Bramham Road, Thorner,

West Yorkshire

Gradiometer Survey

by

Mark Whittingham BSc MA

Contents

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West Yorkshire

(centred at SE 383 408)

Gradiometer Survey

1. Summary

Objectives
To determine the presence and extent of any sub-surface archaeological remains within the survey area and, where possible, to characterise the archaeology thus located.

Methodology
A detailed magnetometer survey using a Geoscan FM36 fluxgate gradiometer was carried out over a 3.64ha area. The survey area was tied in to a local co-ordinate system using a Geotronics Geodimeter 600 total station theodolite.

Results & Conclusions
The gradiometer survey identified linear anomalies representing a possible field system with enclosures, areas of magnetic enhancement, which may indicate quarrying activity, two major orientations of ridge and furrow and two linear anomalies which may indicate the presence of a Roman road. A high pressure gas pipe and a number of isolated dipolar anomalies, "iron spikes", caused by modern ferrous contamination, could also be observed.

2. Introduction and Methodology

2.1 Archaeological Services (WYAS) were commissioned to undertake a geophysical evaluation at Bramham Road, Thorner at SE 383 408 (see Figs 1 & 2). The evaluation was commissioned in advance of a proposal for housing development on the site.

2.2 The evaluation originally required a magnetic susceptibility survey of the whole site and a 50% sample for the gradiometry survey. There was provision for the latter to be expanded up to a 100% sample if the data revealed archaeological features which required further investigation.

Upon viewing the site it became apparent that a magnetic susceptibility survey would not be feasible, due to the recent ploughing which the site had undergone. This ploughing created undulations in the ground surface and would have significantly disturbed the near-surface topsoil. In order to obtain reliable results the susceptibility loop needs to be placed horizontally flat on the ground surface, with the loop only being effective in measuring the magnetic susceptibility to a depth of approximately 100mm. It was decided, therefore, in consultation with West Yorkshire SMR, not to carry out the susceptibility survey as it was unlikely that reliable results could be obtained.

The initial 50% sample for the gradiometer survey revealed the presence of several linear anomalies and areas of magnetic enhancement, which were of possible archaeological significance. Again, after consultation with West Yorkshire SMR, it was decided that the survey be extended to follow these anomalies and to obtain as great an understanding of the archaeology as possible. A total area of 3.64ha (91% sample) was surveyed with the gradiometer.

2.3 At the time of survey, 19th to 23rd September 1997, the site had been recently ploughed and drilled.

2.4 The site overlies the Lower Magnesian Limestone (close to its boundary with the Lower Millstone Grit Series). Stones from this bedrock, brought up to the surface by ploughing, could be observed within the site, indicating a shallow soil cover.

3. Archaeological Background

3.1 The survey site lies within an area which contains landscape features from the late prehistoric to Romano-British times. Much of the evidence for these features comes from cropmarks and, whilst there is no evidence for cropmarks on the site itself, there are cropmark features within a few hundred metres on nearly all sides of the site. These cropmark features consist of trackways, enclosures, linear features and pits.

It is known that a Roman road passes near to the site but its exact position and orientation are not known. There is definite evidence for the road 550m to the east of the site, at Norwood House, where roadworks revealed the presence of an embankment linked to the Roman road, and which seemed to continue in a west-south-west direction. The road was also been detected in Thorner, about 650m to the south-west of the site, during work on a railway embankment. It is currently believed, although there is no direct evidence for this, that the Roman road turns south-west almost immediately to the west of Norwood House and that the modern road follows the same path as the Roman road. This conjecturally places the Roman road to the south of the survey area.

4. Results and Discussion

4.1 The Presentation of the Results

4.1.1 The data is presented in Appendix 4, with the gradiometer data in dot density and X-Y trace formats. An interpretation of the data is shown in Figure 3. All data is displayed at a scale of 1:500, with the interpretation diagram at a scale of .

4.2 The Gradiometer Survey

4.2.1 The site is cut by a high pressure gas pipe, trending east to west, and there are a number of iron spikes, caused by ferrous contamination of the topsoil, across the site.

4.2.2 Two distinct orientations of positive linear anomalies can be observed across the site. One group, trending approximately north-east to south-west, 5-6m apart, is parallel with the current field boundary and to Bramham Road. The second group trends approximately north to south, 5-7m apart, but there is evidence of some of these curving eastwards.

These responses are caused by the former practice of ploughing using a moulder board, rather than a share, which was a later development, to break up the sod. Over time this method of ploughing leads to the formation of distinctive ridges and furrows. The ends of these ridge and furrow features often curve as the moulder board would be kept in the ground as the draft animals were turned. This often produced a raised area running perpendicular to the ridge and furrow called a headland. Even after the visible evidence of ridge and furrow has been removed by modern ploughing magnetic traces can still often be detected.

Those anomalies which curve, notably those within the area delimited by Anomaly **A**, may indicate the presence of a headland (Anomaly **H**?).

There were no extant remains of ridge and furrow so it is possible that some of these linear anomalies may represent a more recent ploughing regime, and not be of archaeological significance.

4.2.3 There are many areas of magnetic enhancement across the site, which have strong, positive magnetic responses. These responses do not have the characteristic sharpness of iron spikes and this, coupled with the breadth of many of the responses, indicate that they are probably not of a ferrous origin.

Areas of magnetic enhancement, with similar responses, have been detected at other sites in West Yorkshire (McNaught 1997), also on magnesian limestone bedrock. After excavation, these have been found to be quarry workings that have subsequently been infilled.

It is probable that the areas of magnetic enhancement at Bramham Road also represent areas of quarrying. Backfilled quarry pits would tend to show as strong, positive magnetic responses because the limestone bedrock has a low magnetic susceptibility, whilst topsoil, both current and past, has a more enhanced magnetic susceptibility. Therefore, once the limestone has been removed the infill material (topsoil) will show as magnetic highs, due to the greater volume of more magnetic material found there.

These areas of enhanced response also tend to be found close or immediately adjacent to the positive linear anomalies caused by ditch features. In these areas, where the topsoil would have either been removed or would be shallow, access to the bedrock would be easier. This positioning of the enhanced responses may be coincidental or it may further indicate the likelihood that they represent areas of quarrying. There is an old limestone quarry, located 100m north-east of the site, which corroborates the fact that quarrying has taken place in the area in the past.

Whilst some of the areas of enhancement have a double-peak response that is often indicative of a kiln or furnace feature, it would be expected that, with the shallow depth of soil on the site, the response from such a feature would be much stronger. The dimensions and shape of these areas also suggests that they are unlikely to be caused by such features.

4.2.4. A series of strong, positive, linear anomalies, many of which are interconnected, can be observed across the site. These probably indicate the presence of a system of field boundaries and enclosures. The largest of these, within the survey area is Anomaly **A**. This has three sides and represents a rectangular feature which is about 110m wide and over 115m long and orientated north to south/east to west.

Three linear anomalies (**B**, **C** and **D**) branch from **A** and are probably part of the same large field system. An enclosure, as represented by Anomaly **E** (35m x 25m), can be observed as an internal feature to Anomaly **A**. A series of inter-connected linear anomalies (**F**) can also be observed within Anomaly **A**, at the southern end of the site. Whilst some of the linears have similar orientations to **A**, they appear in isolation, unlike the remainder of the linear anomalies across the site.

Anomaly **A** is also bisected by several linear anomalies. Anomaly **G** is a linear anomaly with two possible returns and which has a different orientation to Anomaly **A**. Anomaly **H** trends through Anomaly **A** and may merge with **G**, its eastern end is obscured by the high pressure gas pipe, but it may join with the southern part of anomaly **I**. It is unlikely, therefore, that these anomalies represent features associated with **A**.

Anomaly **A** is also cut by Anomaly **I**, which consists of two parallel linear anomalies, 15m apart. Both linears fade in the vicinity of the gas pipe and do not appear to continue, along the same orientation, beyond it, but neither do they have an obvious terminus. The southernmost of the linears may turn and merge into Anomaly **H**, whilst the lack of evidence for the northerly anomaly continuing beyond the gas pipe may be explained by the possible presence of a headland (See section 4.2.2).

One possible explanation for these parallel, linear anomalies is that they represent ditches either side of a road or trackway. A typical trackway associated with a field system, such as this, would only be expected to be 6 or 7m wide. The width in this case, at about 15m, is more than double this. A Roman road would, however, often be as wide as this. It is possible, therefore that the linears (Anomaly **I** and possibly Anomaly **H**) represent ditches either side of a Roman road (aggers). It is known that there is a Roman road in the area, trending approximately from east to west , and whilst it is thought to be to the south of the site, its exact location and orientation in the immediate area is unknown. It is not unreasonable, therefore, to suggest that the road may cut through the site.

Anomaly **J** consists of a linear anomaly with a right-angled return. This anomaly intersects Anomaly **I** at a right-angle, but its east to west trending component does not trend directly parallel to **I**. It is difficult to determine whether Anomaly **J** is related to **I** or **A**, or whether it represents a completely unrelated feature.

5. Conclusions

5.1 There is evidence of a large system of field boundaries and enclosures which have a dominant north to south/east to west orientation. There are some anomalies which have different orientations, indicating different phases of usage. This phasing is further supported by the presence of two distinct orientations of ridge and furrow.

5.2 Areas of magnetic enhancement, adjacent to the linear anomalies, may indicate the presence of quarrying activity.

5.3 There is a Roman road in the vicinity of the site, whose exact location is unknown. Anomaly **I** may indicate the presence of this road, trending east to west, in the eastern side of the site. The orientation of Anomaly **I** closely matches that of the Roman road detected at Norwood House and, if it was assumed that Anomaly **H** was a continuation of the road, after it had doglegged to the south-west, then this would closely match up with the next known location of the road, to the west of Thorner. It is possible, therefore, that the Roman road passes through the site, trending east-west and then turning to the south-west, rather than passing to the south of the site.

5.4 None of the areas of magnetic enhancement encroach upon the possible path of the Roman road, as delimited by Anomalies **I** and **H**, and, indeed, the distance between areas **K1** and **K2**, and **K3** and **K4** is 15m, the same distance as is suggested for the width of the road. This may suggest that there is quarrying associated with the Roman road.

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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Bibliography

McNaught, R.B., (1997). *Land off Field Lane, South Elmsall, West Yorkshire: Geophysical Survey*, WYAS R476

Appendices

Appendix 1 Gradiometer Survey: technical information and methods
Appendix 2 Survey location information
Appendix 3 Survey specification
Appendix 4 Gradiometer data plots

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:

1. **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 archaeological industrial activity.

2. **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.

3. **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.

4. **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.

5. **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 The detailed technique was the method employed 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, with the instrument held pointing north. 800 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. The Contors programme was used to present the grey-scale and dot density plots, whilst Geoplot was used to present the X-Y trace plot.

Appendix 2

Survey location information

The survey baseline was laid out parallel to the hedge demarcating the south-eastern edge of the site. Semi-permanent marker pegs were left at points in the hedge to the south-east (A) and to the western side of the track in the eastern part of the site (B). The co-ordinates of these two points, relative to the free-station position (base point) of the Geodimeter, are given below:-

A 1012.254E2017.799N
B 989.922E/1988.950N

NB These values are local grid co-ordinates, relative to the position of the station, and are not Ordnance Survey co-ordinates.

Using the Ordnance Survey 1:2500 series National Grid co-ordinates were obtained and are given below:-

A 38478 40820
B 38480 40852
Base point 38483 40830

Appendix 3

Survey specification

Appendix 4

Gradiometer data plots