STRATASCAN

Geophysical Survey Report

Barrington Quarry, Cambridgeshire

for

RPS

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REGISTERED IFA ORGANISATION

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1 SUMMARY OF RESULTS

A trial survey of 20ha of magnetic susceptibility followed by 10ha of detailed magnetic survey was carried out over three areas. Following this a further 156ha of magnetic susceptibility was carried out with 32.5ha of detailed magnetic survey.

Anomalies likely to be related to former settlements have been identified in Area 3, Area 9 & 10, and Area 11. Circular features have been observed in Area 2 and Area 21 which are also likely to have an archaeological origin. Area 2 also shows a rectangular feature probably of archaeological origin.

Throughout the rest of the site there is evidence of extensive ridge and furrow ploughing activity.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by RPS to undertake a geophysical survey of an area outlined for the extension of a quarry.

2.2 Site location

The site is located at Barrington, Cambridgeshire at OS ref. TL 385 505.

2.3 Description of site

The survey area is approximately 156ha of agricultural land spread over 3 sites. The topography generally dips to the south.

2.4 Geology and soils

The underlying geology is Cretaceous Chalk (British Geological Survey South Sheet, Fourth Edition Solid, 2001).The site is split over two soil associations. The overlying soils in the south are of the Wantage 2 association. These consist of shallow well drained calcareous silty soils over argillaceous chalk associated with similar soils affected by groundwater, some deeper well drained coarse loamy soils exist in places with complex local soil patterns. The overlying soils in the north are of the Hanslope soil association. These consist of slowly permeable calcareous, clayey soils, with some slowly permeable non calcareous clayey soils (Soil Survey of England and Wales, Sheet 4 Eastern England).

2.5 Site history and archaeological potential

Numerous former field boundaries and other features identified from aerial photos are thought to exist within the site, and a late medieval settlement lies outside the site boundaries to the south. It is thought that a chapel may have once stood in the vicinity of the eastern most site. No further details were available to Stratascan.

2.6 Survey objectives

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

2.7 Survey methods

Three areas totalling 20ha were initially identified for a trial survey of magnetic susceptibility followed by 10ha of detailed magnetic survey (gradiometry). Subsequent to this 156ha were surveyed using magnetic susceptibility with a further 32.5ha of detailed magnetic survey.

More information regarding these techniques is included in the Methodology section below and Appendix.

3 METHODOLOGY

3.1 Date of fieldwork

The fieldwork was carried out over 38 days during the period 5th September 2005 to 8th November 2005. Two further one day visits were made on 9th & 13th January 2006. Weather conditions during the survey were variable.

3.2 Grid locations

The location of the survey grid is based on the Ordnance Survey National Grid, see Figure 6. The referencing and alignment of grids was achieved using a Leica DGPS System 500.

3.3 Survey equipment

3.3.1 Magnetic susceptibility

The equipment used 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 Detailed magnetic survey

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

Magnetic susceptibility
The magnetic susceptibility survey was carried out on a 20 m grid with readings being taken at the node points.

Detailed 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 areas use 30m grids, except Area 20 which is only 20m wide and therefore set up with 20m grids.

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.

Detailed 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.

3.4.3 Data capture

Magnetic susceptibility
The readings are logged into a DGPS unit on site. At the end of each job data is transferred to the office for processing and presentation.

Detailed 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.

3.5 Processing, presentation of results and interpretation

3.5.1 Processing

Magnetic susceptibility
No processing of the data has been undertaken.

Detailed 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 gradiometer data used in this report:

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

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 (Figure 2).

Detailed magnetic survey
The presentation of the data for each area involves a print-out of the raw data both as greyscale (e.g. Figure 8) and trace plots (e.g. Figure 9 and 10), together with a greyscale plot of the processed data (e.g. Figure 11). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the area (e.g. Figure 12).

4 RESULTS

The results of the trial magnetic susceptibility survey proved inconclusive. Although some slight variations may relate to archaeological activity which was subsequently identified by trial detailed magnetic survey.

4.1 Magnetic susceptibility *(Figures 2-5)*

The magnetic susceptibility results show several areas of elevated readings. A band of enhanced susceptibility is observed running east-west through the centre of the larger survey area and also in the south east of this area. The site east of the quarry also shows enhanced measurements which may relate to former buildings, evidence of which has been observed in this area.

Following instruction from RPS the detailed magnetic survey was split into 22 separate areas totalling 42.5 ha (including trials). Most of these are roughly equispaced strips, 60m wide.

4.2 Detailed magnetic survey

Areas 1 – 3 represent the trial survey. The results from these areas demonstrate that detailed magnetic survey is an effective technique in detecting features of an archaeological origin on this site. The survey was then expanded to cover the entire site.

Area 1 (Figures 7 – 12)
Area 1 is split over 2 areas, 1a and 1b.

Area 1a, the smaller of the two areas, shows several linear anomalies. Two of these appear to cross forming a right angle. The strength of these anomalies is variable making their cause ambiguous, although it seems likely they are associated with former field boundaries. In the north west of the area is a region of magnetic debris, the origin of which is unclear although it may be associated with ground disturbance of some form. Other positive linear responses may represent cut features of an archaeological origin.

Area 1b shows a series of weak bipolar anomalies running north east to south west. These are likely to be caused by field drains. Also present are parallel positive linear anomalies probably relating to ridge and furrow ploughing activity.

Small areas of positive with associated negative response may represent infilled pits, while negative areas may be related to built up earthworks.

Area 2 (Figures 13 – 18)
The north of this area shows a rectangular enclosure (55m x 65m) consisting of positive linear responses likely to represent infilled cut features. Two gaps are seen in the anomaly, one in the north west, one in the south west, each around 7m across. These are likely to be entrances to the enclosure. South of this is a positive circular response also likely to be associated with an infilled cut feature of archaeological origin.

Several other weak positive responses are observed in the area which may also be caused by cut features.

Parallel positive linear responses seen across the area are likely to be caused by ridge and furrow ploughing activity.

Area 3 (Figures 19 – 24)
Area 3 is positioned south of the main survey area between Hill Plantation and Cracknow Hill.

The detailed magnetic survey has revealed a complex set of positive anomalies which are probably caused by infilled cut features. The pattern observed is likely to represent the location of a former settlement.

Areas of magnetic debris and magnetic disturbance are probably associated with modern interference, although archaeological industrial activity can not be ruled out.

Area 4 (Figures 25 – 30)
Area 4 is dominated by a positive area anomaly in the south. This is most likely to be a natural feature possibly caused by variations in pedology/geology, features of this type are seen sporadically cross the entire site. Other positive anomalies with associated negative anomalies are observed to the west of this anomaly which may be related.

One positive linear anomaly is seen in the north which may have an archaeological origin.

Other anomalies are probably caused by ploughing and field drains.

Area 5 (Figures 25 – 30)
Similarly to Area 4, Area 5 also shows evidence of ploughing, field drains and natural variations. Three positive linear responses are seen which may represent cut features of an archaeological origin. One positive point anomaly may represent an infilled pit.

Area 6 (Figures 31 – 36)
Area 6 shows numerous positive linear anomalies attributed to ploughing activity generally running in a north west to south east direction. Further positive linear responses have also been identified. These have an uncertain origin, it is possible they are associated with cut features of an archaeological nature.

Area 7 (Figures 31 – 36)
This area shows few anomalies of possible archaeological origin. A positive curvilinear response which may be caused by a cut feature, and two positive point anomalies possibly caused by pits are observed. Other responses include those likely to be associated with field drains, ridge and furrow ploughing and natural variations.

Area 8 (Figures 31 – 36)
As with Area 7 this area shows few anomalies of note. Three positive linear responses, and one negative linear anomaly may have an archaeological origin relating to cut features and earthworks respectively. The remaining anomalies are probably caused by ploughing, field drains and natural variations.

Area 9, 9a & 10 (Figures 37 – 45)
This area is dominated by a network of positive linear anomalies likely to represent a former settlement location. Positive point anomalies may be related to infilled pits also of an archaeological origin.

The area is covered by numerous anomalies probably related to ploughing activity. The cutting relationship between this and the settlement responses is not apparent, although it is clear that there are at least two phases of agricultural activity.

In the south east is a weak bipolar anomaly which may be associated with field drains. Adjacent to this is an anomaly likely to have a pedological/geological origin.

Two strong bipolar anomalies are observed in the north of Area 10 which are probably caused by modern ferrous objects.

Area 11 & 11a (Figures 46 – 51)
A pattern of positive linear anomalies are observed in this area which are likely to be caused by cut features associated with a former settlement. Two positive anomalous areas with negative responses may represent a more complex area of disturbed ground or earthworks. Evidence of ploughing activity is also seen, particularly in the north of the area.

Area 12 (Figures 52 – 57)
Area 12 mainly shows anomalies related to ploughing activity and field drains. It is possible the area of magnetic debris is also related to these features as it lies in a similar orientation. A single positive point anomaly is observed which may relate to an infilled pit.

A region of weak magnetic variation located in the south west is probably of a natural origin.

Area 13 (Figures 58 – 63)
This is divided in two areas, 13a in the north and 13b in the south.

Area 13a shows a single anomaly of possible archaeological origin. This is a weak positive curvilinear response in the north of the area.

Towards the centre of 13b are four weak positive anomalies which are likely to have a natural origin. Cutting across the area are linear responses indicative of ploughing activity and field drains.

Situated in the north of the area are two weak positive linear anomalies which appear to half surround a ferrous spike. Given their position it is possible they are related to the spike anomaly, although this may be a coincidence and it is more likely they have an archaeological origin.

Two strong areas of magnetic disturbance are likely to be related to modern ferrous sources.

Area 14 (Figures 52 – 57)
As seen previously in the adjacent Area 12, this area is dominated by parallel positive anomalies indicative of ridge and furrow ploughing. One positive linear response of possible archaeological origin in seen in the north west corner.

Area 15 (Figures 64 – 69)
This area is dominated by parallel linear anomalies suggestive of ridge and furrow ploughing, with relatively few anomalies that may be of archaeological origin.

Three positive linear anomalies are present in the northern area which may be associated with cut features of an archaeological origin. One negative linear anomaly is also observed on the eastern side of the north area that may be related to a built up earthwork.

The centre of the area has a region on the western side where several positive linear anomalies are seen. Their linearity suggests they may be ploughing marks, although this is uncertain. It is possible they have an archaeological origin. North of this is a sinuous positive anomaly which is probably a response to a natural feature.

Area 16 (Figures 58 – 63)
Area 16 shows several positive anomalies with an associated negative response. While these are not magnetically strong enough to be caused by ferrous material, they may be caused by thermoremnant features such as fires. It is not clear whether this is modern or archaeological in origin. The lack of surface deposits suggests it may be archaeological, although the lack of other anomalies of possible archaeological origin in the region indicates otherwise.

Area 17 (Figures 70 – 75)
This area exhibits evidence of ploughing activity in two different directions, suggesting they occurred in different phases of agricultural activity.

Area 18 (Figures 70 – 75)
The south of Area 18 is dominated by anomalies typical of ploughing activity. Two positive linear anomalies may be associated with cut features of an archaeological origin, while a negative linear anomaly may be related to earthworks. A small positive area anomaly in the north west corner may also be caused by a pit or depression of archaeological origin.

Area 19 (Figures 76 – 81)
In the north of Area 19 is a rectangular area of magnetic debris. Although it is unclear exactly what causes this, it may represent an area of disturbed ground possibly including fragments of mildly magnetic material. Further investigation would be required to clarify this.

A positive anomaly with associated negative response is observed near the centre of the area. This is similar in appearance to anomalies seen in Area 16, and it may also have a thermoremnant cause.

Other anomalies in this area are likely to have an agricultural or natural origin.

Area 20 (Figures 82 – 87)
Area 20 is positioned north of the main site to cover the location of a proposed access road.

Three anomalies of possible archaeological origin have been identified. One negative anomaly in the centre of the area may relate to an earthwork, and two positive linear responses further east may be caused by infilled cut features.

Area 21 (Figures 88 – 93)
This area is also located outside of the main site to the south east.

In the east of the area a positive linear anomaly forming a circular feature is observed. This probably represents a cut feature of archaeological origin. A positive linear anomaly is seen to cut into this, but it is not clear whether these anomalies are related or from separate phases of activity. Several other positive linear anomalies may also be related to cut features of an archaeological origin.

Two discrete bipolar responses are seen in the north of the area. It is unclear what may cause these. They have the form of ferrous spikes but are not magnetically strong enough to be caused by ferrous objects. It is possible they represent infilled pits.

Evidence of ploughing and field drains is also seen in this area.

Area 22 (Figures 94 – 99)
Area 22 is located on the position of a pit discovered during recent excavation work. An area of weak magnetic noise is visible in grid 2204. It is likely this represents the excavated and subsequently infilled trench with its associated spoil heap areas. Within this it is possible to see two positive discrete anomalies. It is unclear whether these are caused by infill disturbance or pit features.

Positive linear anomalies are also identified that may relate to infilled cut features of an archaeological origin.

Two bipolar linear anomalies are probably caused by field drains.

5 CONCLUSION

The geophysical survey has identified three areas with complex patterns of anomalies probably relating to former settlements; Area 3, Area 9 & 10, and Area 11. Activity in Area 9 & 10 is likely to have occurred in at least two phases.

Circular features have been detected in Areas 2 and 21 which are likely to be of archaeological origin. Area 2 also shows a rectangular feature with probable archaeological origins.

Throughout the rest of the site there is extensive evidence of ridge and furrow ploughing and the existence of field drains.

REFERENCES

British Geological Survey, 2001. *Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Solid)*. British Geological Society.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 4 Eastern 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.