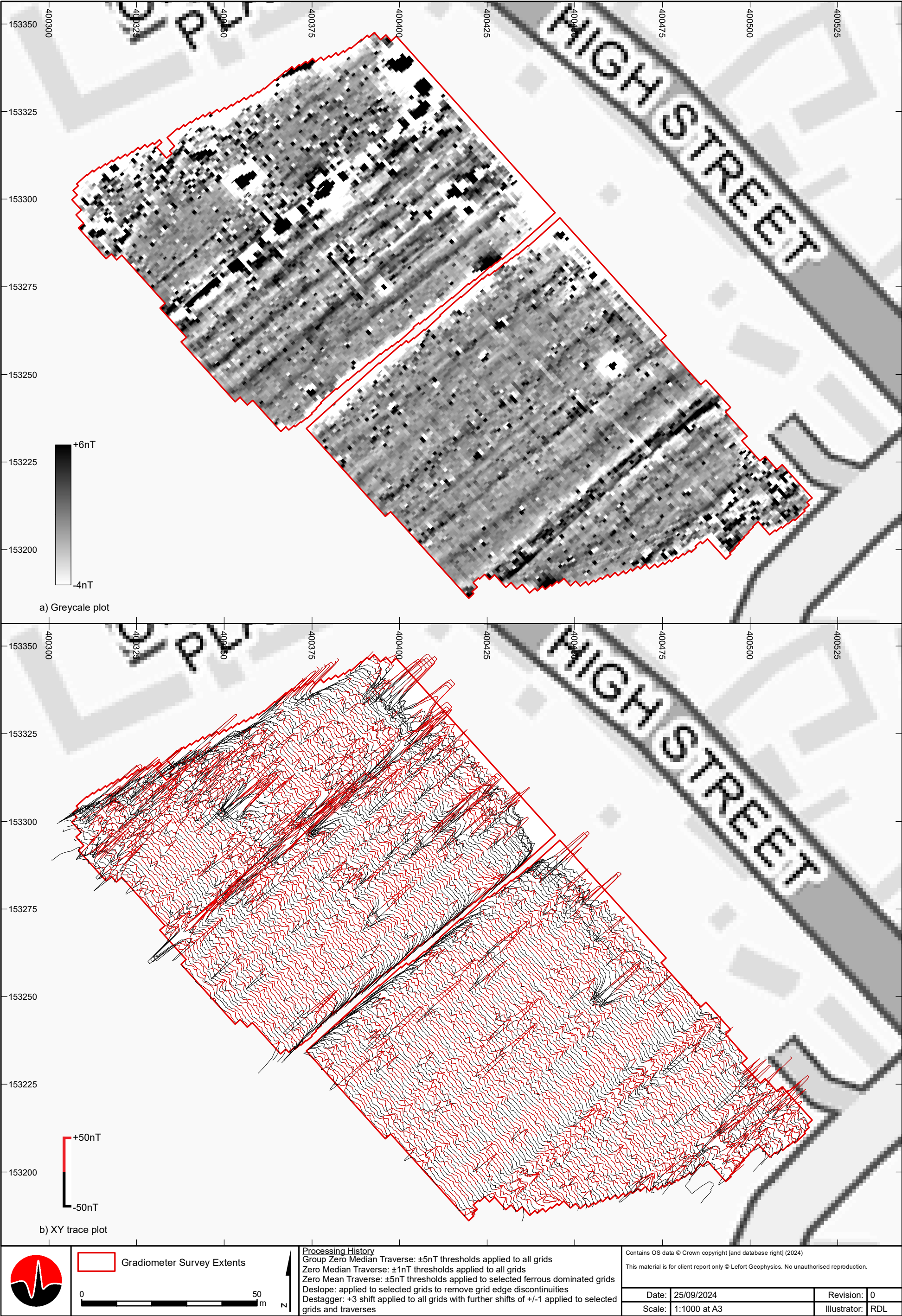
- Increased Magnetic Response – used to define areas of varying magnetic responses.
- Trend – weak narrow linear responses that do not seem to relate to ploughing.

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



Greyscale plot and XY trace plot

Figure 2



Interpretation and greyscale plot of raw unprocessed data

Figure 3

