STRATASCAN

Geophysical Survey Report

Shugborough, Staffordshire

for

Birmingham Archaeology

November 2005

J 2030

David Elks MSc.

REGISTERED • IFA • ORGANISATION

Document Title:	Geophysical Survey Report Shugborough, Staffordshire
Client:	Birmingham Archaeology
Stratascan Job No:	2030
Techniques:	Magnetic Susceptibility, Magnetometry, Resistivity
National Grid Ref:	SJ 989 216

Field Team:	Luke Brown, Laurence Chadd MA., Lee Moorhead MSc., Karl Munster BSc., Mark Styles IMI
Project Manager:	Simon Stowe BSc.
Project Officer:	David Elks MSc.
Report written by:	David Elks MSc.
CAD illustration by:	David Elks MSc.
Checked by:	Peter Barker C.Eng MICE MCIWEM MIFA

Stratascan Ltd.

Vineyard House
Upper Hook Road
Upton upon Severn
WR8 0SA

Tel: 01684 592266
Fax: 01684 594142
Email: ppb@stratascan.co.uk

www.stratascan.co.uk

1. SUMMARY OF RESULTS

A reconnaissance magnetic susceptibility survey was carried out over 2.7ha of land at Shugborough Park, Staffordshire. Three areas were then surveyed with detailed magnetic and resistance techniques totalling 1.35ha.

The results have proved difficult to interpret partially due to the small sizes of survey areas leading to the data being viewed out of context. Some anomalies have been observed which may relate to cut features, stone remains, field boundaries and agricultural activity.

2. INTRODUCTION

2.1. Background synopsis

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

2.2. Site location

The site is located Shugborough Hall, Staffordshire at OS ref. SJ 989 216.

2.3. Description of site

The survey area is 2.7 ha of land mainly used for grazing. One smaller area has a hardcore surface. The underlying geology is Permian and Triassic Sandstones (British Geological Survey South Sheet, Third Edition Solid, 1979). The overlying soils are of the Bromsgrove soil association. These consist of well drained reddish coarse loamy soils mainly over soft sandstone, but deep in places (Soil Survey of England and Wales, Sheet 3 Midland and Western England).

2.4. Site history and archaeological potential

Shugborough Hall and Estate contain a number of listed buildings dating to the 18th and 19th centuries, including the Hall, associated monuments and a walled garden. There are also a number of potential archaeological sites of regional significance dating to the prehistoric, Romano-British and medieval periods, which are recorded within the estate. A ring ditch and pit alignment may exist in the west of the survey area dating to the Bronze Age and Iron Age respectively.

Evidence shows that the area has remained open land up till the present day suggesting that there is a high potential for the survival of archaeological remains.

2.5. Survey objectives

The objective of the survey was to locate any features of possible archaeological origin

2.6. Survey methods

The reconnaissance technique of magnetic susceptibility was employed over the whole 2.7ha survey area. Based on these results two areas were chosen for detailed magnetic and resistance surveys. The smaller area being less than 80m long was not surveyed by magnetic susceptibility as it would only have consisted of two readings which would not give an indicative response to analyse. This area was surveyed with both the detailed techniques of magnetic and resistance survey.

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 five days from the 31st October 2005 to the 4th November 2005 when the weather was mixed.

3.2. Grid locations

The location of the survey grids has been plotted in Figure 3 together with the referencing information. Grids were set out using a Leica 705auto Total Station and referenced to suitable topographic features around the perimeter of the site.

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 *Magnetic survey*

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 *Resistance survey*

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.

Magnetic survey
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 “parallel” rather than “zigzag” mode to avoid heading error.
Resistance survey

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.

Magnetic survey
The Grad601-2 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 0.25m centres provides an appropriate methodology balancing cost and time with resolution.

Resistance survey
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.

Magnetic survey
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.

Resistance survey
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.

Magnetic survey
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

Resistance survey
The processing was carried out using specialist software known as *Geoplot 3* and involved the 'despiking' of high contact resistance readings.

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

Despike	*X radius = 1*
	Y radius = 1
	Spike replacement

3.5.2 *Presentation of results and interpretation*

Magnetic susceptibility
The presentation of the data for this site involves a grey scale plot of the field measurements overlain onto a site plan (see Figure 2).

Magnetic survey
The presentation of the data for each site involves a print-out of the raw data both as grey scale (Figure 7) and trace plots (Figure 8 and 9), together with a grey scale plot of the processed data (Figure 10). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figure 11).

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

4. RESULTS

4.1. Magnetic susceptibility

The magnetic susceptibility readings are generally low to moderate over the entire site. Area 1 in the north of the site has been targeted on enhanced magnetic susceptibility levels and also encompasses an area of lower reading to act as a control test.

Area 3 is also targeted on enhanced magnetic susceptibility levels which may correlate in position to the known pit alignment (Dean, pers comm, 2005).

Area 2 is located on an area of grass and hardcore to the east of the stream.

4.2. Detailed resistance survey

Area 1

This area shows a prominent high resistance linear anomaly running north-east to south-west. It appears to follow the same alignment as the fence line, possibly marking a former field boundary or a modern feature which has been located along the fence.

In the eastern half of the survey area are several low resistance anomalies. These may be related cut features associated with features of rectangular shape, possibly of archaeological origin.

To the west are numerous curvilinear responses of high resistance. The origin of these anomalies is unclear although structural archaeological remains cannot be dismissed.

Area 2

This is positioned in between the road and the hardcore car park. This area does not seem to show any responses of significance. There is a possible high resistance anomaly in the south which may represent stone remains or compacted ground but it is difficult to interpret given the small survey area and lack of context.

Area 3

Two high resistance linear anomalies are observed in the west of the area. These probably represent continuations of those seen in Area 1 and may represent structural features of an archaeological origin.

Areas of high resistance are observed in the east of the area. It is unclear what may cause these. It is possible they have a natural origin although stone remains is also a possible cause.

A low resistance anomaly cuts north west to south east across the fence line. This anomaly may be caused by a cut feature of archaeological origin.

4.3. Detailed magnetic survey

Area 1

A strong linear magnetic anomaly is seen running north east to south west. This is likely to represent the magnetic response of the high resistance linear anomaly also seen in this position. This adds ambiguity to its origin. The strong magnetic nature suggests the feature is ferrous and possibly a service pipe, while the high resistance anomaly is more indicative of a field boundary or stone remains.

Also observed in this area are several other curvilinear positive responses which may represent cut features of an archaeological origin.

Area 2

Area 2 shows mostly magnetic noise which is probably due to sub-surface ferrous objects within the hardcore or from the hardcore itself.

Area 3

Three areas of positive magnetic response and a discrete positive anomaly are observed which may relate to infilled cut features of possible archaeological origin.

Parallel positive linear anomalies marked in the east of the area are likely to be related to ploughing activity.

5. CONCLUSION

Three areas were surveyed with detailed magnetic survey and resistance surveys. Two of these were targeted on areas of enhanced magnetic susceptibility while the third was located on an area of hardcore and grass to the east of the driveway.

The detailed surveys have identified anomalies which are generally ambiguous and difficult to define. This is partially due to the small sizes of survey areas leading to the data being viewed out of context. Despite this responses have been observed which may relate to cut features, stone remains, field boundaries and agricultural activity. Further research is recommended to clarify the exact nature of such anomalies.

REFERENCES

British Geological Survey, 1979. *Geological Survey Ten Mile Map, South Sheet, Third Edition (Solid)*. British Geological Society.

Dean, S. 2005. Personal Comment, site meeting 1/11/05.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 3 Midland and Western England*.