STRATASCAN

Geophysical Survey Report

South Molton
Devon

for

Exeter Archaeology

August 2006

J 2197

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REGISTERED ORGANISATION IFA

Geophysical Survey Summary Sheet

Job number: 2197
Location: South Molton
Client: Exeter Archaeology

Job name: South Molton, Devon
OS ref: SS 715 263

Site description:
The survey area consists of 1ha of pasture land which has undulating topography.

An area of burnt clay and charcoal was observed extending over 20m during a watching brief on the site. It is not apparent whether these represent true features as naturally occurring dark patches have also been observed within the soil. Pot shards have been identified within the top soil, but it is not clear if these are residual.

Geology/pedology:
The underlying geology is of the Upper Carboniferous including coals and Millstone Grit. The overlying soils are of the Neath soil association. These consist of well drained fine loamy soils.

Current land use: Pasture

Technique: Detailed magnetic survey
Instrument: Bartington Grad601-2
Sample interval: 0.25m

Survey area: 1ha

Traverse interval: 1m

Summary of results:
A gradiometer survey was carried out over a 1 ha site at South Molton. The objective was to locate any responses which may be of archaeological origin. Within the area positive linear anomalies were identified that could be related to cut features of possible archaeological origin. However a large number of anomalies relating to ferrous and magnetic objects that are most likely of a modern day origin were also discovered and may mask any fainter archaeological anomalies. Also a number of agricultural marks were seen in the south of the site in two clear orientations.

Survey Date: August 2006

Report date: August 2006

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LIST OF FIGURES

1 INTRODUCTION

1.1 Background synopsis

Stratascan were commissioned by Exeter Archaeology to undertake a geophysical survey.

1.2 Site location

The site is located at South Molton, Devon at OS ref. SS 715 263.

1.3 Description of site

The survey area consists of 1ha of pasture land which has undulating topography. The underlying geology is of the Upper Carboniferous including coals and Millstone Grit (British Geological Survey South Sheet, Fourth Edition Solid, 2001). The overlying soils are of the Neath soil association. These consist of well drained fine loamy soils (Soil Survey of England and Wales, Sheet 5 South West England).

1.4 Site history and archaeological potential

An area of burnt clay and charcoal was observed extending over 20m during a watching brief on the site. It is not apparent whether these represent features of an archaeological origin as naturally occurring dark patches have also been observed within the soil. Pot shards have been identified within the top soil, but it is not clear if these are residual.

1.5 Survey objectives

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

1.6 Survey methods

Detailed magnetic survey was used as an efficient and effective method of locating archaeological anomalies. More information regarding this technique is included in the Methodology section below.

2 METHODOLOGY

2.1 Standards and Guidance

All site work and reporting has been carried out in accordance with English Heritage Research and Professional Services Guideline No.1: Geophysical Survey in Archaeological Field Evaluation, 1995.

Stratascan Limited is a Registered Archaeological Organisation and as such is committed to upholding the standards and policies set out by the Institute of Field Archaeologists.

2.2 Date of fieldwork

The fieldwork was carried out on 2nd August 2006. Weather conditions during the survey were fine and dry. It should be pointed out that for magnetic surveys most weather conditions do not effect the capability of the instruments used nor the quality of the data recorded.

2.3 Grid locations

The location of the survey grids is based on the Ordnance Survey National Grid, see Figure 2. The referencing and alignment of grids was achieved using a Leica GPS System 500.

A DGPS (differential 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. Calculations to correct for these errors are performed at an accurately located base station. The base station then transmits the corrections which are received by DGPS consoles giving sub metre accuracy.

2.4 Survey equipment

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each sensor has a 1m separation between the sensing elements giving a strong response to deep anomalies.

2.5 Sampling interval, depth of scan, resolution and data capture

2.5.1 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.

2.5.2 Depth of scan and resolution

The Grad601-2 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.25m centres provides an appropriate methodology balancing cost and time with resolution.

2.5.3 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 job, data is transferred to the office for processing and presentation.

2.6 Processing, presentation of results and interpretation

2.6.1 Processing

Processing is performed using specialist software known as *Geoplot 3*. 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. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. 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 processed gradiometer data used in this report:

Despike (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values)

Geoplot parameters:
X radius = 1, y radius = 1, threshold = 3 std. dev.
Spike replacement = mean

Zero mean grid (sets the background mean of each grid to zero and is useful for removing grid edge discontinuities)

Geoplot parameters:
Threshold = 0.25 std. dev.

Zero mean traverse (sets the background mean of each traverse within a grid to zero and is useful for removing striping effects)

Geoplot parameters:
Least mean square fit = off

2.6.2 Presentation of results and interpretation

The presentation of the data for each site involves:

- A print-out of the raw data as grey scale (Figure 3), this viewing of the data allows comparison with the processed data showing the effect of processing steps.
- Trace plots (Figure 4 and 5), show the relative magnitude of data measurements which is important for interpretation.
- A print out of the processed data as grey scale (Figure 6), shows a ‘clean’ image of the data after artefacts of the data collection process have been removed.
- Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figure 7), showing the

interpretation of the data. Often very weak anomalies revealing fine detail can be extracted by an experienced professional that may otherwise be overlooked.

3 RESULTS

The magnetometer survey identified a number of geophysical anomalies across the site, some of which may relate to archaeological activity. These anomalies have been divided into the following categories:

- Positive linear anomaly with associated negative response – possible field boundary
- Linear anomaly – probable agricultural mark
- Positive linear anomaly – cut feature of possible archaeological origin
- Strong linear anomaly – probably relating to a modern service
- Negative linear anomaly within area of positive response – uncertain origin
- Moderately strong bipolar anomaly – uncertain origin
- Magnetic debris – probably caused by scatter of ferrous objects
- Magnetic disturbance – probably caused by modern magnetic interference

Positive linear anomaly with associated negative response – possible field boundary
A positive linear anomaly with associated negative response with values up to around +/30nT is observed in the north east of the survey area. This anomaly is of uncertain origin but probably contains some metallic component and may relate to a former field boundary. Fragmentary anomalies possibly associated with a former field boundary are also seen to the south of this feature, parallel to linear anomalies thought to be agricultural in origin.

Linear anomaly – probable agricultural mark
To the south of the site a large area consisting of a series of linear anomalies is observed. These are probable agricultural marks possibly caused by ploughing action. As the anomalies occur in two different directions this could be the result of two separate phases of agricultural activity.

Positive linear anomaly – cut feature of possible archaeological origin
There are five weak positive linear anomalies visible over the site. They are located to the north, south and southwest of the survey area. These anomalies are possibly the result of infilled cut features of possible archaeological origin.

Strong linear anomaly – probably relating to a modern service
A strong bipolar linear anomaly is present on the site running from north west to south east. The linear fashion and strength of this response means that it is probably the result of a modern service.

Negative linear anomaly within area of positive response – uncertain origin
To the east of the survey area two negative linear anomalies are observed within an area of positive response. The origin of this is unclear. Both the positive and negative responses are weakly enhanced suggesting they may have an archaeological origin,

possibly representing earthworks with associated cut features. Further investigation would be required to clarify the exact cause of these anomalies.

Moderately strong bipolar anomaly – uncertain origin
In the southeast of the site there is a strip containing a moderately strong bipolar anomaly that lies between the location of the negative linear anomaly within an area of positive response and the stronger anomaly interpreted as a service. The cause of this anomaly is uncertain, but it is possibly related to a service.

Magnetic debris – probably caused by scatter of ferrous objects
There are two areas of magnetic debris present in the survey area. The largest is located in the northwest corner of the site, with a smaller area situated towards the east of the site. These anomalies are probably a result of disturbed ground. The eastern response is somewhat stronger in magnetic magnitude suggesting it may also contain ferrous or thermoremnant material on the ground or buried near the surface.

Magnetic disturbance – probably caused by modern magnetic interference
Two areas of magnetic disturbance can be found at the survey area. The first and largest of the areas is positioned to the east of the site while the smaller area is towards the west of the survey area. These disturbances are probably a result of a modern magnetic interference caused by fences or buried magnetic objects. The eastern response may also be associated with the moderately enhanced bipolar anomaly located to the south, and as such may relate to service infrastructure. These strong responses may obscure the presence of faint anomalies that could arise from possible archaeological targets.

4 CONCLUSION

The areas of large magnetic disturbances and anomalies situated over the site are probably all related to ferrous objects and ground disturbance of a modern origin. These objects could take the form of modern day services running through the site or metal objects buried beneath the surface, possibly associated with a former land use at the survey location. The series of orthogonal lines that are clearly present seen running through the south of the area are typically the result of ploughing.

The cut features that were identified may be of an archaeological origin, however the large number of areas of strong anomalies resulting from ferrous debris may obscure any other faint anomalies that could be of archaeological origin.

5 REFERENCES

British Geological Survey, 2001. *Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Solid)*. British Geological Society.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 5 South West England*.

APPENDIX A – 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 *thermoremnant* 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. Measuring the magnetic susceptibility of a soil can therefore give a measure of past human activity.

Thermoremnance 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. Thermoremnant archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

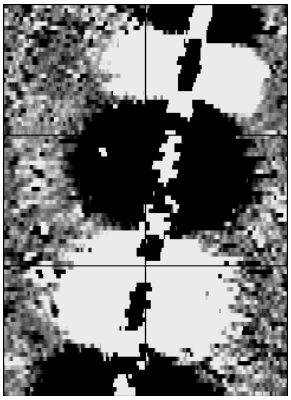
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement 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 either 0.5 or 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.

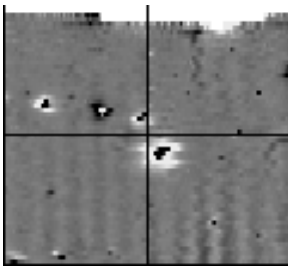
APPENDIX B – Glossary of magnetic anomalies

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

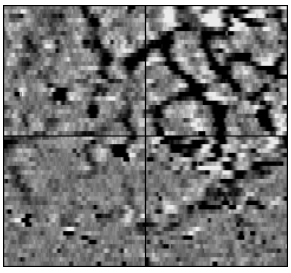


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

Positive anomaly with associated negative response

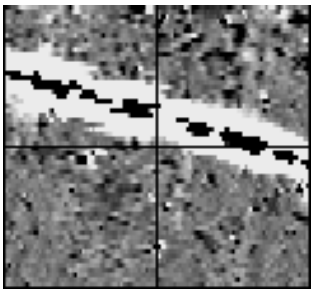
See bipolar and dipolar.

Positive linear



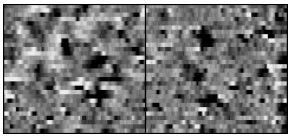
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity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

Positive linear anomaly with associated negative response



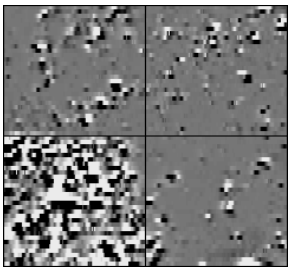
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features or field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

Positive point/area



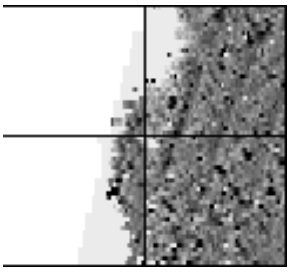
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally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

Magnetic debris



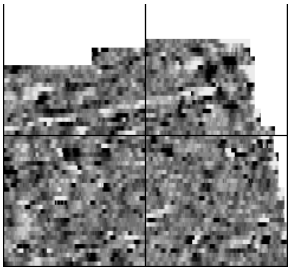
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, and may be caused by something as simple as an area of dug or mixed earth. A stronger anomaly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

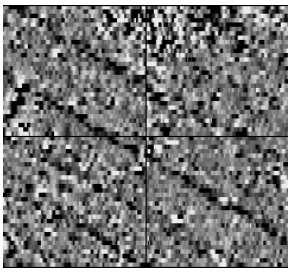


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

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

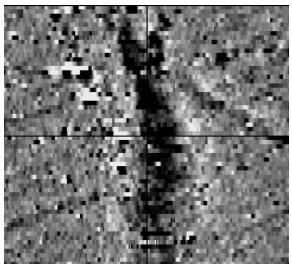
The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a $10m^2$ area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size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

Thermoremnant 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 insitu (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.