STRATASCAN

Geophysical Survey Report

Cranfield Airfield, Bedfordshire

for

MOLAS

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1 SUMMARY OF RESULTS

A magnetic susceptibility survey was carried out over 17ha at Cranfield Airfield, Bedfordshire. Based on these results a further 6.9ha of detailed magnetic survey was carried out.

Numerous linear anomalies have been identified which probably relate to cut features and field boundaries of an archaeological origin, and possible services. In places anomalies are cut by the airfield taxiways which suggests the airfield construction may have disturbed some features. There is also widespread evidence of ridge and furrow ploughing.

2 INTRODUCTION

2.1 Background synopsis

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

2.2 Site location

The site is located at Cranfield Airfield, Bedfordshire at OS ref. SP 951 421.

2.3 Description of site

The survey area is approximately 17ha of land around Cranfield Airfield. The underlying geology is Oxford Clay and Kellaway Beds (British Geological Survey South Sheet, Fourth Edition Solid, 2001). The overlying soils are of the Hanslope association. These consist of slowly permeable calcareous clayey soils with some slowly permeable non calcareous clayey soils and a slight risk of water erosion (Soil Survey of England and Wales, Sheet 4 Eastern England).

2.4 Site history and archaeological potential (Miles, 2004)

The archaeological knowledge of the site is minimal, the presence of the airfield preventing detailed work to be carried out. Studies of the surrounding area suggest there is potential for prehistoric, Roman, medieval and post medieval deposits.

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 of the survey area (17ha). Based on these results a trial gradiometer survey was carried out over 0.9ha covering four separate areas. The trial results identified anomalies with a possible archaeological origin leading to a further 6ha of gradiometer 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 9 days from 22 August 2005 to 24 August 2005, 5 September 2005 to 9 September 2005 and 19 September 2005. During this time the weather was mixed.

3.2 Grid locations

The location of the survey grids has been plotted in Figure 4.

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 Gradiometer

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 dual FM256 Fluxgate Gradiometers, manufactured by Geoscan Research and a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The dual FM256 gradiometers are

suspended on a CF6 frame. One gradiometer acts as a master trigger that controls the second slave gradiometer. The instruments each consist of two fluxgates mounted 0.5m vertically apart, and very accurately aligned to nullify the effects of the Earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. 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 giving a strong response to weak anomalies.

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.

Gradiometer
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

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.

Gradiometer
The FM256 and Grad601-2 have 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.

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.

Gradiometer
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.

Gradiometer
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

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).

Gradiometer
The presentation of the data for each site involves a print-out of the raw data both as grey scale (Figure 5, 9, 10) and trace plots (Figure 6, 7, 11, 12), together with a grey scale plot of the processed data (Figure 8, 13, 14). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figure 15 & 16).

4 RESULTS

4.1 Magnetic susceptibility

The magnetic susceptibility results are generally uniform across the site showing little variation. Areas of relative enhancement have been identified and targeted with detailed magnetic survey. Four areas were selected for trial survey followed by three larger areas for the main survey.

4.2 Detailed magnetic survey

4.2.1 Area 1 & 7

Area 1 was positioned on an area of enhanced magnetic susceptibility and surveyed as part of the initial trial survey. A positive linear anomaly was identified running across the north eastern corner which lead to the area being extended to track the extent of this feature. The extended area is named Area 7. The linear anomaly continues into Area 7 heading in a north-west direction where it is seen to run parallel to another linear anomaly. This second anomaly is stronger with values up to 3000 nT. The weaker anomaly has characteristics typical of an archaeological feature, while the stronger anomaly shows some characteristics expected from a modern service. To the north on the same alignment is a series of further parallel anomalies which are probably caused by ploughing activity. This adds further evidence suggesting they may be associated with field boundaries. This ambiguity, coupled with their parallel nature suggesting they are related, makes defining their origin difficult.

Also within this area are numerous shorter linear anomalies around 10m-20m long. Some of these very weak responses in Area 1 are likely to be natural in origin, while the relatively stronger examples may be of archaeological origin.

The south-west corner shows the presence of a third distinctive linear anomaly (a), this also may be caused by a cut feature representing a former field boundary.

Area 7 continues to cover a smaller section at the southern end of the site and also a strip of land east of the taxiway.

The southern section reveals two linear anomalies, both of which may be of archaeological origin. The more distinct response is probably related to a former field boundary.

On the eastern side is an area of disturbance which is probably related to the construction of the taxiway.

4.2.2 Area 2, 3, 6 & 8

Areas 2 and 3 are part of the trial survey located on areas of enhanced magnetic susceptibility. Area 2 shows evidence of ploughing but no evidence of further anomalies. In Area 3 two positive anomalies are observed: one wider, curvilinear response which seems to be cut through by the airport taxiway in the north, and an

elongate linear anomaly appearing to cut the wider response. Both these responses are likely to represent cut features of a possible archaeological origin. Area 6 was positioned to determine if the curvilinear anomaly continues beyond the taxiway to the north. No evidence has been observed to suggest the continuation of the anomaly in this area. Area 6 shows further evidence of ploughing and a single weak positive linear anomaly which may be related a to a cut feature of archaeological origin.

Area 8 was located to trace the elongate linear anomaly observed in Area 3 and to test if there are any further features associated with the curvilinear response. The positive linear anomaly is seen to continue along the same heading with a small break near the western edge of the area. Other anomalies observed in Area 8 only identify further evidence of ridge and furrow ploughing and magnetic disturbance likely to have a modern origin.

4.2.3 Area 4

This is part of the trial survey positioned on an area of lower magnetic susceptibility as a control measure to test a non-enhanced area.

Converse to expectations the south east corner shows a strong positive magnetic anomaly despite low magnetic susceptibility readings. It is possible this can be explained by the taxiway. The gradiometers used to collect the detailed data detect strongly magnetic objects up to several metres distance. The MS2 probe used to gather magnetic susceptibility data can only detect magnetic objects up to around 20cm away. The gradiometer may be detecting metal reinforcing from within the taxiway surface, whereas the MS2 probe will not pick this response up.

Also within Area 4 are five weak positive linear anomalies which may relate to cut features of an archaeological origin.

4.2.4 Area 5

Area 5 has been positioned as close as vegetation would allow to an Archaeological Notification Area. No detail is observed in the data, which is characterised by strong responses probably of modern origin.

5 CONCLUSION

The magnetic susceptibility survey produced results which enabled areas of detailed magnetic survey to be targeted.

Detailed magnetic survey has identified numerous linear responses across the site that probably relate to cut features and field boundaries of an archaeological origin, and possible services. Evidence of ploughing activity is also widespread throughout the survey area. Some geophysical responses are cut by the taxiway suggesting this may have disturbed features during its construction.

Further investigations would be required to clarify the precise origin of some features.

REFERENCES

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