Land at Santingley Lane,

Crofton,

Wakefield.

(SE 384 177 site centred)

Gradiometer Survey

Contents

Summary

A magnetometer survey covering 1.5 hectares was carried out over the site of a proposed housing development at Santingley Lane, Crofton. Despite severe magnetic disturbance, caused by ferrous contamination in the topsoil, linear anomalies thought to be part of a Romano-British enclosure system have been identified. Anomalies caused by modern service pipes were also identified.

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Introduction & Archaeological Background

Archaeological Services (WYAS) was to carry out a magnetometer survey over a 40% sample of a proposed housing development site, located to the north of Santingley Lane on the south-eastern edge of Crofton (see Figs 1 & 2).

Prior to the commencement of the project the rough pasture vegetation had been mown to facilitate survey although it was still dense and overgrown around the perimeter. There was significant dumping across the site, particularly around the edges, making it extremely uneven underfoot. A small triangular area of the site was located to the east of the main survey area. This was under a mature arable crop at the time of the survey and was not included in the fieldwork.

The site (total area 3.6ha), which slopes down from c. 80m O.D at the southern end to c. 65m O.D at the northern boundary, is situated on Coal Measure sandstone and shales. The survey was carried out on June 29th and 30th 1998.

Although there are no known archaeological remains within the proposed development area, a cropmark thought to be indicative of a late prehistoric/ Romano-British enclosure has been identified *c.* 150m north of the site boundary with a possible associated ditch running south-west towards the application area.

The main aim of the survey was thus to establish whether there are any sub-surface archaeological features in the development area and, if possible, to establish the extent, date and character of such features.

Results & Discussion

The gradiometer data is presented as a greyscale plot super-imposed on a 1:2500 Ordnance Survey digital map base in Figure 2 and as a 1:1250 greyscale plot with an interpretative overlay in Figures 3 and 4. It is also presented as dot density and X - Y trace plot formats at a scale of 1:500 in Appendix 5.

The most noticeable feature of the data is the amount of magnetic disturbance, particularly adjacent to the western edges of the site (nearest the housing), which is caused by the dumping of ferrous material. This is particularly apparent on the X - Y trace plots (see Appendix 3). A discrete, apparently regular, area of magnetic disturbance on the northern edge of the site may be caused either by an accumulation of sub-surface ferrous material or by modern structural remains. Isolated dipolar responses ('iron spikes') are so numerous across the site that only the strongest of these responses have been shown on the interpretation figure. These are also caused by ferrous material either on the surface or in the topsoil.

Other non-archaeological features include the strong dipolar linear anomaly which runs across the centre of the site from south-west to north-east (caused by a sewerage pipe), and the negative linear anomaly running roughly north to south which appears to terminate at a drain cover. This is also caused by a (non-ferrous) service pipe.

Two positive linear anomalies running north to south have been identified parallel with the field boundary. It is thought that they are probably caused by ploughing or by tractor wheelings although it is possible that they have an archaeological origin.

The remainder of the positive linear anomalies are of a possible archaeological origin, the responses being typical of infilled ditches. The most prominent of these is orientated roughly from north to south with an intermittent anomaly running from south-east to north-west to intersect with it. Two faint parallel anomalies, 4m apart, on the same alignment are also identified 40m to the south. These responses may be indicative of ditches either side of a trackway. A short (20m) positive linear anomaly can be seen in the north of the site. It may intersect with the previously described anomalies although its linearity suggests it could be caused by a field drain.

Conclusions

Positive linear anomalies have been identified that possibly form part of a prehistoric or Romano-British system of land division, although field drains could account for some of the observed responses.

The high degree of ferrous contamination across parts of the site could have masked the responses from other archaeological features, particularly from isolated features such as pits or kilns.

Two of the interpreted archaeological ditches run out of the surveyed area into the arable field. The full extent of these anomalies should be evaluated either by a small additional survey (< 0.25ha) following the harvest of the crop or by trial trenching during any Stage 2 Archaeological Works.

> ***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.***

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Appendix 1

Gradiometer survey: technical information and methods

1. Technical Information

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.

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

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

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.

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.

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.

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.

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

2.1 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 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.

2.2 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.

2.3 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. Eight hundred readings were 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.

Survey location information

1. Layout procedure

1.1 A baseline was established on a south-east to north-west alignment, parallel with the field boundary that separates the rough pasture from the improved pasture field. A survey area comprising 60m square grids was laid out over the site using a Geotronics Geodimeter 600 series total station theodolite. Intermediate points were put in later, as and when required, using 60m tapes. The grid points were tied in relative to the field boundaries and to temporary marker pegs using the total station.

1.2 The survey information was super-imposed on the 1:2500 Ordnance Survey Digital Map SE 3817 (see Figure 2) using the field boundaries as reference datum. National Grid co-ordinates were thus obtained for three temporary marker pegs, SLC2 (a bamboo cane), SLC3 and SLC4 (wooden stakes) as noted in Figure 2.

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. If measurements for location purposes are taken from Figure 2 this error should be taken into account.

2. Sample strategy

No survey grids were located beyond the field boundary in the eastern part of the proposed development area due to the presence of the arable crop. It was decided, therefore, that the geophysical survey would incorporate a block of grids 60m by 40m in the narrow southern part of the development area and the remainder of the grids were surveyed as one large block, located approximately in the centre of the northern part of the development area. Overgrown vegetation and dumped material precluded survey within 10m of the western site boundary whilst a pond and a small thicket also meant that the north-east corner of the site was unsurveyable.

Appendix 3

Specification for Field Evaluation

Appendix 4

Geophysical Archive

The geophysical archive comprises:-

- a 3.5 inch floppy disk containing the raw data, survey tie-in information and grid location information, the report text (Word 6), and compressed CorelDraw files of the illustrations
- a full copy of the report
- an A1 paste-up of the 1:500 data plots.

At present these are all held by Archaeological Services (WYAS).

Appendix 5

Gradiometer data plots (1:500)