

**Catsbrain Farm
Kingsdown
Swindon**

MAGNETOMETER SURVEY REPORT

for

Orchard West Ltd

David Sabin and Kerry Donaldson

March 2015

Ref. no. 594

ARCHAEOLOGICAL SURVEYS LTD

**Catsbrain Farm
Kingsdown
Swindon**

Magnetometer Survey Report

for

Orchard West Ltd

Fieldwork by David Sabin

Report by David Sabin BSc (Hons) MIFA and Kerry Donaldson BSc (Hons)

Survey date – 27th February 2015

Ordnance Survey Grid Reference – **SU 17860 88930**



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SUMMARY

A detailed magnetometer survey was carried out by Archaeological Surveys Ltd, within a single field at Catsbrain Farm, Kingsdown, Swindon. This was commissioned by Orchard West Ltd as part of an archaeological investigation into the site ahead of a proposed mixed use development. The results show a cluster of discrete positive anomalies that appear to relate to pit-like features within the eastern part of the site. However it is not clear if these are associated with possible former quarrying or if they relate to cut features with archaeological potential. A number of positive linear anomalies were also located, and these lack a coherent morphology or layout within the site. It is therefore not possible to determine if they relate to naturally formed features, such as cracks within limestone, or if they relate to cut, ditch-like features with archaeological potential. The results also show that the site was originally split by a former field boundary, with evidence of land drainage within each of the former land parcels.

1 INTRODUCTION

1.1 Survey background

- 1.1.1 Archaeological Surveys Ltd was commissioned by Foundations Archaeology on behalf of Orchard West Ltd, to undertake a magnetometer survey of an area of land at Catsbrain Farm, Kingsdown, Swindon. The site has been outlined for a proposed mixed use development and the survey forms part of an archaeological assessment of the site.
- 1.1.2 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2014) and approved by Melanie Pomeroy Kellinger, County Archaeologist for Wiltshire Council.

1.2 Survey objectives and techniques

- 1.2.1 The objective of the survey was to use magnetometry to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site. The methodology is considered an efficient and effective approach to archaeological prospection.
- 1.2.2 The survey and report generally follow the recommendations set out by: English Heritage (2008) *Geophysical survey in archaeological field evaluation*; and Institute for Archaeologists (2002) *The use of Geophysical Techniques in Archaeological Evaluations*. The work has been carried out to the Chartered Institute for Archaeologists (2014) *Standard and Guidance for Archaeological Geophysical Survey*.

1.3 *Site location, description and survey conditions*

- 1.3.1 The site is located at Catsbrain Farm, near Kingsdown, within the parish of Stratton St Margaret, Swindon. It is centred on Ordnance Survey National Grid Reference (OS NGR) SU 17860 88930, see Figures 01 and 02.
- 1.3.2 The geophysical survey covers approximately 3.2ha within a single pasture field. The northernmost part of the field is not within the development boundary and was excluded from the survey. The site is bounded to the east by the A361 Highworth Road, and to B4141 Kingsdown Road to the south.
- 1.3.3 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. Weather conditions during the survey were cool but sunny.

1.4 *Site history and archaeological potential*

- 1.4.1 An archaeological desk-based assessment has been carried out for the site by Foundations Archaeology (2014). It outlines that prehistoric activity dating to the Palaeolithic, Mesolithic, Neolithic and Bronze Age periods has been recorded at Kingsdown cemetery 400m to the north. Late Neolithic and Bronze Age flint waste was also recovered on the site of Kingsdown Lodge, 120m to the north west. Evaluation of the Triangle site to the south of the survey area revealed a number of ditches, pits and postholes dating the Early and Middle Iron Age period. Further features recorded during subsequent excavation included an enclosure complex and a round house dating to the Late Bronze Age or Early Iron Age. Evidence for Roman activity was also recorded at all of these sites, including two crouched burials at the Triangle site.
- 1.4.2 Although the survey area does not contain any recorded sites or findspots there is a high potential for it to contain archaeology from the prehistoric and Roman periods, due to the presence of features in the nearby vicinity. It is also possible that the survey will locate features associated with medieval and post-medieval land use, such as ridge and furrow.

1.5 *Geology and soils*

- 1.5.1 The underlying solid geology across the eastern part of the site is limestone from the Stanford Formation with undifferentiated sandstone, siltstone and mudstone from the Hazlebury Bryan Formation and Kingston Formation in the western part (BGS, 2015).
- 1.5.2 The overlying soil across the survey area is from the Evesham 2 association and is a typical calcareous pelosol. It consists of a slowly permeable, calcareous, clayey soil (Soil Survey of England and Wales, 1983).

- 1.5.3 Magnetometry survey carried out across similar soils has produced good results, although there can be naturally formed anomalies present which at times can be difficult to distinguish from those with an anthropogenic origin. The underlying geology and soils are therefore considered acceptable for magnetic survey.

2 METHODOLOGY

2.1 *Technical synopsis*

- 2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.
- 2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased, and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features, such as pits and ditches, may produce magnetic anomalies that can be mapped by magnetic prospection.
- 2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth, oven etc. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.
- 2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla, which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T).

2.2 *Equipment configuration, data collection and survey detail*

- 2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5 fluxgate gradiometers spaced 0.5m apart with readings recorded at 20 Hz. The gradiometers have a range of recording data between 0.1nT and 10,000nT. They are linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.
- 2.2.2 Data are collected along a series of parallel survey transects wherever possible. The length of each transect is variable and relates to the size of the survey area and other factors including ground conditions. A visual display allows accurate placing of transects and helps maintain the correct separation between adjacent traverses.

2.3 *Data processing and presentation*

- 2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared and automatically compensated using SENSYS MAGNETO®DLMGPS software. Georeferenced raw data are then exported in ASCII format for further analysis and display using TerraSurveyor.
- 2.3.2 The data are collected at $\pm 10000\text{nT}$ and clipped for display at $\pm 20\text{nT}$. Data are resampled to a resolution of effectively 0.5m between tracks and 0.15m along each survey track. Appendix C contains specific information concerning the survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix B for further information on any processes, such as clipping, carried out on the data.
- 2.3.3 A TIFF file is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing (OSGB36 datum) when using GIS or CAD software. The main form of data display used in the report is the minimally processed greyscale plot.
- 2.3.4 The raster images are combined with base mapping using ProgeCAD Professional 2014, creating DWG file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. The CAD plots are effectively georeferenced facilitating relocation of features using GPS, resection method, etc.
- 2.3.5 An abstraction and interpretation is offered for all geophysical anomalies located by the survey. A brief summary of each anomaly, with an appropriate reference number, is set out in list form within the results (Section 3) to allow a rapid and objective assessment of features within each survey area. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.
- 2.3.6 A digital archive is produced with this report, see Appendix D below. The main archive is held at the offices of Archaeological Surveys Ltd.

3 RESULTS

3.1 *General assessment of survey results*

- 3.1.1 The detailed magnetic survey was carried out over a total of 3.2ha within a single pasture field.
- 3.1.2 Magnetic anomalies located can be generally classified as positive and negative anomalies of an uncertain origin, anomalies associated with land management, linear anomalies of an agricultural origin, areas of magnetic





debris and strong discrete dipolar anomalies relating to ferrous objects. Anomalies located within the survey area have been numbered and are described in 3.4 below.

3.2 Statement of data quality

3.2.1 Data are considered representative of the magnetic anomalies present within the site. There are no significant defects within the dataset.

3.3 Data interpretation

3.3.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, a basic key is indicated to allow cross referencing to the abstraction and interpretation plot. CAD layer names are included to aid reference to associated digital files (.dwg/.dxf). Sub-headings are then used to group anomalies with similar characteristics within the survey area.

Report sub-heading CAD layer names and plot colour	Description and origin of anomalies
<p>Anomalies with an uncertain origin</p> <p>AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG NEG LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN</p> 	<p>The category applies to a range of anomalies where <u>there is not enough evidence to confidently suggest an origin</u>. Anomalies in this category <u>may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered</u>. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.</p>
<p>Anomalies relating to land management</p> <p>AS-ABST MAG BOUNDARY AS-ABST MAG LAND DRAIN</p> 	<p>Anomalies are mainly linear and may be indicative of the magnetically enhanced fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation. Land drains can appear in a classic herringbone pattern of interconnected multiple dipolar linear anomalies, or as parallel linear anomalies. A negative response indicates material with lower magnetic susceptibility than the surrounding soils, eg stone, gravel or plastic pipe</p>
<p>Anomalies with an agricultural origin</p> <p>AS-ABST MAG AGRICULTURAL AS-ABST MAG RIDGE AND FURROW</p> 	<p>The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing.</p>
<p>Anomalies associated with magnetic debris</p> <p>AS-ABST MAG DEBRIS AS-ABST MAG STRONG DIPOLAR</p> 	<p>Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous</p>

	<p>material. This type of response is occasionally associated with kilns, furnace structures, or hearths and <u>may therefore be archaeologically significant</u>. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.</p>
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Table 1: List and description of interpretation categories

3.4 List of anomalies

Area centred on OS NGR 417860 188930, see Figures 03 & 04.

Anomalies with an uncertain origin

(1) – Within the eastern half of the survey area is a zone containing several discrete positive anomalies. These have a response of 5nT and appear to relate to pit-like features. The geology within this part of the field is limestone from the Stanford Formation, and it is not certain if these pit-like responses are associated with former quarrying or if they relate to cut features with an archaeological origin.

(2) – Within the western half of the survey area there are a small number of discrete positive responses. Although it is possible that they relate to cut, pit-like features, their isolated locations and lack of associated features prevents confident interpretation.

(3) – The survey area contains a number of weakly positive linear and some negative linear anomalies with no coherent pattern or association. They are very weak (0.5-2nT) and indistinct; however, it is possible that they relate to cut, ditch-like features.

(4) – Two positive linear anomalies extend across the eastern part of the survey area. They are generally oriented east west, and it is possible that they are associated with anomalies (12) and may, therefore, be related to agricultural activity/drainage.

(5) – A short, positive linear anomaly is located in the western part of the survey area. It is oriented parallel with anomalies (8) and may, therefore, be associated with land drainage; however, it is possible that it has some association with anomalies (4) to the east.

(6) – In the south eastern part of the survey area are two positive linear anomalies that are oriented west north west to east south east. These are not generally parallel with anomalies (12); however, they do not appear to continue westwards beyond former field boundary (7) and they may also relate to agricultural activity/drainage.

Anomalies associated with land management

(7) – Extending north to south through the centre of the field are a group of positive and negative linear anomalies with associated magnetic debris. They appear to relate to a field boundary that is present on the 1776 Inclosure Map of Stratton St Margaret, but has been removed by the 1883 Ordnance Survey 1st edition map. However, a field boundary is also recorded in this position on the 1925 Ordnance Survey map.

(8) – A series of parallel negative linear anomalies, oriented west north west to east south east and spaced 10-11m apart are located in the western part of the survey area. They relate to a series of land drains that are delimited by former field boundary (7).

(9) – A series of parallel positive linear anomalies, oriented east north east to west south west and spaced 6-7m apart are also confined within the western half of the survey area. Although an agricultural origin is possible, it appears that these may also relate to land drainage.

(10) – Located in the eastern part of the survey area are a series of parallel linear anomalies that are spaced 5m apart and are alternate positive and negative linear responses. These appear to be related to land drainage.

Anomalies with an agricultural origin

(11) – In the north western part of the survey area are a series of very weakly positive responses. It is possible that these relate to former ridge and furrow.

(12) – A number positive linear anomalies, oriented almost east west, are located in the eastern half of the survey area. These appear to relate to agricultural activity or possibly land drainage.

Anomalies associated with magnetic debris

(13) – A linear band of magnetic debris is located along the western edge of the survey area. This relates to soil containing ferrous and other magnetically thermoremanent material.

(14) – A small patch of magnetic debris is also evident at the north eastern corner of the survey area.

(15) – Strong, discrete, dipolar anomalies are a response to ferrous and other magnetically thermoremanent objects within the topsoil.

4 CONCLUSION

- 4.1.1 The detailed magnetometer survey located a group of pit-like responses within the eastern part of the survey area. This part of the site lies over limestone, and it is possible that these anomalies are related to quarrying. However, a response to cut, pit-like features with archaeological potential should be considered. A small number of isolated discrete positive responses can also be seen within the western part of the survey area. The site also contains a number of weakly positive linear anomalies that lack a coherent morphology or pattern, and although a natural origin is possible, they may relate to cut, ditch-like features.
- 4.1.2 The site is divided into two by a former field boundary, extending north to south. Within each of these former land parcels are contained linear anomalies that are associated with land drainage, with at least two separate series in the western part, and at least one, if not two in the eastern part. The western part of the site contains evidence of former ridge and furrow cultivation oriented almost north south.

5 REFERENCES

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Foundations Archaeology, 2014. *Catsbrain Farm, Kingsdown, Wiltshire, Desk-based Assessment. Report No: 994*.

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

Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremanent material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremanent magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremanent features include ovens, hearths, and kilns. In addition thermoremanent material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – data processing notes

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. It has been found that clipping data to ranges between $\pm 20\text{nT}$ and $\pm 10\text{nT}$ often improves the appearance of features associated with archaeology. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Zero (dstrip) Median/Mean Traverse

The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise differences between the baseline value of gradiometer sensors.

Appendix C – survey and data information

COMPOSITE

Filename: J594-mag-proc.xcp
Description: Imported as Composite from: J594-mag.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates OSGB36
Northwest corner: 417734.047251098, 189016.132177898 m
Southeast corner: 417976.567251098, 188861.332177898 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702

Source GPS Points: 899000

Dimensions

Composite Size (readings): 2021 x 1290
Survey Size (meters): 243 m x 155 m
X Interval: 0.12 m
Y Interval: 0.12 m

Stats

Max: 10.00
Min: -10.00
Std Dev: 2.26
Mean: 0.07
Median: 0.01
Composite Area: 3.7542 ha
Surveyed Area: 2.9784 ha

PROGRAM

Name: TerraSurveyor
Version: 3.0.23.0

Processes: 2

- 1 Base Layer
- 2 Clip from -10.00 to 10.00 nT

GPS based Proce4

- 1 Base Layer.
- 2 Unit Conversion Layer (Lat/Long to OSGB36).
- 3 DeStripe Median Traverse:
- 4 Clip from -10.00 to 10.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire (see inside cover for address). Data are backed-up onto an on-site data storage drive and at the earliest opportunity data are copied to CD ROM for storage on-site and off-site.

Surveys are reported on in hardcopy (recycled paper) using A4 for text and A3 for plots (all plots are scaled for A3). A printed copy and PDF will be issued to the Wiltshire HER and a PDF copy uploaded to OASIS.

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This report has been prepared using the following software on a Windows XP platform:

- TerraSurveyor version 3.0.23.0 (geophysical data analysis),
- SENSYS MAGNETO@ARCH version 1.00-04(geophysical data analysis),
- ProgeCAD Professional 2014 (report graphics),
- OpenOffice.org 3.0.1 Writer (document text),
- PDF Creator version 0.9 (PDF).

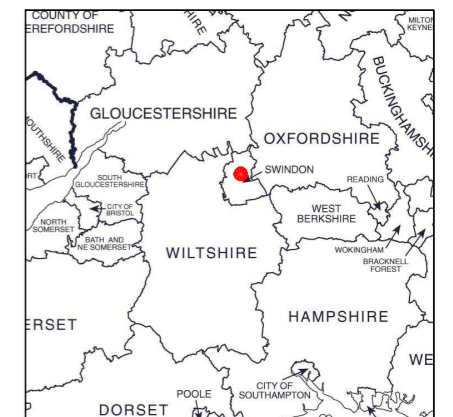
Digital data produced by the survey and report include the following files:

- TerraSurveyor grid and composite files for all geophysical data,
- CSV files for raw and processed composites,
- geophysical composite file graphics as TIF images,
- CAD DWG files in 2007 version,
- report text as OpenOffice.org ODT file,
- report text as PDF / PDF/A,
- PDFs of all figures.

Geophysical Survey Catsbrain Farm Kingsdown Swindon

Map of survey area

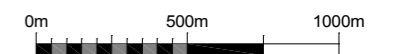
Reproduced from OS Explorer map no.169 1:25 000
by permission of Ordnance Survey on behalf of The
Controller of Her Majesty's Stationery Office.
© Crown copyright. All rights reserved.
Licence number 100043739.



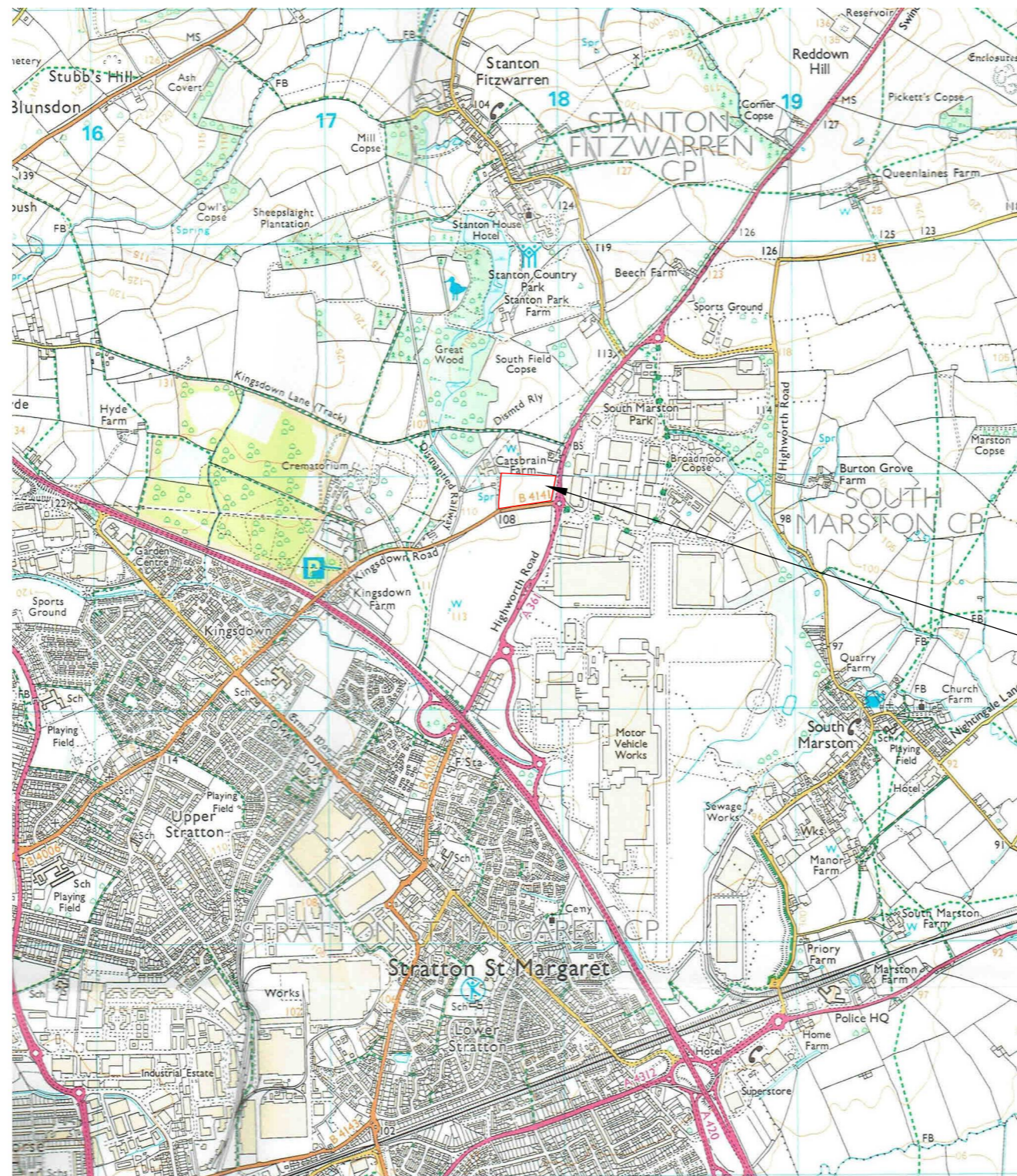
● Survey location

Site centred on OS NGR
SU 17860 88930

SCALE 1:25 000



SCALE TRUE AT A3



Survey location

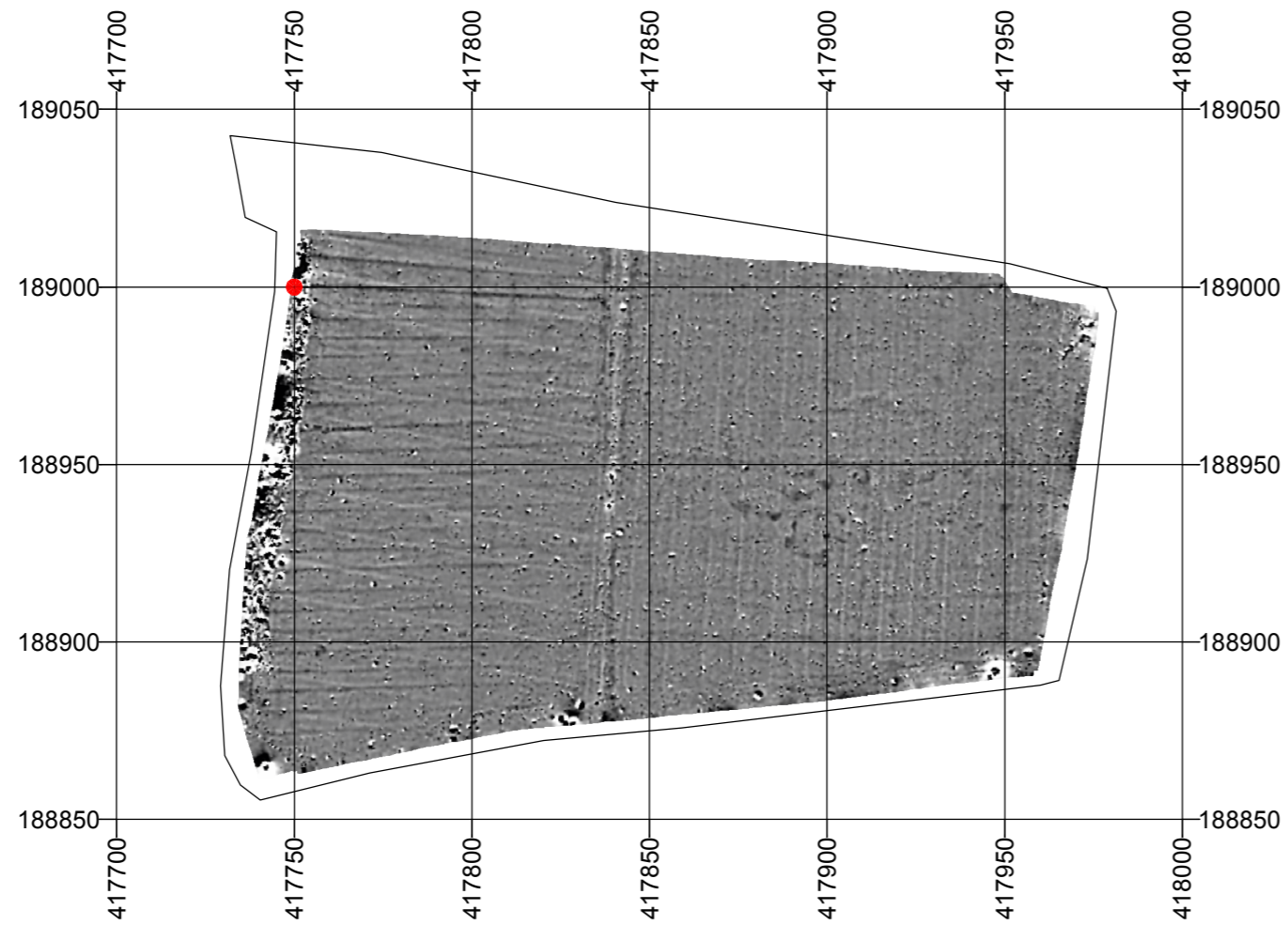
**Geophysical Survey
Catsbrain Farm
Kingsdown
Swindon**

Referencing information

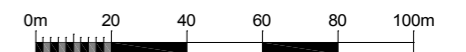
Referencing grid to OSGB36 datum at 50m intervals

Data collected at 20Hz and georeferenced to ETRS89 zone 30 with conversion to OSGB36 using OSTN02

● 417750 189000



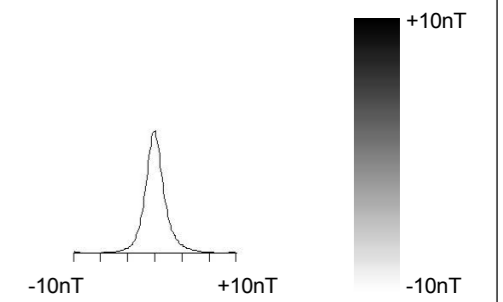
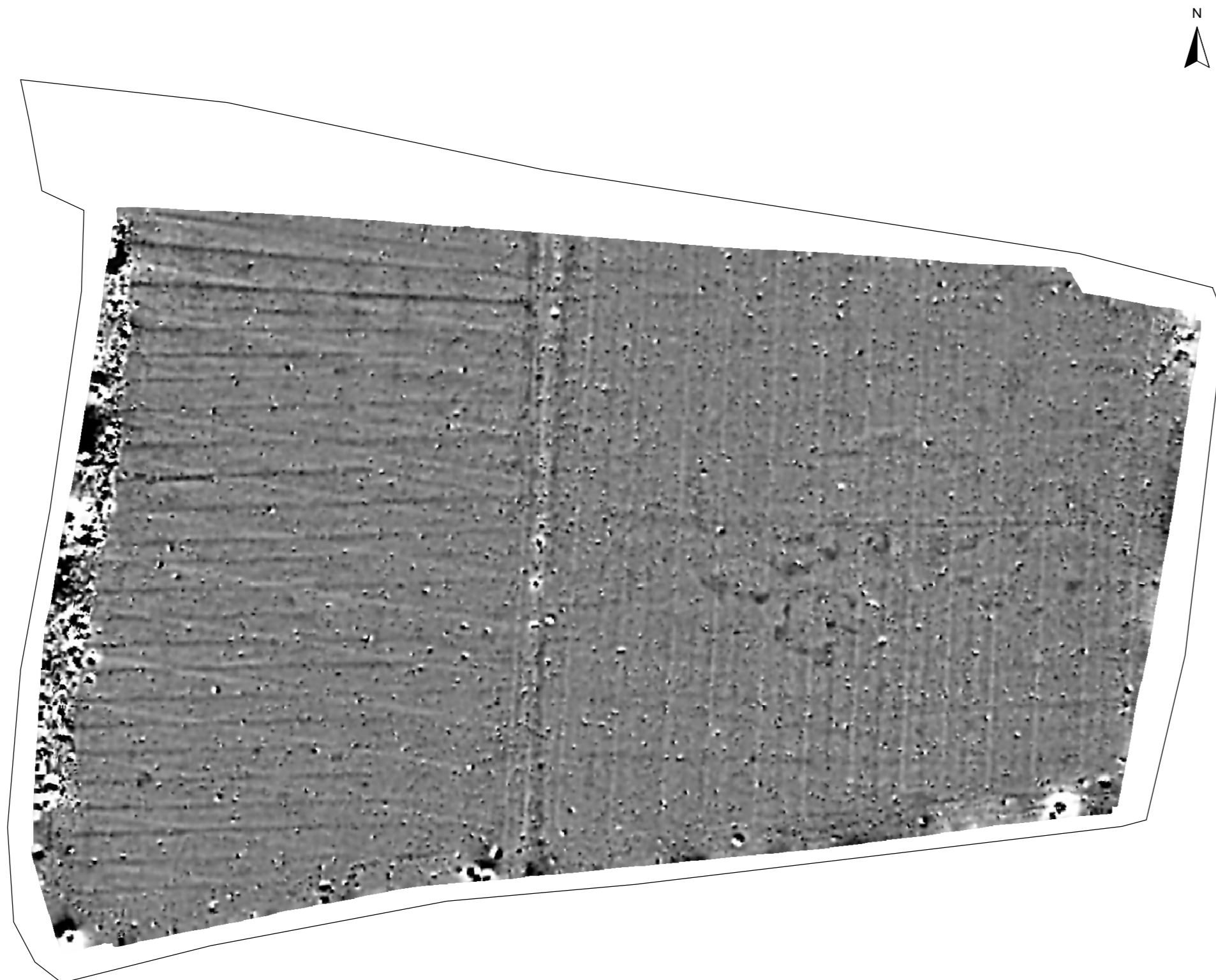
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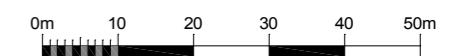
SCALE TRUE AT A3

**Geophysical Survey
Catsbrain Farm
Kingsdown
Swindon**

**Greyscale plot of minimally
processed magnetometer data**



SCALE 1:1000

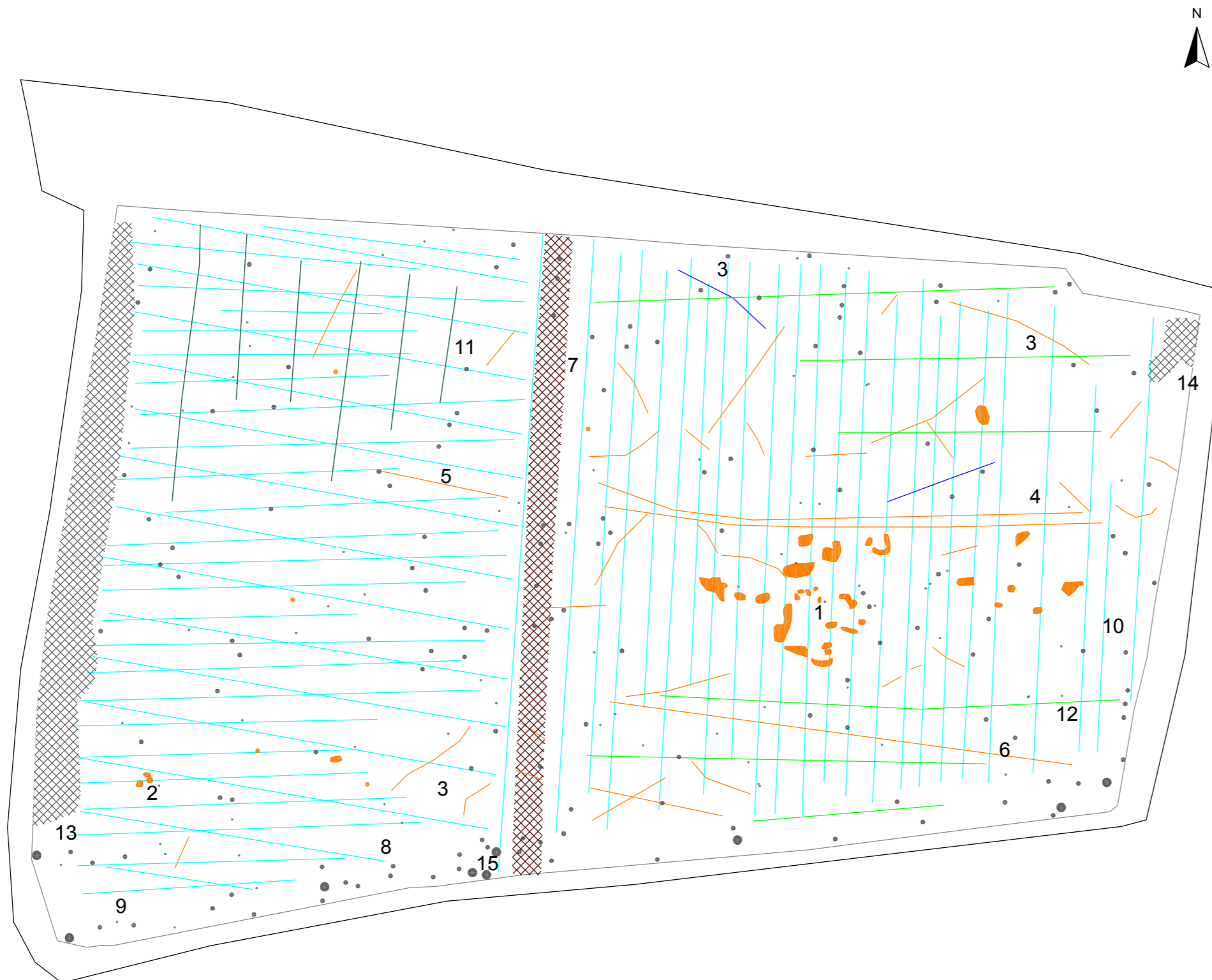











SCALE TRUE AT 43

FIG 03

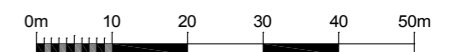
**Geophysical Survey
Catsbrain Farm
Kingsdown
Swindon**

**Abstraction and interpretation of
magnetometer anomalies**



-  Positive linear anomaly - possible ditch-like feature
-  Linear anomaly - of agricultural origin
-  Linear anomaly - ridge and furrow
-  Positive linear anomaly - possible land drain
-  Negative linear anomaly - material of low magnetic susceptibility
-  Discrete positive response - possible pit-like feature
-  Positive linear anomaly - former field boundary
-  Magnetic debris - spread of magnetically thermoremanent/ferrous material
-  Strong dipolar anomaly - ferrous object

SCALE 1:1000



SCALE TRUE AT A3