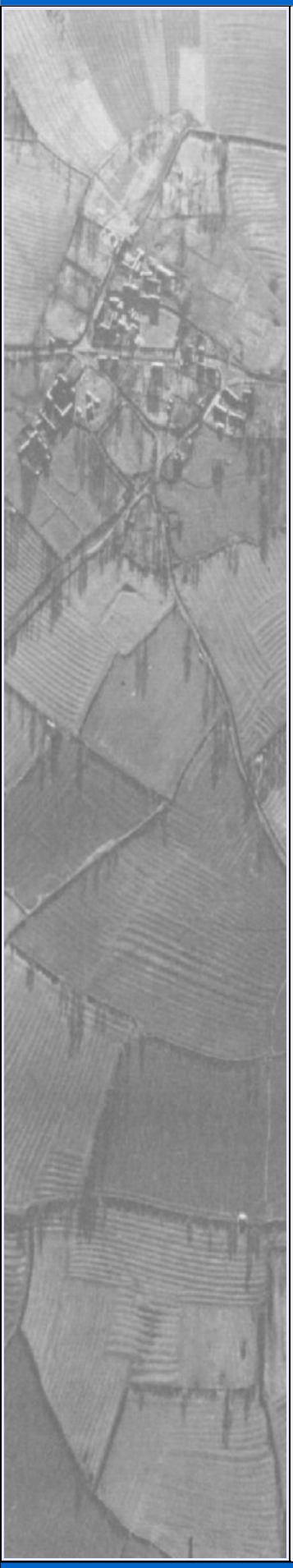

Land at Owdeswell Manor
Andoversford
Gloucestershire

MAGNETOMETER SURVEY REPORT

for

Dr C Levinson

Kerry Donaldson & David Sabin

April 2015

Ref. no. 602

ARCHAEOLOGICAL SURVEYS LTD

Land at Owdeswell Manor
Andoversford
Gloucestershire

Magnetometer Survey Report

for

Dr C Levinson

Fieldwork by David Sabin (Hons) MCIfA
Report by Kerry Donaldson BSc (Hons)
Report checked by David Sabin
Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

Survey date – 7th April 2015
Ordnance Survey Grid Reference – **SP 02085 19200**

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SUMMARY

A detailed magnetometer survey was carried out by Archaeological Surveys Ltd, within two land plots near Owdeswell Manor, Andoversford, Gloucestershire. The results revealed a number of discrete positive responses that appear to relate to pit-like features possibly of natural origin. A small number of short positive linear anomalies have also been located; however, these lack a coherent morphology preventing confident interpretation. A zone of magnetically variable response at the north western corner of the site indicates former quarrying and relates to a depression in the ground surface. Evidence for agricultural activity has also been located.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by the Environmental Dimension Partnership (EDP), on behalf of Dr Charles Levinson, to undertake a magnetometer survey of an area of land at Owdeswell Manor, Andoversford, Gloucestershire. The site has been outlined for a proposed residential development and the survey forms part of an archaeological assessment.

1.1.2 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2015) and approved by Charles Parry, Archaeologist for Gloucestershire County Council prior to commencing the fieldwork.

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 Owdeswell Manor, Andoversford, Gloucestershire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SP 02085 19200, see Figures 01 and 02.

1.3.2 The geophysical survey covers approximately 2.3ha of pasture within the northern part of two fields. The larger area is referred to as Area 1 and the smaller area, immediately to the east, is referred to as Area 2. The surface was generally even and both areas slope down slightly towards the north.

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 sunny and warm.

1.4 Site history and archaeological potential

1.4.1 An Archaeological and Heritage Statement has been prepared by EDP (2015). It outlines that the site does not contain any designed or non-designated heritage assets. The field immediately west of the site may contain cropmark evidence for a possible enclosure, and four Neolithic stone axes were found in the Andoversford area in the 19th century. There is some evidence for prehistoric activity within sites 0.8km to the north east and 0.8km to the south east.

1.4.2 The scheduled Roman town of Wycombe lies 0.7km north east of the site, with further evidence of Roman and also prehistoric activity beyond the scheduled area. There are a number of deserted medieval settlements approximately 0.8km distant, located within the valley floor to the north, east and south of the site.

1.4.3 The lack of archaeological sites and findspots within the site and immediate vicinity may indicate a low potential for the site to contain archaeological features. However, there is always potential for the geophysical survey to locate anomalies that relate to previously unrecorded buried remains should they be present within the site.

1.4.4 The surface conditions within the site were not suitable for the observation of cultural material during the course of the survey. The only feature of note was a shallow depression in the north western corner of Area 1. This may represent a shallow quarry.

1.5 Geology and soils

1.5.1 The underlying solid geology across the site is from the Birdlip Limestone Formation (Inferior Oolite) (BGS, 2015).

1.5.2 The overlying soil across the survey area is from the Elmton 1 association, which are brown rendzinas. These consist of shallow, well drained, brashy, calcareous, fine loamy soils over limestone (Soil Survey of England and Wales, 1983).

1.5.3 Magnetometry carried out over similar geology and soil has produced good

results. The site is, therefore, considered suitable 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. The system is 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.

2.2.3 Data are not collected within fixed grids and data points are considered to be random even though the data are collected in a systematic manner covering all accessible areas (Aspinall, Gaffney and Schmidt, 2009).

2.3 Data processing and presentation

2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display using TerraSurveyor.

2.3.2 The data are collected between limits of ±10000nT and clipped for display. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.12m along each survey track. A zero median traverse function is required in order to remove fixed offset values present within the sensors which do not undergo a zeroing procedure in the field. The approach ensures that the gradiometer sensors are very accurately aligned and fixed to the vertical magnetic field and are not influenced by localised magnetic fields or disturbed by vibration. Although a zero median traverse algorithm can remove anomalies aligned with the survey tracks, in practice this rarely occurs due to the use of long traverses, high resolution measurement and variability within the magnetic susceptibility of long linear features.

2.3.3 Appendix C contains metadata 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.

2.3.4 A TIF 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.

2.3.5 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.

2.3.6 An abstraction and interpretation is offered for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.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.

2.3.7 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 two survey areas covering approximately 2.3ha.

3.1.2 Magnetic anomalies located can be generally classified as positive anomalies of an uncertain origin, linear anomalies of an agricultural origin, anomalies associated with quarrying and strong discrete dipolar anomalies relating to ferrous objects.

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 for each survey area.

Report sub-heading CAD layer names and plot colour	**Description and origin of anomalies**
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN AS-ABST MAG POS UNCERTAIN	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. 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.
Anomalies with an agricultural origin AS-ABST MAG AGRICULTURAL	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.
Anomalies associated with quarrying AS-ABST MAG QUARRYING	Magnetically variable anomalies, which may be negative, indicating a response to geology/drift deposits and/or positive indicating an increased depth of topsoil.
Anomalies associated with magnetic debris AS-ABST MAG STRONG DIPOLAR	Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area centred on OS NGR 402107 219196, see Figures 03 & 04.

Anomalies with an uncertain origin

(1) - The northern part of the survey area contains a small number of narrow and broad linear responses. They are weak (1nT) and indistinct, and while they may relate to agricultural activity, they have an irregular shape.

(2) - The survey area contains widespread and numerous discrete positive anomalies. They have a response of 2-7nT; however, they lack a coherent pattern and although appear as pit-like features, a natural origin should be considered most likely.

Anomalies associated with quarrying

(3) - Located at the north western corner of the survey area is an irregular zone of magnetically variable response. This type of response and morphology would indicate that this part of the site has been subject to former quarrying and there is a corresponding depression within the ground.

Anomalies with an agricultural origin

(4) - The survey area contains a large number of linear anomalies, parallel with the eastern and western field boundaries and indicative of agricultural activity, possibly ridge and furrow.

Anomalies associated with magnetic debris

(5) - Strong, discrete dipolar anomalies are a response to ferrous and other magnetically thermoremnant objects within the topsoil.

3.5 List of anomalies - Area 2

Area centred on OS NGR 402159 219287, see Figures 03 & 04.

Anomalies with an uncertain origin

(6) - The survey area contains two pit-like anomalies with a response of 7-10nT. It is not possible to determine if these are natural or anthropogenic features.

(7) - A small number of short, positive linear anomalies can be seen in the survey

area. It is possible that they relate to cut features, although a natural origin cannot be ruled out.

4 CONCLUSION

4.1.1 The results of the detailed magnetometer survey indicate that the site contains a number of discrete, pit-like responses. Although this type of response may be related to anthropogenic activity, they lack any coherent pattern and associated features and a natural origin should be considered most likely. A small number of short positive linear responses have also been located, and again their origin is not clear due to the limited size of the anomalies and their lack of a clear morphology.

4.1.2 The north western corner of the site contains evidence for former quarrying, and is associated with a depression in the ground surface. Parallel linear anomalies within the western part of the site relate to agricultural activity, possibly ridge and furrow.

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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 thermoremnant 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.

Thermoremnant 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. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant 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 ±20nT and ±10nT 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 (destripe) 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.

High Pass Filtering

A mathematical process used to remove low frequency anomalies relating to survey tracks and modern agricultural features.

Appendix C – survey and data information

Area 1

COMPOSITE
Filename: J602-mag-Area1-proc.xcp
Description: Imported as Composite from: J602-mag-Area1.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y): OSGB36
Northwest corner: 401979.544743084, 219286.030971818 m
Southeast corner: 402167.344743084, 219080.110971818 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702

Source GPS Points: 625300

Dimensions
Composite Size (readings): 1565 x 1716
Survey Size (meters): 188 m x 206 m
Grid Size: 188 m x 206 m
X Interval: 0.12 m
Y Interval: 0.12 m

Stats
Max: 5.53
Min: -5.50
Std Dev: 1.47
Mean: 0.03
Median: -0.04
Composite Area: 3.8672 ha
Surveyed Area: 2.0817 ha

PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0

Processes: 1
1 Base Layer

GPS based Proce3
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 Clip from -5.00 to 5.00 nT

Area 2

COMPOSITE
Filename: J602-mag-Area2-proc.xcp
Description: Imported as Composite from: J602-mag-Area2.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y): OSGB36
Northwest corner: 402134.252772759, 219313.607869903 m
Southeast corner: 402184.772772759, 219261.047869903 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702

Source GPS Points: 50400

Dimensions
Composite Size (readings): 421 x 438
Survey Size (meters): 50.5 m x 52.6 m
Grid Size: 50.5 m x 52.6 m
X Interval: 0.12 m
Y Interval: 0.12 m

Stats
Max: 5.53
Min: -5.50
Std Dev: 1.92
Mean: 0.00
Median: -0.04
Composite Area: 0.26553 ha
Surveyed Area: 0.15244 ha

Processes: 1
1 Base Layer

GPS based Proce3
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 Clip from -5.00 to 5.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire. 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.

A copy of the report in PDF/A format will be supplied to the Gloucestershire Historic Environment Record, together with a DXF of the survey boundary. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

Geophysical data Area 1 - path: J602 Andoversford\Data				
Path and Filename	**Software**	**Description**	**Date**	**Creator**
andsford1\MX\ .prm .dgb .disp	Sensys MXPDA	Proprietary data formats representing magnetometer survey traverses logged to a PDA. Three files for each traverse with numerical prefix representing date and time.		D.J.Sabin
andsford1\MX\J602-mag-Area1.asc	Sensys DLMGPS	ASCII CSV (tab) file representing survey Area 1 in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number.		D.J.Sabin
Area1\comps\J602-mag-Area1.xcp	TerraSurveyor 3.0.23.0	Composite data file derived from ASCII CSV.		D.J.Sabin
Area1\comps\J602-mag-Area1-proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and clipping to ±5nT).		D.J.Sabin
Geophysical data Area 2 - path: J602 Andoversford\Data				
andsford2\MX\ .prm .dgb .disp	Sensys MXPDA	Proprietary data formats representing magnetometer survey traverses logged to a PDA. Three files for each traverse with numerical prefix representing date and time.		D.J.Sabin
andsford2\MX\J602-mag-Area2.asc	Sensys DLMGPS	ASCII CSV (tab) file representing survey Area 2 in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number.		D.J.Sabin
Area2\comps\J602-mag-Area2.xcp	TerraSurveyor 3.0.23.0	Composite data file derived from ASCII CSV.		D.J.Sabin
Area2\comps\J602-mag-Area2-proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and clipping to ±5nT).		D.J.Sabin
Graphic data - path: J602 Andoversford\Data				
Area1\graphics\ J602-mag-Area1-proc.tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±3nT.		K.T.Donaldson
Area1\graphics\ J602-mag-Area1-proc.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.		K.T.Donaldson
Area2\graphics\ J602-mag-Area2-proc.tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±3nT.		K.T.Donaldson
Area2\graphics\ J602-mag-Area2-proc.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.		K.T.Donaldson
CAD data - path: J602 Andoversford\CAD				
J602 version 1.dwg	ProgeCAD 2014	CAD file for creating plots of greyscales, abstraction, interpretation and mapping. Grid coordinates as OSGB. AutoCAD 2010 format.		K.T.Donaldson
Text data - path: J602 Andoversford\Documentation				
J602 report.odt	OpenOffice.org 3.0.1 Writer	Report text as an Open Office document.		K.T.Donaldson

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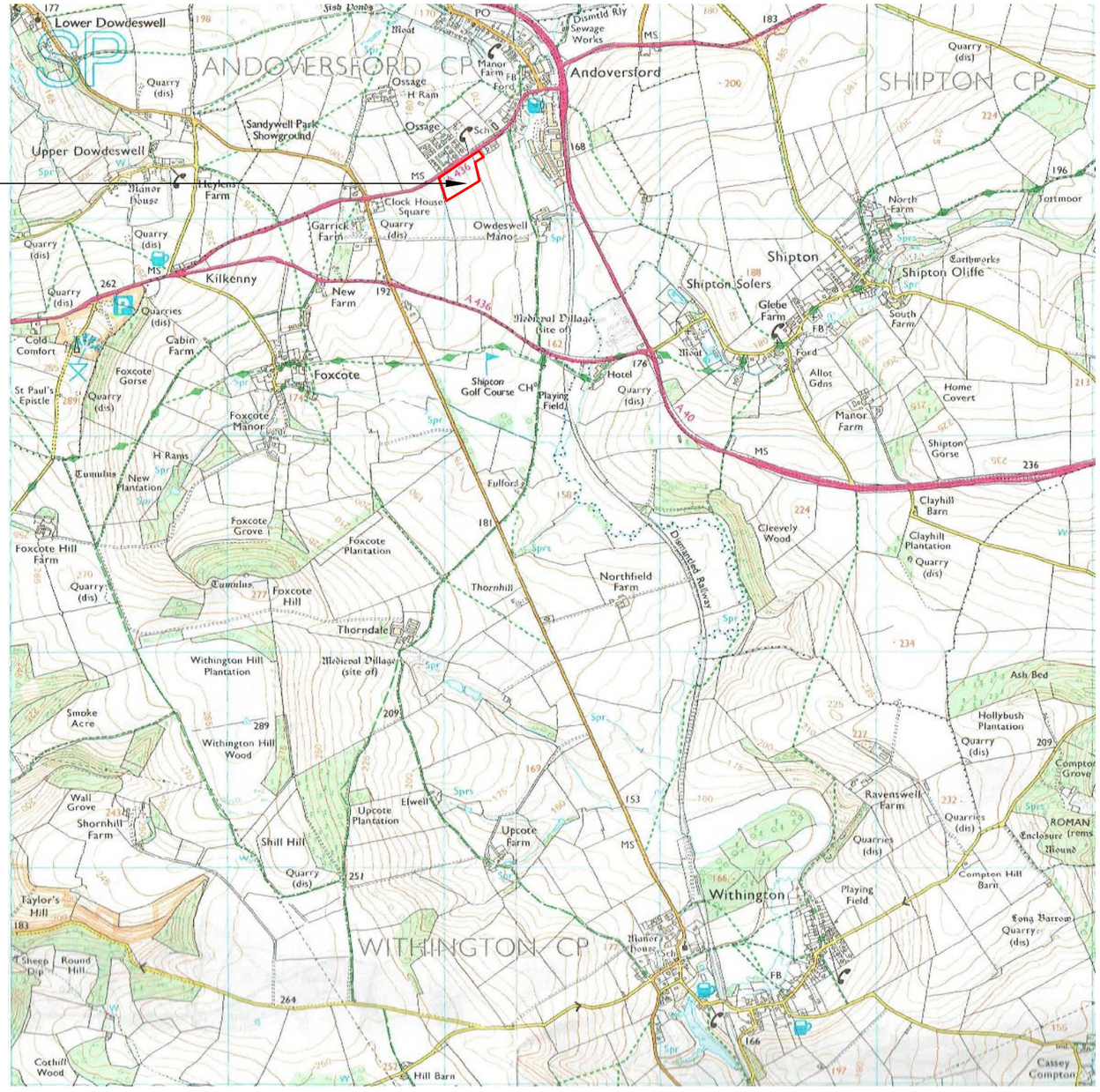
Survey location



N

Archaeological Surveys Ltd

Geophysical Survey
Land at Owdeswell Manor
Andoversford
Gloucestershire

Map of survey area

Reproduced from OS Explorer map no.OL45 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
SP 02085 19200

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

FIG 01

Community

Centre

Primary School

Playing

Field

N

401900 401950 402000 402050 402100 402150 402200

219350 219300 219250 219200 219150 219100 219050

TEMPLEFIELDS

CROSSFIELDS

A436 ROAD

GLOUCESTER

Tel Ex

Area 1

Area 2

Archaeological Surveys Ltd

Geophysical Survey
Land at Owdeswell Manor
Andoversford
Gloucestershire

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

● 402000 219200

SCALE 1:2000

0m 20 40 60 80 100m

SCALE TRUE AT A3

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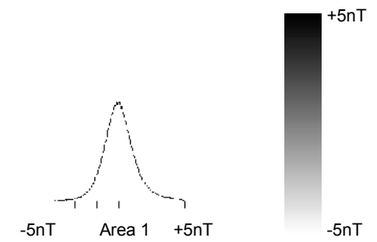
FIG 02

Archaeological Surveys Ltd

Geophysical Survey
Land at Owdeswell Manor
Andoversford
Gloucestershire

Greyscale plot of minimally processed magnetometer data



SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

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FIG 03

Archaeological Surveys Ltd

Geophysical Survey
Land at Owdeswell Manor
Andoversford
Gloucestershire

Abstraction and interpretation of magnetometer anomalies

- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- Zone of magnetically variable response - possible quarry
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

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FIG 04