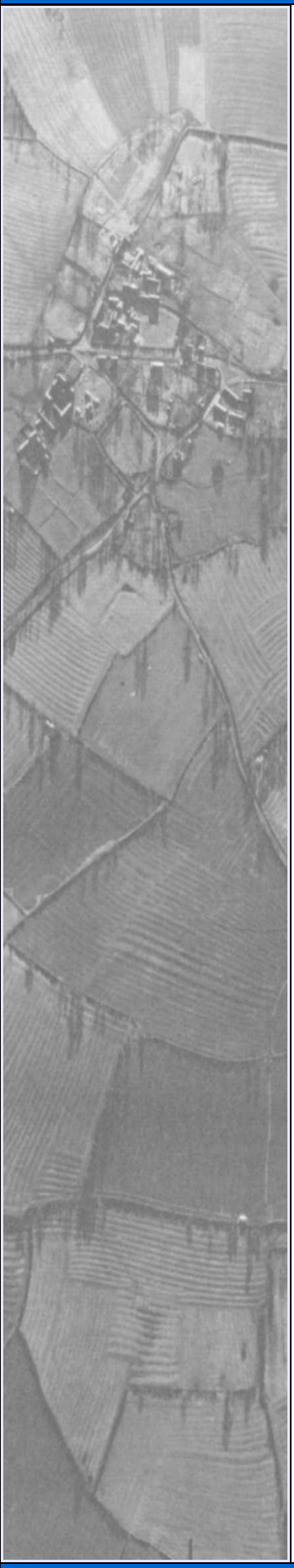

Land at Shrivenham
Oxfordshire

MAGNETOMETER SURVEY REPORT

for

Welbeck Strategic Land LLP

David Sabin and Kerry Donaldson

June 2013

Ref. no. 479

ARCHAEOLOGICAL SURVEYS LTD

Land at Shrivenham
Oxfordshire

Magnetometer Survey Report

for

Welbeck Strategic Land LLP

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

Survey dates – 15th to 22nd May 2013
Ordnance Survey Grid Reference – **SU 23838 89341**

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

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SUMMARY

A detailed magnetometer survey was carried out by Archaeological Surveys Ltd, on behalf of Welbeck Strategic Land LLP, at Shrivenham in Oxfordshire. The survey located a number of ditches, enclosures, ring ditches and pits in the north western part of the site which are indicative of a possible prehistoric or Romano-British settlement covering 3ha. The strength of the anomalies indicates that the cut features contain burnt and other occupational material. The anomalies also correlate with an area of sandy soil and an area of Roman pottery sherds observed on the field surface. The entire site contains evidence for former ridge and furrow cultivation which has truncated and disturbed the underlying archaeology.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Welbeck Strategic Land LLP, at the request of The Environmental Dimension Partnership (EDP), to undertake a magnetometer survey of an area of land at Shrivenham, Oxfordshire. 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 (2013) and approved by Hugh Coddington, County Archaeologist for Oxfordshire 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 Institute for Archaeologists (2011) *Standard and Guidance for Archaeological Geophysical Survey.*

1.2.3 Archaeological Surveys Ltd is a Registered Organisation (RO) with the Institute for Archaeologists (IfA) and carries out its work according to the regulations, guidelines, by-laws and codes of conduct set out by the Institute.

1.3 Site location, description and survey conditions

1.3.1 The site is located on the northern edge of Shrivenham in Oxfordshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SU 23838 89341, see Figures 01 and 02.

1.3.2 The geophysical survey covered approximately 15.6ha within five land parcels labelled Areas 1 to 5 from east to west, representing the order in which the survey was carried out. All of the survey areas contained a bean crop.

1.3.3 Areas 1, 2 and 5 slope down towards the south and south east, with their north western boundaries lying along the crest of a low hill. Area 3 is generally flat and lies immediately to the north of the edge of a residential area. Area 4 contains a shallow valley base orientated south west to north east. The valley base contains a number of low undulations and a dry channel that may relate to a winterbourne.

1.3.4 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. A number of small zones within the site were heavily rutted and partly waterlogged, resulting in very poor conditions for traversing. Weather conditions during the survey were mainly fine.

1.4 Site history and archaeological potential

1.4.1 The Oxfordshire Historic Environment Record (HER) outlines that there are the possible remains of a medieval settlement immediately south of the site (HER no 13749). Aerial photographs from 1969 show a series of earthworks, although the HER notes that their interpretation as a medieval settlement is highly debatable. A possible Roman settlement, identified by pits, ditches, cobbled surfaces and possible building rubble, is located approximately 250m to the north west (HER no 16067). The nearest Scheduled Monument (no 20602) is the Watchfield Anglo-Saxon Cemetery located 1.4km to the north east, with 43 burials from the late 5th and 6th centuries.

1.4.2 The close proximity to a possible medieval settlement immediately to the south and possible Romano-British settlement to the north west indicated some potential for the site to contain geophysical anomalies relating to associated archaeological remains.

1.4.3 During the course of the survey it was possible to make surface observations of cultural material. Widespread low density scatters of Medieval pottery were noted from the southern halves of Areas 1, 2 and 5. No significant cultural material was noted from Area 4, with just some post Medieval pottery within Area 3. Romano-British pottery sherds were noted within the northern half of Area 5, and these appear to show a concentration in the north western part of the area correlating with very sandy soil. Occasional worked flint implements were also observed within Area 5.

1.5 Geology and soils

1.5.1 The site contains three different underlying geologies. In the west is ferruginous sandstone of the Red Down Sandstone Member, in the centre, mudstone from the Ampthill Clay Formation and on the eastern edge, limestone from the Stanford Formation (BGS, 2013).

1.5.2 The overlying soil across the survey area is from the Kingston association, which is a typical stagnogley soil. It consists of a slowly permeable, seasonally waterlogged, fine loamy over clayey soil (Soil Survey of England and Wales, 1983). Of note is a distinct change from clayey soil in the central, southern and eastern parts of the site to a very sandy soil in the north western and western parts, which would correspond to the change in geology from clay to sandstone.

1.5.3 Magnetometry survey carried out across similar soils has produced moderate to good results. The underlying geology and soils are 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 Bartington Grad 601-2 gradiometer. The instrument effectively measures a magnetic gradient between two fluxgate sensors mounted vertically 1m apart. Two sets of sensors are mounted on a single frame 1m apart horizontally.

2.2.2 The instrument is extremely sensitive and is able to measure magnetic variation to 0.01nanoTesla (nT), with an effective resolution of 0.03nT. The data are limited to ±100nT when surveying with the highest sensitivity. All readings are saved to an integral data logger for analysis and presentation.

2.2.3 The instrument is operated according to the manufacturer's instructions with consideration given to the local conditions. An adjustment procedure is required, prior to collection of data, in order to balance the sensors and remove the effects of the Earth's magnetic field; further adjustment is required during the survey due to instrument drift often associated with temperature change.

2.2.4 It can be very difficult to obtain optimum balance for the sensors due to localised magnetic vectors that may be associated with large ferrous objects, geological/pedological features, 'magnetic debris' within the topsoil and natural temperature fluctuations. Imperfect balance results in a heading error often visible as striping within the data; this can be effectively removed by software processing and generally has little effect on the data unless extreme.

2.2.5 The Bartington gradiometer undergoes regular servicing and calibration by the manufacturer. A current assessment of the instrument is shown in Table 1 below.

Sensor type and serial numbers	Bartington Grad - 01 – 1000 Nos. 084, 085, 242 and 396
Date of certified calibration/service	Sensors 084 and 085 - 17th August 2012 (due Aug 2014) Sensors 242 and 396 - 14th October 2011 (due Oct 2013)
Bandwidth	12Hz (100nT range) both sensors
Noise	<100pT peak to peak
Adjustable errors	<2nT

Table 1: Bartington fluxgate gradiometer sensor calibration results

The instrument was considered to be in good working order prior to the survey, with no known faults or defects.

2.2.6 Data were collected at 0.25m centres along traverses 1m apart. The survey area was separated into 40m by 40m grids (1600m²) giving 6400 measurements per grid. This sampling interval is very effective at locating archaeological features and is the recommended methodology for archaeological prospection (English Heritage, 2008).

2.2.7 The survey grids were set out to the Ordnance Survey OSGB36 datum using a Leica GS10 RTK GPS. The GPS is used in conjunction with Leica's SmartNet service, where positional corrections are sent via a mobile

telephone link. Positional accuracy of around 10 – 20mm is possible using the system. The instrument is regularly checked against the ETRS89 reference framework using Ordnance Survey ground marker C1ST7784 (Horton).

2.3 Data processing and presentation

2.3.1 Magnetometry data downloaded from the Grad 601-2 data logger are analysed and processed in specialist software known as ArcheoSurveyor. The software allows greyscale and trace plots to be produced for presentation and display. Survey grids are assembled to form an overall composite of data (composite file) creating a dataset of the complete survey area. Appendix C contains specific information concerning the survey and data attributes and is derived directly from ArcheoSurveyor; this should be used in conjunction with information provided by Figure 02.

2.3.2 Only minimal processing is carried out in order to enhance the results of the survey for display. Raw data are always analysed, as processing can modify anomalies. The following schedule sets out the data and image processing used in this survey:

- clipping of the raw data at ±30nT to improve greyscale resolution,
- clipping of processed data at ±3nT to enhance low magnitude anomalies,
- de-stagger is used to enhance linear anomalies,
- zero median/mean traverse is applied in order to balance readings along each traverse.

Reference should be made to Appendix B for further information on the specific processes carried out on the data. Appendix C metadata includes details on the processing sequence used for each survey area.

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

2.3.4 The main form of data display prepared for this report is the greyscale plot. Both 'raw' and 'processed' data have been shown followed by an abstraction and interpretation plot. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.

2.3.5 Graphic raster images in bitmap format (.BMP) are initially prepared in ArcheoSurveyor. Regardless of survey orientation, data captured along each traverse are displayed and processed by ArcheoSurveyor from left to right. Prior to displaying against base mapping, raster graphics require a rotation to restore north to the top of the image upon insertion into AutoCAD.

2.3.6 The raster images are combined with base mapping using ProgeCAD Professional 2009 and AutoCAD LT 2007, creating DWG file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. Quality can be compromised by rotation of graphics in order to allow the data to be orientated with respect to grid north; this is considered acceptable as the survey results are effectively georeferenced allowing relocation of features using GPS, resection method etc.

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 five survey areas covering approximately 15.6ha.

3.1.2 Magnetic anomalies located can be generally classified as positive linear, curvilinear and discrete positive responses of archaeological potential, positive and negative anomalies of an uncertain origin, 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 below with subsequent discussion in Section 4.

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. Some minor positional adjustment was required for some survey grids and this is related to poor surface conditions caused by deep ruts and waterlogging. Small zones of magnetic disturbance, caused by services and fencing, area apparent within the data although these are considered unlikely to obscure anomalies of archaeological potential.

3.2.2 Due to waterlogging and deeply rutted ground some small zones within Areas 3 and 4 were unsurveyable. There are no anomalies of archaeological potential immediately adjacent to these zones.

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 archaeological potential AS-ABST MAG POS LINEAR ARCHAEOLOGY AS-ABST MAG POS DISCRETE ARCHAEOLOGY AS-ABST MAG POS CURVILINEAR RING DITCH	Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc..
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG NEG LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN AS-ABST MAG POS UNCERTAIN AS-ABST MAG NEG UNCERTAIN	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies 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. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone/subsoil.
Anomalies with an agricultural origin AS-ABST MAG RIDGE AND FURROW	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 magnetic debris AS-ABST MAG DEBRIS AS-ABST MAG STRONG DIPOLAR	Magnetic debris often appears as areas containing many dipolar anomalies that may be weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and relates to magnetically thermoremnant materials (brick, tile, small fragments of ferrous material). This type of response can be associated with kilns, furnace structures, or hearths and may therefore be archaeologically significant. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin AS-ABST MAG DISTURBANCE AS-ABST MAG SERVICE	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 such 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 and with hysteresis adjacent to strong magnetic sources. Buried services may produce characteristic multiple dipolar anomalies dependant upon their construction.
Anomalies associated with ground disturbance/quarrying AS-ABST MAG GROUND DISTURBANCE	Irregular zones of magnetically variable response may indicate former quarrying. These may be mapped features or visible on aerial photographs.

Table 2: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area centred on OS NGR 423995 189460, see Figures 06 & 07.

Anomalies with an uncertain origin

(1) – A weakly positive linear anomaly (<1nT), extends across the southern part of the survey area. It appears to be fragmented, possibly indicating that it has been truncated by ridge and furrow.

(2) – Weakly positive linear anomalies oriented parallel with the southern field boundary. They are fragmented, possibly indicating that they have been truncated by, and therefore, pre-date the ridge and furrow, although an agricultural origin cannot be ruled out.

(3) – The survey area contains a number of short, positive linear and discrete anomalies. While it is possible that they relate to cut features, they do not form any coherent pattern or discernible morphology, and their origin is uncertain.

Anomalies associated with ground disturbance/quarrying

(4) – An amorphous anomaly is located adjacent to the north eastern edge of the survey area. This type of response generally indicates ground disturbance or quarrying, although none is recorded on the site by any Ordnance Survey mapping from the 19th century to the present day. It is not clear, but it is possible that the ridge and furrow (5) extends towards, but not over the anomaly, perhaps suggesting that it post-dates this type of cultivation.

Anomalies with an agricultural origin

(5) – A series of parallel alternate positive and negative linear anomalies in the northern part of the survey area are oriented north east to south west. They relate to former ridge and furrow.

(6) – A series of parallel linear anomalies across the majority of the survey area are oriented parallel with the north eastern field boundary. These are seen as positive linear anomalies, generally separated by wide bands of negative response, but also with more narrowly spaced alternate positive and negative linear anomalies in places. It is possible that these are related to ridge and furrow, but later agricultural activity, such as steam ploughing or mole drainage may be responsible.

Anomalies associated with magnetic debris

(7) – Small patches of magnetic debris are located at the south western and south eastern corners of the survey area. These are a response to magnetically thermoremnant material which may be associated with ground consolidation.

(8) – Strong, discrete, dipolar anomalies are a response to buried ferrous and other magnetically thermoremnant objects. These exist within each survey area.

3.5 List of anomalies - Area 2

Area centred on OS NGR423835 189348, see Figures 08 & 09.

Anomalies of archaeological potential

(9) – A fragmented, positive curvilinear anomaly is located close to the north western corner of the survey area. It relates to a ring ditch with an external diameter of 23m, enclosing an internal area 18m in diameter. It appears to have been truncated by a furrow on the north eastern edge, and also through the centre; however, it is possible that there is a deliberate gap on the south eastern side. The strength of the anomaly is generally 5nT on the northern side, rising to over 20nT on the southern side. This strength of response may indicate that burnt material and occupational debris is incorporated into it.

(10) – A fragmented positive linear anomaly extends from the north eastern corner to the western field boundary. It does not appear to continue directly westwards into Area 5, but may be associated with other anomalies in that survey area. The anomaly is likely to relate to a boundary ditch that has been truncated by later ridge and furrow (16).

(11) – A fragmented positive linear anomaly may form a rectilinear enclosure with anomaly (12). It also appears to continue westwards into Area 5 as anomaly (33). The linear anomaly has been truncated by ridge and furrow.

(12) – A positive linear anomaly may extend southwards to form a rectilinear enclosure with anomaly (11), but this is not clear due to the presence of ridge and furrow. It lies approximately 13m east north east of anomaly (9) and is parallel with anomaly (13).

(13) – A positive linear anomaly located parallel with anomaly (12) and approximately 16m west south west of anomaly (9). These linear anomalies appear to form a defining boundary around the ring ditch.

Anomalies with an uncertain origin

(14) – The survey area contains a number of short and fragmented positive linear anomalies. Although many are generally parallel with anomaly (10), their short and fragmented form prevent confident interpretation.

(15) – A negative linear anomaly extends along the southern edge of the survey area. It is possible that it relates to modern agricultural activity, or possibly a plastic pipe.

Anomalies with an agricultural origin

(16) – The survey area contains evidence for former ridge and furrow, parallel with the eastern and western field boundaries. This has truncated archaeological

anomalies (9) to (11).

3.6 List of anomalies - Area 3

Area centred on OS NGR 423942 189178, see Figures 10 & 11.

Anomalies with an uncertain origin

(17) – Extending along the western edge of the survey area is a positive linear anomaly. While it may appear to be associated with the ridge and furrow (20), it is slightly stronger at 2nT and more clearly defined than those anomalies. It also has a slightly different orientation and, although it is possible that it relates to a ditch-like feature, a more modern agricultural origin is equally possible.

(18) – The survey area contains a number of weakly positive and negative linear anomalies. They do not have any coherent morphology or pattern and are uncertain in origin.

(19) – Two negative linear anomalies are located close to, and parallel with the northern field boundary. This type of response could be associated with agricultural activity.

Anomalies with an agricultural origin

(20) – A series of parallel linear anomalies are a response to former ridge and furrow.

Anomalies associated with magnetic debris

(21) – Strongly magnetic debris indicates a response to ferrous material likely to be modern in origin. A narrow band of more weakly magnetic debris may be associated with an infilled former field boundary.

Anomalies with a modern origin

(22) – Magnetic disturbance from ferrous and other magnetically thermoremnant material within and to the south of the survey area.

3.7 List of anomalies - Area 4

Area centred on OS NGR 423845 189210, see Figures 10 & 11.

Anomalies with an uncertain origin

(23) – The western part of the survey area contains a number of weakly positive

and negative anomalies. These have linear, rectilinear and curvilinear elements, and some appear to relate to visible earthworks and hollows seen on the ground. It is possible that they are associated with drainage channels.

(24) – A weakly positive curvilinear anomaly is located close to the eastern field boundary. It has a similar response to anomalies (23); however, its origin is uncertain.

(25) – The north eastern part of the survey area contains a number of positive discrete anomalies. Whilst some may be associated with ridge and furrow, many appear pit-like, although their origin is uncertain.

Anomalies with an agricultural origin

(26) – A series of linear anomalies parallel with the northern and southern field boundaries are likely to relate to former ridge and furrow cultivation.

Anomalies associated with magnetic debris

(27) – The survey area contains several small patches of magnetic debris that are likely to relate to magnetically thermoremnant material dumped and/or used for ground consolidation.

Anomalies with a modern origin

(28) – A strong, multiple dipolar linear anomaly extends along the north western edge of the survey area and relates to a buried service. Two spurs also appear to extend for a short distance into Areas 5 and 2 to the north.

3.8 List of anomalies - Area 5

Area centred on OS NGR 423649 189218, see Figures 12 & 13.

Anomalies of archaeological potential

(29) – The survey area contains at least five ring ditches with external diameters ranging between 12m and 18m. They have a response of between 7nT and 15nT relating to moderate levels of magnetic enhancement indicative of occupational debris. The majority also contain internal pits and/or areas of burning, indicating possible hearths within round houses.

(30) – Located close to and between anomalies (29) are at least three further positive curvilinear anomalies. Due to their more disturbed and less coherent form they are less clearly definable as ring ditches, although this is a possible interpretation.

(31) – The survey area contains a large number of discrete positive anomalies that

indicate pits. Many of the anomalies are 2-3nT, but some are over 30nT which indicates that they are associated with burnt material.

(32) – The survey area contains a number of positive linear and rectilinear anomalies. These form a series of rectangular and sub-rectangular enclosures containing pits and ring ditches on the northern side. They have a similar magnitude as anomalies (31), again indicating burnt material and other occupational debris.

(33) – A positive linear anomaly extends through the eastern part of the survey area. It appears to continue eastwards into Area 2 as anomaly (11). The anomaly is parallel to anomalies (34) to the south, and has been truncated by the ridge and furrow.

(34) – Two positive linear anomalies appear to relate to boundary ditches defining the southern extent of the archaeological anomalies (29) to (33).

Anomalies with an uncertain origin

(35) – Several negative linear anomalies can be seen within the survey area, oriented parallel with the northern and southern field boundaries, but also with anomalies (32) to (34). It is difficult to determine their date or function and an agricultural origin is possible.

(36) – The survey area contains a number of short, positive linear anomalies. They do not have a coherent pattern; however, it is possible that they relate to fragmented cut features.

Anomalies with an agricultural origin

(37) – The survey area contains evidence of former ridge and furrow. It can be seen as narrow negative linear anomalies and alternate wider bands of positive response. In this case, the negative anomalies relate to the furrow which have truncated the underlying archaeology. The positive response is more likely to relate to the ridges which have preserved the underlying archaeology.

Anomalies with a modern origin

(38) – Magnetic disturbance at the north western corner of the survey area is associated with a buried service or pipe.

4 DISCUSSION

4.1.1 Area 1 contains evidence for quarrying along the north eastern edge of the site. It also contains two sets of former ridge and furrow. The survey area contains a number of weakly positive linear anomalies, many of which are

short and or fragmented, and although of uncertain origin, it is possible that some relate to cut features.

4.1.2 Area 2 contains a ring ditch with an external diameter of 23m, but without obvious internal or external pits or areas of burning. However, the southern and western parts of the ring ditch are significantly enhanced, indicating burnt material is likely to be incorporated. Linear ditches appear to bound the ring ditch and there is also evidence of truncation by furrows. These anomalies appear to form the eastern edge of a possible prehistoric and/or Romano-British settlement, seen mainly within Area 5 to the west.

4.1.3 Area 3 is located in the southern part of the site and contains a number of weakly positive and negative linear anomalies that cannot be confidently interpreted.

4.1.4 Area 4 contains a number of weakly positive and negative linear, sinuous and discrete anomalies that may be associated with natural or man made drainage, although this is not certain.

4.1.5 The north western part of Area 5 contains archaeological features covering approximately 3ha. There is a series of rectilinear enclosures and ditches that enclose at least five ring ditches, pits and areas of burning, with a further three ring ditches possible. The strength of the anomalies indicates widespread burnt and other occupational debris. The ring ditches are generally between 12m and 18m in diameter, which would indicate that these relate to substantially large round houses. This part of the site is less than 250m south east of the possible Roman settlement (HER no 16067) and an association is likely.

5 CONCLUSION

5.1.1 The survey located a number of linear ditches, enclosures, ring ditches and pits that appear to relate to possible prehistoric and/or Romano-British settlement in the north western part of the site. The archaeology covers approximately 3ha and includes a possible nine ring ditches. The features appear to correlate with the distribution of sandy, well-drained soil within the site and a scatter of Romano-British pottery sherds. Many of the archaeological features have been disturbed by former ridge and furrow cultivation.

5.1.2 The site also contains numerous positive anomalies, many of which are weak and short or fragmented. It is difficult to accurately determine the origin of these anomalies because of their fragmentation and lack of coherent morphology; however, it is possible that some relate to cut features of archaeological potential.

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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 gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 1m apart. The instrument is carried about 30cm 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. If no enhanced feature is present the field measured by both sensors will be similar and the difference close to zero.

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 ±1nT 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 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 slight differences between the set-up and stability of gradiometer sensors and can remove striping. The process can remove archaeological features that run along a traverse so data analysis is also carried out prior its application.

De-stagger

Compensates for small positional errors within data collection by shifting the position of the readings along each traverse by a specified amount. Data lost at the end of each traverse are extrapolated from adjacent value in the same row.

Deslope

Corrects for striping and distortion caused by metal objects/services etc.. The process calculates a curve based on a polynomial best fit mathematical function for each traverse. This curve is then subtracted from the actual data.

Edge Match

Calculates the mean of the 2 lines (rows or columns) of data either side of the edge to match. It then subtracts the difference between the means from all datapoints in the selected area.

FFT (Fast Fourier Transform) spectral filtering

A mathematical process used to determine the frequency components of a traverse. Repetitive features, such as plough marks, produce characteristic spectral zones that can be suppressed allowing greyscale images to appear clearer.

Appendix C – survey and data information

Area 1 raw magnetometer data

COMPOSITE
Filename: J479-mag-Area1-raw.xcp
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 16/05/2013
Assembled by: on 17/05/2013
Direction of 1st Traverse: 132 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: Zero

Dimensions
Composite Size (readings): 960 x 280
Survey Size (meters): 240 m x 280 m
Grid Size: 40 m x 40 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 30.00
Min: -30.00
Std Dev: 2.38
Mean: 0.17
Median: 0.17
Composite Area: 6.72 ha
Surveyed Area: 4.4468 ha

Processes: 2
1 Base Layer
2 Clip from -30.00 to 30.00 nT

Source Grids: 39
1 Col:0 Row:0 grids\37.xgd
2 Col:0 Row:1 grids\38.xgd
3 Col:0 Row:2 grids\39.xgd
4 Col:0 Row:3 grids\40.xgd
5 Col:0 Row:4 01.xgd
6 Col:0 Row:5 02.xgd
7 Col:0 Row:6 03.xgd
8 Col:1 Row:0 grids\33.xgd
9 Col:1 Row:1 grids\34.xgd
10 Col:1 Row:2 grids\35.xgd
11 Col:1 Row:3 grids\36.xgd
12 Col:1 Row:4 04.xgd
13 Col:1 Row:5 05.xgd
14 Col:1 Row:6 06.xgd
15 Col:2 Row:0 grids\29.xgd
16 Col:2 Row:1 grids\30.xgd
17 Col:2 Row:2 grids\31.xgd
18 Col:2 Row:3 grids\32.xgd
19 Col:2 Row:4 07.xgd
20 Col:2 Row:5 08.xgd
21 Col:2 Row:6 09.xgd
22 Col:3 Row:0 grids\25.xgd
23 Col:3 Row:1 grids\26.xgd
24 Col:3 Row:2 grids\27.xgd
25 Col:3 Row:3 grids\28.xgd
26 Col:3 Row:4 10.xgd
27 Col:3 Row:5 11.xgd
28 Col:4 Row:0 grids\21.xgd
29 Col:4 Row:1 grids\22.xgd
30 Col:4 Row:2 grids\23.xgd
31 Col:4 Row:3 grids\24.xgd
32 Col:4 Row:4 12.xgd
33 Col:4 Row:5 13.xgd
34 Col:5 Row:0 16.xgd
35 Col:5 Row:1 17.xgd
36 Col:5 Row:2 18.xgd
37 Col:5 Row:3 19.xgd
38 Col:5 Row:4 14.xgd
39 Col:5 Row:5 15.xgd

Area 1 processed magnetometer data

COMPOSITE
Path: D:\Business\Jobs\J479 Shrivenham\Data\Area 1\comps\

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.15
Mean: 0.08
Median: 0.00
Composite Area: 6.72 ha
Surveyed Area: 4.4468 ha

Processes: 7
1 Base Layer
2 Clip from -30.00 to 30.00 nT
3 DeStripe Median Traverse: Grids: All
4 De Stagger: Grids: 22.xgd 23.xgd 24.xgd 12.xgd 17.xgd 18.xgd 19.xgd 14.xgd Mode: Both By: -1 intervals
5 De Stagger: Grids: 19.xgd Mode: Both By: -1 intervals
6 De Stagger: Grids: 23.xgd Mode: Both By: -1 intervals
7 Clip from -3.00 to 3.00 nT

Area 2 raw magnetometer data

COMPOSITE
Filename: J479-mag-Area2-raw.xcp
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 20/05/2013
Assembled by: on 21/05/2013
Direction of 1st Traverse: 30.5 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: Zero

Dimensions
Composite Size (readings): 960 x 200
Survey Size (meters): 240 m x 200 m
Grid Size: 40 m x 40 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 30.00
Min: -30.00
Std Dev: 2.10
Mean: -0.05
Median: 0.06
Composite Area: 4.8 ha
Surveyed Area: 3.3096 ha

Processes: 2
1 Base Layer
2 Clip from -30.00 to 30.00 nT

Source Grids: 28
1 Col:0 Row:0 grids\28.xgd
2 Col:0 Row:1 grids\09.xgd
3 Col:0 Row:2 grids\10.xgd
4 Col:0 Row:3 grids\11.xgd
5 Col:0 Row:4 grids\08.xgd
6 Col:1 Row:0 grids\27.xgd
7 Col:1 Row:1 grids\12.xgd
8 Col:1 Row:2 grids\13.xgd
9 Col:1 Row:3 grids\14.xgd
10 Col:1 Row:4 grids\07.xgd
11 Col:2 Row:0 grids\26.xgd
12 Col:2 Row:1 grids\15.xgd
13 Col:2 Row:2 grids\16.xgd
14 Col:2 Row:3 grids\17.xgd
15 Col:2 Row:4 grids\06.xgd
16 Col:3 Row:0 grids\25.xgd
17 Col:3 Row:1 grids\18.xgd
18 Col:3 Row:2 grids\19.xgd
19 Col:3 Row:3 grids\20.xgd
20 Col:3 Row:4 grids\05.xgd
21 Col:4 Row:0 grids\21.xgd
22 Col:4 Row:1 grids\22.xgd
23 Col:4 Row:2 grids\23.xgd
24 Col:4 Row:3 grids\24.xgd
25 Col:4 Row:4 grids\04.xgd
26 Col:5 Row:2 grids\01.xgd
27 Col:5 Row:3 grids\02.xgd
28 Col:5 Row:4 grids\03.xgd

Area 2 processed magnetometer data

COMPOSITE
Filename: J479-mag-Area2-proc.xcp

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.01
Mean: 0.03
Median: 0.00
Composite Area: 4.8 ha
Surveyed Area: 3.3096 ha

Processes: 8
1 Base Layer
2 Clip from -30.00 to 30.00 nT
3 DeStripe Median Traverse: Grids: All
4 De Stagger: Grids: 04.xgd Mode: Both By: -1 intervals
5 De Stagger: Grids: 19.xgd Mode: Both By: -1 intervals
6 De Stagger: Grids: 12.xgd Mode: Outbound By: -1 intervals
7 De Stagger: Grids: 24.xgd Mode: Both By: -1 intervals
8 Clip from -3.00 to 3.00 nT

Area 3 raw magnetometer data

COMPOSITE
Filename: J479-mag-Area3-raw.xcp
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 20/05/2013
Assembled by: on 21/05/2013
Direction of 1st Traverse: 121.5 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: Zero

Dimensions
Composite Size (readings): 480 x 240
Survey Size (meters): 120 m x 240 m
Grid Size: 40 m x 40 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 30.00
Min: -30.00
Std Dev: 3.54
Mean: -0.30
Median: -0.12
Composite Area: 2.88 ha
Surveyed Area: 1.5264 ha

Processes: 2
1 Base Layer
2 Clip from -30.00 to 30.00 nT

Source Grids: 13
1 Col:0 Row:4 grids\13.xgd
2 Col:1 Row:0 grids\01.xgd
3 Col:1 Row:1 grids\02.xgd
4 Col:1 Row:2 grids\03.xgd
5 Col:1 Row:3 grids\10.xgd
6 Col:1 Row:4 grids\11.xgd
7 Col:1 Row:5 grids\12.xgd
8 Col:2 Row:0 grids\04.xgd
9 Col:2 Row:1 grids\05.xgd
10 Col:2 Row:2 grids\06.xgd
11 Col:2 Row:3 grids\07.xgd
12 Col:2 Row:4 grids\08.xgd
13 Col:2 Row:5 grids\09.xgd

Area 3 processed magnetometer data

COMPOSITE
Filename: J479-mag-Area3-proc.xcp

Stats
Max: 3.00
Min: -3.00
Std Dev: 0.99
Mean: -0.02
Median: 0.00
Composite Area: 2.88 ha
Surveyed Area: 1.5264 ha

Processes: 4
1 Base Layer
2 Clip from -30.00 to 30.00 nT
3 DeStripe Median Traverse: Grids: All
4 Clip from -3.00 to 3.00 nT

Area 4 raw magnetometer data

COMPOSITE
Filename: J479-mag-Area4-raw.xcp
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 21/05/2013
Assembled by: on 21/05/2013
Direction of 1st Traverse: 120 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: Zero

Dimensions
Composite Size (readings): 320 x 320
Survey Size (meters): 80 m x 320 m
Grid Size: 40 m x 40 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 30.00
Min: -30.00
Std Dev: 4.07
Mean: -0.23
Median: -0.23
Composite Area: 2.56 ha
Surveyed Area: 1.5366 ha

Processes: 2
1 Base Layer
2 Clip from -30.00 to 30.00 nT

Source Grids: 16
1 Col:0 Row:0 grids\03.xgd
2 Col:0 Row:1 grids\04.xgd
3 Col:0 Row:2 grids\08.xgd
4 Col:0 Row:3 grids\09.xgd
5 Col:0 Row:4 grids\10.xgd
6 Col:0 Row:5 grids\14.xgd
7 Col:0 Row:6 grids\15.xgd
8 Col:0 Row:7 grids\16.xgd
9 Col:1 Row:0 grids\01.xgd
10 Col:1 Row:1 grids\02.xgd
11 Col:1 Row:2 grids\05.xgd
12 Col:1 Row:3 grids\06.xgd
13 Col:1 Row:4 grids\07.xgd
14 Col:1 Row:5 grids\11.xgd
15 Col:1 Row:6 grids\12.xgd
16 Col:1 Row:7 grids\13.xgd

Area 4 processed magnetometer data

COMPOSITE
Filename: J479-mag-Area4-proc.xcp

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.12
Mean: -0.03
Median: -0.04
Composite Area: 2.56 ha
Surveyed Area: 1.5366 ha

Processes: 4
1 Base Layer
2 Clip from -30.00 to 30.00 nT
3 DeStripe Mean Traverse: Grids: All Threshold: 0.5 SDs
4 Clip from -3.00 to 3.00 nT

Area 5 raw magnetometer data

COMPOSITE
Filename: J479-mag-Area5-raw.xcp
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 22/05/2013
Assembled by: on 22/05/2013
Direction of 1st Traverse: 43.8 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702
Origin: Zero

Dimensions
Composite Size (readings): 1120 x 240
Survey Size (meters): 280 m x 240 m
Grid Size: 40 m x 40 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 30.00
Min: -30.00
Std Dev: 3.50
Mean: 1.13
Median: 1.24
Composite Area: 6.72 ha
Surveyed Area: 3.1922 ha

Processes: 2
1 Base Layer
2 Clip from -30.00 to 30.00 nT

Source Grids: 29
1 Col:0 Row:0 grids\27.xgd
2 Col:0 Row:1 grids\28.xgd
3 Col:0 Row:2 grids\29.xgd
4 Col:1 Row:0 grids\24.xgd
5 Col:1 Row:1 grids\25.xgd
6 Col:1 Row:2 grids\26.xgd
7 Col:2 Row:0 grids\21.xgd
8 Col:2 Row:1 grids\22.xgd
9 Col:2 Row:2 grids\23.xgd
10 Col:3 Row:0 grids\18.xgd
11 Col:3 Row:1 grids\19.xgd
12 Col:3 Row:2 grids\20.xgd
13 Col:4 Row:0 grids\15.xgd
14 Col:4 Row:1 grids\16.xgd
15 Col:4 Row:2 grids\17.xgd
16 Col:4 Row:3 grids\01.xgd
17 Col:4 Row:4 grids\02.xgd
18 Col:4 Row:5 grids\03.xgd
19 Col:5 Row:0 grids\10.xgd

20 Col:5 Row:1 grids\11.xgd
21 Col:5 Row:2 grids\12.xgd
22 Col:5 Row:3 grids\04.xgd
23 Col:5 Row:4 grids\05.xgd
24 Col:5 Row:5 grids\06.xgd
25 Col:6 Row:1 grids\13.xgd
26 Col:6 Row:2 grids\14.xgd
27 Col:6 Row:3 grids\07.xgd
28 Col:6 Row:4 grids\08.xgd
29 Col:6 Row:5 grids\09.xgd

Area 5 processed magnetometer data

COMPOSITE
Filename: J479-mag-Area5-proc.xcp

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.64
Mean: -0.04
Median: 0.00
Composite Area: 6.72 ha
Surveyed Area: 3.1917 ha

Processes: 10
1 Base Layer
2 DeStripe Median Traverse: Grids: All
3 Clip from -3.00 to 3.00 nT
4 De Stagger: Grids: 12.xgd Mode: Outbound By: -1 intervals
5 De Stagger: Grids: 14.xgd Mode: Outbound By: -1 intervals
6 De Stagger: Grids: 11.xgd Mode: Outbound By: -1 intervals
7 De Stagger: Grids: 01.xgd Mode: Outbound By: 1 intervals
8 De Stagger: Grids: 26.xgd Mode: Outbound By: 1 intervals
9 De Stagger: Grids: 01.xgd Mode: Outbound By: 1 intervals
10 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 (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 digital copy (pdf) will be sent to the Oxfordshire County Archaeologist and a printed copy sent to the Oxfordshire HER.

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

- ArcheoSurveyor version 2.5.19.5 (geophysical data analysis),
- ProgeCAD Professional 2009 (report graphics),
- AutoCAD LT 2007 (report figures),
- OpenOffice.org 3.0.1 Writer (document text),
- PDF Creator version 0.9 (PDF archive).

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

- ArcheoSurveyor grid and composite files for all geophysical data,
- CSV files for raw and processed composites,
- geophysical composite file graphics as Bitmap images,
- AutoCAD DWG files in 2000 and 2007 versions,
- report text as OpenOffice.org ODT file,
- report text as Word 2000 doc file,
- report text as rich text format (RTF),
- report text as PDF,
- PDFs of all figures.