GEOPHYSICAL SURVEY REPORT

STRATASCAN™

SUMO Survey Services SUMO Group Member

Project name:

Hydes Solar Farm, Little Bardfield, Essex

Client:

Archaeological Solutions

February 2014

Job ref:

J6253

Report author:

Orlando J. Prestidge BA(Hons) MA AIfA

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Field team:

Rebecca Davies BA,
Ben Bowen,
Tim Hamflett MSc

Techniques:

Detailed magnetic survey – Gradiometry

Project manager:

Simon Haddrell BEng(Hons) AMBCS PIFA

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Report written By:

Orlando J. Prestidge BA(Hons) MA AIfA

Site centred at:

TL 650 299

CAD illustrations by:

Orlando J. Prestidge BA(Hons) MA AIfA

Post code:

CM7 4TY

Checked by:

David Elks MSc AIFA

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1 SUMMARY OF RESULTS

A detailed gradiometry survey was conducted over approximately 18.75 hectares of agricultural land. A number of features of archaeological origin have been identified throughout the survey area. These include cut features and possible enclosures. These features most likely relate to the possible "...celtic field system dating from the Bronze Age through to the early Middle Ages..." mentioned in the DBA provided by Archaeological Solutions Ltd. The evidence within the survey data correlates with the description that the features"...are often coaxial ie forming a system by which boundaries of adjacent fields make a series of long roughly parallel lines."

Two former field boundaries, visible on historic mapping of 1876, are also present.

Other modern and natural features have also been identified including magnetic disturbance, magnetic spikes and ploughing.

2 INTRODUCTION

2.1 Background synopsis

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

2.2 Site location

The site is located near Little Bardfield, near Braintree in Essex at OS ref. TL 650 299.The site sits to the south of Markswood Farm, and is an open area of arable land.

2.3 Description of site

The survey area is approximately 18.75 hectares of agricultural land, currently in arable use, under wheat stubble. The topography is mainly flat, although there were regular obstructions in the form of straw bales, and these are represented by small gaps within the data set.

2.4 Geology and soils

The underlying geology is London Clay Formation – Clay, silt and sand. (British Geological Survey website). The drift geology is Lowestoft Formation - Diamicton (British Geological Survey website).

The overlying soils are known as Hanslope which are typical slowly permeable calcareous clayey soils. (Soil Survey of England and Wales, Sheet 6 South East England).

2.5 *Site history and archaeological potential*

The following is taken from the DBA provided by Archaeological Solutions Ltd, and written by AES Archaeology, Excavation and Surveys (Keen 2013):

"Paleolithic to Iron Age

Evidence for prehistoric archaeological remains in the wider landscape has to date been a small collection of Neolithic worked flints found at Shalford, along with early bronze age burials (ECC FAU, 2010). Iron age occupation of the surrounding landscape has been revealed to some extent by excavations at Thaxted of prehistoric flint and late Bronze Age to early Iron Age pottery (Rozwadowski, M., 2008), at Great Bardfield, of finds dating to the late Iron Age and late Bronze Age (Orr, K., CAT, 2007) and at Finchingfield where evidence was revealed for mid and late Iron Age occupation (Benfield, S., 2005, Lister, C., 2006).

To the north west of the site and east of Marks Wood, a series of cropmarks show the remnants of ancient field boundaries (Figure 8, SMR No 19010). A further collection of similar cropmarks lie south east of the proposed site (SMR No 19013). The latter are possibly part of a celtic field system dating from the Bronze Age through to the early Middle Ages, these are often coaxial ie forming a system by which boundaries of adjacent fields make a series of long roughly parallel lines.

Romano-British

Some evidence to date has been found for the wider Roman landscape surrounding the proposed site. Roman tile has been recorded as present in the walls of St Katharine's Church (SMR No 1519). Earth banks near Lodge Wood were thought to represent part of a Roman road. Roman finds consisting of second century pottery and a wall foundation, and believed to form part of a Roman settlement were found at Finchingfield (Benfield, S., 2005, Lister, C., 2006, SMR Nos 1505, 1506). A Roman burial was found at Great Bardfield (Orr, K., CAT, 2007). Excavations at Thaxted revealed Roman pottery (Rozwadowski, M., 2008). Roman ditches were discovered at Shalford (ECC FAU, 2010). No evidence to date has been uncovered for Roman activity within or in the vicinity of the proposed site.

Anglo-Saxon and Medieval

The proposed site falls in an anglo-saxon/medieval landscape within the parish of Little Bardfield. The early medieval landscape was dominated by two manors, Little Bardfield Hall and Mole Hall. At the time of the Domesday survey the manor of Little Bardfield was held by Eustace Earl of Bologne and his under tenant Adelolf de Merk. From the name Adelolf de Merk, or Merks, it is deemed that many placenames in Essex were derived, it is possible that the name Marks Wood was also derived from this source. The manor was held by Henry de Merk from 1210 until 1268 and remained in the family held by Andrew de Merk until at least 1283. In 1351 the manor of Little Bardfield and its lands was passed to the Abbey and Convent of St John's in Colchester.

Within a radius of 1.5km there are several sites recorded in the Essex heritage environment records of anglo-saxon and medieval buildings, and medieval field boundaries and moats.

To the north east of the site lies the village of Little Bardfield and the

Church of St Katharine, the church is dated as early as saxon with the large west tower being one of the few outstanding pieces of saxon architecture in Essex (SMR Nos 1519, 1520, 1521 and 1522). To the west of the church, earthworks and fish ponds have been recorded, which are the remains of a possible deserted medieval village SMR No 1523)

The proposed site lies within the proximity of cropmarks, which show the remains of medieval field boundaries, at New Barn, The Lodge, Bustard Green, The Hydes and Stones. The field boundaries reflect the reorganisation in the medieval period into extensive 'open' or sub-divided field systems, associated with hamlets of families who worked strips of land dispersed through the systems. (Figure 4, SMR Nos 46576, 46577, 46582, 46590, and 46592).

Remnants of medieval life also remain in the form of medieval moats and buildings at Fanns Farm, The Grove and west of Little Bardfield Hall (HER Nos 1196, 1280, 1566). A medieval Hedingham ware kiln was also found in Great Bardfield (Orr, K., CAT, 2007). The most noteable evidence of medieval life in the vicinity of the site is Markswood Farmhouse, a grade II listed building (SMR No 38196).

Post-Medieval

The manorial estate of Little Bardfield remained in church hands until the dissolution of the monastries in 1539, when it was then granted to Robert Foster Esq by King Henry VIII. The manor passed on to William Chishull Esq on 3 April 1541 until his death on 12 Aug 1570. From 1570 to 1777 the manorial estate was held by a series of landowners, William Smith, John Buttal, Christopher Buttal, Thomas Wale and Henry Wale Esq. The name of Henry Wale can be found enscribed on Chapman and Andre's map of 1777, and mentioned by the Rev Phillip Morant as the present landowner at his time of writing the History and Antiquities of Essex in 1763.

The land on which the proposed site lies belonged in the nineteenth century to William Walford and was occupied by William Phillips.

In context with the wider early post medieval landscape the proposed site lies to the south of the site of sixteenth century, Little Hyde, house and farm building, now demolished and under plough (SMR No 1566).

On the proposed site itself, current boundaries on the north east, south west and part of the south east can be traced back to the 1838 tithe map. The proposed field for the site therefore has retained some historical boundaries, in spite of being covered by woodland until at least 1838. The woodland known as Marks Wood still remains, but in much reduced size to the north west of the 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*

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. More information regarding this technique is included in the Methodology section below and 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 The proposed site of Hydes Solar Farm, Little Bardfield has identified a number of anomalies that have been characterised as being either of a *probable* or *possible* 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 Positive anomalies associated with archaeological cut features. These appear as several large linear and large curvi-linear features very likely relate to the possible "celtic field system dating from the Bronze Age through to the early Middle Ages..." mentioned in the DBA provided by Archaeological Solutions Ltd.

3.2 Possible Archaeology

2 Linear anomaly possibly related to former field boundary or ditch, visible on historic mapping of 1876

3.3 Other Anomalies

3 Closely spaced parallel linear anomalies, probably related to agricultural activity such as ploughing.

4 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.

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

6 Linear anomaly possibly related to land drains.

4 CONCLUSION

A detailed gradiometry survey was conducted over approximately 18.75 hectares of agricultural land. A number of features of archaeological origin have been identified throughout the survey area. These include cut features and possible enclosures. These features most likely relate to the possible "...celtic field system dating from the Bronze Age through to the early Middle Ages..." mentioned in the DBA provided by Archaeological Solutions Ltd. The evidence within the survey data correlates with the description that the features"...are often coaxial ie forming a system by which boundaries of adjacent fields make a series of long roughly parallel lines."

Two former field boundaries, visible on historic mapping of 1876, are also present.

Other modern and natural features have also been identified including magnetic disturbance, magnetic spikes and ploughing.

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http://www.archaeologists.net/sites/default/files/nodefiles/Geophysics2010.pdf

Keen, D, 2013, *An Archaeology and Desk-based Assessment; Proposed Site of Hydes Solar Farm, Little Bardfield, Essex*, AES Archaeology, Excavation and Surveys

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.

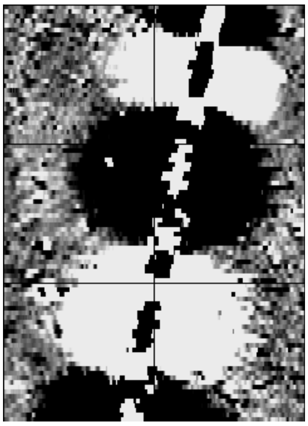
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement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

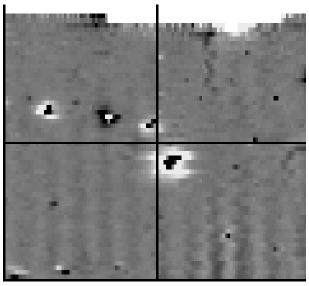
APPENDIX C – GLOSSARY OF MAGNETIC ANOMALIES

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

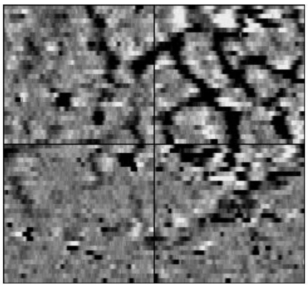


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

Positive anomaly with associated negative response

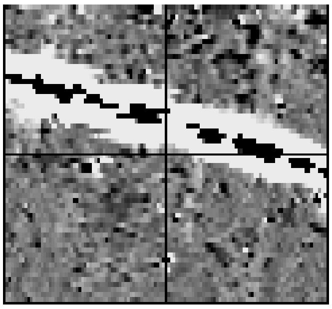
See bipolar and dipolar.

Positive linear



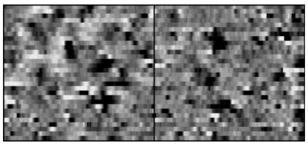
A linear response which is entirely positive in polarity. These are usually related to in-filled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity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

Positive linear anomaly with associated negative response



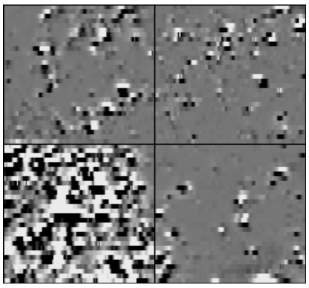
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field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

Positive point/area



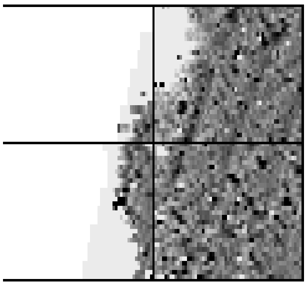
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by in-filled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally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

Magnetic debris



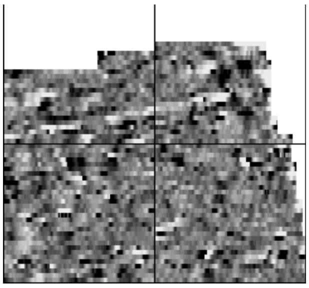
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly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

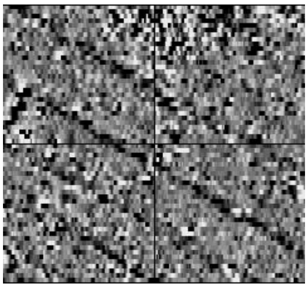


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

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).

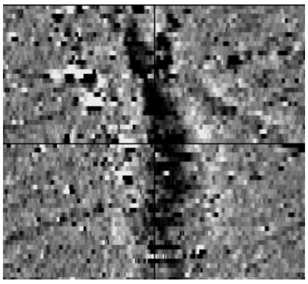
Strength of response

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.

STRATASCAN LTD

Vineyard House Upper Hook Road Upton upon Severn
Worcestershire WR8 0SA United Kingdom

T:0 1684 592266 F: 01684 594142
info@stratascan.co.uk www.stratascan.co.uk