STRATASCAN

Geophysical Survey Report

Rugeley Eastern Bypass, Staffordshire

for

Birmingham Archaeology

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1. SUMMARY OF RESULTS

The geophysical survey undertaken outside Rugeley, Staffordshire, was successful in locating a number of anomalies of possible archaeological origin. Possible pits were located in both the magnetometer and resistance data. Large high and low resistance linear anomalies may indicate the presence of ditches and banks to the western limits of the survey area. Former agricultural activity is evident in both data sets.

2. INTRODUCTION

2.1. Background synopsis

Stratascan were commissioned by Birmingham Archaeology to undertake a geophysical survey of an area outlined for development as a bypass.

2.2. Site location

The site is located opposite the sewage works outside Rugeley, Staffordshire.
OS ref. SK 032 202.

2.3. Description of site

The survey area is approximately 2.5ha of agricultural land currently used as pasture. The underlying geology is Permian and Triassic sandstone. (British Geological Survey South Sheet, Third Edition Solid, 2001). The overlying soils are classified as Wick 1 soils which are a type of Glaciofluvial or river terrace drift (Soil Survey of England and Wales, Sheet 4 Midland and Western England).

2.4. Site history and archaeological potential

No specific details were available to Stratascan

2.5. Survey objectives

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

2.6. Survey methods

The reconnaissance technique of magnetic susceptibility was employed over the whole of the survey area. From the results areas were targeted with detailed magnetometer and resistivity surveys. 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 six days from the 12 Dec 05 when the weather was cold and dry.

3.2. Grid locations

The location of the survey grids has been plotted in Figure 2.

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 Magnetometry 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 Earths magnetic field.

3.3.3 *Resistivity*

This method relies on the relative inability of soils (and objects within the soil) to conduct an electrical current which is passed through them. As resistivity is linked to moisture content, and therefore porosity, hard dense features such as rock will give a relatively high resistivity response, while features such as a ditch which retains moisture give a relatively low response.

The resistance meter used was an RM15 manufactured by Geoscan Research incorporating a mobile Twin Probe Array. The Twin Probes are separated by 0.5m and the associated remote probes were positioned approximately 15m outside the grid. The instrument uses an automatic data logger which permits the data to be recorded as the survey progresses for later downloading to a computer for processing and presentation.

Though the values being logged are actually resistances in ohms they are directly proportional to resistivity (ohm-metres) as the same probe configuration was used through-out.

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 20m 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. All traverses are surveyed in a "zigzag" mode.

Resistivity
Readings were taken at 1.0m centres along traverses 1.0m apart. This equates to 900 sampling points in a full 30m x 30 grid. All traverses were surveyed in a "zigzag" mode.

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 Grad 601-2 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 0.5m centres provides an appropriate methodology balancing cost and time with resolution.

Resistivity
The 0.5m probe spacing of a twin probe array has a typical depth of penetration of 0.5m to 1.0m The collection of data at 1m centres with a 0.5m probe spacing provides an appropriate methodology balancing cost and time with resolution.

3.4.3 Data capture

Magnetic susceptibility
The readings are logged manually on site, and then transferred to the office where they are entered into a computer and grey scale plots are produced.

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.

Resistivity
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:

Zero mean grid	*Threshold = 0.25 std. dev.*
Zero mean traverse	*Last mean square fit = off*
Despike	*X radius = 1 Y radius = 1*
	Threshold = 3 std. dev.
	Spike replacement = mean

Resistivity
The processing was carried out using specialist software known as *Geoplot 3* and involved the 'despiking' of high contact resistance readings and the passing of the data though a high pass filter. This has the effect of removing the larger variations in the data often associated with geological features. The net effect is aimed at enhancing the archaeological or man-made anomalies contained in the data.

The following schedule shows the processing carried out on the processed resistance plots.

Despike	*X radius = 1*
	Y radius = 1
	Spike replacement
High pass filter	*X radius = 10*
	Y radius = 10
	Weighting = Gaussian

3.5.2 Presentation of results and interpretation

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

Magnetometer
The presentation of the data for each site involves a print-out of the raw data both as grey scale (Figures 10 and 15) and trace plots (Figures 11, 12, 16 and 17), together with a grey scale plot of the processed data (Figures 13 and 18). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figures 14, 19 and 21).

Resistivity
The presentation of the data for the site involves a print-out of the raw data as a grey scale plot (Figures 4 and 7), together with a grey scale plot of the processed data (Figures 5 and 8). Anomalies have been identified and plotted onto the ‘Abstraction and Interpretation of Anomalies’ drawing (Figures 6, 9 and 20).

4. RESULTS

4.1. Magnetic susceptibility

This reconnaissance technique highlighted two areas of high magnetic susceptibility, both to the south eastern limits of the survey area. The rest of the survey area showed very little change in magnetic susceptibility.

4.2. Detailed magnetometry

Area 1

Positive linear anomalies are evident to the western edge of this area. Their shape, size and parallel orientation suggest that they are agricultural in origin. Four discrete positive anomalies evident in this area have been interpreted as possible pits. A number of bipolar anomalies are scattered across Area 1 indicating the presence of buried ferrous objects.

Area 2

A number of positive linear anomalies have been identified within this area that may be of archaeological origin. The positive linear anomaly running horizontally across the survey area may be related to a previous field boundary. The same may be said in regard to the north-south orientated positive and negative linear anomalies in the centre of the site. However, a number of other positive linear anomalies within this survey area do not have the characteristics of former field boundaries. As a result further investigation may be required in order to fully understand these features.

A number of large discrete positive anomalies are evident to the south west of this survey area. The size and quantity of these features may suggest that they are archaeological or possibly geological in origin. Therefore, further investigation is required in order to ascertain the nature of these anomalies. A number of smaller positive discrete anomalies in this area have been interpreted as possible pits and may be of archaeological potential.

It is interesting to note that the area of high magnetic susceptibility partially sampled in the east of this area is not represented within the gradiometer data.

A large area of magnetic debris and disturbance can be noted running north-south through this survey area. This is due to the presence of a modern pipe and track way. Other evidence for modern activity comes in the form of bipolar anomalies representing buried ferrous objects.

4.3. Detailed resistivity

Area 1

The resistance data here is dominated by area anomalies. Discrete areas of low resistance may be related to possible pits. Discrete areas of high resistance may indicate that some pits have been back-filled with stones or some other material with a greater resistance than average for that area.

High and low resistance linear area anomalies may indicate some form of bank and ditch arrangement, possibly representing former field boundaries. However, the ditches in this area measure up to 10m across in places which would seem too large for the purpose of dividing land into fields.

Area 2

High and low resistance linear anomalies within this area represent the banks and ditches of former ridge and furrow. The high resistance area anomaly in this area may indicate the presence of compacted ground. The two areas of low resistance may be geological, however, their origin remains unknown.

5. CONCLUSION

The detailed survey techniques used at Rugeley were successful in locating a number of anomalies that may be of archaeological potential. The data collected with the resistance meter provided mainly area anomalies, whereas the magnetometer data displayed both linear and discrete area anomalies.

The magnetometer data has located a number of targets of possible archaeological origin. Discrete positive anomalies, interpreted as possible pits, are present in the data from both survey areas. Larger discrete positive anomalies in Area 2 may indicate the presence of pits. However, further investigation is required in order to ascertain as to whether these anomalies are of archaeological or geological origin.

A number of positive linear anomalies within the magnetometer data represent former agricultural activity and field boundaries. However, a few positive linear anomalies in Area 2 that do not share the characteristics of agricultural activity may be of archaeological origin.

The resistance data in Area 1 has revealed an interesting set of high and low resistance linear area anomalies. The size of these ditches and banks suggests that they do not represent field boundaries and therefore may warrant further investigation. Within this area of linear anomalies are a number of discrete areas of both high and low resistance. These may represent large pits with different types of back-fill material.

There is no real correlation of located anomalies between the magnetometer and the resistance surveys.