Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at Sawmills Field, Dartington, South Hams, Devon
National grid coordinates: 278479, 62037

Report: 130425
Ross Dean BSc MSc MA MIfA
25 April 2013

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Accompanying CD-ROM

Report ..... Adobe PDF format
Copies of report figures ..... Adobe PDF format
Data files ..... grid files generated using DW Consulting TerraSurveyor3
Minimal processing data plots and metadata ..... Adobe PDF format
GIS project, shape files and classification schema
- GIS project and shape files ..... ESRI standard
- GIS classification schema ..... Adobe PDF format

AutoCAD version of the survey interpretation ..... AutoCAD DWG

1 Survey description and summary

Type of survey: twin-sensor fluxgate gradiometer
Date of survey: 22 April 2013
Area surveyed: 2ha.
Lead surveyor: Ross Dean BSc MSc MA MIfA

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

Location

Site:	Land at Sawmills Field
Parish:	Dartington
District:	South Hams
County:	Devon
NGR:	SX 784 620
NG coordinates:	278479, 62037 (point)
OASIS number:	substrat1-148996
Archive:	At the time of writing, the archive of this survey will be held by Substrata but this will change during 2013. There is a forthcoming requirement from Devon County Council Historic Environment Service that all project such as this have a digital archive held by a recognised archiving service. Please contact Substrata to find details of which service was chosen for this and future surveys.

Summary
This report was commissioned by AC Archaeology Ltd on behalf of clients and was produced by Substrata in preparation for submission of a forthcoming planning application.

The magnetic contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. A total of 19 magnetic anomaly groups were identified as pertaining to potential archaeology.

Two of the anomaly groups are likely to represent former Devon banks mapped as field boundaries on the 1889 Ordnance Survey 1st edition map of the area and subsequently removed. Two anomaly groups coincide with the location of a small sub-rectangular enclosure recorded in the Devon County Council Historical Environment Record (entry MDV28880). A further group may represent a sub-circular archaeological structure such as a ring ditch or round house although the data is disrupted by buried ferrous material and so this interpretation is open to question. The remaining anomaly groups may relate to archaeological linear features, such as field boundaries or other enclosures, from more than one phase of past land management.

Survey aims
1. Define and characterise and detectable archaeological remains on the site.
2. Inform any future archaeological investigation of the area.

Survey Objectives
1. Complete a gradiometer survey across agreed parts of the survey 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.

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).

2 Site description

Landscape
The survey area comprises part of one relatively flat field lying at between 25m and 30m O.D. The area is bounded by the A385 to the south, the remainder of the field to the west, woodland and a disused quarry to the north and a stream and field boundary to the east.

Land use at the time of the survey
Grass pasture.

Geology
The site is located on a solid geology of Devonian Torbay Group Nordon Formation which comprises mudstones, siltstones limestones and sandstones (British Geological Survey, undated1; undated 2). The disused quarry to the northeast of the site exploited a Devonian to Carboniferous microgabbro.

Soils
The soils are of the Denbigh1 association which comprise fine loamy typical brown earths on solid or shattered rock within 0.8m depth (Soil Survey of England and Wales, 1983; Findley et al, 1983: 103 and 196).

Historic Landscape Characterisation
Modern enclosures adapting post-medieval fields: modern enclosures that have been created by adapting earlier fields of probable post-medieval date (Devon County Council, undated)

Known archaeological sites in the survey area
There is one Historical Environment Record (HER) entry within the survey area:

MDV28880: Enclosure, (between) Prehistoric - 698000BC to 42 AD, Shinner's bridge; part of a small rectangular ditched enclosure at least 40m by 30m. Recorded as a cropmark from an aerial photograph. Location centred on SX 7841 6214

Previous fieldwork within the survey area
No formal programmes of archaeological work are recorded in the HER that directly relate to the survey area.

3. 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 attempts to identify and characterise anomalies and anomaly groups that may pertain to archaeological deposits and structures.

The reader is referred to section 4.

3.1 Results

Figure 1 (this section) shows the interpretation of the survey and table 1 is an extract from a detailed analysis of the survey data provided in the attribute tables of the GIS project on the accompanying CD-ROM.

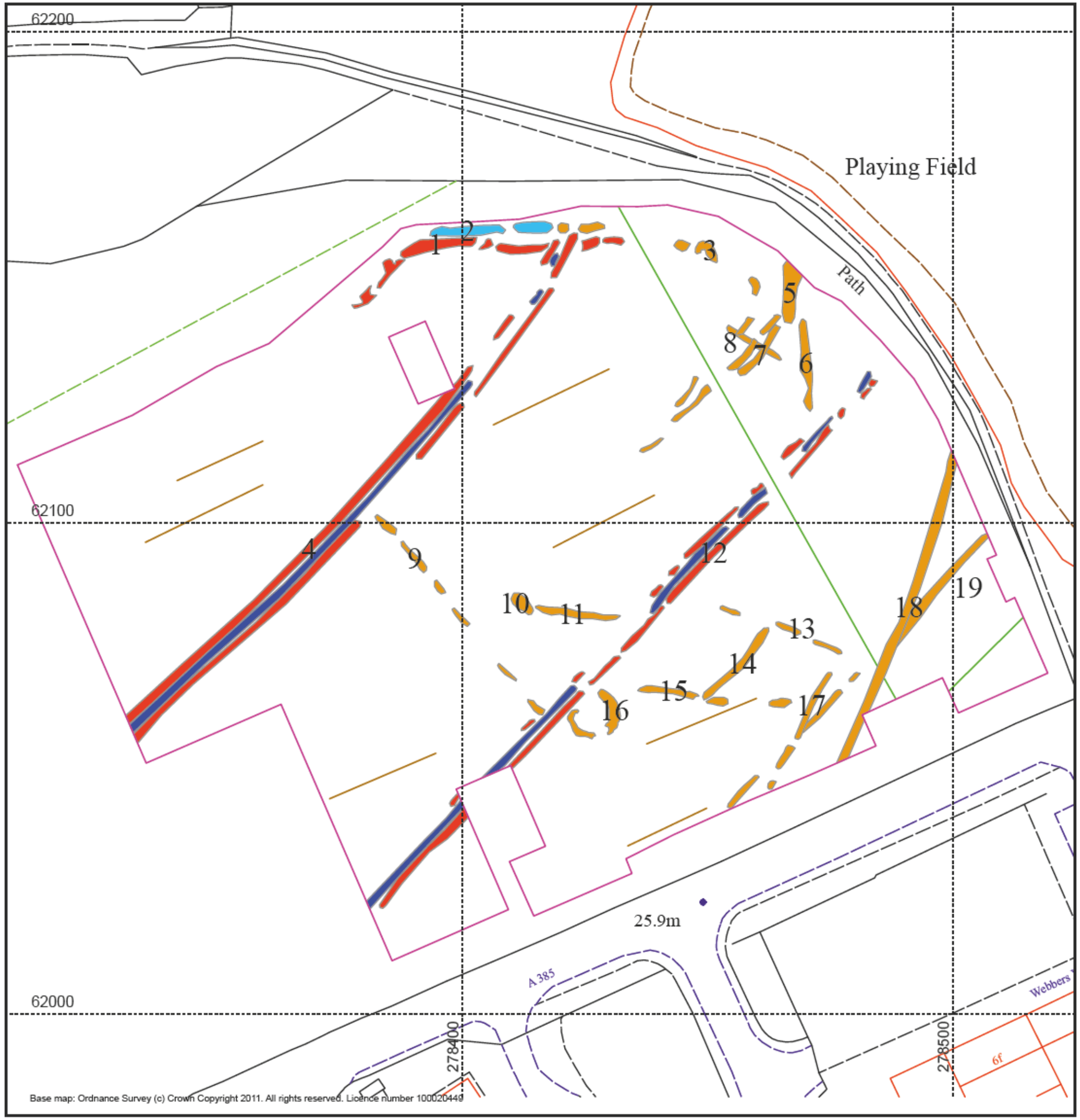
Figure 1 and table 1 comprise the analysis and interpretation of the survey data.

The processed gradiometer data is presented in figure 2, appendix 1.

Survey data analysis
Site: An archaeological gradiometer survey
Land at Sawmills Field, Dartington, South Hams, Devon
National grid coordinates: 278479, 62037 (point)
Report: 130425

anomaly group	characterisation certainty	anomaly class	anomaly form	additional archaeological characterisation	comments	supporting evidence
1	likely	positive	curvilinear	enclosure boundary	anomaly group corresponds to shape and location of northern boundary of HER entry MDV28880; a rectangular enclosure approx 40m by 30m	DCCHER entry MDV28880
2	possible	negative	linear	enclosure boundary	anomaly group corresponds to shape and location of northern boundary of HER entry MDV28880; a rectangular enclosure approx 40m by 30m - may be negative shadow anomaly	DCCHER entry MDV28880
3	possible	positive				
4	likely	positive/negative/positive	linear	Devon bank field boundary	anomaly group corresponds with a field boundary mapped on the OS 1889 1st edition and later editions - gone by 1954	Ordnance Survey 1889 1st edition and later OS maps
5	possible	positive	linear			
6	possible	positive	linear			
7	possible	positive	linear			
8	possible	positive	linear			
9	possible	positive	linear			
10	possible	positive	linear			
11	possible	positive	linear		anomaly group may denote a linear feature disrupted by later cultivation	
12	likely	positive/negative/positive	linear	Devon bank field boundary	anomaly group corresponds with a field boundary mapped on the OS 1889 1st edition and later editions - gone by 1905	Ordnance Survey 1889 1st edition and later OS maps
13	possible	positive	linear		anomaly group may denote a linear feature disrupted by later cultivation	
14	possible	positive	linear		anomaly group may denote a linear feature disrupted by later cultivation	
15	possible	positive	linear		anomaly group may denote a linear feature disrupted by later cultivation	
16	possible	positive	sub-circular		anomaly group may represent a disrupted sub-circular feature	
17	possible	positive	linear			
18	possible	positive	linear			
19	possible	positive	linear			

Table 1: data analysis



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N

Legend

- gradiometer survey area

gradiometer potential archaeology

- likely archaeology, positive anomaly (4)
- likely archaeology, negative anomaly (4)
- possible archaeology, positive anomaly
- possible archaeology, negative anomaly
- possible archaeology, plouging traces (2)

gradiometer possible services

- possible service, ferrous cable, pipe or drain

Notes:
1. All interpretations are provisional and represent potential archaeological deposits.
2. Representative of trends; only anomalies relevant to potential archaeology are recorded.
3. Anomalies likely to represent very recent ground disturbance are not highlighted.
4. Anomalies designated "likely archaeology" have supporting evidence e.g. historicasl maps and/or visible earthworks.

While accurate, this figure is intended for use as a reference in the accompanying report and not as a source of positional information.

It is recommended that accurate positional information be obtained from the georeferenced GIS project or AutoCAD plan of the survey interpretation found on the accompanying CD-ROM.

0 10 20 40 Meters

Figure 1: survey interpretation

3.2 Discussion

Refer to figures 1 (this section) and 2 (appendix 1).

Not all anomalies or anomaly groups identified in the survey dataset are discussed below. All identified anomaly groups are recorded in the GIS project on the accompanying CD-ROM. Those anomaly groups possibly representing archaeological deposits are included in data analysis table 1.

Data related to historical maps and other records

Anomaly groups **1** and **2** coincide with the northern boundary of a small rectangular ditched enclosure recorded in the Devon County Council Historic Environment Record (entry MDV28880, summarised in section 2 of this report).

Groups **4** and **12** relate to former field boundaries mapped on the Ordnance Survey 1:2500 1st edition map of 188-89. Group 12 was not recorded on the Ordnance Survey map of 1905. Group 4 had been removed by the time the Ordnance Survey map of 1954 was published.

Data with no previous provenance

Anomaly group **16** is distorted by anomalies resulting from at least two deposits of ferrous material but may represent a sub-circular archaeological structure such as a ring ditch or round house.

Group **3** are a linear arrangement of discrete anomaly groups that may relate to one or more linear features disrupted by ploughing.

Groups **10**, **11**, **14** and **15** are relatively vague but are indicative of possible disrupted archaeological linear features.

The remaining anomaly groups are more clearly defined and may represent linear archaeological features, possibly field boundaries or other enclosures, demonstrating more than one phase of past land management.

3.3 Conclusions

The magnetic contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. A total of 19 magnetic anomaly groups were identified as pertaining to potential archaeology.

Two of the anomaly groups are likely to represent former Devon banks mapped as field boundaries on the 1889 Ordnance Survey 1st edition map of the area and subsequently removed. Two anomaly groups coincide with the location of a small sub-rectangular enclosure recorded in the Devon County Council Historical Environment Record (entry MDV28880). A further group may represent a sub-circular archaeological structure such as a ring ditch or round house although the data is disrupted by buried ferrous material and so this interpretation is open to question. The remaining anomaly groups may relate to archaeological linear features, such as field boundaries or other enclosures, from more than one phase of past land management.

4 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.

5 Acknowledgements

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

6 References

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Appendix 1 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.

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N

Legend

gradiometer processed data (nT)

High : 6

Low : -6

While accurate, this figure is intended for use as a reference in the accompanying report and not as a source of positional information.

It is recommended that accurate positional information be obtained from the georeferenced GIS project or AutoCAD plan of the survey interpretation found on the accompanying CD-ROM.

0 10 20 40 Meters

Figure 2: shade plot of processed data

Appendix 2 Methodology

Table 2: methodology	
Documents Project design: Dean (2013)	
Methodology 1. The work was undertaken in accordance with the project design. 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.	
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.	
Equipment *Instrument:* Bartington Instruments grad601-2 *Firmware:* version 6.1	**Data Capture** *Sample Interval:* 0.25-metres *Traverse Interval:* 1 metre *Traverse Method:* zigzag *Traverse Orientation:* GN337
Data Processing, Analysis and Presentation Software DW Consulting TerraSurveyor3 ArcGIS 9.3 Microsoft Corp. Office Publisher 2003.	

Appendix 3 Data processing

Table 3: gradiometer survey - processed data metadata
Software: TerraSurveyor Version: 3.0.19.16
Stats Max: 265.33 Min: -254.79 Std Dev: 25.10 Mean: 0.52 Median: 0.00 Processes: 5 1 Base Layer 2 Clip at 1.00 SD 3 De Stagger: Grids: da18.xgd da19.xgd da17.xgd da20.xgd da16.xgd da21.xgd da15.xgd da22.xgd da14.xgd da23.xgd Mode: Both By: -2 intervals 4 De Stagger: Grids: da01.xgd da02.xgd da03.xgd Mode: Both By: -1 intervals 5 DeStripe Median Sensors: All Note: interpolation match x & y doubled is completed during export from TerraSurveyor to georeferenced ERSI format

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 magnetised 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.