STRATASCAN

Geophysical Survey Report

Police HQ, Middlemoor, Exeter

for

RPS Planning, Transport and Environment

February 2005

J 1970

David Elks MSc.

REGISTERED IFA ORGANISATION

Document Title:	**Geophysical Survey Report Police HQ, Middlemoor, Exeter**
Client:	**RPS Planning, Transport and Environment**
Stratascan Job No:	**J 1970**
Techniques:	**Detailed magnetic survey (gradiometry)**
National Grid Ref:	**SX 958 922**

Field Team:	Luke Brown, Richard Fleming
Project Manager:	Simon Stowe BSc.
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

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1 SUMMARY OF RESULTS

A detailed magnetic survey was carried out over a total of 7.2ha of land split into two areas at the Police HQ, Middlemoor, Exeter.

Both survey areas defined regions of magnetic debris and disturbance probably relating to a modern origin. Also toward the centre and south of both areas are linear anomalies which may represent features of an archaeological origin.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by RPS Planning, Transport and Environment to undertake a geophysical survey of an area of land outlined for development .

2.2 Site location

The site is located at Police Headquarters, Middlemoor, Devon at OS ref. SX 958 922.

2.3 Description of site

The total survey area is approximately 7.2ha of grassed land currently used as a sports ground. The survey is split in to two areas. Area 1 is 2.7ha located at the northern end of the site while Area 2 is 4.5ha located at the southern end of the site.

2.4 Geology and soils

The underlying geology is Permian basal breccias, sandstones and mudstones (British Geological Survey South Sheet, Third Edition Solid, 1979). The overlying soils are of the Bridgenorth soil association. These consist of well drained sandy and coarse loamy soils over soft sandstone with occasional deeper soils. They are at risk of water and wind erosion (Soil Survey of England and Wales, Sheet 5 South West England).

2.5 Site history and archaeological potential

Previous studies have identified prehistoric, Roman, and later features on the Middlemoor Estate. Within the survey area itself medieval and post medieval field boundaries have also been noted, while evidence suggests the wider landscape was continuously occupied from the Mesolithic through to the Iron Age.

Given this long history, the likelihood of locating features of an archaeological origin is considered high.

2.6 Survey objectives

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

2.7 Survey methods

Detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating archaeological anomalies. More information regarding this technique is included in the Methodology section below.

3 METHODOLOGY

3.1 Date of fieldwork

The fieldwork was carried out over 5 days from 7th February – 11th February 2005. Weather conditions during the survey were dry and sunny.

3.2 Grid locations

The location of the survey grids has been plotted in Figures 2 & 8 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 Survey equipment

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.

3.4 Sampling interval, depth of scan, resolution and data capture

3.4.1 Sampling interval

Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

3.4.2 Depth of scan and resolution

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.

3.4.3 Data capture

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

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 processing carried out on Area 1:

1. *Despike* (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values)

   Geoplot parameters:
   X radius = 1, y radius = 1, threshold = 3 std. dev.
   Spike replacement = mean

2. *Zero mean traverse* (sets the background mean of each traverse within a grid to zero and is useful for removing striping effects)

   Geoplot parameters:
   Least mean square fit = on,
   threasholds Max.= 10 Min.= -10

The following schedule shows the processing carried out on Area 1:

1. *Despike* (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values)

   Geoplot parameters:
   X radius = 1, y radius = 1, threshold = 3 std. dev.
   Spike replacement = mean

2. *Search and replace* (used to remove extreme values which remain after despiking)

3. *Zero mean grid* (sets the background mean of each grid to zero and is useful for removing grid edge discontinuities)

   Geoplot parameters:
   Threshold = 0.25 std. dev.

4. *Zero mean traverse* (sets the background mean of each traverse within a grid to zero and is useful for removing striping effects)

   Geoplot parameters:
   Least mean square fit = on,

3.5.2 Presentation of results and interpretation

The presentation of the data for each site involves a print-out of the raw data both as greyscale (e.g. Figure 3) and trace plots (e.g. Figure 4 and 5), together with a greyscale plot of the processed data (e.g. Figure 6). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (e.g. Figure 7).

4 RESULTS

The geophysical survey has revealed anomalies in both areas which can be broadly classified as:

- positive linear anomalies of possible archaeological origin
- positive linear anomalies with an associated negative return possibly relating to remains of embankment with ditch
- negative linear anomalies possibly having an agricultural origin
- bipolar linear anomalies indicative of modern services
- areas of magnetic disturbance and debris with a probable modern origin
- strong discrete dipolar point anomalies probably related to modern ferrous objects.

4.1 Area 1 (Figures 2 – 7)

Area 1 is dominated by a large region of magnetic debris covering most of the survey area. It is likely this is caused by modern ground disturbance leaving enhanced topsoil and hardcore and possibly ferrous debris on or close to the surface. This will mask out any weak responses from archaeological features that may be present. Also seen are four areas of magnetic disturbance probably relating to outdoor lights. These anomalies appear to be connected via a linear bipolar response. It is possible this may represent the outdoor power cable supplying the lighting.

Towards the centre of the survey area are four weak negative linear anomalies which appear roughly parallel and are separated by 5-10m. These are of an uncertain origin although is likely they are all related to each other due to their proximity and similar form. It is possible they are of an agricultural origin.

Running in a west-east orientation across the site is a weak positive linear anomaly with an associated negative return. The long straight line form it takes suggests it may be related to a field boundary possibly consisting of a ditch and bank.

4.2 Area 2 (Figures 8 - 13)

Similarly with Area 1 there is a large region of magnetic disturbance in the north of the survey area. There are three more areas of disturbance in the south, it is likely these are related to modern ground disturbance. In the centre of the survey area are a further three areas of disturbance, which probably relate to sports equipment.

Several positive linear anomalies of weak enhancement are present in the south of the survey area. Five of these trend in the same direction indicating they may be related. It is possible these are infilled cut features of archaeological origin. In the same region is a negative linear anomaly with an associated positive response on either side. This may also be of archaeological origin representing an embankment with accompanying ditches on both sides.

Area 1 & 2 contain positive point responses with an associated negative return, these are probably caused by modern ferrous objects in the top soil.

5 CONCLUSION

Both areas contain large regions of magnetic disturbance and debris indicating there has been recent ground disturbance on the site. It is possible this may overwhelm weak magnetic anomalies from archaeological features leaving them undetected.

In Area 1 anomalies related to modern features have been identified, there are also several linear anomalies in the centre of the area which may be associated with archaeological features.

Area 2 contains anomalies representing modern features and also locates anomalies in the south of the area which may have an archaeological origin.

REFERENCES

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

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 5 South West England*.

APPENDIX A – Basic principles of magnetic survey

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremnant* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremnance is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremnant archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically either 0.5 or 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.