GEOPHYSICAL SURVEY REPORT

STRATASCAN™

SUMO Survey Services
SUMO Group Member

Project name:

Helston, Cornwall

Client:

Cornwall County Council

February 2016

Job ref:

J9445

Report author:

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Survey date:
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1 SUMMARY OF RESULTS

A detailed gradiometry survey was conducted over approximately 16.7 hectares of grassland. Several features of archaeological origin have been identified. A possible Iron Age/Romano-British round and associated causewayed enclosure with linear anomalies have been detected. A rectilinear enclosure and associated pits have been identified, and given that the site lies within an area of Anciently Enclosed Land, a prehistoric origin cannot be ruled out. Additional linear anomalies and possible pits may be archaeological in origin, though may also be natural. Further linear anomalies and field boundaries may represent different phases of activity, and may be associated with possible field systems of nearby early medieval settlements/farmsteads. The number of field boundaries and evidence of ridge and furrow suggests the site has been largely used for agricultural purposes since the medieval period. The remaining features are natural or modern and include underground services, magnetic disturbance, and magnetic spikes.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey of an area outlined for development. This survey forms part of an archaeological investigation being undertaken by Cornwall County Council.

2.2 Site location

The site is located to the north of Gay's Hill Lane, Helston, at OS Ref. SW 669 268. The A394, Clodgey Lane, forms the western boundary of the site with agricultural land to the north and east.

2.3 Description of site

The survey area is approximately 18 hectares of grassland, however areas of overgrown vegetation and barns reduced the surveyable area to approximately 16.7 hectares. The survey area is undulating with a general slope down towards the east.

2.4 Geology and soils

The underlying geology is Mylor Slate Formation – Slate and Siltstone (British Geological Survey website). There is no drift geology recorded for the majority of the site, however an area of Alluvial deposits are recorded in the north-east (British Geological Survey website).

The overlying soils are known as Denbigh 2, which are typical brown earths. These consist of well drained fine loamy soils (Soil Survey of England and Wales, Sheet 5 South West England).

2.5 *Site history and archaeological potential*

A search of Cornwall Historic Environment Record (Cornwall County Council, 2016) within a 500m radius of the site identifies a number of prehistoric and medieval remains. Immediately to the north of the site a sub-rectangular enclosure (HER No. 51936), approximately 50m x 40m, is visible as cropmarks on aerial photographs and appears to have a possible entrance to the south. This enclosure is potentially an Iron Age/Romano-British round. A series of linear ditches (HER No. 51937) to the south of this feature may be associated with the possible round and have a comparable Iron Age/Romano-British origin. A group of 10 oblong shaped pits (HER No. 51938) in the same location as the possible round and field system are of unknown date, however they lie within an area of Anciently Enclosed Land and may be prehistoric in origin.

The early medieval settlements of Tresprison (HER No. 30243) and Tregarrick (HER No. 30239) are recorded approximately 200m to the north-east and 300m east of the site respectively, having first been documented in 1304. It is possible that these represented small settlements or farmsteads that lay within a wider agricultural landscape.

Within a broader 1km radius of the site several further prehistoric and medieval features are recorded. The remains of an Iron Age round at Crasken (HER No. 30106), with a causewayed entrance and associated field system (HER No. 30106.10) are recorded approximately 800m north-east of the site. A second possible round (HER No. 51933) is thought to be an annexe of the Crasken round. To the east of the site a series of curvilinear and linear features are visible (HER No. 51945) and are thought to be associated with a former round. A further enclosure is recorded east of the site (HER No. 51941) and is similar to other possible prehistoric features spread across nearby fields, including a round (HER No. 51943) and a field system (HER No. 51942).

A large number of additional early medieval settlements are recorded within the 1km radius and include: Crasken (HER No. 30106.20), Casterills (HER No. 30224), Gwealhellis (HER No. 302501.10), Nansloe (HER No. 30110), Gwealfolds (HER No. 302224.1) Roskillen (HER No. 30238) and Goonwin (HER No. 30229).

The large number of significant Iron Age/Romano-British remains surrounding the site indicate that there is a high potential to discover remains of this period, particularly as the site lies within an area of Anciently Enclosed Land. Given the considerable number of early medieval settlements around the site it can also be determined that there is a high potential for agricultural remains of this period to be detected.

2.6 *Survey objectives*

The objective of the survey was to locate any features of possible archaeological origin in order that they may be assessed prior to development.

2.7 *Survey methods*

This report and all fieldwork have been conducted in accordance with both the English Heritage guidelines outlined in the document: *Geophysical Survey in Archaeological Field*

Evaluation, 2008 and with the Chartered Institute for Archaeologists document *Standard and Guidance for Archaeological Geophysical Survey.*

Given the potential for Iron Age, Roman, and medieval activity, detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating archaeological anomalies. More information regarding this technique is included in Appendix A.

2.8 Processing, presentation and interpretation of results

2.8.1 Processing

Processing is performed using specialist software. This can emphasise various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all minimally processed gradiometer data used in this report:

1. *Destripe* (Removes striping effects caused by zero-point discrepancies between different sensors and walking directions)
2. *Destagger* (Removes zigzag effects caused by inconsistent walking speeds on sloping, uneven or overgrown terrain)

2.8.2 Presentation of results and interpretation

The presentation of the data for each site involves a print-out of the minimally processed data both as a greyscale plot and a colour plot showing extreme magnetic values. Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site.

3 RESULTS

The detailed magnetic gradiometer survey conducted at Helston has identified a number of anomalies that have been characterised as being either of a *probable* or *possible* archaeological origin.

The difference between *probable* and *possible* archaeological origin is a confidence rating. Features identified within the dataset that form recognisable archaeological patterns or seem to be related to a deliberate historical act have been interpreted as being of a probable archaeological origin.

Features of possible archaeological origin tend to be more amorphous anomalies which may have similar magnetic attributes in terms of strength or polarity but are difficult to classify as being archaeological or natural.

The following list of numbered anomalies refers to numerical labels on the interpretation plots.

*3.1 **Probable Archaeology***

1-3 Positive sub-circular and linear anomalies in the north-west of the site. The sub-circular feature is similar to Iron Age/Romano-British rounds which are recorded near to the site. The linear feature which extends to the south of the circular anomaly, comprising a ditch (Anomaly 2) with banks on either side (Anomaly 2a), may be part of a causewayed entrance, similar to that visible at the Crasken round (HER No. 30106). Within the round itself an area of enhanced magnetic response (Anomaly 3) is likely related to the settlement activity.

4 Positive linear anomalies and associated negative anomalies (Anomaly 4a) in the north of the site, representative of a double-ditched enclosure. Two small discrete positive anomalies (Anomaly 4b) are indicative of former backfilled pits and are likely related to the enclosure. Given the close proximity of prehistoric remains, an Iron Age/Romano-British origin cannot be ruled out for this feature, though its exact origin is unknown.

5 A positive linear anomaly with associated negative anomaly in the north of the site, running north-east to south-west. This is indicative of a banked ditch, and is similar in appearance to the feature extending south from the possible round. Given that the site lies within an area of Anciently Enclosed Land, it is possible that this feature is prehistoric in origin and forms part of a wider field system.

6 A series of positive linear anomalies across the north of the site. These are indicative of former cut features of archaeological origin. Given their proximity to the possible round and a known field system to the north, it is likely that these are of prehistoric origin and represent part of an additional field system.

7-8 A series of positive linear anomalies in the south-east of the site. These are indicative of former cut features, such as ditches, with associated negative response. These are likely to represent part of a former field system, however their differing orientation to those of Anomaly 12 suggests they are from a different phase of activity. Anomaly 8 is a curvilinear positive anomaly in the south of the site. It is indicative of a former cut feature, such as a ditch. The exact origin of this feature cannot be determined with confidence, though its

position within an area of Anciently Enclosed Land means that a prehistoric origin cannot be ruled out.

3.2 Possible Archaeology

9 A small number of positive linear anomalies across the site. These are indicative of former cut features of possible archaeological origin. These may be related to the field boundaries and enclosures identified in the site, though their exact origin is unknown.

10 Positive linear anomalies in the east of the site. These are indicative of former cut features, and are not dissimilar in appearance to Anomaly 5. The origin of these is unknown, they may be archaeological in origin but may also be natural.

11 Three small discrete positive anomalies in the north-east of the site. These are indicative of former cut features, such as backfilled pits, and may be archaeological or natural in origin.

3.3 Medieval/Post-Medieval Agriculture

12 A number of positive linear anomalies with central negative response. These are likely to be related to former field boundaries, though are not visible on available mapping dating back to 1811.

13 A small area of slightly curved, parallel linear anomalies in the east of the site. These are related to medieval ridge and furrow cultivation.

14 Closely spaced parallel linear anomalies across the site. These are related to modern agricultural activity, such as ploughing.

3.4 Other Anomalies

15 A number of areas of amorphous magnetic variation in the south and centre of the site. These are likely to be natural, i.e. geological, in origin.

16 Three strong bipolar linear anomalies in the running along the west and through the centre of the site. These are related to modern underground services, such as pipes or cables.

17 Areas of magnetic disturbance are the result of substantial nearby ferrous metal objects such as fences and underground services. These effects can mask weaker archaeological anomalies, but on this site have not affected a significant proportion of the area.

18 A number of magnetic 'spikes' (strong focussed values with associated antipolar response) indicate ferrous metal objects. These are likely to be modern rubbish.

4 DATA APPRAISAL & CONFIDENCE ASSESSMENT

Slate geologies in Cornwall generally provide good results for gradiometer survey. In this instance, the data across the site shows a high contrast between archaeological features and the background magnetic response. A large number of archaeological features have been identified, and it is can be determined that the survey has been effective.

The archaeological anomalies in the northeast of the site gradually fade into the superficial deposits suggesting that the alluvium may be masking further features in this location.

5 CONCLUSION

The survey at Helston has identified a number of features of archaeological and agricultural origin. A likely Iron Age/Romano-British round has been identified, supporting information from the HER search of the site lying within an area of extensive prehistoric activity. The round has a possible causewayed entrance, similar to one known to the north of the site at Crasken (HER No. 30106), and associated field system. A further rectilinear enclosure and associated pits has been identified and is again of possible prehistoric origin. Linear anomalies and possible pits may be associated with the Iron Age/Romano-British activity seen on the site, though their exact origin is unknown. Additional linear anomalies may represent an early medieval field system associated with the nearby settlements or farmsteads of Tresprison and Tregarrick. Further former field boundaries have also been identified, along with an area of ridge and furrow cultivation and modern ploughing across the site, suggesting that the site has been used for agricultural purposes since the medieval period.

The remaining features are natural or modern in origin. The natural features include areas of amorphous magnetic variation, while the modern features include underground services, disturbance from nearby ferrous metal objects, and magnetic spikes which are likely to be modern in origin.

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APPENDIX A – METHODOLOGY & SURVEY EQUIPMENT

Grid locations

The location of the survey grids has been plotted together with the referencing information. Grids were set out using a Leica 705auto Total Station and referenced to suitable topographic features around the perimeter of the site or a Leica Smart Rover RTK GPS.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. A SmartNet RTK GPS uses Ordnance Survey's network of over 100 fixed base stations to give an accuracy of around 0.01m.

Survey equipment and gradiometer configuration

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTeslas (nT) in an overall field strength of 48,000nT, can be accurately detected using an appropriate instrument.

The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil.

To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The instrument consists of two fluxgates very accurately aligned to nullify the effects of the Earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each gradiometer has a 1m separation between the sensing elements so enhancing the response to weak anomalies.

Sampling interval

Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

Depth of scan and resolution

The Grad 601-2 has a typical depth of penetration of 0.5m to 1.0m, though strongly magnetic objects may be visible at greater depths. The collection of data at 0.25m centres provides an optimum methodology for the task balancing cost and time with resolution.

Data capture

The readings are logged consecutively into the data logger which in turn is daily down- loaded into a portable computer whilst on site. At the end of each site survey, data is transferred to the office for processing and presentation.

APPENDIX B – BASIC PRINCIPLES OF MAGNETIC SURVEY

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremanent* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremanence is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremanent archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

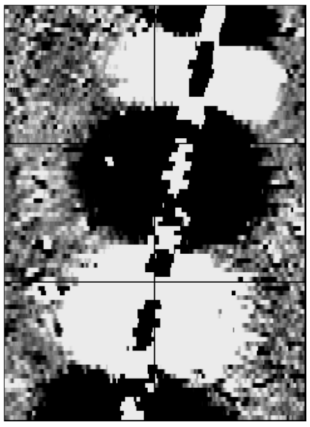
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

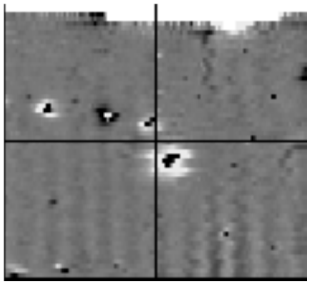
APPENDIX C – GLOSSARY OF MAGNETIC ANOMALIES

Bipolar



A bipolar anomaly is one that is composed of both a positive response and a negative response. It can be made up of any number of positive responses and negative responses. For example a pipeline consisting of alternating positive and negative anomalies is said to be bipolar. See also dipolar which has only one area of each polarity. The interpretation of the anomaly will depend on the magnitude of the magnetic field strength. A weak response may be caused by a clay field drain while a strong response will probably be caused by a metallic service.

Dipolar

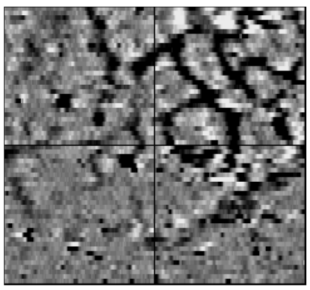


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very strong anomaly is likely to be caused by a ferrous object.

Positive anomaly with associated negative response

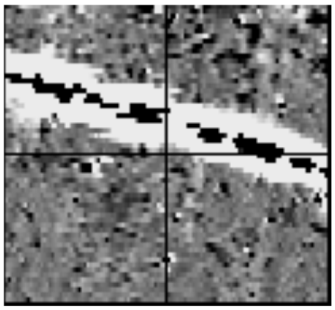
See bipolar and dipolar.

Positive linear



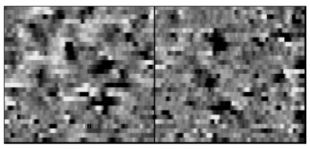
A linear response which is entirely positive in polarity. These are usually related to in-filled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity and some may even have a natural origin.

Positive linear anomaly with associated negative response



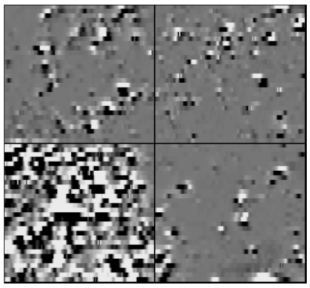
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field boundaries.

Positive point/area



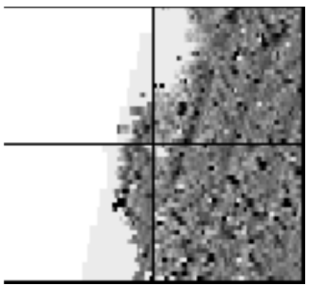
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by in-filled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally occurring depressions in the ground.

Magnetic debris



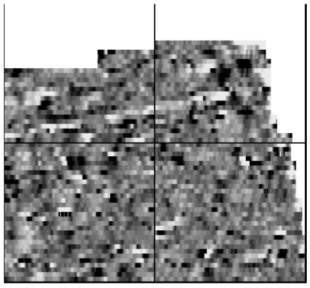
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly (+/-250nT) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremanent material such as bricks or ash.

Magnetic disturbance



Magnetic disturbance is high amplitude and can be composed of either a bipolar anomaly, or a single polarity response. It is essentially associated with magnetic interference from modern ferrous structures such as fencing, vehicles or buildings, and as a result is commonly found around the perimeter of a site near to boundary fences.

Negative linear

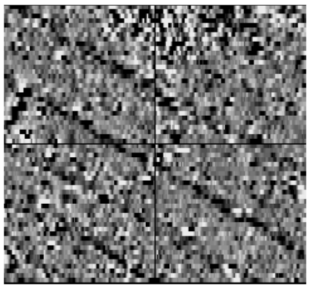


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative to the background top soil is built up. See also ploughing activity.

Negative point/area

Opposite to positive point anomalies these responses may be caused by raised areas or earthen banks. These could be of an archaeological origin or may have a natural origin.

Ploughing activity



Ploughing activity can often be visualised by a series of parallel linear anomalies. These can be of either positive polarity or negative polarity depending on site specifics. It can be difficult to distinguish between ancient ploughing and more modern ploughing. Clues such as the separation of each linear, straightness, strength of response and cross cutting relationships can be used to aid this, although none of these can be guaranteed to differentiate between different phases of activity.

Polarity

Term used to describe the measurement of the magnetic response. An anomaly can have a positive polarity (values above 0nT) and/or a negative polarity (values below 0nT).

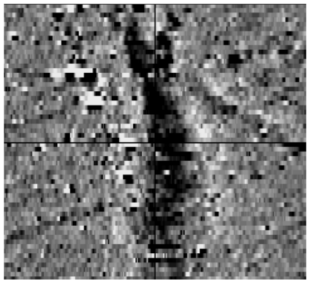
Strength of response

The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a 10m^2 area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size and shaped anomaly but with values up to only 4nT may have a natural origin. Colour plots are used to show the amplitude of response.

Thermoremanent response

A feature which has been subject to heat may result in it acquiring a magnetic field. This can be anything up to approximately +/-100 nT in value. These features include clay fired drains, brick, bonfires, kilns, hearths and even pottery. If the heat application has occurred in situ (e.g. a kiln) then the response is likely to be bipolar compared to if the heated objects have been disturbed and moved relative to each other, in which case they are more likely to take an irregular form and may display a debris style response (e.g. ash).

Weak background variations



Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be caused by changes in the underlying geology or soil type which may contain unpredictable distributions of magnetic minerals, and are usually apparent in several locations across a site.

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