STRATASCAN

Geophysical Survey Report

Down Ampney, Wiltshire

for

Thames Valley Archaeological Services

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1 SUMMARY OF RESULTS

A magnetic susceptibility reconnaissance survey was carried out over 54ha of land near Down Ampney, Wiltshire. Following this three areas of enhanced magnetic susceptibility and one area of moderate magnetic enhancement were targeted with detailed magnetic survey (13.5ha).

In these four areas numerous weak positive linear anomalies were found in a regular pattern suggestive of ploughing activity. In addition several anomalies most likely associated with modern services were located running through Areas 1 and 2. Finally there were anomalies that may have an archaeological origin, with several possible cut features being identified within the data.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by Thames Valley Archaeological Services to undertake a geophysical survey of an area outlined for development as a gravel quarry.

2.2 Site location

The site is located near to Down Ampney, Wiltshire close to Cirencester at OS ref. SU 084 965.

2.3 Description of site

The survey area is approximately 54ha of flat grassland. The underlying geology is Oxford Clay and Kellaways Beds (British Geological Survey South Sheet, Fourth Edition Solid, 2001) with overlying river terrace deposits (British Geological Survey South Sheet, First Edition Quaternary, 1977). The site lies on the border of two overlying soil types, known as Kelmscot soils and Badsey 1 soils. Kelmscot soils are calcareous fine loamy soils over gravel that are variably affected by groundwater where as Badsey 1 soils are well drained calcareous and non calcareous fine loamy soils over limestone gravel (Soil Survey of England and Wales, Sheet 5 South West England).

2.4 Site history and archaeological potential

The site is located adjacent to Scheduled Ancient Monument No. 899 and within 1km of SAM Nos. 477 and 900. The site is shown to contain several crop marks indicating the archaeological potential is high.

2.5 Survey objectives

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

2.6 Survey methods

The reconnaissance technique of magnetic susceptibility was employed over the whole of the survey area. From this four areas of enhancement were targeted with detailed magnetometer survey. More information regarding these techniques is included in the Methodology section below.

3 METHODOLOGY

3.1 Date of fieldwork

The fieldwork was carried out over nine days from 7th December 2006 to 20th December 2006 when the weather was mostly fine with some rain.

3.2 Grid locations

The location of the survey grids is based on the Ordnance Survey National Grid, see Figure 4. The referencing and alignment of grids was achieved using a Leica DGPS System 500 and Leica TS 705auto Total Station.

3.3 Description of techniques and equipment configurations

3.3.1 Magnetic Susceptibility

Alteration of iron minerals in topsoil through biological activity and burning can enhance the magnetic susceptibility (MS) of that soil. Measuring the MS of a soil can therefore give a measure of past human activity and can be used to target the more intensive and higher resolution techniques of Detailed Magnetic Survey and Resistivity. Measurements of MS were carried out using a field coil which provides a rapid scan and has the benefit of allowing "insitu" readings to be taken.

The equipment used on this contract was an MS2 Magnetic Susceptibility meter manufactured by Bartington Instruments Ltd. A field coil known as an MS2D was used to take field readings. This assessed the top 200mm or so of topsoil. To overcome the problem of ground contact all readings were taken 4 or 5 times and an average taken. All obvious localised "spikes" were ignored.

3.3.2 Magnetometer

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTesla (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 Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each sensor has a 1m separation between the sensing elements increasing the sensitivity to small changes in the Earth's magnetic field.

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

3.4.1 Sampling interval

Magnetic susceptibility
The magnetic susceptibility survey was carried out on a 20 m grid with readings being taken at the node points.

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

3.4.2 Depth of scan and resolution

Magnetic Susceptibility
The MS2D coil assesses the average MS of the soil within a hemisphere of radius 200mm. This equates to a volume of some 0.016m^3 and maximum depth of 200mm. As readings are only at 20m centres this results in a very coarse resolution but adequate to pick up trends in MS variations.

Magnetometer
The Bartington 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. The data was collected at a resolution of 0.1 nT.

3.4.3 Data capture

Magnetic susceptibility
Reading coordinates are uploaded to a DGPS console prior to leaving the office. Magnetic susceptibility values recorded on site are manually entered into the console at the appropriate position. The console is downloaded to a PC at the end of each job.

Magnetometer
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.

3.5 Processing, presentation of results and interpretation

3.5.1 Processing

Magnetic susceptibility
No processing of the data has been undertaken.

Magnetometer
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 magnetometer data used in this report:

Despike	*X radius = 1 Y radius = 1* *Threshold = 3 std. dev.* *Spike replacement = mean*
Zero mean traverse	*Pos. Threshold = 5, Neg. Threshold = -5.*

3.5.2 Presentation of results and interpretation

Magnetic susceptibility
The presentation of the data for this site involves a colour scale plot of the field measurements overlain onto a site plan (see Figures 2 & 3).

Magnetometer
The presentation of the data for each area involves a print-out of the raw data both as grey scale (e.g. Figure 5) and trace plots (e.g. Figure 6 & 7), together with a grey scale plot of the processed data (e.g. Figure 8). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (e.g. Figure 9).

4 RESULTS

4.1 Magnetic susceptibility

The magnetic susceptibility data (Figure 3) shows several areas having higher readings, indicating the magnetic enhancement of the soil in these areas. The western end of the survey area is notably higher, as is the south eastern edge of the area. A smaller area of enhancement can be seen in the centre of the eastern survey area. It was thus decided to target these areas with detailed magnetic survey (see Figure 4) to further investigate the causes for these enhancements. In addition an area with lower magnetic enhancement was targeted (Area 2) in order to check this lower response area as a control.

4.2 Detailed magnetic survey

Magnetic anomalies were detected in all four areas, which have been highlighted in abstraction plots. For ease of discussion the anomalies have been assigned to several different categories. In addition the results for each area will be discussed separately.

Area 1 (north)
In the abstraction for this area (Figure 9) several different categories of anomaly have been identified and are explained below.

Positive anomaly with associated negative response – ferrous object
Several strong dipolar responses have been identified in this area. These are most likely to be caused by modern ferrous debris.

Area of positive magnetic response – possible archaeological or geological response
A large anomaly running through the central portion of the area falls into this category and a smaller anomaly at the northern border of the survey area. The larger anomaly appears roughly linear and is around 140m long and at its widest is around 17m. The magnitude of the response is fairly strong typically between 5 and 17 nT which is too weak to be caused by a ferrous object or modern service. The nature of the response together with the associated positive anomalies to either side seems similar to a cut feature such as a ditch, however, the size, shape and alignment of the anomaly makes an archaeological origin less likely. It is possible this is a modern cut feature or a strong geological response. The smaller more northerly response could possibly be a continuation of this anomaly or a separate entity however the extent of the survey precludes further interpretation of this anomaly.

Area of negative magnetic response associated with nearby positive anomaly
These negative anomalies are most likely to be the negative response of a dipolar anomaly with the positive section directly adjoining them discussed above. The anomalies have been separated so as to provide better clarity.

Positive linear anomaly – probable agricultural mark
Throughout this area and indeed the site as a whole linear features appear along similar alignments, mostly northwest to south east with some anomalies perpendicular to this. Typically these features typically have a response of 0.5 - 1 nT with some stronger anomalies of around 1.5 nT, this order of response would indicate the anomalies were caused by ground disturbance rather than other enhancement methods which generally provide stronger responses. The most likely explanation for these features is ploughing carried out in two orientations roughly perpendicular to each other. It is not possible to ascertain at what time this ploughing was carried out without further investigation.

Positive area anomaly – pit or depression of possible archaeological origin
Two anomalies of this category appear in the centre of the area, they appear as discrete areas with typical readings of 2 to 5 nT. Although the nature of response may be

suggestive of a pit or depression, the exact nature of these features can only be confirmed with excavation.

Area of positive response – probable geological/pedological response
In the north east of the survey area an area of mixed positive response can be identified, with typical responses being only 1-2 nT. In conjunction with the size and shape of this anomaly, this seems to indicate this anomaly is most likely due to underlying geology or pedology.

Magnetic Disturbance – associated with pipe/cable
At the western border is a very high positive linear anomaly that is truncated by the border of the survey area. The high readings from this anomaly (up to 3000 nT) and its linear nature indicate it is most likely to be a modern service. To the east of this anomaly is a thin bipolar anomaly and at the south eastern edge of the survey area a wider bipolar anomaly can also be seen. These high amplitude, bipolar responses are typically associated with pipes or cables and are thus also likely to be modern services.

Area of strong positive and negative response – response related to nearby pipe/service
Due to the highly magnetic nature of pipes and cables the magnetic disturbance caused by them is often broad and strong and is detectable by the magnetometer some distance away from the service.

Area 1 (South)
The abstraction for this area is shown in Figure 14.

Discrete anomaly – possible pit
Two of these anomalies appear towards the southern end of the survey area. They are relatively weak typically around 2 nT and appear to be quite well defined. Such low responses are often associated with ground disturbance or filling of more magnetic soils as opposed to thermoremnance or ferrous responses which are generally much larger in amplitude.

Positive linear anomaly – cut feature of possible archaeological origin
Several anomalies of this category have been identified and have been labelled in figure 14 in order to aid identification. Anomaly A appears in the central portion of Area 1 (South). It appears as a low amplitude anomaly with a response of around 1.4nT and turns from a east-west orientation to a north-south orientation. Anomalies B and C are two linear anomalies that appear on a similar alignment and may possibly be related to a feature truncated at some point, possibly the nearby agricultural mark. The response is of similar amplitude to the agricultural marks (around 0.5 – 1 nT), however, the alignment of this feature is distinctly different to the alignment of the agricultural marks on the rest of the survey area and therefore possibly of a different origin. To the east of these anomalies lies anomaly D. This anomaly has a similar magnetic response as the previous anomalies B and C, its alignment is slightly different to the general trend for agricultural marks and therefore, presents the possibility of a different origin.

In the south of the survey area two anomalies (E and F) appear roughly perpendicular to each other. Anomalies F, G, H and I appear along a similar orientation (roughly southwest to northeast) and are aligned in such a way it is possible they form the response for one linear feature that may have a varying magnetic signature or have been interrupted by some activity. Anomalies F to I have a larger amplitude response than the anomalies discussed so far, between 0.5 and 2 nT. Anomaly E has a magnetic response between 0.5 and 1.5 nT.

Positive linear anomaly – agricultural mark
The anomalies in this area that fall into this category are similar in nature to those seen in Area 1 (North).

Positive anomaly with associated negative response – ferrous object
Several strong dipolar responses have been identified in this area these are most likely to be caused by modern ferrous debris.

Magnetic disturbance – associated with pipes or service
These anomalies continue from Area 1 (north) and are similar in nature, the most easterly anomaly appears to turn and leave the survey area.

Area of strong positive and negative response – response related to nearby pipe/service
Both linear magnetic anomalies identified above have associated area responses, these extend further from the eastern anomaly than the western anomaly.

Area 2
Area 2 is located east of Area 1 and the abstraction is shown on Figure 9.

Linear anomaly – possibly related to land drains
Several anomalies of this type appear in this area. They have a bipolar signature similar to ferrous pipes or services but have an amplitude of response which is much weaker. In this case between –1.5 to 5 nT. One possible explanation for this kind of magnetic response is use of fired ceramic pipes as land drains which would carry a thermoremnant signature that could be detected. It is also worth noting that these anomalies seem to have a similar alignment to the anomalies identified as possible agricultural marks suggesting they may be associated with the same activity.

Positive linear anomaly – agricultural mark
The agricultural marks in this area appear less frequently than other areas of the site although they appear to have a similar alignment to Area 1 (north) and have similar magnetic responses.

Positive anomaly with associated negative response – ferrous object
Two anomalies of this category have been identified in this area, they are most likely to be caused by modern ferrous debris.

Magnetic disturbance – associated with pipes or service
One anomaly of this category has been detected running towards Area 1 (north). However, no anomaly was located in Area 1 that would obviously link up with this anomaly and it is possible that it turns or ends in the unsurveyed area.

Area of strong positive and negative response – response related to nearby pipe/service
This area of strong dipolar response is most likely to be associated with the linear anomaly discussed above.

Area 3
Area 3 is located towards the east of the site, the anomalies found are abstracted in Figure 19.

Discrete anomaly – possible pit
One anomaly of this type was located in Area 3 towards the southeast of the area (anomaly N). It appears to be a discrete anomaly around 2 nT in amplitude.

Positive anomaly with associated negative response – ferrous object
Three anomalies of this category have been identified in this area and are most likely to be caused by pieces of ferrous debris.

Positive linear anomaly – agricultural mark
The anomalies in this area appear to be on a similar alignment to those in Areas 1 and 2 despite the fact that Area 3 is in a different field at present. The anomalies running roughly southwest to northeast appear well defined and to be regularly spaced around ten meters apart with a response of around 0.5 -1.2 nT. This would seem to indicate an origin for these anomalies other than ploughing. One possible explanation is that these anomalies are the result of some modern deep cutting activity, possibly to improve drainage of the site. The marks running northwest to southeast seem similar in nature to those found in areas 1 and 2 and suggests ploughing activity.

Positive linear anomaly – feature of possible archaeological origin
In the northwest of the survey area appear several apparently curvilinear anomalies (K1, K2, J, J2 and J3). The anomalies are very weak, only around 1 nT in amplitude and appear to be truncated by agricultural marks. The unusual morphology of these anomalies may indicate an archaeological origin however the disturbance in the area by agricultural activity makes the exact extent of these anomalies difficult to ascertain. Running through the centre of the area are two long linear anomalies (L and M) that appear in a similar location to the southwest to northeast agricultural marks. The response of these anomalies is between 1.5 and 2.5 nT and the alignment of these two linear anomalies appears different to the overall trend associated with the agricultural anomalies and therefore may have a different origin.

Area of negative response – unknown origin
At the western border of the survey area appears a non-linear area anomaly of around -10 to –15 nT in amplitude. It appears to extend further outside the survey area. However, without further surveying to ascertain the characteristics of this anomaly the origin of this anomaly remains uncertain.

Area of magnetic variation – possible geological/pedological response
This anomaly is a broad feature with a roughly linear positive anomaly at its centre and negative anomalies to either side. The positive anomaly is around 0.1 - 3 nT while the negative anomalies range between –0.3 to –1.7 nT in amplitude. The anomalies appear to be truncated by some of the agricultural marks nearby. The morphology and nature of

the response seem to point to a geological or pedological origin for this feature however without further investigation it is difficult to ascertain the exact origin.

Area 4
Area 4 is located to the southeast of Area 3, the full area is abstracted on Figure 24.

Positive linear anomaly – cut feature of possible archaeological origin
Two linear anomalies roughly parallel to each other appear in the southwest of the survey area (anomalies R and S). Anomaly R appears to bend towards the north and both R and S have a different orientation to the agricultural marks in the area. Both anomalies are around 0.2 – 0.5 nT in amplitude, possibly indicating they are the result of a cut feature. To the east of these anomalies appear two curvilinear anomalies (Q1 and Q2) that range between 0.7 and 1 nT. At the far southern end of the survey area are a number of broad positive anomalies running approximately west-east (X1-X3). These anomalies appear to be linked and appear to truncate one agricultural mark that runs northwest to south east, but is itself interrupted by a broader anomaly that runs southwest to northeast. The alignment of this anomaly suggests that its origin may be something other than the agricultural activity identified. The amplitude of the magnetic response from this feature is around 1.5 nT which may suggest it is linked to a cut feature. To the northeast of the site there are two linear anomalies, O and P, that appear to change direction, indicating they are unlikely to be agricultural marks and thus may have an archaeological origin.

Discrete anomaly – possible pit
Five discrete anomalies in this category appear in the south of the site, two large anomalies (T1 and T2) have responses in the order of 2 –3 nT while the smaller anomalies to the south (U, V and W) have responses of 3 – 5nT.

Positive anomaly with associated negative response – ferrous object
Two large anomalies of this category have been identified in the east of the area and two smaller anomalies in the southeast. These anomalies are most likely to be caused by modern ferrous debris or varying size and depth.

Positive linear anomaly – agricultural mark
There are a large number of positive linear anomalies most likely to be agricultural marks in this area. The amplitude of response for these anomalies is around 1 nT in this area.

5 CONCLUSION

Initial surveying with magnetic susceptibility identified several areas of high readings that indicated magnetic enhancement in these areas. Three of these high response areas and one moderate response area were targeted with detailed magnetometer survey.

Throughout the four areas surveyed with detailed magnetic survey numerous weak amplitude positive linear anomalies were found, most likely originating from agricultural activity. This activity made the identification of other anomalies more difficult however, several anomalies of possible archaeological origin have been identified although the exact origin for these magnetic responses cannot be determined without further investigation.

REFERENCES

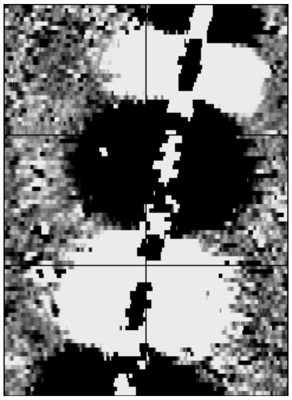
British Geological Survey, 2001. *Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Solid)*. British Geological Society.

British Geological Survey, 1977. *Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Quaternary)*. British Geological Society.

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

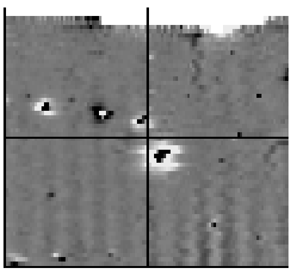
APPENDIX A – Glossary of magnetic anomalies

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

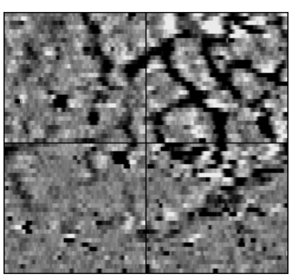


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

Positive anomaly with associated negative response

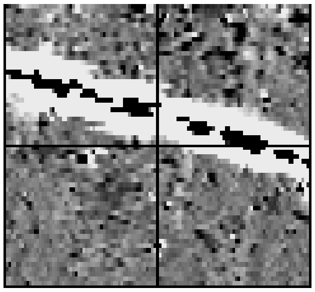
See bipolar and dipolar.

Positive linear



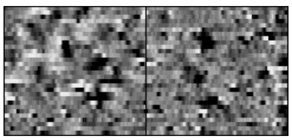
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity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

Positive linear anomaly with associated negative response



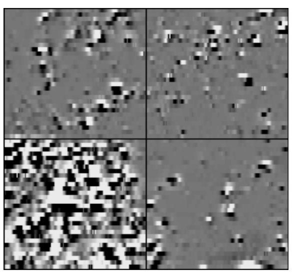
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field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

Positive point/area



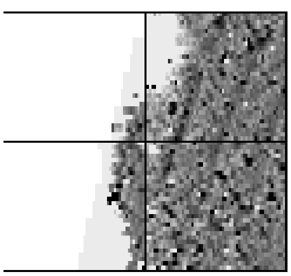
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally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

Magnetic debris



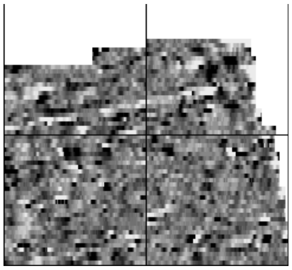
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly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

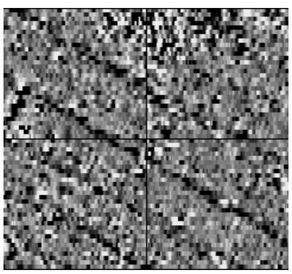


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

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).

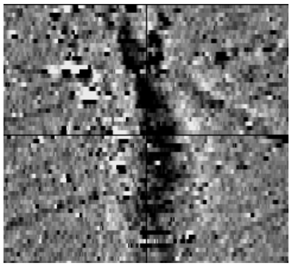
Strength of response

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.