Land at the junction of Doncaster Road & Field Lane,

South Elmsall,

West Yorkshire.

(SE 488 119 site centred)

Gradiometer Survey

Contents

Archaeological Services WYAS
14 St John's North, Wakefield WF1 3QA
Land at the junction of Doncaster Road & Field Lane,

South Elmsall.

Gradiometer Survey

1. Summary

1.1 **Client**

Commercial Development Projects Ltd.
Huddersfield Road
Elland
West Yorkshire
HX5 9BW.

1.2 **Objectives**

To determine the presence and extent of any sub-surface archaeological remains within the application area and if possible to characterise any such features.

1.3 **Methodology**

A magnetometer survey covering a sample area of 4 hectares was carried out using a Geoscan FM36 fluxgate gradiometer and data logger at the junction of Doncaster Road and Field Lane, South Elmsall.

1.4 **Results & Conclusions**

Several anomalies of possible archaeological origin were identified during the survey. These responses are typical of infilled ditches, perhaps forming part of the major system of land division/enclosure identified immediately west of the current site during earlier geophysical surveys and subsequent excavations.

2. *Introduction & Archaeological Background*

2.1 Archaeological Services (WYAS) was commissioned by Mr R. Gregory of Commercial Development Projects Ltd. to carry out a geophysical survey on land at the junction of Doncaster Road and Field Lane, South Elmsall (see Fig. 1).

2.2 The site was estimated at *c.* 8.6 hectares of which a minimum 40% sample (3.44 hectares) was to be surveyed (see Fig. 2). The location of these sample areas was to have been determined by the results of a magnetic susceptibility survey covering the whole of the site. However, after visiting the site it was apparent that the magnetic susceptibility study would not be appropriate given that *c*. 50% of the site was roughly ploughed. Instead the positions of the sample blocks was determined by standard survey criteria (see Appendix 2) and by the requirement to cover the projected alignment of a linear cropmark feature identified to the south of Field Lane. This feature has been postulated as the outer defensive ditch of a Roman marching camp (see Appendix 3).

2.3 All of the fields to the west of the current site, east of South Elmsall and north of Field Lane, have previously been evaluated by geophysical survey (McNaught 1997) and selected trial excavation (O'Neil in prep.) This field work has confirmed that the landscape was divided into a series of enclosures of probable late prehistoric and/or Romano-British date along a north-east/south-west axis.

2.4 The survey was carried out between March 10th to March 17th 1998. At this time approximately 50% of the site was under a young cereal crop with the remainder, as mentioned above, having been ploughed and left fallow.

2.5 The geology is Lower Magnesian Limestone with varying depths of topsoil.

3. *Results & Discussion*

3.1 The gradiometer data is presented as a greyscale plot at a scale of 1:2500 in Figure 2 with an overlay of the interpretation in Figure 3. The data are presented as dot density and X - Y trace plot formats at a scale of 1:500 in Appendix 4.

3.2 The most obvious general trend in the data is the difference in the magnetic background between the fields that were under crop at the time and those that were fallow after ploughing. In the seeded fields the background is very 'flat' while over the two ploughed fields the data is considerably more perturbed. This difference is particularly apparent when looking at the 1:500 X - Y trace plot (see Appendix 4) which is essentially displaying 'raw' data. The dot density plots have been filtered giving a more even background. This difference is primarily attributable to the difficulty in maintaining the instrument in a vertical position and at a consistent height above the ground whilst traversing across uneven ground.

3.3 Two areas of magnetic disturbance have been identified. The larger of the two is caused by buried rubble resulting from the destruction of a building adjacent to Doncaster Road.

3.4

3.5 Other responses that are non-archaeological are the ubiquitous isolated dipolar responses, ‘iron spikes’, that are caused by ferrous material in the topsoil, which is usually present as a result of manuring and/or dumping.

3.6

4. Conclusions

The results and subsequent interpretation of geophysical surveys should not be treated as an absolute representation of the underlying archaeology. It is normally only possible to prove the archaeological nature of anomalies through intrusive means such as by trial excavation.

Acknowledgements

Report
Alistair Webb BA

Graphics
Mark Whittingham BSc MA

Fieldwork
Alistair Webb
Mark Whittingham

Appendices

Appendix 1 Gradiometer survey: technical information and methods
Appendix 2 Survey location information
Appendix 3 Specification For Field Evaluation
Appendix 4 Gradiometer data plots

Appendix 1

Gradiometer survey: technical information and methods

1. Technical Information

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.

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.

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.

High, sharp responses are usually due to iron objects in the topsoil. These produce a rapid change from positive to negative readings ("iron spikes").

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

A Iron Spikes (Dipolar Anomalies)

These responses are referred to as dipolar and are caused by buried or surface iron objects. Little emphasis is usually given to such responses as iron objects of recent origin are common on agricultural sites. Occasionally, however, iron spikes can indicate the presence of smithing activity by detecting hammerscale.

B Rapid, strong variations in magnetic response

Also referred to as areas of magnetic disturbance, these can be due to a number of different types of feature. They are often associated with burnt material, such as industrial waste or other strongly magnetised material. It is not always easy to determine their date or origin without supporting information.

C Positive, linear anomalies

The strength of these responses varies depending on the underlying geology. They are commonly caused by ancient ditches or more recent agricultural features.

D Isolated positive responses

These usually exhibit a magnitude of between 2nT and 300nT and, depending on their response, can be due to pits, ovens or kilns. They can also be due to natural features on certain geologies. It can, therefore, be very difficult to establish an anthropogenic origin without an intrusive means of examining the features.

E 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.

2. Methodology

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 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 used as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be surveyed. Scanning can also be used to map out the full extent of features located during a detailed survey.

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.

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 x 20m square grids. Eight hundred readings were therefore taken in each grid and in-house software (Geocon Version 9) was used to interpolate the “missing” line of data so that 1600 readings in total were obtained for each complete grid.

Appendix 2

Survey location information and sample strategy

1. Survey location information

A baseline was established on a south-west to north-east alignment, broadly parallel with Field Lane, and a survey grid at 60m intervals laid out over the whole of the site using a Geotronics Geodimeter 600 series theodolite. Intermediate points were put in later as and when required using 60m tapes. These points were surveyed in relative to the site boundaries and to fixed survey points established during earlier surveys and excavations whose Ordnance Survey co-ordinates were known. The survey information was superimposed on the 1:2500 Ordnance Survey Digital Map SE 3823 (see Figure 2) using the fixed points and field boundaries as reference datum. National Grid co-ordinates were thus obtained for WDA1 and WDA2 as indicated in the following figure.

It should be noted that the Ordnance Survey co-ordinates for 1:2500 digital maps have an error of +/- 1.08m at a 99% degree of confidence. Figure 2 should not, therefore, be used for accurate measurement or location purposes.

2. Sample strategy

Initially blocks of grids (no smaller than 60m by 40m) were selected for survey such that no two adjacent blocks were more than 40m apart, subject to the constraints of the sample. No partial grids were surveyed and no readings were taken within 10m of the site boundary.

After completion of the minimum sample (40%) the data was processed and additional blocks added in order to reveal the full extent of the anomalies identified. This resulted in an additional 1 hectare being surveyed.

Appendix 3

Specification For Field Evaluation

Appendix 4

Gradiometer data plots (1:500)