GEOPHYSICAL SURVEY REPORT

STRATASCAN™

SUMO Survey Services
SUMO Group Member

Project name:

Sports Ground, Fullbridge Road, Peterborough

Client:

Surfacing Standards Ltd

July 2015

Job ref:

J8578

Report author:

Thomas Richardson MSc ACIfA

GEOPHYSICAL SURVEY REPORT

Project name:
Sports Ground, Fullbridge Road, Peterborough
Client:
Surfacing Standards Ltd

Job ref:
J8578

Techniques:
Detailed magnetic survey – Gradiometry

Survey date:
19th June 2015

Site centred at:
TF 175 028

Post code:
PE4 6GL

Field team:
Joe Perry BA
Leanne Swinbank BA

Project manager:
Simon Haddrell BEng(Hons) AMBCS PCIfA

Report written By:
Thomas Richardson MSc ACIfA

CAD illustrations by:
Thomas Richardson MSc ACIfA

Checked by:
David Elks MSc ACIfA

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1 SUMMARY OF RESULTS

A detailed gradiometry survey was conducted over approximately 1.8 hectares of sports pitches. The survey has not identified any anomalies of archaeological origin. All of the anomalies identified are modern in origin, relating to agricultural activity, services, service trenches, scattered magnetic debris, ferrous objects, and fencing.

2 INTRODUCTION

2.1 *Background synopsis*

Stratascan were commissioned to undertake a geophysical survey of an area outlined for a sports pitch development. This survey forms part of an archaeological investigation being undertaken by Surfacing Standards Ltd.

2.2 *Site location*

The site is located to the west of Fullbridge Road, Peterborough, Cambridgeshire at OS ref. TF 175 028.

2.3 *Description of site*

The survey area is approximately 1.95 hectares, however small areas of overgrown vegetation around the field boundaries reduced the surveyable area to 1.8 hectares of flat grass land, currently used as sports pitches.

2.4 *Geology and soils*

The underlying geology is Oxford Clay Formation - Mudstone (British Geological Survey website). The drift geology is River Terrace Deposits, 2 – Sand and Gravel across the east of the site, with none recorded in the west (British Geological Survey website).

The overlying soils are not recorded due to the urban environment of the site (Soil Survey of England and Wales, Sheet 4 Eastern England England).

2.5 *Site history and archaeological potential*

Extract from 'Brief for Evaluation and Geophysical Survey' (Surfacing Standards Ltd 2015):

A field-walking survey carried out within the current allotments north of the proposed development site has produced pottery dating to the Roman, Anglo-Saxon, medieval and post-medieval period. Amongst the Roman materials were fragments of a box flue tile which would have originally associated with the hypocaust of a bathhouse.

Although the presence of the finds is likely to relate to manuring of the open fields from the nearby historic settlements at Walton and Werrington (ridge and furrow are recorded in the

area), their concentrations could also indicate the presence of a Roman site.

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*

All survey data points had their position recorded using Trimble R8 Real Time Kinematic (RTK) VRS Now GNSS equipment. The geophysical survey area is georeferenced relative to the Ordnance Survey National Grid.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	CARTEASY^{N} cart system (Bartington 1000L Sensors)	0.75m	10Hz (approximating 0.125m)

All survey work is carried out in accordance with the current English Heritage guidelines (EH 2008).

Due to the good response of Chalk geology for gradiometer survey, detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating a wide range archaeological anomalies. More information regarding this technique is included in Appendix A.

2.8 *Processing, presentation and interpretation of results*

2.8.1 *Processing*

Data has been processed using an in house software package (CartEasy^{N}) and a colour plot has been produced using Surfer 8 software. The processed applied were:

Zero Median Traverse	This process sets the background median of each traverse to zero. Limits are applied to reduce the effect of extreme readings which can skew the statistics. The operation minimises the differences between adjacent sensors.
Projection	Greyscale images require data to be sampled at regular intervals on each traverse. Due to the high precision of the RTK GNSS on the CartEasy^{N} magnetometer cart small velocity & traverse separation variations result in an irregular sampling interval. Projection

	involves converting WGS84 coordinates to OSGB36 and re-sampling the collected data at regular intervals during the post processing stage.
Colouring extreme values	Surfer 8 software is used to colour extreme values within the dataset. A colour scale is used with plotting parameters set at +100nT and -100nT.

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. 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 Fullbridge Road has not identified any anomalies of a *probable* or *possible* archaeological origin. The following list of numbered anomalies refers to numerical labels on the interpretation plots.

3.1 Probable Archaeology

No probable archaeology has been identified within the survey area.

3.2 Possible Archaeology

No possible archaeology has been identified within the survey area.

3.3 Medieval/Post-Medieval Agriculture

1 Areas of closely spaced parallel linear anomalies. These are indicative of modern agricultural activity, such as ploughing.

3.4 Other Anomalies

2 High amplitude positive linear anomalies with associated negative responses.

These are indicative of underground services.

3 Negative linear anomalies in the south and east of the site. These are likely to relate to modern service trenches.

4 Areas of scattered magnetic debris across the south of the site. These are likely to be modern in origin.

5 Areas of magnetic disturbance are the result of substantial nearby ferrous metal objects such as fences and underground services. These effects can mask weaker archaeological anomalies, but on this site have not affected a significant proportion of the area.

6 A number of magnetic 'spikes' (strong focussed values with associated antipolar response) indicate ferrous metal objects. These are likely to be modern rubbish.

4 DATA APPRAISAL & CONFIDENCE ASSESSMENT

Oxford Clay geologies can give a variable response to magnetic survey. The presence of agricultural features in the data suggests that the survey has been somewhat effective. However, noise from modern anomalies including the service and scattered magnetic debris have the potential to mask archaeological anomalies. Therefore it is not possible to say with confidence that the survey would have detected archaeological anomalies were they present.

5 CONCLUSION

The survey at Fullbridge Road has not identified any anomalies of archaeological origin. There is no evidence that any of the finds from field walking relate to archaeological activity on the site. All of the anomalies identified are modern in origin. These relate to agricultural activity, services, service trenches, scattered magnetic debris, ferrous objects, and fencing.

6 REFERENCES

British Geological Survey South Sheet, 1977. *Geological Survey Ten Mile Map, South Sheet First Edition (Quaternary).* Institute of Geological Sciences.

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

British Geological Survey, n.d., *website*: (http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps) Geology of Britain viewer.

Chartered Institute For Archaeologists. *Standard and Guidance for Archaeological Geophysical Survey.* http://www.archaeologists.net/sites/default/files/nodefiles/Geophysics2010.pdf

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation.*

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

Surfacing Standards Ltd, 2015. *Brief for Evaluation and Geophysical Survey.* Application number: PAOTH/15/00071

APPENDIX A – METHODOLOGY & SURVEY EQUIPMENT

Every point that is recorded is referenced using a Trimble R8 RTK GNSS system.

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. .

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 CartEasyN magnetometer cart system utilizing Bartington 1000L Gradiometer sensors. 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.

Sampling interval

For cart collected data readings were taken at intervals of 0.125m along traverses 0.75m apart.

Depth of scan and resolution

The CartEasyN magnetometer cart system collects data at 10Hz which approximates 0.125m.

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.

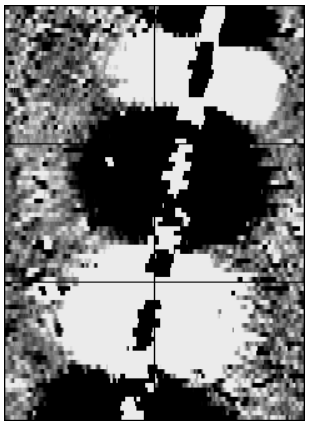
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement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

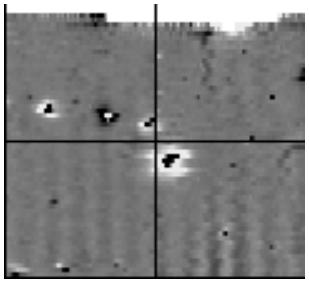
APPENDIX C – GLOSSARY OF MAGNETIC ANOMALIES

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

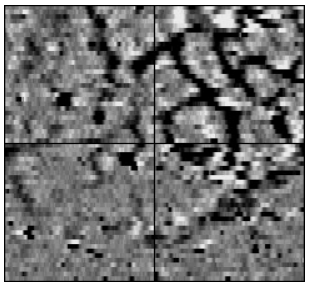


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

Positive anomaly with associated negative response

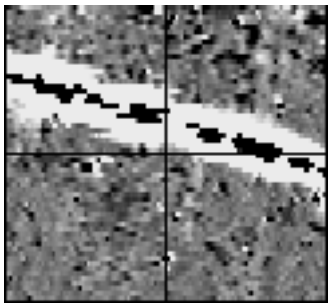
See bipolar and dipolar.

Positive linear



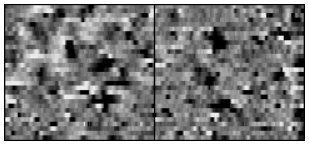
A linear response which is entirely positive in polarity. These are usually related to in-filled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity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

Positive linear anomaly with associated negative response



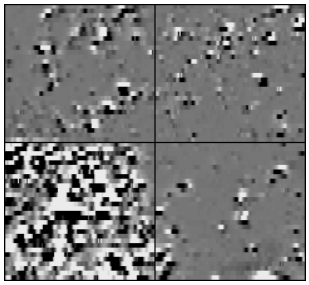
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field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

Positive point/area



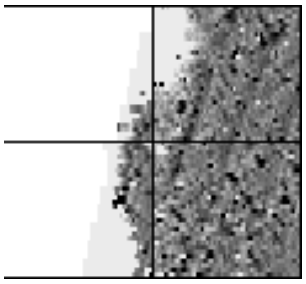
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by in-filled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally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

Magnetic debris



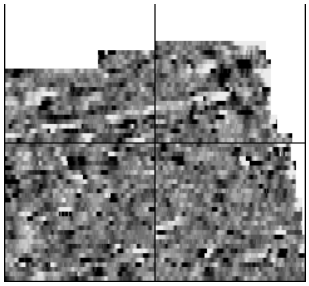
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly (+/-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

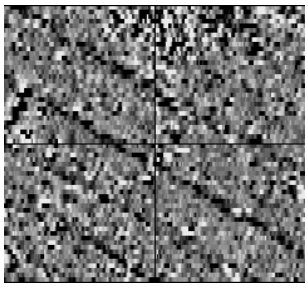


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative to the background top soil is built up. See also ploughing activity.

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).

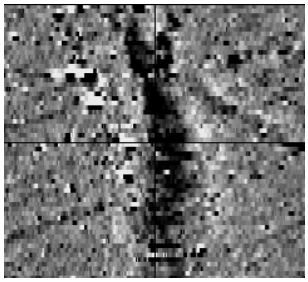
Strength of response

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 10m^2 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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STRATASCAN LTD
Vineyard House Upper Hook Road Upton upon Severn
Worcestershire WR8 0SA United Kingdom

T:01684 592266 F: 01684 594142
info@stratascan.co.uk www.stratascan.co.uk

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