Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at Palm Cross Green, Modbury, Devon

NGR 265550 51800

Report: 120331
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Client:
Revival Planning Consultancy

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Accompanying CD-ROM

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1 Survey description and summary

Type of survey: twin-sensor fluxgate gradiometer
Date of survey: 13 March 2012
Area surveyed: 1.8ha
Lead surveyor: Ross Dean BSc MSc MA MIfA

Client
Revival Planning Consultancy

Location

Site:	Land at Palm Cross Green, Modbury
Parish:	Modbury
District:	South Hams
County:	Devon
NGR:	265550 51800
OASIS number:	substrat1-122360

Survey purpose
This report was completed at the request of Revival Planning Consultancy on behalf of Fuse Architecture as part of an assessment of the archaeological potential of land at Palm Cross Green, Modbury, Devon. This work was part of an assessment exercise in advance of potential development. It is intended that the report will be submitted within a suite of supporting documents as part of a forthcoming planning application. Guidance on the content of the report was provided by Graham Tait of the Devon County Council Historic Environment Service.

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.

Results Summary
The magnetic contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. Twenty-one anomaly groups representing potential archaeological features or deposits were recorded (figure 1) including anomalies representing possible industrial or craft deposits, various possible linear and curvilinear field boundaries or enclosures predating the current field patterns and two tenuous subcircular structures.

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 Schmidt (2002). 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 lies to the west of the town of Modbury. The survey area is within a large field sloping downhill to the north-east. The area is bound to the north and south by stone walls with hedging and wire and to the east by a substantial stone wall beyond which are houses and other buildings. To the west the survey area boundary lies within the field.

Land use
Pasture with grazing sheep at the time of the survey.

Geology
The site on lower Devonian mudstones, siltstones and sandstones (British Geological Survey, undated).

Soils
The soils in the survey area are defined as typical brown podzolic earths of the Denbigh 2 association (Soil Survey of England and Wales, 1983). A typical profile is:

0 - 20cm: dark brown, slightly stony clay loam
20 - 50cm: brown, moderately stony clay loam
50 - 70cm: yellowish brown, mottled, moderately or very stony clay loam
70 - 100cm: light brownish grey, mottled, very stony clay loam

(Findley et al, 1983: 148).

Known archaeological sites in the survey area
There are no known archaeological sites within the survey area.

Historical Landscape Characterisation
Post-medieval enclosures with medieval elements: these enclosures are probably based on medieval fields, but the many straight field boundaries suggest they were substantially reorganised in the post-medieval period (Devon County Council, undated)

3. Results and discussion

The survey was designed to record magnetic anomalies. The anomalies themselves cannot be regarded as actual archaeological features and the widths of the anomalies shown do not represent the width 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.

Any surveying and other positional work using the information provided in this report should make use of the maps provided in the GIS project on the accompanying CD-ROM. While accurate, the paper reproductions presented here are provided at a scale suitable for survey description only and are not intended to offer sufficiently accurate positional information.

Results

Figure 1 shows details of the interpretation of the gradiometer survey. Table 1 is an extract from a detailed analysis of the 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 gradiometer survey data.

The processed gradiometer data is presented in figure 2 and a plot of the unprocessed data can be found on the accompanying CD-ROM.

The magnetic contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. Twenty-one anomaly groups representing potential archaeological features or deposits were recorded as shown in figure 1.

Discussion

Please refer to figure 1 and table 1.

An area of ground to the west of the survey yielded a number of highly contrasting anomaly groups mixed with dipole anomalies characteristic of ferrous material (groups **1** to **5**). These contrasting anomalies have a pattern consistent with in-situ deposits that have undergone considerable heating such as during metal production or working. It may be that their forms are fortuitous and affected by the adjacent dipoles but there remains the possibility that these represent archaeological industrial or craft deposits.

Anomaly group **12** represents an archaeological curvilinear deposit and groups **10** and **11** may be associated with 12. Such anomaly patterns are typical of field boundaries and other land divisions comprising of a ditch with an associated bank.

Anomaly groups **6**, **7**, **8**, **13**, **14**, **15**, **16** and **17** represent possible archaeological deposits and features typically associated with field boundaries and other enclosures. None of these potential features conform to the extant field system and they may represent earlier phases of fields and/or enclosures.

Group **9** represents a field boundary in-situ and shown on Ordnance Survey maps until after 1952 and before 1975.

Anomaly groups **18** and **19** are tenuous and may be "shadow anomalies" caused by the surrounding anomaly patterns. Nonetheless their shapes are consistent with archaeological structures such as roundhouses and so they are included here as potential archaeological features.

Survey data analysis

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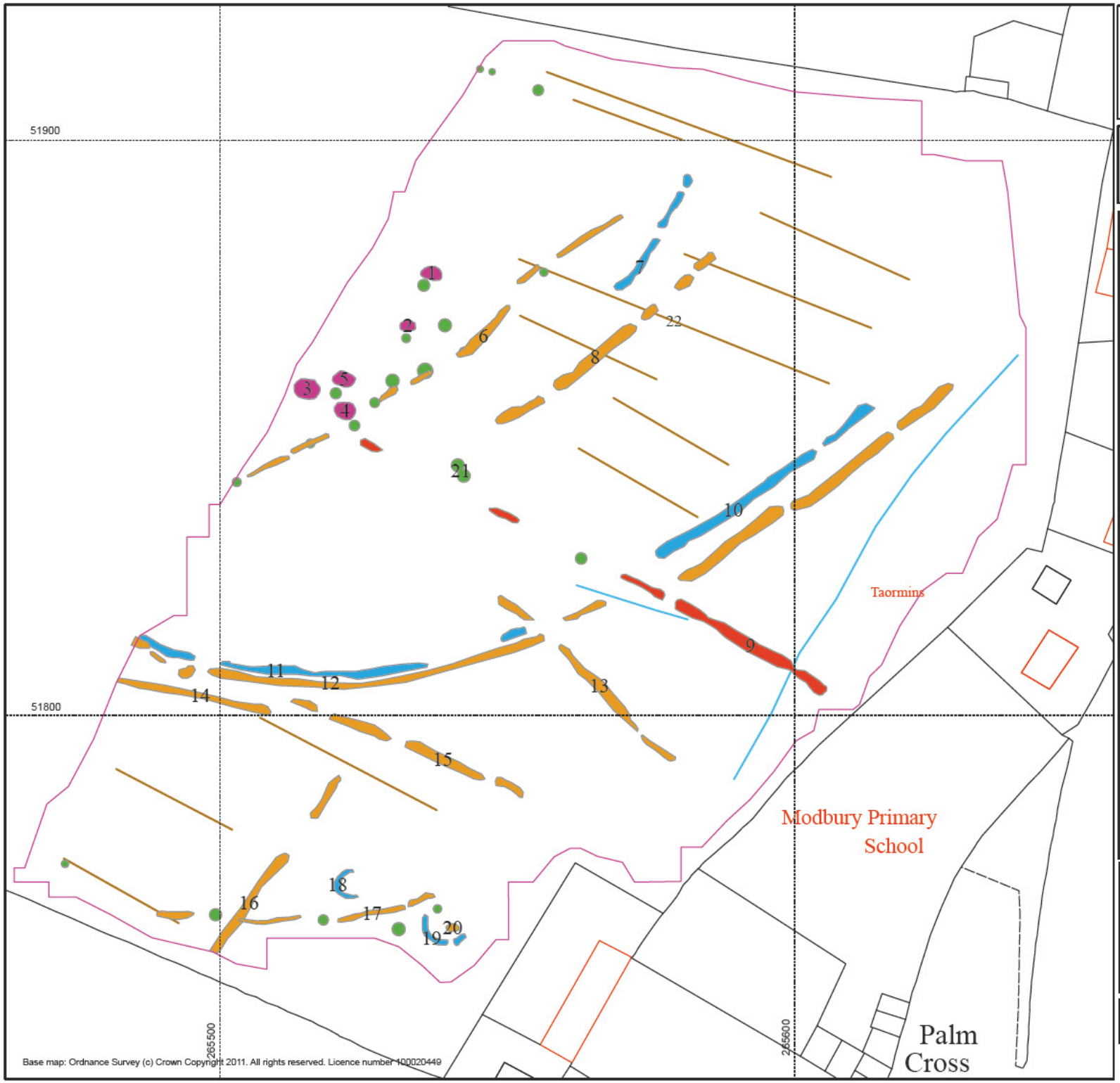
anomaly group	associated anomaly group(s)	characterisation certainty	anomaly class	anomaly form	archaeological characterisation	comments	supporting evidence
1		possible	north-south high-low		heated deposits	this anomaly may represent ferrous material but has characteristics indicating possible in-situ heated deposits	
2		possible	north-south high-low		heated deposits	this anomaly may represent ferrous material but has characteristics indicating possible in-situ heated deposits	
3		possible	north-south high-low		heated deposits	this anomaly may represent ferrous material but has characteristics indicating possible in-situ heated deposits	
4		possible	north-south high-low		heated deposits	this anomaly may represent ferrous material but has characteristics indicating possible in-situ heated deposits	
5		possible	north-south high-low		heated deposits	this anomaly may represent ferrous material but has characteristics indicating possible in-situ heated deposits	
6		possible	positive	linear			
7		possible	negative	linear			
8		possible	positive	linear			
9		likely	positive	linear	field boundary	anomaly groups represent a field boundary in situ until after 1952 and prior to 1972	OS maps and extant earthworks
10	11 12	possible	negative	linear			
11	10 12	possible	negative	linear		either anomaly is the negative "shadow" of anomaly group 12 or it represents a possibly related archaeological feature	
12	10 11	possible	positive	curvilinear			
13		possible	positive				
14		possible	positive	linear			
15		possible	positive				
16		possible	positive	linear		possible enclosure	
17		possible	positive	linear			
18		possible	negative	subcircular		tenuous - anomaly pattern could well be the results of surrounding anomaly influence rather than representing archaeology	
19	20	possible	negative	subcircular		tenuous - anomaly pattern could well be the results of surrounding anomaly influence rather than representing archaeology	
20	19	possible	positive	oval	pit	juxtaposition with anomaly group 19 justifies inclusion as possible archaeology	
21		possible	dipole	ferrous material			
22		possible	repeated parallels		ploughing		

Table 1: gradiometer data analysis



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Legend

- gradiometer survey area

gradiometer potential archaeology

certainty, class

- likely, positive (supporting evidence)
- possible, positive anomaly
- possible, negative anomaly
- possible, north-south high-low
- possible, dipole (2, 4)

gradiometer potential archaeological trends

certainty, class

- possible, repeated parallels

gradiometer potential services

certainty, class

- possible, low contrast linear

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. Filled circles used to define anomalies are symbols and do not indicate possible circular archaeological features unless specifically indicated in the text.

0 10 20 40 Meters

Figure 1: survey interpretation, potential archaeology

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 will 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 Salvatore of Revival Planning Consultancy for commissioning us to complete this survey.

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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

processed gradiometer data

Value

High : 5

nT

Low : -5

0 10 20 40 Meters

Figure 2: processed gradiometer data

Appendix 2 Methodology

Table 2: methodology

Documents
Project design: Dean (2012)

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 Schmidt (2002).
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	**Data Capture**
Instrument: Bartington Instruments grad601-2 *Firmware:* version 6.1	*Sample Interval:* 0.125-metres *Traverse Interval:* 1 metre *Traverse Method:* zigzag *Traverse Orientation:* GN

Data Processing, Analysis and Presentation Software
DW Consulting ArcheoSurveyor2
ArcGIS 9.3
Microsoft Corp. Office Publisher 2003.

Appendix 3 Data processing

Table 3: processed gradiometer data metadata
Software: DW Consulting ArcheoSurveyor2 v 2.5.11.0

Stats

Max:	127.46
Min:	-124.01
Std Dev:	9.36
Mean:	0.59
Median:	0.30

Processes: 8

1 Base Layer
2 De Stagger: Grids: mo01.xgd mo08.xgd mo02.xgd mo07.xgd mo03.xgd mo06.xgd mo05.xgd mo04.xgd Mode: Both By: -6 intervals
3 De Stagger: Grids: mo09.xgd mo10.xgd Mode: Both By: -6 intervals
4 De Stagger: Grids: mo11.xgd Mode: Both By: -6 intervals
5 De Stagger: Grids: mo19.xgd mo20.xgd Mode: Both By: -6 intervals
6 De Stagger: Grids: mo21.xgd mo22.xgd mo23.xgd Mode: Both By: -6 intervals
7 Move (Area: Top 60, Left 1201, Bottom 77, Right 1409) to X 0, Y 12
8 Clip from -124.01 to 127.46 nT

Note: interpolation match x & y doubled is completed during export from ArcheoSurveyor 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. The gradiometers (a type of magnetometer) and resistance meters employed are sensitive to depths of between 0 and 1.5m below ground level, with maximum sensitivity at depths of 1m or less.

2 Magnetometer surveying

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. Identifiable archaeological features include areas of occupation, hearths, kilns, furnaces, ditches, pits, postholes, ridge-and-furrow, timber structures, wall footings, roads, tracks and similar buried features.

A gradiometer is a type of magnetometer and is sensitive to relatively small changes in the earth's magnetic field. Substrata uses two types of gradiometer both specifically designed for field use by archaeologists. Our primary surveying instruments are Bartington *Grad*601-2 (dual sensor) fluxgate gradiometers with automatic data loggers. We also use a Geoscan FM36 fluxgate gradiometer with the option of either manual or automatic sampling triggers. The Bartington gradiometers provide proven technology in archaeological magnetic surveying and offer fast, accurate set-up and survey rates. The Geoscan FM36 provides an effective, if older, solution when surveys are required within woodland and other areas of limited accessibility.

3 Earth resistance surveying

This method measures changes in the electrical resistance of the ground being surveyed. In practice, differences in the electrical resistance of materials facilitates the detection and interpretation of masonry and brick foundations, paving and floors, drains and other cavities, large pits, building platforms, robber trenches, timber structures, 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 multi-probe resistance meters and purpose-built automatic data-loggers. The MPX15 multi-probe facility can be used to speed up standard surveys and it is also useful when simultaneous multiple-depth analysis is required.