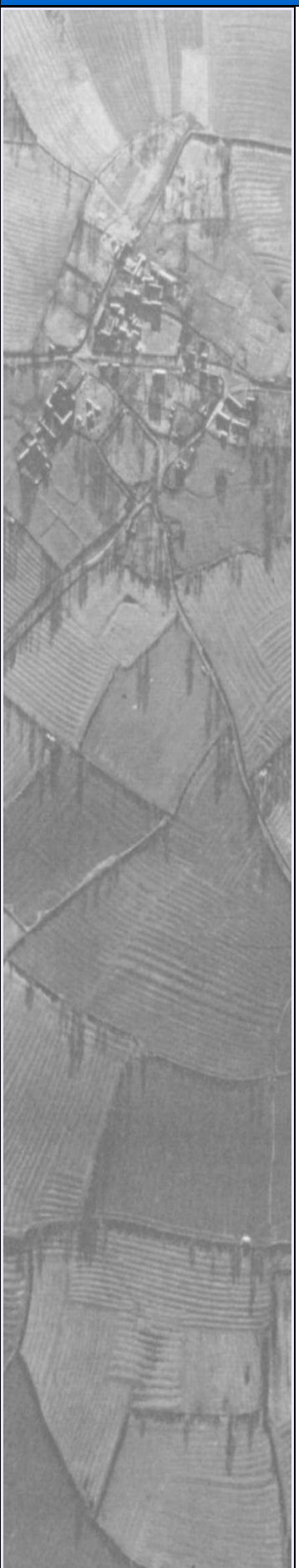

Kingston Farm II
Bradford-on-Avon
Wiltshire

MAGNETOMETER SURVEY REPORT

for

BOA Property Ltd and
CG Fry & Son Ltd

David Sabin and Kerry Donaldson

December 2011

Ref. no. 387

ARCHAEOLOGICAL SURVEYS LTD

Kingston Farm II, Bradford-on-Avon, Wiltshire

Magnetometer Survey

for

BOA Property Ltd and
CG Fry & Son Ltd

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

Survey date - **from 13th to 19th December 2011**
Ordnance Survey Grid Reference - **ST 83530 60740**

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SUMMARY

A detailed magnetometer survey was carried out by Archaeological Surveys Ltd on land at Kingston Farm to the east of Bradford-on-Avon, Wiltshire. The survey was carried out as part of an archaeological assessment prior to a proposed residential development. The survey located a number of positive linear anomalies that appear to relate to former enclosure ditches of archaeological potential. Several other linear and curvilinear ditch-like anomalies of archaeological potential were also located. Other anomalies are probably indicative of former agricultural activity and include lynchets, former field boundaries and possible ridge and furrow cultivation.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Michael Heaton Heritage Consultants, on behalf of BOA Property Ltd and CG Fry & Son Ltd, to undertake a magnetometer survey of an area of land at Kingston Farm on the eastern edge of Bradford-on-Avon, Wiltshire. The site has been outlined for a proposed residential development. The survey forms part of an archaeological assessment of the site.

1.1.2 A previous geophysical survey was carried out by Archaeological Surveys in April 2011, on land immediately north and east, ahead of installation of solar arrays. This survey located several geophysical anomalies that appeared to relate to cut features such as ditches, ring ditches, enclosures and pits with an archaeological origin.

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.

1.2.2 The aim of the survey would be to inform decision-making as to further archaeological evaluation work and/or archaeological mitigation as part of the planning permission process, in line with the requirements of Planning Policy Statement (PPS) 5 policy HE6.1.

1.2.3 The methodology is considered an efficient and effective approach to archaeological prospection. 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*.

1.3 Site location, description and survey conditions

1.3.1 The site is located at Kingston Farm, on the eastern edge of Bradford-on-Avon in Wiltshire and centred on Ordnance Survey National Grid Reference (OS NGR) ST 83530 60740 see Figures 01 and 02.

1.3.2 The geophysical survey covers approximately 8.3ha of agricultural land split within five separate Areas (1-5). Area 1 (3.1ha) lies within a single field forming the western side of the site. The ground cover consisted of long grass and wild plant growth. Area 2 (3ha) covers the majority of a field immediately east of Area 1, see Plate 1. The southern part of the field could not be surveyed due to the presence of unharvested maize and an open cable trench. Area 3 (0.3ha) is a small zone to the south east of Area 2 where ground cover consisted of rough grass. Area 4 (0.6ha) is a 30m wide strip along the southern side of a field that contains part of a photovoltaic solar array, see Plate 2. The area now covered by the array was previously subject to magnetometry in April 2011. Area 5 (1.3ha) is a strip up to 60m wide that lies along the southern side of a field also containing a photovoltaic solar array.

Plate 1: Survey Area 2 looking north west

Plate 2: Survey Area 4 looking east

1.3.3 The ground conditions across the site were variable but generally considered to be suitable for the collection of magnetometry data. Long grass and wild plants were encountered within Area 1 and produced difficult walking conditions. Open soil subject to heavy rain and maize stubble in Area 2 also produced difficult conditions underfoot. Weather conditions during the survey were variable with periods of heavy rain, snow and high winds separated by brighter spells.

1.4 Site history and archaeological potential

1.4.1 A previous geophysical survey carried out immediately to the east (Archaeological Surveys, 2011), located a number of positive linear, rectilinear, curvilinear and discrete anomalies that related to ditches, enclosures, ring ditches and pits with archaeological potential. The Wiltshire SMR also lists an undated field system, recorded as shadow sites from aerial photographs, in the area. There is, therefore, a high potential for further archaeological features to be located by the geophysical survey.

1.4.2 Open soil in Area 2 was subject to heavy rain and provided excellent conditions for the observation of cultural material on the field surface. Frequently visible were pottery sherds of 18th – early 20th centuries along with 19th century clay pipe bowls, coal clinker and oyster shells. Infrequently noted were Late Medieval and early Post Medieval pottery sherds with a very small number of earlier medieval sherds. No material was retained except for a 'ship penny' jetton, typically dating to the mid 16th century. The widespread pottery sherds revealed no particular concentration in the field and are likely to

be related to manuring and soil improving with waste material from the nearby town.

1.5 Geology and soils

1.5.1 The underlying geology is Forest Marble, within Area 1 on the western edge of the site, and Cornbrash across the rest of the survey areas (BGS, 2011). The overlying soils across the site are from the Sherborne association and are Brown Renzinas. These consist of shallow, well drained, brashy, calcareous clayey soils over limestone (Soil Survey of England and Wales, 1983).

1.5.2 Magnetometry carried out adjacent to the site revealed strong magnetic contrast between the fill of cut features and the material into which they are cut. These soils can, however, produce strong pit-like anomalies relating to natural features.

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 Bartington Grad 601-2 gradiometers. The instruments effectively measure 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 instruments are extremely sensitive and are 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 instruments are 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 gradiometers undergo regular servicing and calibration by the manufacturer. A current assessment of the instruments 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 - 6th August 2010 (due Aug 2012) Sensors 242 and 396 - 6th 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 instruments were 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 30m by 30m grids (900m²) giving 3600 recorded 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 Penmap RTK GPS and oriented parallel to field boundaries. 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 of 75.215° anticlockwise for Areas 1 and 2, 75.045° an ticlockwise for Areas 3 and 4 and 62.852° anticlockwise for Area 5 to resto re north to the top of the image. Greyscale images are rotated by 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.. A digital archive is produced with this report allowing separate analysis if necessary, see Appendix D below.

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 8.3ha.

3.1.2 Magnetic anomalies located can be generally classified as positive linear and discrete positive responses of archaeological potential, positive and negative linear 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 and suitability of technique

3.2.1 Data are considered representative of the magnetic anomalies present within the site. Small zones of magnetic disturbance were encountered within Areas 1, 2 and 5 although it is considered unlikely that more significant anomalies have been obscured by these areas. Surface conditions were variable and often poor for traversing and some very minor positional adjustment was carried out on data in parts of the site; no significant distortion is likely.

3.2.2 Magnetic contrast associated with anomalies generally appears good, particularly when related to positive anomalies indicative of cut features. Negative anomalies, probably indicative of subsoil with low magnetic susceptibility, are also present and suggest a strong contrast in magnetic susceptibility between topsoil and subsoil.

3.2.3 Highly variable weak anomalies and some discrete positive anomalies probably relate to the underlying geology. Magnetic 'noise' from agricultural activity is moderately strong across much of the site. It probably relates to the

incorporation of fragments of magnetically thermoremnant material into the soil during episodic manuring or soil improvements prior to the mid 20th century.

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	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 AREA UNCERTAIN AS-ABST MAG NEG AREA UNCERTAIN	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies with an agricultural origin AS-ABST MAG AGRICULTURAL AS-ABST MAG LYNCHET	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. A broad response may relate to an extant lynchet or headland.
Anomalies associated with magnetic debris AS-ABST MAG DEBRIS AS-ABST MAG STRONG DIPOLAR	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, or hearths 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 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.

Table 2: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area centred on OS NGR 383280 160840, see Figures 06 & 07.

Anomalies of archaeological potential

(1) – A positive rectilinear anomaly located in the western part of the survey area. It extends north-north-eastwards 52m from the southern field boundary, where it then turns 90° towards the west.

(2) – A positive rectilinear anomaly extends north-north-easterly from the southern field boundary near the eastern edge of the survey area. It then extends in a north westerly direction towards the north western edge of the site. It may relate to a cut feature with some archaeological potential, although agricultural cultivation marks can be seen parallel with it on the northern side.

Anomalies with an uncertain origin

(3) – A weakly positive linear anomaly extends across the northern part of the site. Although it's origin is uncertain, it should be noted that it is parallel with the northern field boundary, and an agricultural origin is possible.

(4) – A positive linear anomaly, with parallel negative linear anomaly on its southern side, is located in the south eastern corner of the survey area. The anomalies suggest a ditch and bank, and it is possible that it is associated with a former field boundary or agricultural feature.

(5) – The survey area contains several weak, fragmented positive linear and possible curvilinear anomalies. Their form and magnitude prevent confident interpretation.

(6) – A broad, amorphous variable response is located close to the eastern edge of the survey area. It is possible that this relates to the underlying geology, although this is uncertain.

(7) – The survey area contains many discrete positive responses. It is not possible to determine if they are pit-like features with an anthropogenic origin, or if they are of natural origin.

Anomalies with an agricultural origin

(8) – A series of parallel linear anomalies appear to have been created by agricultural activity.

(9) – Broad positive and corresponding negative linear anomalies relate to extant lynchets.

Anomalies associated with magnetic debris

(10) – A patch of magnetic debris is located within the north eastern corner of the survey area. It is possible that this relates to dumped or burnt material with a modern origin.

(11) – Strong, discrete, dipolar anomalies relate to ferrous objects within the topsoil.

Anomalies with a modern origin

(12) – Two strong, multiple dipolar, linear anomalies, near the south eastern corner of the survey area, indicate buried services that have caused magnetic disturbance.

3.5 List of anomalies - Area 2

Area centred on OS NGR 383470 160800, see Figures 08 & 09.

Anomalies of archaeological potential

(13) – Positive linear anomalies forming three sides of a rectilinear enclosure approximately 70m across. There appears to be a deliberate gap or entrance on the north western corner; the south western corner also has a gap in the data; however, it is not clear if it is deliberate, or as a result of truncation by ploughing. The northern and southern sides of the enclosure show increasing magnitude towards the east, peaking at approximately 10nT; this may imply a focus of activity further to the east beyond the surveyed area.

(14) – Positive linear anomalies close to the south east corner of anomaly (13). They extend southwards and also eastwards and relate to cut features.

Anomalies with an uncertain origin

(15) – Two parallel positive linear anomalies extend diagonally north west to south east across the north eastern corner of anomaly (13). It is not possible to determine if this anomaly is associated directly with the enclosure, or even if it is archaeological in origin. The anomalies show moderate enhancement up to approximately 15nT.

(16) – Discrete positive anomalies appear to relate to pit-like features, and a concentration of them can be seen in the southern half of the rectilinear enclosure (anomaly 13). It is possible that these are associated with the enclosure; however, the soil and underlying geology can result in magnetically enhanced discrete features.

(17) – A negative linear anomaly extends north east to south west within anomaly (13). This appears to be a response to material with low magnetic susceptibility.

(18) – A weakly positive linear anomaly extends south westward from close to the southern edge of anomaly (13). It is possible that it is associated with anomaly (17).

(19) – A broad, positive linear anomaly, with parallel negative linear response on the northern side, can be seen extending across the southern part of the survey area. It is possibly an extension of the field boundary in Area 1 to the west, and it also leads to the end of the field boundary to the north of Area 3, where it changes direction, heading to the north east.

(20) – A broad positive linear anomaly joins anomaly (19) from the south. It appears to relate to a former boundary feature.

(21) – In the south eastern corner of the survey area, broad, weak positive anomalies can be seen, together with a negative linear anomaly. It is possible that these are similar in origin to anomaly (20), possibly related to former field boundaries.

(22) – A broad, positive anomaly, and parallel negative linear anomaly appear between anomalies (13), (14) and (23). Similar in form to anomaly (21), it is possible that they have a similar origin and function.

(23) – Two weakly positive linear anomalies, with parallel negative responses to the north, extend across the site from east to west. They are parallel with anomaly (19), possibly relating to former lynchets or other cultivation features.

(24) – At the northern edge of the survey area are two positive curvilinear anomalies with a moderately high response.

(25) – Two parallel weakly positive linear anomalies are located with the western half of the area and are parallel to the western field boundary. It is possible that they are a response to plough marks.

(26) – Short, weakly positive linear anomalies can be seen within the survey area. Their origin is uncertain.

Anomalies associated with magnetic debris

(27) – A circular patch of magnetic debris lies across the northern part of the enclosure. Although relating to magnetically thermoremnant material, the origin of this material is uncertain.

(28) – A patch of magnetic debris is visible close to the northern edge of the survey area. It lies next to a gateway from the road into the field and is likely to relate to magnetically thermoremnant material that has been used in ground consolidation of the entranceway.

Anomalies with a modern origin

(29) – A strong, multiple dipolar, linear anomaly extends from the western edge of the survey area, north-north-eastwards towards Saltacre Lodge to the north west of the survey area. It is a response to a buried service or pipe.

3.6 List of anomalies – Area 3

Area centred on OS NGR 383550 160670, see Figures 10 & 11.

Anomalies of archaeological potential

(30) – A positive linear anomaly is seen to cross the very northern part of the survey area and is likely to extend eastwards. It appears to relate to a cut feature, possibly adjoining the southern extent of anomaly (14) to the east.

Anomalies with an uncertain origin

(31) – Broad, positive linear anomalies, with parallel negative anomalies immediately north, may relate to agricultural features, such as former ridge and furrow.

3.7 List of anomalies - Area 4

Area centred on OS NGR 383655 160610, see Figures 10 & 11.

Anomalies of archaeological potential

(32) – A broad positive curvilinear anomaly located in the eastern part of the survey area appears to relate to a former ditch-like feature.

Anomalies with an uncertain origin

(33) – Weakly positive linear anomalies and a discrete response are located to the north east of anomaly (32). Due to their low magnitude, it is difficult to determine the origin of these anomalies; however, they do appear to be parallel with anomaly (32) and an association is possible.

(34) – Positive and negative broadly linear anomalies may relate to former ridge and furrow.

(35) – Discrete positive anomalies that may relate to pit-like features although it is not certain if they are anthropogenic or natural in origin.

3.8 List of anomalies - Area 5

Area centred on OS NGR 383880 160520, see Figures 12 & 13.

Anomalies with an uncertain origin

(36) – Positive linear and possible curvilinear anomalies of uncertain origin are located close to the western field boundary.

(37) – A positive linear anomaly, located in the centre of the survey area, extends in a north-north-easterly direction from the southern field boundary. It appears to relate to a ditch-like feature, although could be agricultural in origin.

(38) – The survey area contains several weakly positive linear and curvilinear anomalies. It is not possible to ascertain if they relate to cut features or agricultural marks.

(39) – Discrete positive anomalies are located across the survey area. It is not possible to determine if they relate to pit-like features with an anthropogenic or natural origin.

Anomalies with an agricultural origin

(40) – Parallel linear anomalies have been caused by agricultural activity.

4 DISCUSSION

4.1.1 Anomalies of archaeological potential have been located within four of the survey areas. In Area 1, on the western edge of the site, two positive rectilinear anomalies appear to relate to former ditch-like features, although it cannot be determined if they have any association. Anomaly (1) appears to relate to two sides of a rectilinear enclosure and anomaly (2) may have a similar origin but it should be noted that agricultural marks appear to be parallel with it along the northern side, suggesting that this may have been a more recent topographic feature.

4.1.2 In Area 2, positive linear anomalies form three sides of a rectilinear enclosure with a width of approximately 70m. The eastern side has not been located and is likely to lie within the area of trees to the east. In the vicinity of the south eastern corner of this enclosure are other positive linear anomalies, relating to further ditches. It also appears that there is an associated cut feature immediately to the east within the northern part of Area 3, indicating the eastward continuation of the archaeological anomalies. A previous geophysical survey in the area immediately to the east and north east (Archaeological Surveys, 2011), located a number of anomalies with archaeological potential (see Figs 14 and 15). Positive and negative linear anomalies in the southern part of Area 2 may relate to former field boundaries, and these appear to have cut the southern extension of anomaly (14), possibly suggesting they are later.

4.1.3 Within Area 4, a positive curvilinear anomaly is indicative of a former ditch-like feature with archaeological potential. Although it is clearly defined within the current survey, the anomaly is seen further north as a much weaker feature and a series of pits in the previous magnetometer survey (see 4.1.2) and could not be clearly defined or interpreted.

5 CONCLUSION

5.1.1 The magnetometry located a number of anomalies that may relate to cut features with archaeological potential. Several rectilinear elements possibly partially define three or four former enclosures within Areas 1 and 2, with a possible continuation of one of these enclosures into Area 3. A well-defined curvilinear anomaly within Area 4 may also have archaeological potential. Area 5, forming the eastern part of the site, appeared comparatively 'quiet' with only a small number of very weak anomalies of uncertain origin.

5.1.2 The results from Area 1 demonstrate the presence of magnetic anomalies correlating with extant lynchets. Extending across Area 2, positive and negative linear anomalies appear to demonstrate the presence of a former field boundary which appears to continue eastwards from the lynchets and southern boundary of Area 1. Parallel linear anomalies within Areas 3 and 4 could be indicative of former ridge and furrow.

5.1.3 The survey has indicated the archaeological potential of several magnetic anomalies and the possible presence of early enclosures; however, taking a previous survey into consideration also (Archaeological Surveys, 2011), there is evidence for a focus of anthropogenic activity outside of the current survey boundary to the east of Area 2.

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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 data

COMPOSITE
Filename: J387-mag-Area1-raw.xcp
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 16/12/2011
Assembled by: on 16/12/2011
Direction of 1st Traverse: 45 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702

Dimensions
Composite Size (readings): 840 x 300
Survey Size (meters): 210 m x 300 m
Grid Size: 30 m x 30 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 30.00
Min: -30.00
Std Dev: 3.62
Mean: 0.01
Median: 0.24
Composite Area: 6.3 ha
Surveyed Area: 3.1038 ha

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

Source Grids: 45
1 Col:0 Row:8 grids\36.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\04.xgd
6 Col:1 Row:4 grids\32.xgd
7 Col:1 Row:5 grids\33.xgd
8 Col:1 Row:6 grids\34.xgd
9 Col:1 Row:7 grids\35.xgd
10 Col:1 Row:8 grids\37.xgd
11 Col:2 Row:0 grids\05.xgd
12 Col:2 Row:1 grids\06.xgd
13 Col:2 Row:2 grids\07.xgd
14 Col:2 Row:3 grids\08.xgd
15 Col:2 Row:4 grids\28.xgd
16 Col:2 Row:5 grids\29.xgd
17 Col:2 Row:6 grids\30.xgd
18 Col:2 Row:7 grids\31.xgd
19 Col:2 Row:8 grids\38.xgd
20 Col:3 Row:0 grids\09.xgd
21 Col:3 Row:1 grids\10.xgd
22 Col:3 Row:2 grids\11.xgd
23 Col:3 Row:3 grids\12.xgd
24 Col:3 Row:4 grids\24.xgd
25 Col:3 Row:5 grids\25.xgd
26 Col:3 Row:6 grids\26.xgd
27 Col:3 Row:7 grids\27.xgd
28 Col:3 Row:8 grids\39.xgd
29 Col:4 Row:1 grids\13.xgd
30 Col:4 Row:2 grids\14.xgd
31 Col:4 Row:3 grids\15.xgd
32 Col:4 Row:4 grids\20.xgd
33 Col:4 Row:5 grids\21.xgd
34 Col:4 Row:6 grids\22.xgd
35 Col:4 Row:7 grids\23.xgd
36 Col:4 Row:8 grids\40.xgd
37 Col:4 Row:9 grids\41.xgd
38 Col:5 Row:4 grids\16.xgd
39 Col:5 Row:5 grids\17.xgd
40 Col:5 Row:6 grids\18.xgd
41 Col:5 Row:7 grids\19.xgd
42 Col:5 Row:8 grids\42.xgd
43 Col:5 Row:9 grids\43.xgd
44 Col:6 Row:8 grids\44.xgd
45 Col:6 Row:9 grids\45.xgd

Area 1 processed data

COMPOSITE
Filename: J387-mag-Area1-proc.xcp

Stats
Max: 3.00
Min: -3.05
Std Dev: 1.09

Mean: 0.01
Median: 0.00
Composite Area: 6.3 ha
Surveyed Area: 3.1037 ha

Processes: 5
1 Base Layer
2 DeStripe Median Traverse: Grids: All
3 Clip from -3.00 to 3.00 nT
4 De Stagger: Grids: 26.xgd Mode: Both By: 1 intervals
5 De Stagger: Grids: 25.xgd Mode: Both By: 1 intervals

Area 2 raw data

COMPOSITE
Filename: J387-mag-Area2-raw.xcp
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 18/12/2011
Assembled by: on 18/12/2011
Direction of 1st Traverse: 45 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702

Dimensions
Composite Size (readings): 960 x 210
Survey Size (meters): 240 m x 210 m
Grid Size: 30 m x 30 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 30.00
Min: -30.00
Std Dev: 4.48
Mean: 0.26
Median: 0.29
Composite Area: 5.04 ha
Surveyed Area: 2.9424 ha

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

Source Grids: 46
1 Col:0 Row:1 grids\46.xgd
2 Col:0 Row:2 grids\01.xgd
3 Col:0 Row:3 grids\02.xgd
4 Col:0 Row:4 grids\03.xgd
5 Col:0 Row:5 grids\04.xgd
6 Col:1 Row:1 grids\45.xgd
7 Col:1 Row:2 grids\05.xgd
8 Col:1 Row:3 grids\06.xgd
9 Col:1 Row:4 grids\07.xgd
10 Col:1 Row:5 grids\08.xgd
11 Col:2 Row:0 grids\43.xgd
12 Col:2 Row:1 grids\44.xgd
13 Col:2 Row:2 grids\09.xgd
14 Col:2 Row:3 grids\10.xgd
15 Col:2 Row:4 grids\11.xgd
16 Col:2 Row:5 grids\12.xgd
17 Col:3 Row:0 grids\41.xgd
18 Col:3 Row:1 grids\42.xgd
19 Col:3 Row:2 grids\13.xgd
20 Col:3 Row:3 grids\14.xgd
21 Col:3 Row:4 grids\15.xgd
22 Col:3 Row:5 grids\16.xgd
23 Col:3 Row:6 grids\17.xgd
24 Col:4 Row:1 grids\40.xgd
25 Col:4 Row:2 grids\18.xgd
26 Col:4 Row:3 grids\19.xgd
27 Col:4 Row:4 grids\20.xgd
28 Col:4 Row:5 grids\21.xgd
29 Col:4 Row:6 grids\22.xgd
30 Col:5 Row:1 grids\39.xgd
31 Col:5 Row:2 grids\23.xgd
32 Col:5 Row:3 grids\24.xgd
33 Col:5 Row:4 grids\25.xgd
34 Col:5 Row:5 grids\26.xgd
35 Col:5 Row:6 grids\27.xgd
36 Col:6 Row:1 grids\38.xgd
37 Col:6 Row:2 grids\28.xgd
38 Col:6 Row:3 grids\29.xgd
39 Col:6 Row:4 grids\30.xgd
40 Col:6 Row:5 grids\31.xgd
41 Col:6 Row:6 grids\32.xgd
42 Col:7 Row:2 grids\33.xgd
43 Col:7 Row:3 grids\34.xgd
44 Col:7 Row:4 grids\35.xgd
45 Col:7 Row:5 grids\36.xgd
46 Col:7 Row:6 grids\37.xgd

Area 2 processed data

COMPOSITE
Filename: J387-mag-Area2-proc.xcp

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.55
Mean: -0.03
Median: -0.10
Composite Area: 5.04 ha
Surveyed Area: 2.9424 ha

Processes: 6
1 Base Layer
2 DeStripe Mean Traverse: Grids: All Threshold: 1 SDs
3 Edge Match (Area: Top 60, Left 720, Bottom 89, Right 839) to Left edge
4 De Stagger: Grids: 20.xgd Mode: Both By: 1 intervals
5 De Stagger: Grids: 21.xgd Mode: Both By: 1 intervals
6 Clip from -3.00 to 3.00 nT

Area 3 raw data

COMPOSITE
Filename: J387-mag-Area3.xcp
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 18/12/2011
Assembled by: on 18/12/2011
Direction of 1st Traverse: 45 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702

Dimensions
Composite Size (readings): 360 x 60
Survey Size (meters): 90 m x 60 m
Grid Size: 30 m x 30 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 28.69
Min: -14.90
Std Dev: 2.59
Mean: 1.14
Median: 0.96
Composite Area: 0.54 ha
Surveyed Area: 0.29665 ha

Processes: 1
1 Base Layer

Source Grids: 5
1 Col:0 Row:0 grids\05.xgd
2 Col:0 Row:1 grids\06.xgd
3 Col:1 Row:0 grids\02.xgd
4 Col:1 Row:1 grids\03+04.xgd
5 Col:2 Row:0 grids\01.xgd

Area 3 processed data

COMPOSITE
Filename: J387-mag-Area3-proc.xcp

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.72
Mean: 0.03
Median: 0.00
Composite Area: 0.54 ha
Surveyed Area: 0.2965 ha

Processes: 4
1 Base Layer
2 DeStripe Median Traverse: Grids: All
3 Clip from -3.00 to 3.00 nT
4 De Stagger: Grids: 01.xgd Mode: Both By: 1 intervals

Area 4 raw data

COMPOSITE
Filename: J387-mag-Area4-raw.xcp
Description:
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 20/12/2011
Assembled by: on 20/12/2011
Direction of 1st Traverse: 45 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.

Dummy Value: 32702

Dimensions
Composite Size (readings): 120 x 210
Survey Size (meters): 30 m x 210 m
Grid Size: 30 m x 30 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 30.00
Min: -30.00
Std Dev: 2.32
Mean: 0.81
Median: 0.69
Composite Area: 0.63 ha
Surveyed Area: 0.558 ha

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

Source Grids: 7
1 Col:0 Row:0 grids\01.xgd
2 Col:0 Row:1 grids\02.xgd
3 Col:0 Row:2 grids\03.xgd
4 Col:0 Row:3 grids\04.xgd
5 Col:0 Row:4 grids\05.xgd
6 Col:0 Row:5 grids\06.xgd
7 Col:0 Row:6 grids\07.xgd

Area 4 processed data

COMPOSITE
Filename: J387-mag-Area4-proc.xcp

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.47
Mean: 0.06
Median: 0.00
Composite Area: 0.63 ha
Surveyed Area: 0.558 ha

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

Source Grids: 7
1 Col:0 Row:0 grids\01.xgd
2 Col:0 Row:1 grids\02.xgd
3 Col:0 Row:2 grids\03.xgd
4 Col:0 Row:3 grids\04.xgd
5 Col:0 Row:4 grids\05.xgd
6 Col:0 Row:5 grids\06.xgd
7 Col:0 Row:6 grids\07.xgd

Area 5 raw data

COMPOSITE
Filename: J387-mag-Area5-raw.xcp
Instrument Type: Bartington (Gradiometer)
Units: nT
Surveyed by: on 20/12/2011
Assembled by: on 20/12/2011
Direction of 1st Traverse: 45 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702

Dimensions
Composite Size (readings): 240 x 300
Survey Size (meters): 60 m x 300 m
Grid Size: 30 m x 30 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 30.00
Min: -30.00
Std Dev: 2.62
Mean: 0.99
Median: 1.05
Composite Area: 1.8 ha
Surveyed Area: 1.3139 ha

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

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

Area 5 processed data

COMPOSITE
Filename: J387-mag-Area5-proc.xcp

Stats
Max: 3.00
Min: -3.00
Std Dev: 1.27
Mean: 0.07
Median: 0.05
Composite Area: 1.8 ha
Surveyed Area: 1.3139 ha

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

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at Castle Combe, 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). The distribution of both hardcopy report and digital data is considered the responsibility of the Client unless explicitly stated in the survey Brief, Written Scheme of Investigation or other contractual agreement.

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

- ArcheoSurveyor version 2.5.14.0 (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,
- photographic record in JPEG format.