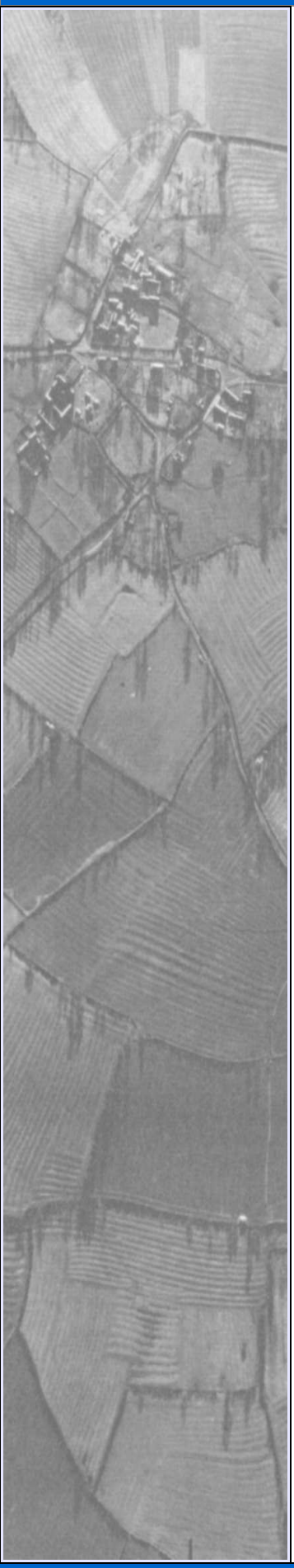


Land east of Sams Lane
Broad Blunsdon
Swindon

MAGNETOMETER SURVEY REPORT

for

Cotswold Archaeology

Kerry Donaldson & David Sabin

June 2018

Ref. no. J755

ARCHAEOLOGICAL SURVEYS LTD

Land east of Sams Lane
Broad Blunsdon
Swindon

Magnetometer Survey Report

for

Cotswold Archaeology

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

Survey dates – 21st to 23rd May 2018
Ordnance Survey Grid Reference – **SU 15550 90575**

Archaeological Surveys Ltd
1 West Nolands, Nolands Road, Yatesbury, Calne, Wiltshire, SN11 8YD
Tel: 01249 814231 Fax: 0871 661 8804
Email: info@archaeological-surveys.co.uk
Web: www.archaeological-surveys.co.uk

CONTENTS

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES

SUMMARY

A geophysical survey, comprising detailed magnetometry, was carried out by Archaeological Surveys Ltd within the northern part of a single arable field at Broad Blunsdon, Swindon. The results indicate evidence for quarrying in the north western part of the site and a positive rectilinear anomaly may relate to a surrounding enclosure ditch, although it could be associated with the orientation of two sets of ridge and furrow within this part of the field. Another zone of ground disturbance is evident further east and this appears to be associated with ridge and furrow. However, it is not clear if it has been caused by it, or if it relates to former quarrying disturbed by ridge and furrow. A small group of positive responses have been located in the north eastern part of the site, although it is uncertain whether they relate to cut features or have an association with ridge and furrow.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Cotswold Archaeology to undertake a magnetometer survey of an area of land at Broad Blunsdon, Swindon. 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 (2018) and approved by Melanie Pomeroy-Kellinger, County Archaeologist for Wiltshire Council Archaeology Service.

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 Geophysical survey can provide useful information on the archaeological potential of a site; however, the outcome of any survey relies on a number of factors and as a consequence results can vary. The success in meeting the aims and objectives of a survey is, therefore, often impossible to predetermine.

1.3 Standards, guidance and recommendations for the use of this report

1.3.1 The survey and report generally follow the recommendations set out by: English Heritage (2008) *Geophysical survey in archaeological field evaluation;* European Archaeological Council (2015) *Guidelines for the Use of*

Geophysics in Archaeology; 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.*

1.3.2 Archaeological Surveys Ltd provide a detailed geophysical survey report and it is recommended that where possible the contents should be considered in full. The Summary provides a brief overview of the results with more detail available in the Discussion and/or Conclusion. The *List of anomalies* within the Results provides a detailed assessment of the anomalies within separate categories which can be useful in inferring a level of confidence to the interpretation. Quality and factors influencing the interpretation of anomalies is also set out within the results.

1.3.3 It is recommended that the full report should always be considered when using data and interpretation plots; where this is not possible, in the field for example, the abstraction and interpretation plots should retain their colour coding and be used with a corresponding legend.

1.3.4 Where targeting of anomalies by excavation is to be carried out, care should be taken to place trenches over solid lines or features visible on the abstraction and interpretation plots. Archaeological Surveys abstraction and interpretation avoids the use of dashed or dotted lines; broken or fragmented anomalies may well correspond closely with subsurface truncation.

1.4 Site location, description and survey conditions

1.4.1 The site is located to the east of Sams Lane on the eastern edge of Broad Blunsdon, within the parish of Blunsdon St Andrew, Swindon. It is centred on Ordnance Survey National Grid Reference (OS NGR) SU 15500 90615, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 6ha within the northern part of a single arable field which contained a number of individual mature trees. The site is generally flat, though it tends to fall very gently towards the south and the north eastern corner.

1.4.3 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. Weather conditions during the survey were fine.

Plate 1: Survey area looking north west

1.5 Site history and archaeological potential

1.5.1 An Historic Environment Desk-Based Assessment has been carried out for the site (Cotswold Archaeology, 2016). It outlines that there are no recorded heritage assets within the site, and although there has been no archaeological evaluation carried out within the site, pipelines extending along the eastern and southern edges did not reveal any archaeological features within the vicinity. Investigations in the wider vicinity, however, have located a number of archaeological sites and the scheduled monument of Castle Hill Hillfort and Lynchets is situated 320m to the north north east.

1.5.2 The site is likely to have been used for agricultural purposes from at least the medieval period, and early mapping shows that a central north east to south west oriented field boundary crossed the site until the late 1960s. In 1970 the field boundary was removed but the field is mapped as containing several mature trees, a line of which still exist in the western part of the site. A 1946 aerial photograph appears to show circular features within the field. However, whether these relate to potential prehistoric ring ditches or agricultural features is not known. If they relate to prehistoric ring ditches, there is potential for the magnetometer survey to locate them along with other associated features should they exist within the site.

1.5.3 The surface conditions within the site were suitable for the observation of cultural material during the course of the survey. No significant scatters were noted and very little material of recent origin was present. Close to the north western corner of the field there is a small scatter of stone and brick.

1.6 Geology and soils

1.6.1 The underlying solid geology across the majority of the site is Jurassic limestone from the Stanford Formation, part of the Corallian Group, with mudstone from the Ampthill Clay Formation in the south eastern corner (BGS, 2017). During the course of the survey some large gastropod specimens and corallian limestone fragments were observed.

1.6.2 The overlying soil across the survey area is from the Sherborne association and is a brown rendzina. It consists of a shallow, well drained, brashy, calcareous, clayey soil over limestone (Soil Survey of England and Wales, 1983).

1.6.3 Magnetometry survey carried out across similar soils has produced good results. 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 (FGM650) spaced 0.5m apart with readings recorded at 20 Hz. The cart is pushed at walking speed and not towed. Each sensor is not zeroed in the field as the vertical axis alignment is precisely fixed leaving sensor offsets that are removed during data processing. The fixing of the vertical alignment ensures the sensors are not unduly influenced by localised magnetic fields and that the vertical component of a magnetic anomaly is measured. 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 Due to the fixed offsets within the fluxgate sensors, as a result of the manufacturing and tensioning process, the survey data do not provide a visually useful dataset until a zero median traverse algorithm is applied. It is recognised that this has the potential to affect some anomalies detrimentally by removing linear features orientated parallel to survey transects. However, this has not been noted as a particular problem with the system due to the high resolution data collection, generally long length of traverses and variability within the magnetic characteristics of a linear anomaly.

2.2.3 Data are collected along a series of parallel survey transects to achieve 100% coverage of the surveyable land. 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. 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).

2.2.4 Fluxgate sensors are highly sensitive to temperature change and this manifests as drift during the course of a survey. This can be particularly noticeable during the morning as temperatures rise and the equipment warms or cools. Sensor drift within the course of a traverse will appear as a line trending from negative to positive after processing with a zero median traverse algorithm. To remove the potential for temperature drift, data were collected after a 20 minute stabilisation period and traverses were limited to a time of generally <100s.

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. The software effectively allocates a geographic position for each data point and can compensate for fixed offsets present within the FGM650 sensors. The offsets are positive or negative values present on all fluxgate gradiometer sensors. Some systems use manual or electronic balancing to effectively zero the sensors; however, this is a short term measure that is prone to drift through temperature changes and vibration and can easily be incorrectly set due to localised magnetic fields. The FGM650 sensors are very accurately aligned to the vertical magnetic gradient and are highly stable showing

negligible drift on long traverses. The offset values are removed using TerraSurveyor software.

2.3.2 Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display within TerraSurveyor. The removal of offset values (compensation) of the sensors is also carried out in TerraSurveyor using a zero median traverse function. Data are then considered to be minimally processed. Note: without the zero median traverse function it is not possible to create a meaningful data plot as all sensors have a different offset value. 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 The minimally processed data are collected between limits of ±10000nT and clipped for display at ±3nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.4 Additional data processing has been carried out in the form of high pass filtering (Fig 04). This effectively removes low frequency variation along a traverse that has been caused by large magnetic bodies, cultivation or rapid temperature change. Data treated to additional processing has been compared to unprocessed data to ensure that no significant anomalies have been removed.

2.3.5 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 processing.

2.3.6 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. With regard to the Sensys MXPDA, minimally processed data are considered by the manufacturer to be data that are compensated by SENSYS MAGNETO DLMGPS software, see 2.3.1 and 2.3.2. Note: traceplots are not considered to be appropriate as they do not provide an accurate or useful assessment of the magnetic anomalies due to the very high density of data collection.

2.3.7 The raster images are combined with base mapping using ProgeCAD Professional 2016, creating DWG (2010) 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.

2.3.8 An abstraction and interpretation is drawn and plotted 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. Appendix E sets out CAD layer names with colour and graphic

content for each interpretation category, see 3.3.

2.3.9 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 the survey area. Where further interpretation is possible, or where a number of possible origins should be considered, more subjective discussion is set out in Section 4.

2.3.10 The abstraction and interpretation procedure has been supported by analysis of a digital terrain model (Fig 10) derived from the Environment Agency's 1m resolution LiDAR DTM data. Shaded relief plots are created using Surfer 10.

2.3.11 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 6ha within the northern part of a single arable field.

3.1.2 Magnetic anomalies located can be generally classified as positive anomalies of an uncertain origin, anomalies associated with ground disturbance/quarrying, linear anomalies of an agricultural origin, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects and strong multiple dipolar linear anomalies relating to buried services or pipelines.

3.1.3 Anomalies located within each survey area have been numbered and are described in 3.4 below with subsequent discussion in Section 4.

3.2 Statement of data quality and factors influencing the interpretation of anomalies

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

3.2.2 Magnetic disturbance close to the south eastern corner of the survey area is related to modern steel objects, possibly associated with a water pipeline, and has the potential to obscure weak anomalies in the vicinity. A narrow band of roughly ploughed land in the southern part of the field is associated with slightly higher levels of 'magnetic noise' caused by the uneven surface; however, it is unlikely that weak anomalies have been obscured in this area.

3.2.3 Data were subject to high pass filtering to suppress both magnetic disturbance and linear anomalies associated with modern cultivation. Filtered and unfiltered data are analysed and compared to ensure no significant

anomalies have been removed by the additional processing.

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, see Table 1.

Interpretation category	Description and origin of anomalies
Anomalies with archaeological potential	Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc. The category is used where there is a high level of confidence which may be due to additional supporting information where morphology is unclear or uncharacteristic.
Anomalies with an uncertain origin	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. Morphology may be unclear or uncharacteristic and there may be a lack of additional supporting information. 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.
Anomalies relating to land management	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. The multiple dipolar response indicates ceramic land drains.
Anomalies associated with ground disturbance/quarrying	Magnetically variable anomalies which may be negative indicating a response to geology/drift deposits and/or positive indicating an increased depth of topsoil. Very strongly magnetic anomalies are a response to highly magnetic material of modern origin which can be used to infill a quarry depression. It should be considered that former quarry pits may be of archaeological potential.
Anomalies with an agricultural origin	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. This category does not include agricultural features of early date or considered to be of archaeological potential (e.g. animal stockades, enclosures, farmsteads, etc).
Anomalies associated with magnetic debris	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. They often occur where there has been dumping or ground make-up and are related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, hearths and nail spreads from former wooden structures or rooves and may, therefore, be archaeologically significant. 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.

Anomalies with a modern origin	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc.. Often a significant area around these features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically adjacent to strong magnetic sources. Buried services may produce characteristic multiple dipolar anomalies dependant upon their construction.

Table 1: List and description of interpretation categories

3.4 List of anomalies

Area centred on OS NGR 415550 190575, see Figs 03 – 09.

Anomalies with an uncertain origin

(1) - What appears to be an L-shaped, weakly positive, rectilinear anomaly is located in the north western part of the site. This may relate to an enclosure ditch; however, there is some uncertainty due to the similar orientation of the ridge and furrow cultivation. Although it may have an association with the ridge and furrow, an archaeological origin is possible.

(2) - A positive response is situated within the confines of anomaly (1). While it may be associated with quarrying (7) a cut, pit-like feature with an archaeological origin is possible.

(3) - A small number of weakly positive linear anomalies are located within the confines of anomaly (1). It is possible that they have some association with the quarrying (7) or may relate to ridge and furrow; however, former ditch-like features should be considered.

(4) - Situated close to the north eastern corner of the survey area are a number of positive responses. A positive linear anomaly appears to form a possible rectilinear feature, with discrete, pit-like anomalies nearby. While they may relate to cut features with archaeological potential, an association with ridge and furrow is also possible.

(5) - The survey area contains a number of discrete, positive responses, with a cluster in the central northern part of the site. It is not possible to determine if they relate to natural features, disturbance caused by ploughing or deliberate cut features. Other, more isolated pit-like anomalies are also of uncertain origin.

Anomalies associated with land management

(6) - A positive linear anomaly, associated with strong dipolar responses relates to a former boundary feature, visible on Ordnance Survey mapping between 1884 and 1923, but removed by 1970.

Anomalies associated with ground disturbance/quarrying

(7) - A group of magnetically variable responses are located towards the north western corner of the site. Several relate to depressions visible on LiDAR imagery. This type of response is indicative of infilled former quarries.

(8) - Located in the north eastern part of the site are a number of positive responses that relate to ground disturbance. They are mainly located within a shallow depression in the ground surface and while some are amorphous, others are pit-like, but the majority are situated in linear formations. They appear to have been either formed through the ploughing process associated with ridge and furrow (9) disturbing shallow solid geology, which has later filled with an increased depth of topsoil, or they may relate to ridge and furrow disturbing a previously quarried area.

Anomalies with an agricultural origin

(9) - Linear anomalies, oriented north east to south west, are strongly evident in the north eastern part of the site, but can be seen as weaker anomalies further to the south west. They are generally not visible along a central band, which corresponds to a low bank within the field visible on LiDAR imagery. They are associated with ground disturbance (8) in the north east.

(10) - Positive linear anomalies located towards the north eastern edge of the survey area and oriented north north east to south south west. They appear to relate to ridge and furrow, possibly indicating an earlier, reverse S-shape phase.

(11) - Linear anomalies, parallel with the eastern and western field boundaries relate to a later phase of ridge and furrow.

(12) - Linear anomalies relating to the modern cultivation trend.

Anomalies with a modern origin

(13) – A multiple dipolar linear anomaly relates to a pipeline extending through the south western corner of the survey area.

4 DISCUSSION

4.1.1 A group of quarry pits (7) are situated in the north western corner of the survey area. Several correspond to depressions within the ground surface visible within LiDAR imagery. It is not possible to date them, but a surface depression may indicate that they date to the medieval or post-medieval periods. A lack of strongly magnetic responses within the fill indicates that they are unlikely to be modern. They appear to be surrounded by a possible enclosure ditch (1) and part of this can be seen as a cropmark on aerial images. However, due to the orientation of two sets of ridge and furrow, it is

not clear if the L-shaped anomaly (1) is associated with an enclosure ditch. A positive anomaly (2) is located close to the quarry pits (7) and has a similar response, however it is less amorphous, with dimensions of 7.6m in length and 3.4m wide at the north eastern and south western ends, narrowing to 2m in the centre. Linear anomalies (3) also within this part of the site may relate to ridge and furrow, although cut, ditch-like features are also possible.

4.1.2 Further positive linear and discrete responses (4) are located in the north eastern corner of the site. Again these could relate to cut features, although an association with ridge and furrow is possible. A group of discrete positive responses (5) appears to be situated on a broad linear bank, oriented north west to south east, visible on LiDAR imagery (Fig 10) but which does not have a corresponding magnetic response. A zone containing amorphous areas of ground disturbance (8) is located in a shallow depression to the east of the low linear bank, with others near and possibly on the bank. These areas of disturbed ground are also associated with ridge and furrow (9); however, it is not clear if they have been caused by ploughing disturbing shallow geology, or if they relate to former quarrying, later disturbed by ploughing.

4.1.3 There are several phases of ridge and furrow, with a north east to south west trend (9) mainly located in the southern part of the survey area. At the far eastern edge another series (10) may relate to an earlier reverse-S shaped phase caused by long periods of ploughing with a team of oxen and typically medieval in date. Much of the site also contains evidence for agricultural activity oriented parallel with the eastern and western field boundaries. This may in part relate to a later phase of ridge and furrow (11), with the modern plough trend also parallel with it (12).

5 CONCLUSION

5.1.1 The geophysical survey has located a positive rectilinear anomaly in the north western part of the site. However, it is not clear if it relates to an enclosure ditch or changes to the orientation of former ridge and furrow cultivation. It appears to bound a group of infilled quarry pits. Further east are group of amorphous pit-like anomalies, indicative of ground disturbance. They are located within a series of ridge and furrow; however, it is not clear if they have been formed during ploughing or if they relate to former quarrying that has been later disturbed by ridge and furrow. In the north eastern corner of the site are a number of positive responses, but again it is not possible to determine if they relate to cut features, or have an association with ridge and furrow.

6 REFERENCES

British Geological Survey, 2017. *Geology of Britain viewer [online]* available from http://mapapps.bgs.ac.uk/geologyofbritain3d/index.html[accessed 18/5/2018].

Aspinall, A., Gaffney, C. and Schmidt, A. 2009. *Magnetometry for Archaeologists*. Lanham (US), AltaMira Press.

British Geological Survey, 2017. *Geology of Britain viewer [online]* available from http://mapapps.bgs.ac.uk/geologyofbritain3d/index.html[accessed 18/5/2018].

Chartered Institute for Archaeologists, 2014. *Standard and Guidance for archaeological geophysical survey*. CIfA, University of Reading.

Cotswold Archaeology 2016. *Land East of Sams Lane, Broad Blunsdon, Wiltshire: Historic Environment Desk-Based Assessment.*

English Heritage, 2008. *Geophysical survey in archaeological field evaluation. Research and Professional Service Guideline No.1.* 2nd ed. Swindon: English Heritage.

European Archaeological Council, 2015. *EAC Guidelines for the Use of Geophysics in Archaeology: Questions to Ask and Points to Consider.* Europae Archaeologia Consilium and Association Internationale sans But Lucratif, Belgium.

Institute for Archaeologists, 2002. *The use of Geophysical Techniques in Archaeological Evaluations*. IfA Paper No. 6. IfA, University of Reading.

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 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 magnetic field. The difference between the two sensors will relate to the strength of 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 ±5nT and ±3nT 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, modern agricultural features and other large magnetic bodies within or adjacent to survey areas.

Low Pass Filtering

A mathematical process used to remove high frequency anomalies relating to uneven ground, vibration, etc.

Appendix C – survey and data information

Minimally processed data

Filename: J755-mag.xcp
Description: Imported as Composite from: J755-mag.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 415303.637, 190759.108 m
Southeast corner: 415803.737, 190367.158 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 3137800
Dimensions
Composite Size (readings): 3334 x 2613
Survey Size (meters): 500 m x 392 m
Grid Size: 500 m x 392 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 3.32
Min: -3.30
Std Dev: 0.92
Mean: 0.01
Median: 0.01
Composite Area: 19.601 ha
Surveyed Area: 6 ha

PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00 nT

Filtered data

Filename: J755-mag-proc-hpf.xcp
Description: Imported as Composite from: J755-mag.asc
Stats
Max: 3.32
Min: -3.30
Std Dev: 0.85
Mean: 0.02
Median: 0.00
GPS based Proce5
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 High pass Uniform (median) filter: Window dia: 300
5 Clip from -3.00 to 3.00 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 printed copy of the report and a PDF copy will be supplied to the Wiltshire Historic Environment Record. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

File type	Naming scheme	Description
Data	J755-mag-**[area number/name]**.asc J755-mag-**[area number/name]**.xcp J755-mag-**[area number/name]**-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J755-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	J755-**[version number]**.dwg	CAD file in 2010 dwg format
Report	J755 report.odt	Report text in Open Office odt format

Table 2: Archive metadata

Appendix E – CAD layers for abstraction and interpretation plots

The table below sets out Archaeological Surveys Ltd CAD layer names with associated colours and graphical content. Where CAD files are available layers may be extracted for further CAD/GIS use. Note: hatched polygon boundaries are contained within layers with the RGB colour code 254, 255, 255 (near white) in order to prevent their visibility.

Report sub-heading and associated CAD layer names	Colour with RGB index	Layer content
Anomalies with an uncertain origin		
AS-ABST MAG POS LINEAR UNCERTAIN	255,127,0	Line, polyline or polygon (solid)
AS-ABST MAG POS DISCRETE UNCERTAIN	255,127,0	Solid donut, point or polygon (solid)
Anomalies relating to land management		
AS-ABST MAG BOUNDARY	127,0,0	Line, polyline or polygon (solid or cross hatched ANSI37)
Anomalies with an agricultural origin		
AS-ABST MAG AGRICULTURAL	Green 0,255,0	Line or polyline
AS-ABST MAG RIDGE AND FURROW	0,127,63	Line, polyline or polygon (cross hatched ANSI37)
Anomalies associated with magnetic debris		
AS-ABST MAG DEBRIS	132, 132, 132	Polygon (cross hatched ANSI37)
AS-ABST MAG STRONG DIPOLAR	132, 132, 132	Solid donut, point or polygon (solid)
Anomalies with a modern origin		
AS-ABST MAG DISTURBANCE	132, 132, 132	Polygon (hatched ANSI31)
AS-ABST MAG SERVICE	132, 132, 132	Line or polyline
Anomalies with a natural origin		
Anomalies associated with ground disturbance/quarrying		
AS-ABST MAG QUARRYING/ GROUND DISTURBANCE	255,255, 127 or 255,223,127	Polygon (net)

Table 3: CAD layering

Appendix F – copyright and intellectual property

This report may contain material that is non-Archaeological Surveys Ltd copyright (eg Ordnance Survey, Crown Copyright) or the intellectual property of third parties, which we are able to provide for limited reproduction under the terms of our own copyright licences, but for which copyright itself is non-transferable by Archaeological Surveys Ltd. Users remain bound by the conditions of the Copyright, Design and Patents Act 1988 with regard to multiple copying and electronic dissemination of this report.

Archaeological Surveys Ltd shall retain intellectual property rights for the materials and records created as part of this project. A non-exclusive, transferable, sub-licensable, perpetual and royalty-free licence shall be granted to the client on full payment of works in order for them to use, reproduce and enhance the reports, documentation, graphics and illustrations produced as part of this project for the purpose for which they were commissioned. Copyright licence will also be granted to the local authority for planning use and within in the Historic Environment Record for public dissemination upon payment by the client. Any document produced to meet planning requirements may be freely copied for planning, development control, research and outreach purposes without recourse to the originator, subject to all due and appropriate acknowledgements being provided and to the terms of the original contract with the client. Archaeological Surveys Ltd shall retain the right to be identified as the author and originator of the material.

The report, data and any associated material produced by Archaeological Surveys Ltd cannot be freely used for any commercial activity other than those set out above. Any unauthorised use will be considered to be in breach of copyright.

Title of Goods remains with Archaeological Surveys Ltd until payment has cleared. Late payment may jeopardise any planning decision as there will be no transfer of title, licensing or any other right of copy or use of this report. Archaeological Surveys Ltd do not give permission for use of the report and associated data in cases of late payment. Any such use will be considered to be in breach of copyright. Late payment may also incur interest at 8% over the Bank of England base rate. Non-payment will be pursued by legal action.

Archaeological Surveys Ltd

Geophysical Survey
Land east of Sams Lane
Broad Blunsdon
Swindon

Map of survey area

● Survey location

Site centred on OS NGR
SU 15500 90615

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

FIG 01

Archaeological Surveys Ltd

Geophysical Survey
Land east of Sams Lane
Broad Blunsdon
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

● 415350 190650

SCALE 1:2000

0m 20 40 60 80 100m

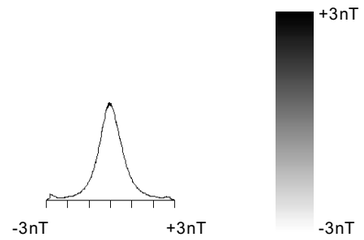
SCALE TRUE AT A3

FIG 02

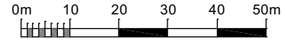
Archaeological Surveys Ltd

Geophysical Survey
Land east of Sams Lane
Broad Blunsdon
Swindon

Greyscale plot of minimally processed magnetometer data



SCALE 1:1250



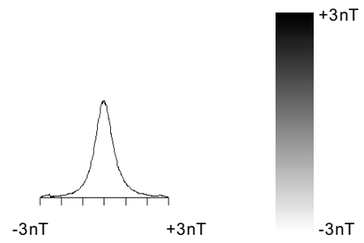
SCALE TRUE AT A3

FIG 03

Archaeological Surveys Ltd

Geophysical Survey
Land east of Sams Lane
Broad Blunsdon
Swindon

Greyscale plot of filtered magnetometer data



SCALE 1:1250

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 04

Archaeological Surveys Ltd

Geophysical Survey
Land east of Sams Lane
Broad Blunsdon
Swindon

Abstraction and interpretation of magnetic anomalies

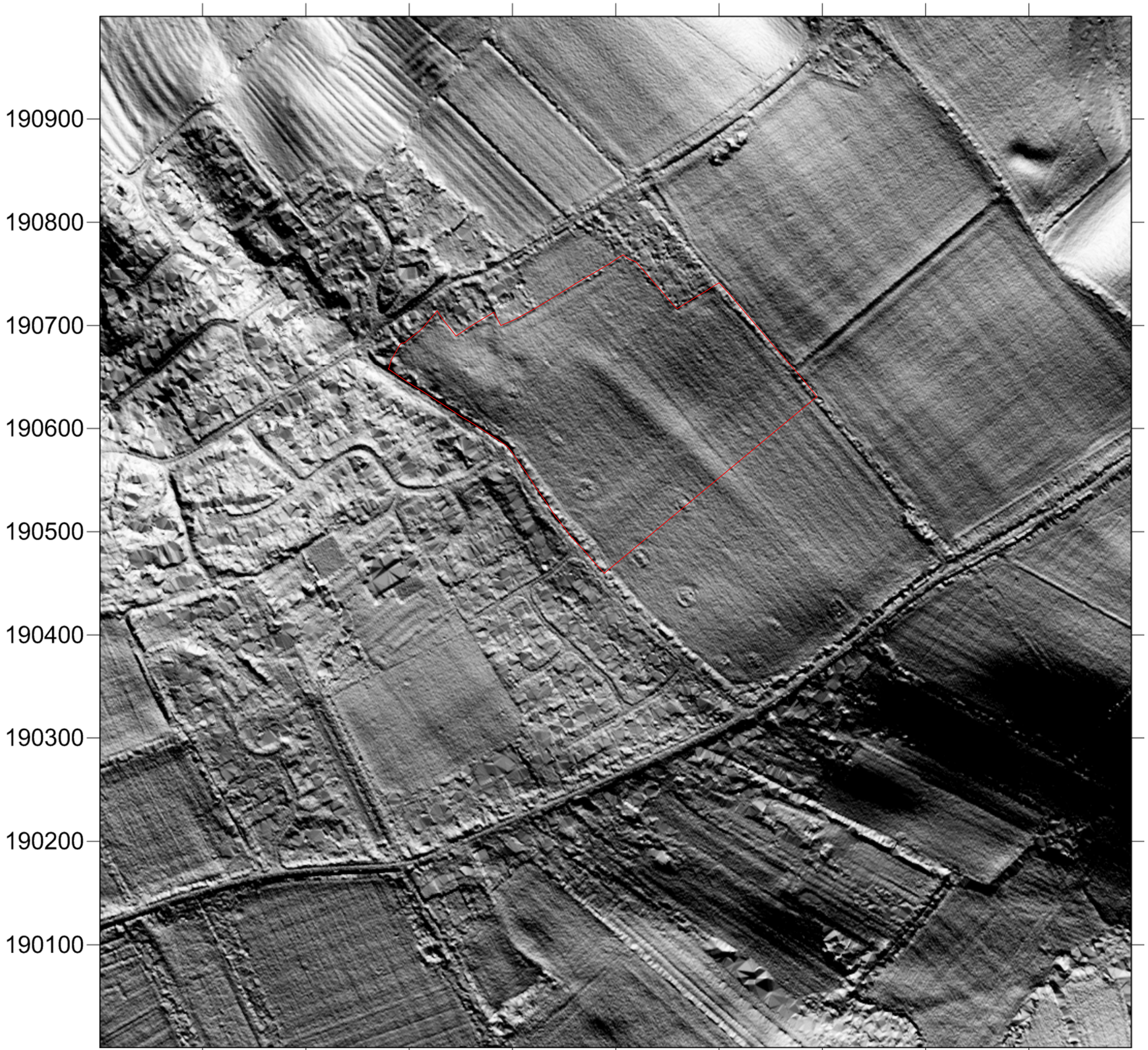
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - ridge and furrow
- Positive linear anomaly - former field boundary
- Linear anomaly - of agricultural origin
- Discrete positive response - possible pit-like feature
- Magnetic response - associated with infilled quarrying
- Magnetic response - ground disturbance associated with ridge and furrow / possible quarrying
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline
- Strong dipolar anomaly - ferrous object

SCALE 1:1250

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 05



Archaeological Surveys Ltd

Geophysical Survey
Land east of Sams Lane
Broad Blunsdon
Swindon

Digital Terrain Model

Derived from Environment Agency's LiDAR data 1m resolution

SCALE 1:4000

0m 40 80 120 160 200m

SCALE TRUE AT A3

FIG 06