GEOPHYSICAL SURVEY REPORT

# STRATASCAN™

SUMO Survey Services SUMO Group Member

Project name:

## Stokeford Farm Solar, East Stoke, Wareham

Client:

## Holme Estate

## February 2015

Job ref:

**J7839**


Report author:

**Thomas Richardson MSc ACIfA**

# GEOPHYSICAL SURVEY REPORT

Project name:
**Stokeford Farm Solar, East Stoke, Wareham**
Client:
**Holme Estate**

Job ref:
**J7839**

Field team:
**Tim Hamflett** MSci ACIfA, **Richard Collins** BA (Hons), **Stephen Weston** BA (Hons), **Joshua Jones** BSc (Hons)

Techniques:
**Detailed magnetic survey – Gradiometry**

Project manager:
**Simon Haddrell** BEng(Hons) AMBCS PCIfA

Survey date:
**6th-8th & 19th-23rd January 2015**

Report written By:
**Thomas Richardson** MSc ACIfA

Site centred at:
**SY 872 877**

CAD illustrations by:
**Thomas Richardson** MSc ACIfA

Post code:
**BH20 6BA**

Checked by:
**David Elks** MSc ACIfA

# TABLE OF CONTENTS

# LIST OF FIGURES

# 1 SUMMARY OF RESULTS

A detailed gradiometry survey was conducted over approximately 34 hectares of arable and grassland. The survey has identified four areas of former settlement and a post-medieval former field boundary. A number of possible archaeological anomalies have been identified; however it is not possible to determine their origin with any degree of confidence. The remaining anomalies are of natural or modern origin, relating to agricultural activity, land drains, 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 solar farm development. This survey forms part of an archaeological investigation being undertaken by Holme Estate.

## *2.2 Site location*

The site is located to the north of the A352, Stokeford, Dorset at OS ref. SY 872 877.

## *2.3 Description of site*

The survey area is approximately 34 hectares split over eight undulating fields of mixed arable and grassland. Fields 1, 2, 3, 6 and 7 are grassland, Field 5 is arable, Field 8 is mixed grassland and arable, whilst Field 4 was unsurveyable due to machinery.

## *2.4 Geology and soils*

The underlying geology is sand of the Broadstone Sand Member across the majority of the site with an area of silty clay of the Oakdale Clay Member in the east (British Geological Survey website). The drift geology is sand and gravel river terrace deposits (British Geological Survey website).

The overlying soils in the east of the site are known as Efford 1, which are typical argillic brown earths. These consist of fine loamy soils over gravel. The west of the site is covered by Sollom 2, which are typical gley-podzols. These consist of deep, stoneless, humose sandy soils. The north of the area is covered by Southampton, which are typical paleo-argillic podzols. These consist of very flinty, sandy soils (Soil Survey of England and Wales, Sheet 5 South West England).

## 2.5 *Site history and archaeological potential*

Extract from 'Stokeford Farm Solar, East Stoke, Wareham, Dorset Written Scheme of Investigation (WSI) For A Programme of Geophysical Survey' (RPS 2014):

*There are no recorded archaeological sites or findspots within the proposal site. Just to the north are the recorded locations of three round barrows – burial monuments of Bronze Age date. All of these are known from earlier maps of the area, but have subsequently been destroyed. Another possible round barrow, now destroyed, was located just to the east of the proposal site. Other similar examples of this monument type remain present within the wider landscape, several as Scheduled Monuments. They are predominantly located along either side of the ridge that separates the valleys of the Rivers Piddle and Frome, not on the highest part of the ridge but on the upper slopes.*

*To the north and the east of the proposal site are two sections of a linear earthwork known as the Battery Bank. Both of the sections just outside the proposal site are Scheduled Monuments: the one to the north is c. 230 m long whilst the one to the east is c. 180 m long. The Battery Bank is actually a series of linear earthen bank and ditch features that extend discontinuously for approximately 5.5 km along the ridge that separates the valley of the River Piddle (to the north) from that of the River Frome (to the south). The date of these earthworks is unclear but they may well be of Early Medieval or perhaps slightly earlier date. Other sections of the Battery Bank, also Scheduled, are present further to the east and north-west of the proposal site.*

*To the south of the proposal site, material of Roman date (sherds of pottery and a shale core) have been found during grave digging in the churchyard of the church of St Mary in 1932. Roman coins have been found at a location further to the south, close to Manor Farm at East Stoke. To the east of the proposal site along the A352 road is a milestone of the Wareham Trust, indicating 3 miles to Wareham and 14 miles to Dorchester.*

## 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.*

Given the potential for prehistoric, Roman and medieval activity, detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating a wide variety of archaeological anomalies. 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. 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 Stokefield Farm 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*

**1-4** Areas of positive linear anomalies across the site. These are likely to relate to former settlement areas.

**5** A small discrete positive anomaly in Field 3. This is indicative of a former pit feature, likely related to the settlement activity seen in Anomaly 2.

**6** A linear anomaly in the south of Field 1. This is related to a former field boundary present on available mapping 1888-1913.

## 3.2 *Possible Archaeology*

**7** A positive linear (7a) and negative linear (7b) anomaly in the west of Field 2. These are indicative of former ditch (7a) and bank (7b) anomalies, and may relate to the settlement activity seen in Anomaly 1 or be of agricultural origin.

**8** Positive linear anomalies across the site. These are indicative of former cut features, and may be of archaeological or agricultural origin.

**9** Negative linear anomalies in Fields 2, 3, 5 and 7. These are indicative of former bank or earthwork features, and may be of archaeological or agricultural origin.

**10-11** Small discrete positive anomalies in Fields 1, 2, 3 and 5. These are indicative of small former cut features, such as back filled pits, and may be of archaeological or natural origin. Anomalies 10 are in close proximity to an area of settlement (Anomaly 2) and as such may be related to this.

## 3.3 *Other Anomalies*

**12** Areas of closely spaced parallel linear anomalies across the north of the site. These are indicative of modern agricultural activity, such as ploughing.

**13** Weak bipolar linear anomalies in Field 7. These are indicative of land drains.

**14** Areas of scattered magnetic debris in Fields 5 and 7. These are likely to be modern in origin.

**15** Areas of magnetic variation across the site. These anomalies are likely to be of geological or pedological origin.

**16** 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.

**17** 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 at Stokefield Farm has identified a number of probable and possible archaeological anomalies. Four areas of former settlement can be seen, which is consistent with the prehistoric and Roman activity seen in the surrounding area. A post-medieval former field boundary can also be seen. A number of possible archaeological anomalies have been identified; however it is not possible to determine their origin with any degree of confidence. The remaining anomalies are of modern or natural origin. The modern anomalies relate to agricultural activity, land drains, scattered magnetic debris, ferrous objects and fencing.

# 5 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.

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

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

RPS, 2014. *Stokeford Farm Solar, East Stoke, Wareham, Dorset Written Scheme of Investigation (WSI) For A Programme of Geophysical Survey*

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 5 South West England*.

# 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.

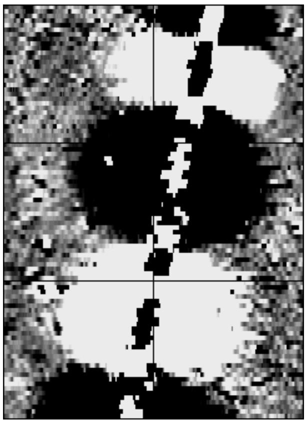
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement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

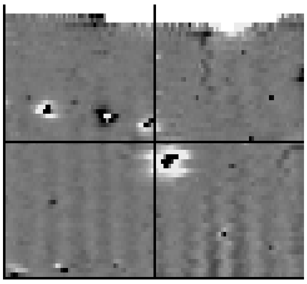
# APPENDIX C – GLOSSARY OF MAGNETIC ANOMALIES

**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**

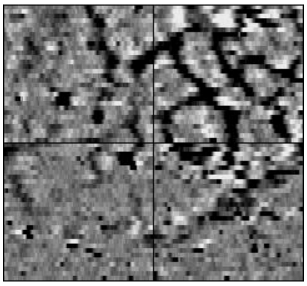


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very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

**Positive anomaly with associated negative response**

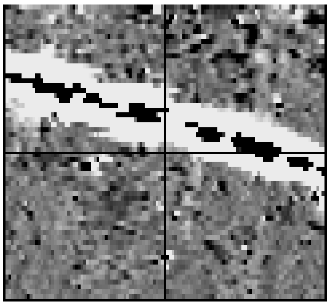
See bipolar and dipolar.

**Positive linear**



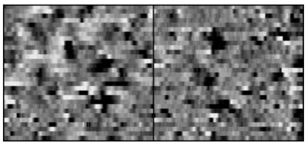
A linear response which is entirely positive in polarity. These are usually related to in-filled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity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

**Positive linear anomaly with associated negative response**



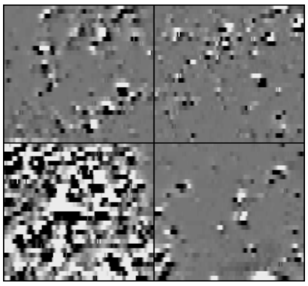
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field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

**Positive point/area**



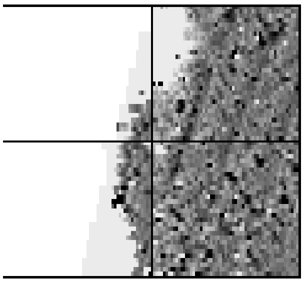
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by in-filled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally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

**Magnetic debris**



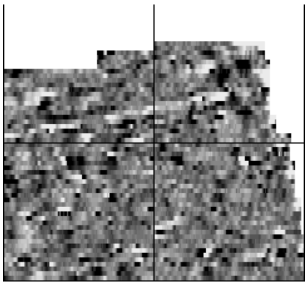
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly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

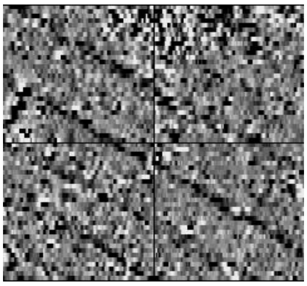


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative to the background top soil is built up. See also ploughing activity.

**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).

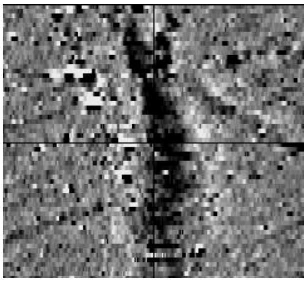
**Strength of response**

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.

STRATASCAN™

SUMO Group Member

**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