Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at Grattons, Dartington Hall, Dartington, Devon

Ordnance Survey (E/N): 279524,62742 (point)

Report: 150125

Ross Dean BSc MSc MA MIfA

25 January 2015

Substrata
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1 Survey description and summary

1.1 Survey

Type:	twin-sensor fluxgate gradiometer
Date:	22 January 2014
Area:	1.8ha
Lead surveyor:	Ross Dean BSc MSc MA MIfA

1.2 Client

AC Archaeology Ltd, 4 Halthaies Workshops, Bradninch, Nr Exeter, Devon EX5 4QL

1.3 Location

Site:	Land at Grattons
Village & Civil Parish:	Dartington
District:	South Hams
County:	Devon
Nearest Postcode:	TQ9 6ED
NGR:	SX 795 627
Ordnance Survey E/N:	279524,62742 (point)

1.4 Archive

OASIS number:	substrat1-201410
Archive:	At the time of writing, the archive of this survey will be held by Substrata.

1.5 Introduction

This report was commissioned by AC Archaeology Ltd on behalf of Dartington Hall Trust in order to help establish the cultural heritage and archaeological implications of a proposal for a solar array at the above site. The application site lies within a single agricultural field of approximately 4.8 hectares located to the west of Dartington Hall and the proposed solar array will cover approximately 2 hectares of this area extending up to a ridgeline that runs through the field. The location of the proposed development area is shown in Figure 1.

1.6 Summary

The magnetic contrast across the area was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. Twenty-two magnetic anomaly groups were identified as possibly representing archaeological deposits or features, the majority of which are fragmented linear and curvilinear groups that are most likely to relate to past field boundaries or other enclosures of unknown date. One curvilinear group has a clear signal across the data set. Of the other anomaly groups mapped, one may indicate the presence of heated materials perhaps filling a ditch or forming a track, wall footing or culvert. Two groups may represent either archaeological pits or natural deposits. One group is suggestive of possible archaeological deposits just outside the north-western boundary of the designated survey area.

2 Survey aims and objectives

2.1 Aims

1. Define and characterise and detectable archaeological remains on the site.
2. Help establish the cultural heritage and archaeological implications of a proposal for a solar array.

2.2 Objectives

1. Complete a gradiometer survey across agreed parts of the application area.
2. Identify any magnetic anomalies that may be related to archaeological deposits, structures or artefacts.
3. Within the limits of the techniques and dataset, archaeologically characterise any such anomalies or patterns of anomalies.
4. Accurately record the location of the identified anomalies.

5. Produce a report based on the survey that is sufficiently detailed to inform any subsequent development on the site about the location and possible archaeological character of the recorded anomalies.

3 Standards

The standards used to complete this survey are defined by the Institute for Archaeologists (2011). The codes of approved practice that were followed are those of the Institute for Archaeologists (2008 and 2009) and Archaeology Data Service/Digital Antiquity Guides (undated). The document text was written using the house style of the Institute for Archaeologists (Institute for Archaeologists, undated).

4 Site description

4.1 Landscape and land use

The application area is located between 65m and 80m AOD within a single agricultural field to the west of Dartington Hall (Figure 1). The field contains a prominent ridge toward the centre on the north-western side of the survey area, with the ground then sloping down to the west and east, giving commanding views over the surrounding landscape.

4.2 Geology

The application area is located on a solid geology boundary with Tuff of the Devonian Nordon Formation on the western side of the application area creating a natural ridge. On the eastern side the rocks are of the Devonian Nordon Formation which comprise mudstones, siltstones and limestones. The superficial geology is not recorded in the source used (British Geological Survey, undated).

5 Archaeological background

An assessment of the archaeological background of the site is contained in Lutescu-Jones (2014), an Historic Environment Assessment which was completed as part of the programme of works of which this report is a part. The following is an extract from that document:

There are no known archaeological sites recorded within the boundaries of the field, although it does lie in an area where there is extensive evidence for prehistoric and medieval activity. There is a recorded late prehistoric flint scatter in the field immediately to the north and there are two Iron Age hillslope enclosures approximately 1000m to the northwest. Many of the recorded medieval sites in the vicinity relate to Dartington Hall estate. These include the remains of the medieval hall, the former church and the deerpark. The northern boundary of Grattons coincides with the scheduled deerpark boundary complex and to the north is an ovoid earthwork enclosure, also forming part of the deerpark. The site forms part of a single agricultural field which is part of the Dartington Hall estate and which has maintained its plan shape and boundaries since at least 1803. Three of the boundaries contain hedges and are depicted on maps dating to c. 1840 (*ibid*; 6 - 8)

6 Results, discussion and conclusions

This survey was designed to record magnetic anomalies. The anomalies themselves cannot be regarded as actual archaeological features and the dimensions of the anomalies shown do not represent the dimensions of any associated archaeological features. The analysis presented below identifies and characterises anomalies and anomaly groups that may relate to archaeological deposits and structures.

The reader is referred to section 7.

6.1 Results

Figure 2 shows the interpretation of the survey data. It includes the anomaly groups identified as relating to archaeological deposits along with their numbers. Table 1 is an extract of the detailed analysis of the survey data which is provided in the attribute tables of the GIS project on the accompanying CD-ROM and in the project archive.

Figure 2 and Table 1 comprise the analysis of the survey data. Plots of the processed data are provided in Figures 3 and 4.

6.2 Discussion

General points

Anomalies though to relate to natural features were not mapped. Recent man-made objects such as manholes, water management equipment, drains, cables and other services were only mapped where they comprised significant magnetic responses across the dataset that needed clarification. If mapped, they are listed in Table 1 but are not discussed below.

Data collection along the south-western and south-eastern field edges was restricted as shown in Figures 2 to 4 due to the presence of magnetic materials in and adjacent to the field boundaries. Strong magnetic responses mapped close to these field boundaries are likely to relate to such materials except where indicated otherwise in Figure 2.

Data relating to historical maps and other records

No magnetic anomaly groups coincided with features recorded on historical maps.

Data with no previous archaeological provenance

The majority of magnetic anomaly groups mapped as relating to potential archaeological deposits are linear and curvilinear groups that are most likely to relate to past field boundaries or other enclosures of unknown date. These groups are generally fragmented, most likely as a result of soil disturbance caused by ploughing and other agricultural activities. Magnetic anomaly group **4** is an exception with a clear signal across the data set and only two relatively minor disruptions.

Of the other anomaly groups mapped, group **1** has a relatively strong magnetic signal that may indicate the presence of heated materials. The implication is that heated materials, speculatively fired bricks, may have been used to fill a ditch or as part of a track, wall footing or culvert.

Group **5** lies on the edge of the survey area and outwith the designated survey area (survey grids occasionally exceed the survey limits to keep the field process efficient) and is only partially recorded. Its complexity implies that there may be ground disturbance and possibly archaeological deposits adjacent to the application area at this point.

Groups **19** and **22** may represent either archaeological pits or natural deposits.

6.3 Conclusions

The magnetic contrast across the area was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. Twenty-two magnetic anomaly groups were identified as possibly representing archaeological deposits or features, the majority of which are fragmented linear and curvilinear groups that are most likely to relate to past field boundaries or other enclosures of unknown date. One curvilinear group has a clear signal across the data set. Of the other anomaly groups mapped, one may indicate the presence of heated materials perhaps filling a ditch or forming a track, wall footing or culvert. Two groups may represent either archaeological pits or natural deposits. One group is suggestive of possible archaeological deposits just outside the north-western boundary of the designated survey area.

7 Disclaimer and copyright

The description and discussion of the results presented in this report are the authors, based on his interpretation of the survey data. Every effort has been made to provide accurate descriptions and interpretations of the geophysical data set. The nature of archaeological geophysical surveying is such that interpretations based on geophysical data, while informative, can only be provisional. Geophysical surveys are a cost-effective early step in the multi-phase process that is archaeology. The evaluation programme of which this survey is part may also be informed by other archaeological assessment work and analysis. It must be presumed that more archaeological features will be evaluated than those specified in this report.

8 Acknowledgements

Substrata would like to thank John Valentin of AC Archaeology Ltd for commissioning us to complete this survey.

9 Bibliography

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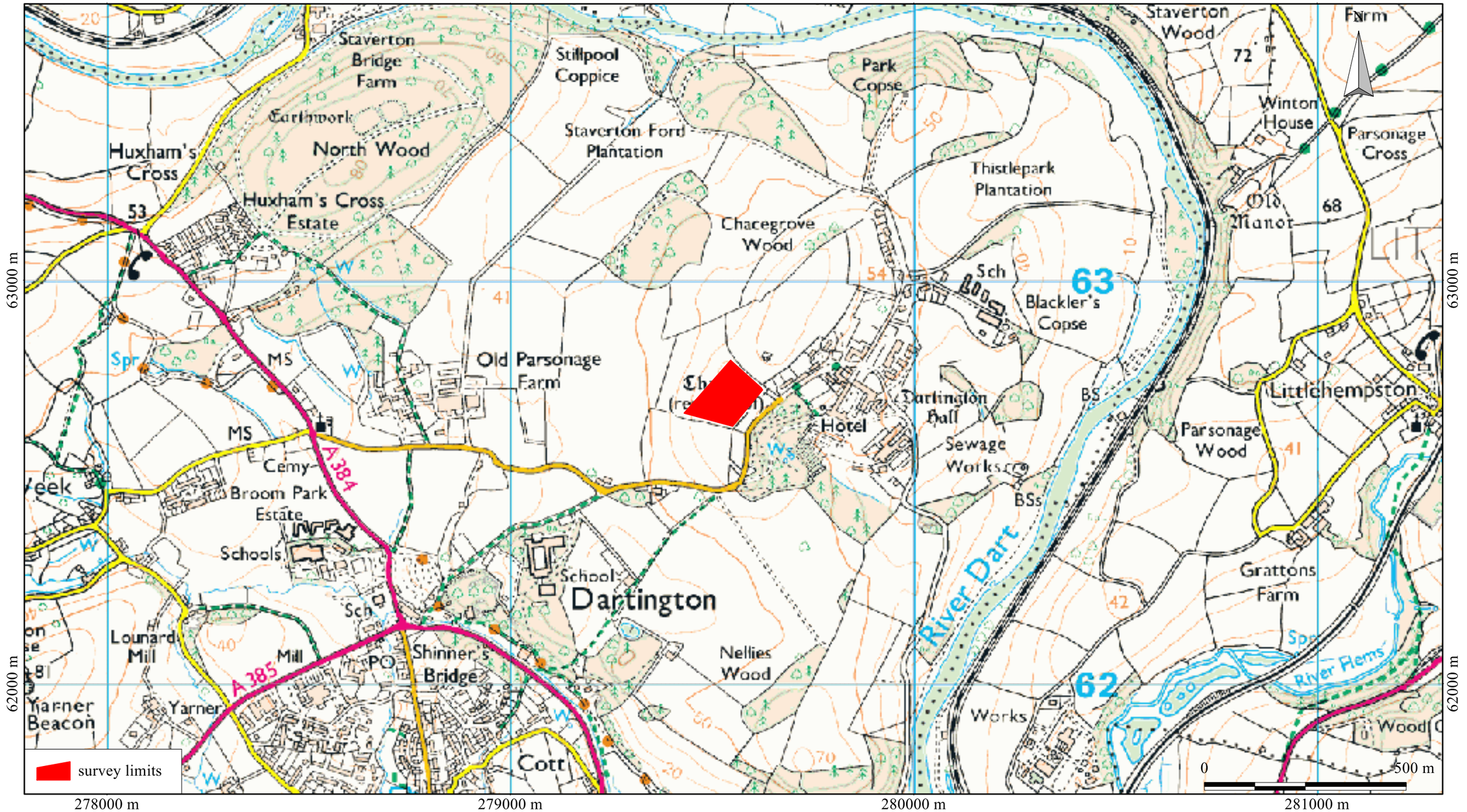
Lutescu-Jones, P. (2014) *Grattons, Dartington Hall, Dartington, Devon Centred on NGR SX 79524 62742 Historic Environment Assessment*, AC Archaeology Ltd unpublished document ACD112/11 rev December 2014

Appendix 1 Analysis table and supporting plots

General Guidance

The anomalies represented in the survey plots provided in this appendix are magnetic anomalies. The apparent size of such anomalies and anomaly patterns are unlikely to correspond exactly with the dimensions of any associated archaeological features.

A rough rule for interpreting magnetic anomalies is that the width of an anomaly at half its maximum reading is equal to the width of the buried feature, or its depth if this is greater (Clark, 2000: 83). Caution must be applied when using this rule as it depends on the anomalies being clearly identifiable and distinct from adjacent anomalies. In northern latitudes the position of the maximum of a magnetic anomaly will be displaced slightly to the south of any associated physical feature.



British Grid
centre X: 279553.15 m, centre Y: 62705.56 m

Scale: 1:10000 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 1: location map

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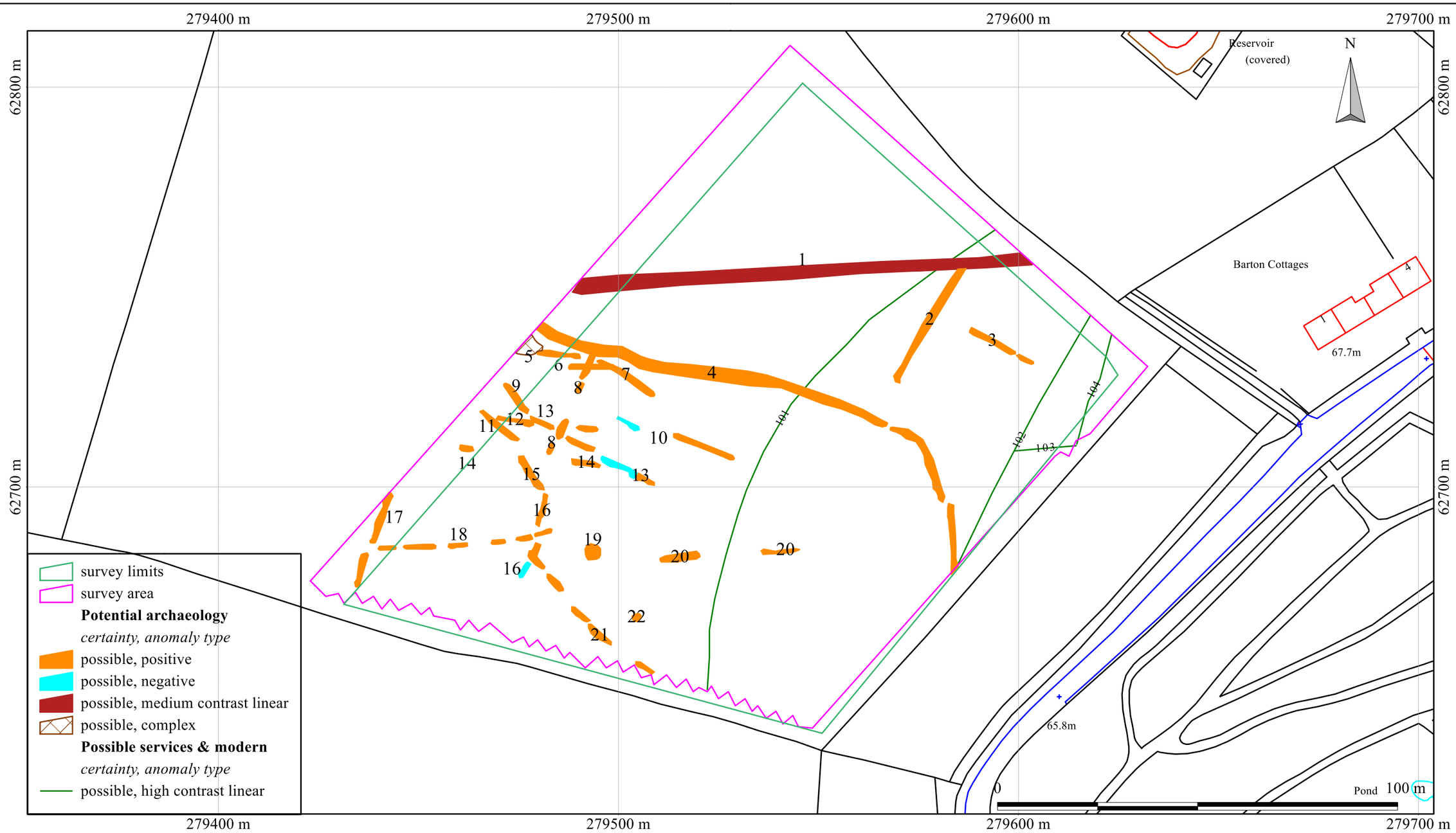
anomaly group	anomaly characterisation certainty & class	anomaly form	additional archaeological characterisation	comments
1	possible, medium contrast linear	disrupted linear	brick structure	anomaly group is typical of those representing a structure composed of fired bricks or other heated material
2	possible, positive	linear		
3	possible, positive	disrupted linear		
4	possible, positive	disrupted curvilinear		
5	possible, complex			anomaly groups lies on the edge of survey area but their apparent interaction implies a possible sub-surface feature to the west of the survey area at this point
6	possible, positive	parallel linears		anomaly groups run parallel and may indicate a relatively complex feature such as remnants of a ditched track
7	possible, positive	linear		
8	possible, positive	disrupted linear		
9	possible, positive	linear		
10	possible, positive & negative	disrupted linear		anomaly groups comprise positive and negative magnetic responses reflecting the same linear feature
11	possible, positive	linear		
12	possible, positive	disrupted linear		
13	possible, positive & negative	disrupted linear		anomaly groups comprise positive and negative magnetic responses reflecting the same linear feature
14	possible, positive	disrupted linear		
15	possible, positive	linear		
16	possible, positive & negative	disrupted linear		anomaly groups comprise positive and negative magnetic responses reflecting the same linear feature
17	possible, positive	disrupted linear		
18	possible, positive	disrupted linear		
19	possible, positive	oval	pit	anomaly groups may represent an archaeological pit or a natural feature
20	possible, positive	disrupted linear		
21	possible, positive	disrupted linear		
22	possible, positive	oval	pit	anomaly groups may represent an archaeological pit or a natural feature
101	possible, high contrast linear		iron or steel pipe, cable or drain	
102	possible, high contrast linear		iron or steel pipe, cable or drain	
103	possible, high contrast linear		iron or steel pipe, cable or drain	
104	possible, high contrast linear		iron or steel pipe, cable or drain	

Table 1: data analysis



British Grid
centre X: 279528.02 m, centre Y: 62716.15 m

Scale: 1:1000 @ A3. Spatial Units: Meter. Do not scale off this drawing

Notes:
1. All interpretations are provisional and represent potential archaeological deposits.
2. Anomalies designated "likely archaeology" have supporting evidence e.g. historical maps and or visible earthworks.
3. Representative; not all instances are mapped.
4. Anomalies likely to represent geological or other natural deposits are not mapped unless relevant to potential archaeological events or deposits.

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Figure 2: survey interpretation

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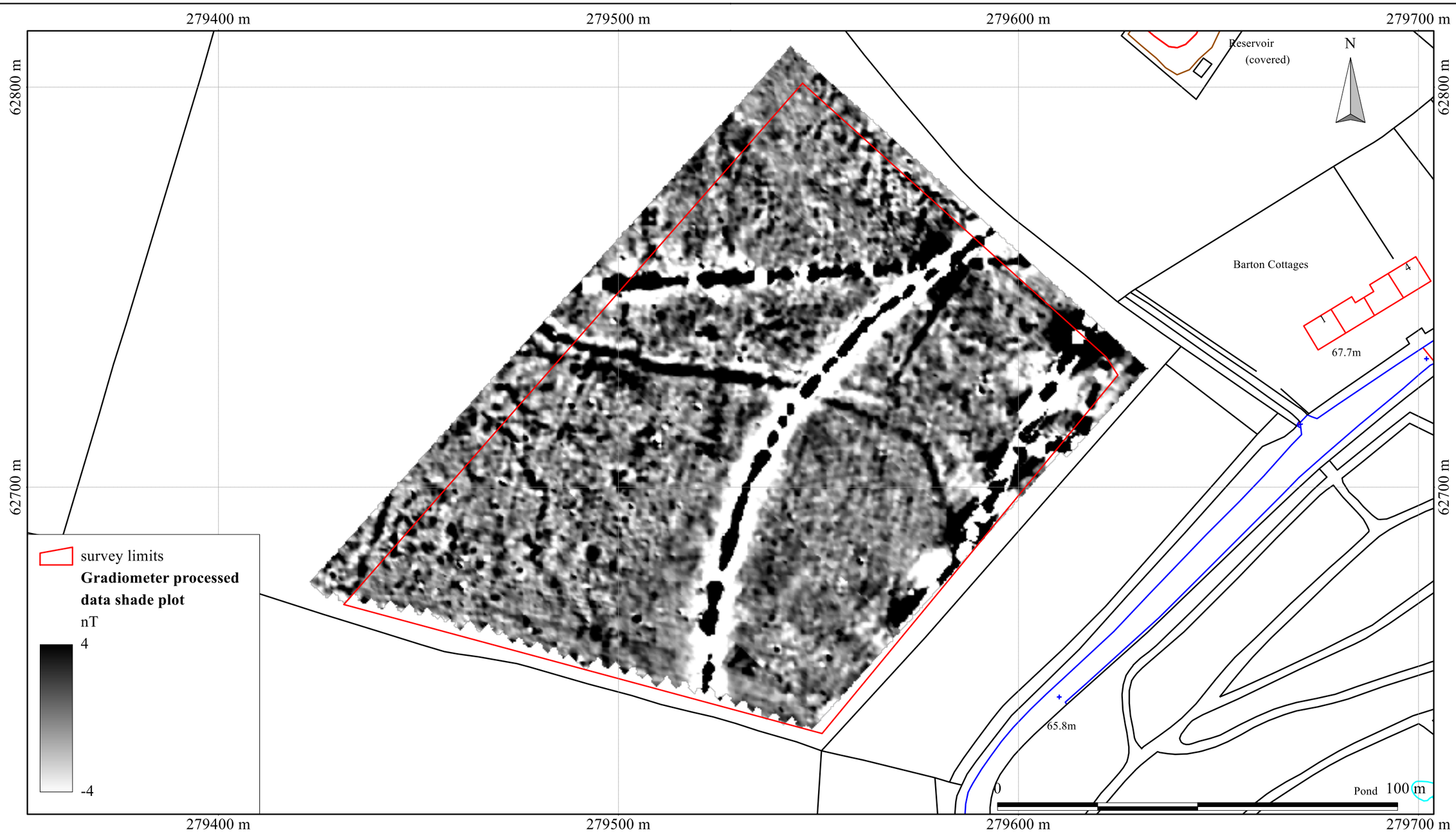

British Grid
centre X: 279528.02 m, centre Y: 62716.15 m

Scale: 1:1000 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 3: shade plot of processed data

Substrata
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279400 m 279500 m 279600 m 279700 m

62800 m

62700 m

Reservoir
(covered)

N

Barton Cottages

67.7m

65.8m

Pond

0 100 m

survey limits

Gradiometer processed data

contour plot

nT

> 8.00

4.00 - 8.00

2.00 - 4.00

1.00 - 2.00

-1.00 - 1.00

-2.00 - -1.00

-4.00 - -2.00

-8.00 - -4.00

< -8.00

279400 m 279500 m 279600 m 279700 m

British Grid
centre X: 279528.02 m, centre Y: 62716.15 m

Scale: 1:1000 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 4: contour plot of processed data

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Appendix 2 Methodology Summary

<table>
<tr><th colspan="2">Table 1: methodology summary</th></tr>
<tr><td colspan="2">Documents
Survey methodology statement: Dean (2014)</td></tr>
<tr><td colspan="2">Methodology
1. The work was undertaken in accordance with the survey methodology statement. The geophysical (gradiometer) survey was undertaken with reference to standard guidance provided by the Institute for Archaeologists (2011) and Archaeology Data Service/Digital Antiquity Guides (undated).
2. The survey grid location information and grid plan was recorded as part of the project in a suitable GIS system.
3. Data processing was undertaken using appropriate software, with all anomalies being digitised and geo-referenced. The final report included a graphical and textual account of the techniques undertaken, the data obtained and an archaeological interpretation of that data and conclusions about any likely archaeology.</td></tr>
<tr><td colspan="2">Grid
Method of Fixing: DGPS set-out using pre-planned survey grids and Ordnance Survey coordinates.
Composition: 30m by 30m grids
Recording: Geo-referenced and recorded using digital map tiles.
DGPS used: Spectra Precision PM5V2 GPS with external antenna and survey pole and DigiTerra Explorer 7 as the survey control program.</td></tr>
<tr><td>Equipment
Instrument: Bartington Instruments grad601-2
Firmware: version 6.1</td><td>Data Capture
Sample Interval: 0.25-metres
Traverse Interval: 1 metre
Traverse Method: zigzag
Traverse Orientation: GN42</td></tr>
<tr><td colspan="2">Data Processing, Analysis and Presentation Software
IntelliCAD Technology Consortium IntelliCAD 7.2
DW Consulting TerraSurveyor3
Manifold System 8 GIS
Microsoft Corp. Office Excel 2013
Microsoft Corp. Office Publisher 2013
Adobe Systems Inc Adobe Acrobat 9 Pro Extended</td></tr>
</table>

Appendix 3 Data processing

Table 2: gradiometer survey - processed data metadata
SITE Instrument Type: Bartington Grad 610 Units: nT Direction of 1st Traverse: 0 deg Collection Method: ZigZag Sensors: 2 @ 1.00 m spacing. Dummy Value: 32702 PROGRAM Name: TerraSurveyor Version: 3.0.25.0
Stats Max: 591.67 Min: -598.97 Std Dev: 54.76 Mean: 1.31 Median: 0.00 Processes: 6 1 Base Layer 2 Clip at 2.00 SD 3 De Stagger: Grids: All Mode: Both By: -2 intervals 4 De Stagger: Grids: ar13.xgd ar22.xgd ar14.xgd ar21.xgd ar15.xgd ar20.xgd ar16.xgd ar19.xgd ar17.xgd ar18.xgd Mode: Both By: -1 intervals 5 DeStripe Median Sensors: ar1.xgd ar12.xgd ar2.xgd ar11.xgd ar13.xgd ar3.xgd ar10.xgd ar14.xgd ar4.xgd ar9.xgd ar15.xgd ar5.xgd ar8.xgd ar16.xgd ar6.xgd ar7.xgd ar17.xgd 6 DeStripe Median Traverse: Grids: ar22.xgd ar21.xgd ar20.xgd ar19.xgd ar18.xgd Note: converting the gradiometer data into ESRI GIS files imposed an x=y interpolation on the entire dataset

Appendix 4 Geophysical surveying techniques

1 Introduction

Substrata offers magnetometer and earth resistance surveying. We also provide other archaeology-specific geophysical surveys such as ground penetrating radar and resistivity. The particular method or combination of methods used depends on local soil conditions and the survey requirements. These methods are capable of delivering fast and accurate assessments of the archaeology of both large and small sites.

Further details can be found on our website at www.substrata.co.uk.

2 Magnetometer surveying

Standard magnetometer surveys are the workhorse of archaeological surveying when speed and cost-effectiveness are important. Identifiable archaeological features include areas of occupation, hearths, kilns, furnaces, ditches, pits, post-holes, ridge-and-furrow, timber structures, wall footings, roads, tracks and similar buried features.

Magnetometer surveying is used to detect and map small changes in the earth's magnetic field caused by concentrations of ferrous-based minerals within the soil and subsoil, and by materials buried beneath the surface. While most of these changes are too small to affect a compass needle, they can be detected and mapped by sensitive field equipment. During surveys the different magnetic properties of top-soils, sub-soils, rock formations and archaeological features are recorded as variations against a background value. Subsequently magnetic anomalies resulting from potential archaeology can be identified and interpreted.

Bartington grad601-2 gradiometers

A gradiometer is a type of magnetometer and is sensitive to relatively small changes in the earth's magnetic field. Our primary surveying instruments are Bartington Grad601-2 (dual sensor) fluxgate gradiometers with automatic data loggers. They are specifically designed for field use by archaeologists. The Bartington gradiometers provide proven technology in archaeological magnetic surveying and offer fast, accurate set-up and survey rates. They are sensitive to depths of between 0 and 1.5m below ground level, with optimum sensitivity at depths of 1m or less.

Multiple sensor arrays

A technique relatively new to commercial archaeological surveying but well understood in academic circles involves the use of multiple magnetometer sensors towed behind a quad bike or similar vehicle. With multiple sensors and the use of on-board GPS units, it is possible to achieve faster survey rates at competitive commercial rates when compared to the use of multiple instruments and the techniques discussed above provided the ground is suitable for the vehicle and array. Substrata is pleased to announce that we now offer this service on suitable larger sites

3 Earth resistance surveying

Earth resistance surveying is an excellent tool for detecting buried archaeology. Its relatively slow rate of survey compared to magnetometer surveys means that it usually employed in commercial surveys when a detailed understanding of buried building remains is required. This technique measures changes in the electrical resistance of the ground being surveyed. In practice, the recording of differences in the electrical resistance of near-surface deposits and structures allows the detection and interpretation of masonry and brick foundations, paving and floors, drains and other cavities, large pits, building platforms, robber trenches, ditches, graves and similar buried features.

Resistance to electrical current flow in the ground depends on the moisture content and structure of the soil and other materials buried beneath the surface. For example, the higher the moisture content of a soil, the less resistant it is to electrical current flow. A ditch completely buried beneath the present ground surface is likely to have an infill soil different to that surrounding the ditch in terms of compactness and composition. As a result, the soil filling the buried ditch will retain moisture in a different way to the surrounding soil which means it will

have an electrical resistance at variance with the surrounding environment. By passing a small current through the ground it is possible to detect, record, plot and interpret such changes in electrical resistance.

For earth resistance surveying Substrata uses the Geoscan Research RM15 series multi-probe resistance meters and purpose-built automatic data-loggers. The Geoscan MPX15 multiplexer is an integral part to the instrument configuration and facilitates multi-probe arrays which speed up survey area coverage rates and, if required, facilitate simultaneous multiple-depth data collection.