

GEOPHYSICAL SURVEY REPORT

STRATASCAN™



Project name:
**Land North of Highfield House, Church Road, Warboys,
Cambridgeshire**

Client:
Albion Archaeology

July 2014

Job ref:
J7121

Report author:
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Job ref:

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Field team:

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Techniques:

**Detailed magnetic survey –
Gradiometry**

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Survey date:

11th July 2014

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TABLE OF CONTENTS

LIST OF FIGURES.....	2
1 SUMMARY OF RESULTS	3
2 INTRODUCTION	3
2.1 Background synopsis.....	3
2.2 Site location	3
2.3 Description of site	3
2.4 Geology and soils	3
2.5 Site history and archaeological potential	4
2.6 Survey objectives	4
2.7 Survey methods	4
2.8 Processing, presentation and interpretation of results.....	5
2.8.1 Processing	5
2.8.2 Presentation of results and interpretation.....	5
3 RESULTS.....	5
3.1 Probable Archaeology.....	6
3.2 Possible Archaeology	6
3.3 Other Anomalies	6
4 CONCLUSION	7
5 REFERENCES	8
APPENDIX A – METHODOLOGY & SURVEY EQUIPMENT	9
APPENDIX B – BASIC PRINCIPLES OF MAGNETIC SURVEY	10
APPENDIX C – GLOSSARY OF MAGNETIC ANOMALIES.....	11

LIST OF FIGURES

Figure 01	1:25 000	Location plan of survey area
Figure 02	1:1000	Location of survey grids and referencing
Figure 03	1:1000	Colour plot of gradiometer data showing extreme values
Figure 04	1:1000	Plot of minimally processed gradiometer data
Figure 05	1:1000	Plot of processed gradiometer data
Figure 06	1:1000	Abstraction and interpretation of gradiometer anomalies

1 SUMMARY OF RESULTS

A detailed gradiometry survey was conducted over approximately 3 hectares of grassland. A number of features of archaeological origin have been identified. These mostly relate to military radio transmitter installations dating to the Second World War and Cold War, although extensive ridge-and-furrow ploughing is also present.

Other anomalies are likely modern in origin and include magnetic disturbance (related to the bases of former military radio transmitters) and isolated magnetic spikes.

2 INTRODUCTION

2.1 *Background synopsis*

Stratascan were commissioned to undertake a geophysical survey of an area outlined for development of two purpose built factory units and associated hard standing and external storage. This survey forms part of an archaeological investigation being undertaken by Albion Archaeology.

2.2 *Site location*

The site is located near Warboys, Cambridgeshire at OS ref. TL 302 788. The site sits directly south of the town of Warboys itself, west of Ballantyne Farm, and forms part of the former Second World War (WWII) airfield site.

2.3 *Description of site*

The survey area is approximately 3 hectares of mown grassland. The land is currently unused, and the topography is flat overall. A number of large obstructions are present in the form of the overgrown bases of former radio transmitter masts, buildings related to the WWII airfield, and thick vegetation surrounding the boundaries of the survey area. These obstructions have limited the overall survey area to 3 hectares, instead of the original 4.1 hectares.

2.4 *Geology and soils*

The underlying geology is West Walton Formation and Ampthill Clay Formation (undifferentiated) - Mudstone (British Geological Survey website). The drift geology is Oadby Member - Diamicton (British Geological Survey website).

The overlying soils are known as Cannamore which are typical stagnogleyic brown calcareous earths. These consist of deep calcareous and non-calcareous fine loamy and clayey soils with slowly permeable subsoils and slight seasonal waterlogging (Soil Survey of England and Wales, Sheet 4 Eastern England).

2.5 **Site history and archaeological potential**

The following is taken from the Project Design for Archaeological Field Evaluation, produced by Albion Archaeology (2014):

“The proposed development site lies within a medieval landscape represented by settlement and cultivation remains.

To the south east of the site is Caldecote deserted medieval village, thought to be located at the junction of the B1040 and A141 roads (CHER 08666). Documentary records suggest the village was abandoned by the early 16th century. No traces of the village could be detected on aerial photographs examined as part of the current evaluation, though ridge and furrow earthworks were visible in the supposed location of the village and to the south and east of the proposed development site (Air Photo Services 2012). Ridge and furrow cropmarks are also recorded in the CHER in the vicinity of the Warboys Industrial Estate (CHER MCB19674).

Further afield, c.1.3km to the south-west, lies the site of the Abbot of Ramsey’s Manor House (CHER 01057, DCB185). This once large and prestigious holding now comprises earthworks representing the remains of moated precincts containing the house and outbuildings, garden and fishponds beyond. To the north of this is recorded the Saxon settlement of Broughton (CHER 04285).

Two other moated sites lie similar distances from the site to the north-east (CHER 01072) and south-east (CHER 01071).

In more recent years the proposed development site was part of the land occupied by RAF Warboys (CHER CB15154), a Second World War heavy bomber and station. By 1960 the airfield was converted for use as an air defence missile base. The aerial photographic survey (Air Photo Services 2012) showed that the majority of the airfield was demolished by the 1970s, by which time the land had reverted to arable use. The runways were removed by 1989 and only the outline of the airfield and its munitions store remain as farm tracks.

The proposed development area is surrounded by a high metal security fence of probable post WWII date indicating the military use of the site during the Cold War. A substantial, heavily reinforced structure is also present in the eastern corner of the site. The date of this building is uncertain but it probably dates to the Second World War, with its use continuing into the Cold War.”

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**

This report and all fieldwork have been conducted in accordance with both the English Heritage guidelines outlined in the document: *Geophysical Survey in Archaeological Field Evaluation, 2008* and with the Institute for Archaeologists document *Standard and Guidance for Archaeological Geophysical Survey*.

Detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating archaeological anomalies. English Heritage (2008) recorded average – poor responses for magnetometer survey over Mudstone However, due to the likelihood of relatively modern magnetic features (related to the RAF airfield) being present, magnetometer was chosen as the preferred survey method. More information regarding this technique is included in Appendix A.

2.8 *Processing, presentation and interpretation of results*

2.8.1 *Processing*

Processing is performed using specialist software. 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. 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 minimally processed gradiometer data used in this report:

1. *Destripe* (Removes striping effects caused by zero-point discrepancies between different sensors and walking directions)
2. *Destagger* (Removes zigzag effects caused by inconsistent walking speeds on sloping, uneven or overgrown terrain)

2.8.2 *Presentation of results and interpretation*

The presentation of the data for each site involves a print-out of the minimally processed data both as a greyscale plot and a colour plot showing extreme magnetic values, together with a greyscale plot of the processed data. Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site.

3 **RESULTS**

The detailed magnetic gradiometer survey conducted at Warboys has identified a number of anomalies that have been characterised as being of a *probable* archaeological origin.

The difference between *probable* and *possible* archaeological origin is a confidence rating. Features identified within the dataset that form recognisable archaeological patterns or seem to be related to a deliberate historical act have been interpreted as being of a probable archaeological origin.

Features of possible archaeological origin tend to be more amorphous anomalies which may have similar magnetic attributes in terms of strength or polarity but are difficult to classify as being archaeological or natural.

The following list of numbered anomalies refers to numerical labels on the interpretation plots.

3.1 *Probable Archaeology*

- 1 Strong magnetic anomalies related to the bases of WW2 radio transmitter masts.
- 2 Areas of magnetic debris related to military radio transmitter installations.
- 3 Sub-circular magnetic anomalies related to bases of post-WW2 'bomber net' radio transmitter masts.
- 4 Linear anomalies probably connected to cabling related to former transmitter masts.
- 5 Widely spaced curving parallel linear anomalies, probably related to ridge-and-furrow.
- 6 Linear anomaly related to former field boundary visible on historic mapping (dating to 1880).

3.2 *Possible Archaeology*

No possible archaeology has been identified within the survey area.

3.3 *Other Anomalies*

- 7 Areas of magnetic disturbance are the result of substantial nearby ferrous metal objects. On this site, they are the result of visible former radio mast bases, now overgrown. These effects can mask weaker archaeological anomalies, but on this site have not affected a significant proportion of the area.
- 8 A number of magnetic 'spikes' (strong focussed values with associated antipolar response) indicate ferrous metal objects. These are likely to be modern rubbish.

4 CONCLUSION

The survey conducted at Warboys has identified a number of features of archaeological origin. The survey area sits within the boundary of the former RAF Warboys military airfield, in use during WWII and the Cold war period, and this is reflected within the survey data. Across the west of the survey area, a number of regularly-shaped features relate to the bases of former radio transmitter masts, and areas of strong magnetic debris also likely relate to these former structures, and their dismantling. The smaller groups of features likely relate to the base of WWII transmitter masts, the standing remains of which are visible on other WWII bomber airfields. The larger, sometimes concentric, sub-circular features likely relate to post-war masts, possibly part of the 'bomber net' radio network used by the strategic nuclear V Bomber aircraft during the cold war (RAF Lincolnshire website 2014).

The T-shaped building, still standing in the south west of the survey area, was likely an RAF direction finding station, used for tracking the bomber aircraft of RAF Warboys during WWII. It likely continued in a similar use during the Cold War period.

None of the masts are standing today, although the bases of four former masts are present as overgrown obstacles within the survey area. These are represented in the survey data as areas of "dummy" or blank data, with small halos of magnetic disturbance surrounding them.

The masts are visible on aerial photographs dating to 1945, it is likely they remained in use until the 1960s (RAF Lincolnshire website 2014).

Extensive evidence of ridge-and-furrow ploughing is also visible across the site. This relates to medieval agricultural activity and corroborates the statement within the Project Design that *"...the proposed development site lies within a medieval landscape represented by settlement and cultivation remains"* (Albion Archaeology 2014).

There are also a number of isolated magnetic spikes visible within the survey data. These are likely of modern origin.

5 REFERENCES

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www.raf-lincolnshire.info

APPENDIX A – METHODOLOGY & SURVEY EQUIPMENT

Grid locations

The location of the survey grids has been plotted 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 or a Leica Smart Rover RTK GPS.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. A SmartNet RTK GPS uses Ordnance Survey's network of over 100 fixed base stations to give an accuracy of around 0.01m.

Survey equipment and gradiometer configuration

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTeslas (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 instrument consists of two fluxgates 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 gradiometer has a 1m separation between the sensing elements so enhancing the response to weak anomalies.

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.

Depth of scan and resolution

The Grad 601-2 has a typical depth of penetration of 0.5m to 1.0m, though strongly magnetic objects may be visible at greater depths. The collection of data at 0.25m centres provides an optimum methodology for the task balancing cost and time with resolution.

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 site survey, data is transferred to the office for processing and presentation.

APPENDIX B – 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 *thermoremanent* 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.

Thermoremanence 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. Thermoremanent archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

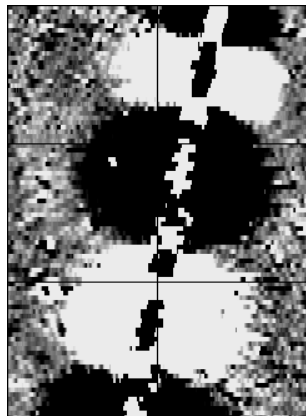
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement 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 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.

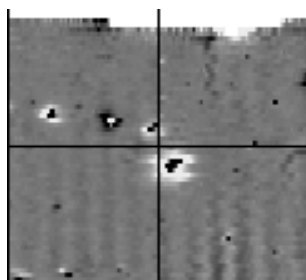
APPENDIX C – GLOSSARY OF MAGNETIC ANOMALIES

Bipolar



A bipolar anomaly is one that is composed of both a positive response and a negative response. It can be made up of any number of positive responses and negative responses. For example a pipeline consisting of alternating positive and negative anomalies is said to be bipolar. See also dipolar which has only one area of each polarity. The interpretation of the anomaly will depend on the magnitude of the magnetic field strength. A weak response may be caused by a clay field drain while a strong response will probably be caused by a metallic service.

Dipolar

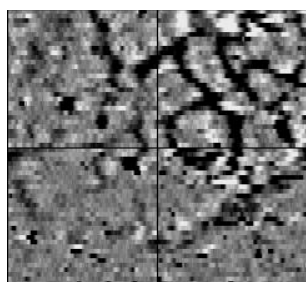


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very strong anomaly is likely to be caused by a ferrous object.

Positive anomaly with associated negative response

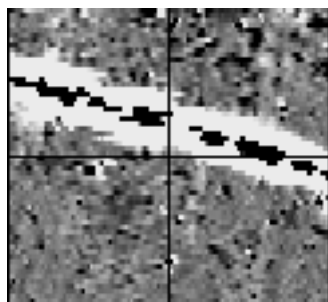
See bipolar and dipolar.

Positive linear



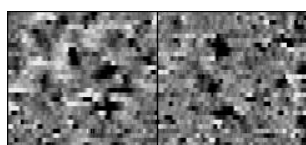
A linear response which is entirely positive in polarity. These are usually related to in-filled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity and some may even have a natural origin.

Positive linear anomaly with associated negative response



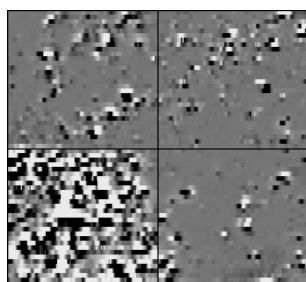
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field boundaries.

Positive point/area



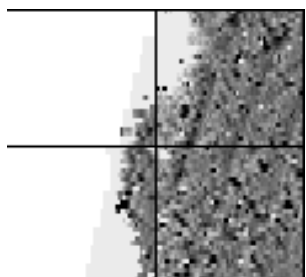
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by in-filled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally occurring depressions in the ground.

Magnetic debris



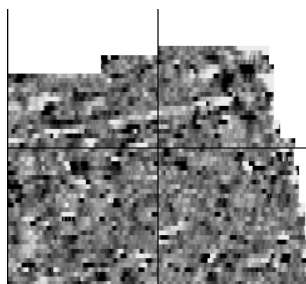
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low ($\pm 3nT$) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly ($\pm 250nT$) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremanent material such as bricks or ash.

Magnetic disturbance



Magnetic disturbance is high amplitude and can be composed of either a bipolar anomaly, or a single polarity response. It is essentially associated with magnetic interference from modern ferrous structures such as fencing, vehicles or buildings, and as a result is commonly found around the perimeter of a site near to boundary fences.

Negative linear

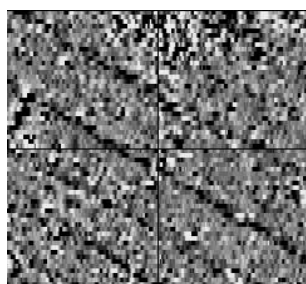


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative to the background top soil is built up. See also ploughing activity.

Negative point/area

Opposite to positive point anomalies these responses may be caused by raised areas or earthen banks. These could be of an archaeological origin or may have a natural origin.

Ploughing activity



Ploughing activity can often be visualised by a series of parallel linear anomalies. These can be of either positive polarity or negative polarity depending on site specifics. It can be difficult to distinguish between ancient ploughing and more modern ploughing. Clues such as the separation of each linear, straightness, strength of response and cross cutting relationships can be used to aid this, although none of these can be guaranteed to differentiate between different phases of activity.

Polarity

Term used to describe the measurement of the magnetic response. An anomaly can have a positive polarity (values above 0nT) and/or a negative polarity (values below 0nT).

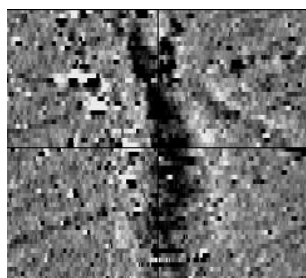
Strength of response

The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a 10m² area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size and shaped anomaly but with values up to only 4nT may have a natural origin. Colour plots are used to show the amplitude of response.

Thermoremanent response

A feature which has been subject to heat may result in it acquiring a magnetic field. This can be anything up to approximately +/-100 nT in value. These features include clay fired drains, brick, bonfires, kilns, hearths and even pottery. If the heat application has occurred in situ (e.g. a kiln) then the response is likely to be bipolar compared to if the heated objects have been disturbed and moved relative to each other, in which case they are more likely to take an irregular form and may display a debris style response (e.g. ash).

Weak background variations



Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be caused by changes in the underlying geology or soil type which may contain unpredictable distributions of magnetic minerals, and are usually apparent in several locations across a site.

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