Land at Stair Foot Lane,

Alwoodley,

Leeds.

(SE 2833 4040 site centred)

Geophysical Survey

Contents

Summary

A geophysical survey, covering approximately 1.5 hectares, was carried out on land where it is proposed to plant a deciduous woodland. A linear anomaly, which may have an archaeological origin, has been identified, although it is thought that a geological origin is more likely. Other linear responses are probably caused by pathways and by ridge and furrow ploughing.

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1. Introduction & Archaeological Background

1.1 Archaeological Services (WYAS) was commissioned by Mr. I. Sanderson, Principal Archaeologist (Advisory Service) of the West Yorkshire County Sites and Monuments, to carry out a geophysical (fluxgate gradiometer) survey on land east of Stair Foot Lane, Alwoodley, near Leeds (see Figs 1 & 2).

1.2 Stair Foot Lane bounds the site to the north and west with existing deciduous woodland forming the limits on the other sides. In total the site covers approximately 1.75 hectares. It is proposed that the field, which is owned by Leeds City Council, be planted with oak trees that will be sponsored by donations to Leeds Hospice.

1.3 The highest part of the site is in the northern corner which enjoys a dominating outlook to the south towards Leeds. From this high point the land slopes down both to the south and south-west. The underlying solid geology is Millstone Grit. At the time of survey (November 10th and 11th 1999) the site was under short grass that had been mown prior to survey.

1.4 There are no known archaeological features within the site itself. However, in the woodland to the east of the site a carved boulder bearing the image of a figure has been located. Expert opinion has suggested that this carving probably has an Iron Age origin. Also in the surrounding woods are a number of collapsed boulder walls which are thought could also date to the same period. Nevertheless a medieval or post-medieval date for these walls cannot be discounted. Therefore it was perceived that, given the proximity of known archaeological features, there might be other buried archaeological features within the site, which might be detrimentally affected by the proposed planting programme.

1.5 The objectives of the survey were:

- to establish the presence and extent of any geophysical anomalies within the survey area
- to characterise any such anomalies.

2. Results & Discussion

2.1 The gradiometer data is presented as a greyscale plot superimposed on a digital Ordnance Survey map base at a scale of 1:2500 in Figure 2. The data is also presented at a scale of 1:1000 in Figure 3a with an interpretation at the same scale in Figure 3b. Large scale (1:500) greyscale and X-Y trace plots of the data are presented in Appendix 4.

2.2 A general characteristic of the data is the difference in magnetic background between the higher, northern and eastern, parts of the site and the lower areas to the south and west. For example it can be seen, particularly on the 1:500 greyscale plots, that there are numerous small, iregular areas of both positive and negative response over the eastern half of the site; these anomalies are not thought to be archaeological so consequently have not been indicated on the interpretation figure. It is thought that these anomalies reflect variations in the magnetic susceptibility of the underlying geology and that they are more apparent on the upper slopes because of the presumed shallow depth of topsoil. It is assumed that the same geological variations occur on the lower lying parts of the site but that the greater depth of topsoil in these areas lessens the magnetic contrast thereby making these geological changes less apparent. A similar phenomenon was observed over parts of the site at Brackenhall Green, Baildon (Nicholls 1997) which was also located on a Millstone Grit outcrop with a very thin top-soil.

2.3 Vague linear striations can be seen on a north-west to south-east orientation, orthogonal to Stair Foot Lane. These have probably been created by the practice, begun in the Medieval period, of ploughing fields in a series of relatively narrow strips using a plough utilising a moulder board rather than a share to turn the sod. Over many years, if the exact form of the original strip is maintained, a characteristic ridged topography will result. Often, even when modern ploughing has destroyed any visual evidence for ridge and furrow ploughing, magnetic traces can still be detected, as is the case here.

2.4 At the eastern end of the site two negative linear anomalies have been identified. One aligns exactly with the stone wall that forms the north-eastern site boundary and may indicate a former ditched boundary division. The second anomaly correlates with the line of a public footpath which skirts the periphery of the site. A third anomaly along the southern site boundary probably has a similar origin.

2.5 Along the northern boundary a strong linear dipolar response is attributed to the proximity of a barbed wire fence and the area of magnetic disturbance to an accumulation of building rubble.

2.6 The number of "iron spikes" which are noted across all parts of the site probably indicate that the field has been cultivated over a number of years (also indicated by the evidence for ridge and furrow ploughing), the ferrous material causing these responses probably being introduced through manuring.

2.7 One short, linear anomaly, which shows both as a strong positive and negative response, has been identified on a north to south alignment. At the north-eastern end of this anomaly is an isolated positive anomaly. These type of responses could be indicative of an infilled ditch with a large pit (it is visible on three consecutive traces) or area of burning. However, a geological origin cannot be discounted.

3. Conclusions

3.1 In the English Heritage guidelines for geophysical survey (David 1995) it is stated that the response to magnetometer survey on Sedimentary geologies, such as Millstone Grit, is "average to poor". It is uncertain whether this generalisation relates to the magnetic properties of the rock itself or to the low magnetic susceptibility of the soils that have developed/pertain on this geology or to a combination of the above factors. Certainly, both here and at the only other site in West Yorkshire where magnetometer survey has been carried out on Millstone Grit geology (Brackenhall Green, Baildon) the magnetic background seems to be relatively quiet but with patchy, irregular responses that have been attributed to changes in the geology which are more noticeable where the topsoil is very thin. It is probable that in both these cases the upland location and sloping nature of the land has resulted in a very thin topsoil.

3.2 Until a magnetometer survey is carried out on a site with known archaeology where this type of geology prevails, or on a site where archaeological anomalies are interpreted and subsequently proven or disproven by trial excavation, it is difficult to determine the "reliability" of magnetometry in detecting archaeological features on Millstone Grit geology. However, the response from the linear anomaly on this site may indicate an archaeological feature. The remaining anomalies are due to relatively recent human activity.

The absence of geophysical anomalies should not be interpreted as indicating an absence of archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits. This is usually undertaken by means of targeted trial trenching.

The results and subsequent interpretation of geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. The nature of any sub-surface remains can normally be determined by direct investigation of these deposits by targeted trenching.

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Bibliography

David, A. 1995, 'Geophysical survey in archaeological field evaluation', English Heritage Research & Professional Services Guidelines No. 1

Nicholls, J. 1997, 'Brackenhall Green, Baildon; Geophysical Survey', Archaeological Services WYAS Report No. 453

Figures

Appendices

Appendix 1

Gradiometer Survey: Technical Information

1. Magnetic Susceptibility and Soil Magnetism

1.1 Iron makes up about 6% of the Earth's crust and is mostly dispersed through soils, clays and rocks as chemical compounds. These compounds have a weak, measurable magnetic response which is termed its magnetic susceptibility. Human activities can redistribute these compounds and change (enhance) others into more magnetic forms. These anthropogenic processes result in small localised anomalies in the Earth's magnetic field which are detectable by a gradiometer.

1.2 In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for the more magnetic compounds to concentrate in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. Less magnetic material such as masonry or plastic service pipes which intrude into the topsoil will tend to give a negative magnetic response relative to the background level.

1.3 The magnetic susceptibility of the soil can also be enhanced significantly by heating. This can lead to the detection of features such as hearths, kilns or burnt areas.

2. Types of Magnetic Anomaly

2.1 The types of response mentioned above can be divided into five main categories which are described below:

Isolated Dipolar Anomalies (Iron Spikes)

These responses are typically caused by iron objects on the surface or in the topsoil. Whilst archaeological artefacts could cause such anomalies, unless there is supporting evidence for an archaeological interpretation, little emphasis is usually given to such anomalies as iron objects of recent origin are common on rural sites, often being present as a consequence of manuring.

Areas of Magnetic Disturbance
These responses can have several causes and are often associated with burnt material, such as industrial waste or other strongly magnetised/fired material. They are usually assumed to have a modern origin unless there is other supporting information.

Positive Curvi/Linear Anomalies
They are commonly caused by infilled ditches which may be archaeologically significant. Former or current agricultural practice can also result in such anomalies.

Isolated Positive Anomalies
These anomalies can exhibit a magnitude of response of between 2nT and 300nT and can be caused by pits or post holes, ovens or kilns. They can also be caused by natural/geological features on certain geologies. It can often be very difficult to establish an anthropogenic origin without intrusive investigation.

Negative Linear Anomalies
These are normally very faint and are commonly caused by features such as plastic water pipes which are less magnetic than the surrounding soils and geology. They too can be caused by natural features on some geologies.

3. Methodology

3.1 There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as *scanning* and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10-15m apart. The instrument logger is not used and there is therefore no data collection. This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey. In some circumstances scanning can also be used to map out the full extent of features located during a detailed survey.

3.2 The second method is referred to as *detailed survey* and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.5m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation.

3.3 During this survey a Geoscan FM36 fluxgate gradiometer and ST1 sample trigger were used to take readings at 0.5m intervals on zig-zag traverses 1m apart within 20m by 20m square grids.

4. Data Processing and Presentation

4.1 The data has been presented in this report using X-Y trace plots and greyscale images. The former option shows the 'raw' data with no processing other than grid biasing whilst in the latter the data has been selectively processed to remove spurious errors such as striping effects and edge discontinuities caused by instrument drift and inconsistencies in survey technique caused by poor field conditions.

4.2 An X-Y plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a stacked plot. A hidden line algorithm has been employed to block out lines behind major 'spikes' and the data has been clipped at 10nT. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the shape of individual anomalies can be discerned and potentially archaeological anomalies differentiated from 'iron spikes'. In- house software (XY3) was used to create the X-Y trace plots.

4.2 In-house software (Geocon 9) was used to interpolate the data so that 1600 readings were obtained for each 20m by 20m grid. Contors was used to produce the greyscale images in which maximum and minimum cut-off limits have been chosen to best present the data; in the greyscale images the data is displayed using a linear incremental scale.

Appendix 2

Survey Location Information

1. Layout procedure

1.1 A site baseline was established on a roughly north to south alignment and all points on the site grid were set out using a Geotronics Geodimeter 600 series total station theodolite. Two temporary marker pegs (wooden stakes) were left *in situ* (Fig. 2 - A and B) and the site boundary also tied in using the Geodimeter thus enabling the grid to be accurately relocated if further work is required.

1.2 The site grid was then superimposed on an Ordnance Survey digital map base as a 'best fit' and co-ordinates obtained for the two temporary marker pegs. These are given on Figure 2 and are accurate to +/- 1.08m, the standard degree of accuracy quoted by the Ordnance Survey for 1:2500 digital mapping.

Archaeological Services (WYAS) cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

Appendix 3

Geophysical Archive

The geophysical archive comprises:-

- an archive disk containing the raw data, grid location information, report text (Word 6), and compressed CorelDraw/AutoCAD files of the graphics
- a full copy of the report

At present the archive is held by Archaeological Services (WYAS) although it is anticipated that it will eventually be lodged with the Archaeology Data Service (ADS). Brief details will also be forwarded for inclusion on the English Heritage Geophysical Survey Database (no information on the client shall be included) after the contents of the report are deemed to be in the public domain (*i.e* available for consultation in the relevant Sites and Monument Record Office).

Appendix 4

Gradiometer Data Plots (1:500)