Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at Seaton, Devon
OS grid coordinate 324600 091700

Report: 120124
Ross Dean BSc MSc MA MIfA

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Accompanying CD-ROM

Report ..... Adobe PDF format
Copies of report figures ..... Adobe PDF format
Data Files and grid plan
- Survey areas and grids ..... JPEG
- Data files ..... grid files generated using DW Consulting ArcheoSurveyor2

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

1 Survey description and summary

Type of survey: twin-sensor fluxgate gradiometer
Date of survey: 24 to 31 January 2012
Area surveyed: 9.7ha
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 Seaton, Devon
Parish:	Seaton
District:	East Devon
County:	Devon
OS grid coordinate:	324600, 91700
OASIS number:	substrat1-124085

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 relatively low but sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. A total of 27 magnetic anomaly groups were identified as representing possible archaeological deposits or features, none of which can be related to features recorded on the Ordnance Survey maps of 1889 or later. These potential archaeological deposits or features include field boundaries or similar enclosures, a stony track, two areas of strongly heated material or other craft/industrial related material and one in-situ heating event such as a hearth, kiln or furnace.

The number of anomaly groups pertaining to possible archaeology rises to the east of the survey area. This may reflect the deposition of colluvium and/or alluvium across the area rather than the actual density of potential archaeological deposits. Given this low response and the possible sediment depositional patterns, it is certain that more archaeological deposits exist than have been identified in this report.

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 on the northern edge of the town of Seaton. It comprises five fields bound by hedges and wire fencing. With a height variation of between approximately 25m and 15m O.D., the land slopes down from the west to the east and southeast (figure 2). The eastern boundary is approximately 300m from the floodplain of the river Axe.

Land use at the time of the survey
Pasture and immature crops.

Geology
The site is located on a solid geology of Upper (Keuper) Marls Triassic Brandscombe Mudstone formation of the Mercia Mudstone Group overlain by Quaternary sand and gravel river terrace deposits (British Geological Society, 2004; undated 1; undated 2).

Soils
The soils are defined as stagnogleyic argillic brown earths of the Whimple 3 association (Soil Survey of England and Wales, 1983). The association is of seasonably waterlogged reddish fine loamy or fine silty over clayey soils (Findley et al, 1983: 306).

Known archaeological sites in the survey area
There are no known archaeological sites within the survey area.
Table 4 in appendix 4 is a summary of Historical Environment Record entries for areas adjacent to the survey site.

Historical Landscape Characterisation
Fields 1 to 4 (figure 2): Post-medieval enclosures with medieval elements: these enclosures are probably based on medieval fields, but the many straight field boundaries suggest they were substantially re-organised in the post-medieval period (Devon County Council, undated).

Field 5 (figure 2): Medieval enclosures: fields probably first enclosed with hedge-banks during the middle ages (Devon County Council, undated).

Previous archaeological investigations at the site
There are no recorded previous archaeological investigations within the survey area.
Table 5 in appendix 4 is a summary of Historical Environment Record Events entries for areas adjacent to the survey site.

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

The survey was split into 5 areas (field 1 to field 5) for the purposes of analysis and discussion. These areas are shown in figure 2.

Figure 1 shows the interpretation of survey areas 3 to 5. No anomalies pertaining to possible archaeology were found in the data for fields 1 and 2. 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.

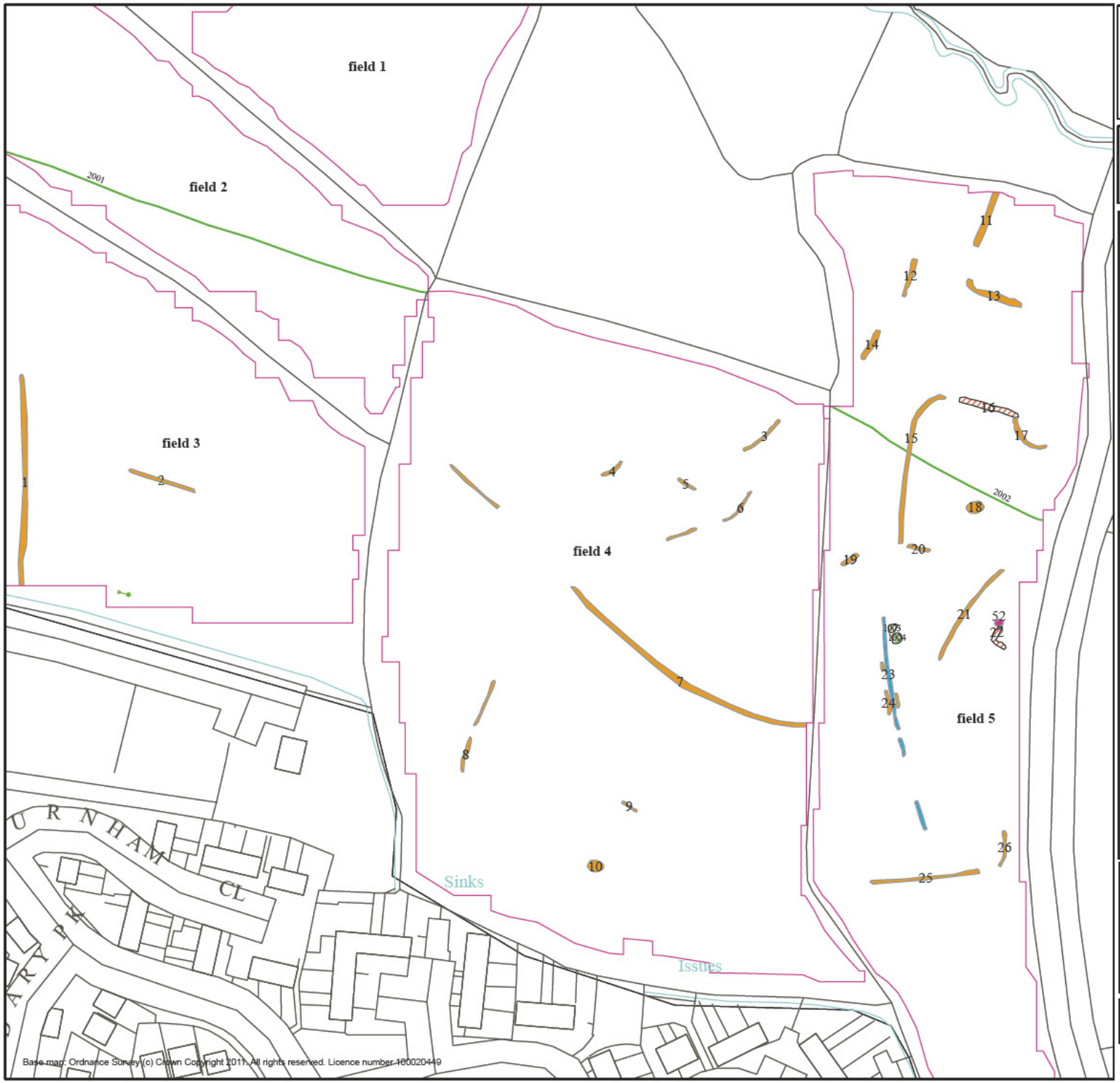
Figure 1 and table 1 together comprise the analysis and interpretation of the survey data.

Figure 2 is a summary plot of the survey interpretation for the entire survey area. The processed gradiometer data is presented in figure 3.

Survey data analysis
Site: Land at Seaton, Devon
NGR 324600 091700
Report: 120124

field	anomaly group	characterisation certainty	anomaly class	anomaly form	archaeological characterisation	comments	supporting evidence
3	1	possible	positive	linear		in direction of traverses and adjacent to grid edge but not survey error or the result of processing	
3	2	possible	positive	linear			
4	3	possible	positive	linear		anomaly patterns in this area are vague but have the look of remnant enclosure boundaries	
4	4	possible	positive	linear		anomaly patterns in this area are vague but have the look of remnant enclosure boundaries	
4	5	possible	positive	linear		anomaly patterns in this area are vague but have the look of remnant enclosure boundaries	
4	6	possible	positive	curvilinear		anomaly patterns in this area are vague but have the look of remnant enclosure boundaries	
4	7	possible	positive	curvilinear	field boundary	predates the OS 1989 map and approximately on the line of an extant field boundary to the east	Ordnance Survey 1889 1:2500 map
4	8	possible	positive	linear			
4	9	possible	positive	linear			
4	10	possible	positive	oval	large pit or disturbance	vague anomaly group - possibly a 'shadow' caused by the adjacent dipole anomalies	
5	11	possible	positive	linear	ditch		
5	12	possible	positive	linear	ditch		
5	13	possible	positive	linear	ditch	possible continuation of field boundary to east removed before 1889	Ordnance Survey 1889 1:2500 map
5	14	possible	positive	linear	ditch		
5	15	possible	positive	curvilinear			
5	16	possible	high contrast	linear	industrial/craft deposits	anomaly pattern suggests a linear boundary or feature with possible craft/industrial deposits - also found in the next field east in a separate survey	Dean, R. (2011) An Archaeological Gradiometer Survey Land to north of Seaton cemetery Seaton Devon NGR 324900 91700. Unpublished Substrata Report No. 110329
5	17	possible	positive	curvilinear			
5	18	possible	positive	oval	large pit	anomaly could be a 'shadow' of adjacent strong ferrous anomalies but is strong enough to warrant inclusion as potential archaeology	
5	19	possible	positive	linear			
5	20	possible	positive	linear			
5	21	possible	positive	curvilinear			
5	22	possible	high contrast	multilinear	industrial/craft deposits	anomaly pattern suggests a linear boundary or feature with possible craft/industrial deposits - also found in the next field east in a separate survey	Dean, R. (2011) An Archaeological Gradiometer Survey Land to north of Seaton cemetery Seaton Devon NGR 324900 91700. Unpublished Substrata Report No. 110329
5	23	possible	negative	linear	Devon bank or track	anomaly patterns are vague	
5	24	possible	positive	linear	Devon bank or track	anomaly patterns	
5	25	possible	positive	linear		extremely vague	
5	26	possible	positive	curvilinear		vague	
5	52	possible	north-south high-low		in situ heated deposits	probably ferrous material but needs checked	

Table 1: gradiometer data analysis, potential archaeology, all fields



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N

Legend

- survey area

potential archaeology

certainty, class

- possible, positive
- possible, negative
- possible, high contrast
- possible, north-south high-low

potential natural

certainty, class

- possible, weak broad bipolar (2)
- possible, sinuous broad linear
- possible, high 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 20 40 80 Meters

Figure 1: survey interpretation, potential archaeology

3.2 Discussion

Refer to figures 1 and 3.

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.

None of the anomaly groups shown in figure 1 can be related to features recorded on the Ordnance Survey maps of 1889 or later.

Anomaly group **7** (field 4) may represent a continuation of the field boundary separating fields 2 and 3 but this is by no means certain.

By their apparent spatial relationship, anomaly groups **11**, **13**, **15**, **16** and **17** (field 5) may represent enclosure boundaries.

Anomaly groups **16** and **22** (field 5) have an unusual magnetic contrast that may indicate the presence of strongly heated material or other craft/industrial related material. Similar anomalies were recorded in a field bordering the eastern side of field 5 during a previous gradiometer survey (Dean, 2011b).

Anomaly group **52** (field 5) may represent an in-situ heating event such as a hearth, kiln or furnace. Caution must be exercised in this interpretation as such anomaly patterns can also be generated by fortuitously situated and orientated ferrous materials.

The linear anomaly groups **23** and **24** (field 5) may represent either a former Devon bank pre-dating the Ordnance Survey 1:2500 map of 1889 or a stony track.

3.3 Conclusions

A total of 27 magnetic anomaly groups were identified as representing possible archaeological deposits or features.

The magnetic contrast across the survey areas was relatively low but sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses. The number of anomaly groups pertaining to possible archaeology rises to the east of the survey area. This may reflect the deposition of colluvium and/or alluvium across the area rather than the actual density of potential archaeological deposits. Given this low response and the possible sediment depositional patterns, it is certain that more archaeological deposits exist than have been identified in this report.

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 Valentin of AC Archaeology Ltd for commissioning us to complete this survey.

6 References

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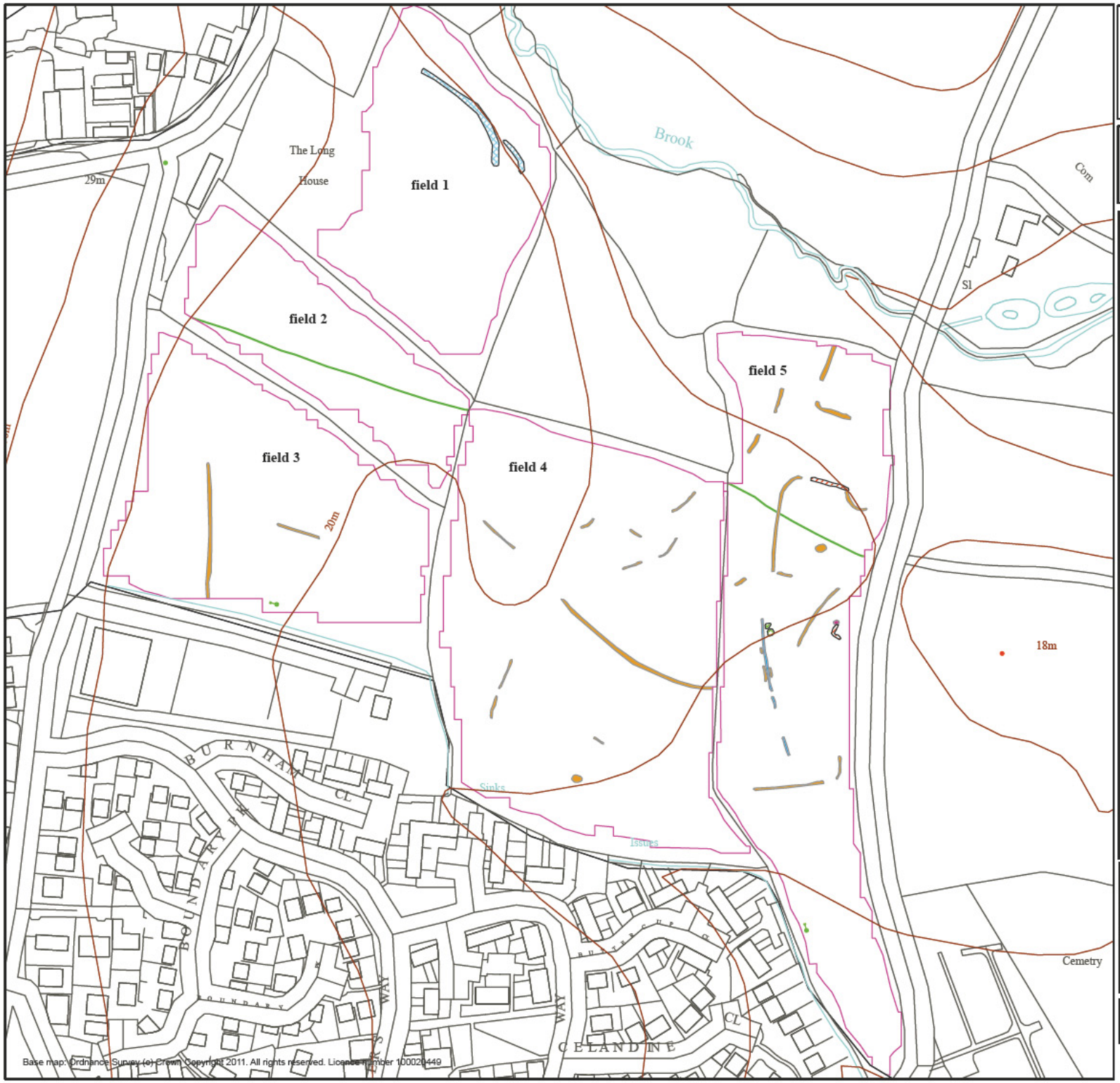
Appendix 1 Supporting plots

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

- survey area

potential archaeology

certainty, class

- possible, positive
- possible, negative
- possible, high contrast
- possible, north-south high-low

potential natural

certainty, class

- possible, weak broad bipolar (2)
- possible, sinuous broad linear
- possible, high 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.
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4. Filled circles used to define anomalies are symbols and do not indicate possible circular archaeological features unless specifically indicated in the text.

0 25 50 100 Meters

Figure 2: survey interpretation, all fields

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N

Legend

processed gradiometer data

Value

High : 2

nT

Low : -2

0 25 50 100 Meters

Figure 3: 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: survey data processing - archaeology processing
Software: DW Consulting ArcheoSurveyor v 2.5.11.0

Stats

Max:	117.92
Min:	-179.65
Std Dev:	6.32
Mean:	0.08
Median:	0.00
Surveyed Area:	9.4683 ha

Processes: 16

1 Base Layer
2 Clip at 1.00 SD
3 Search & Replace From: -8000 To: 8000 With: Dummy (Area: Top 47, Left 1918, Bottom 89, Right 2058)
4 Search & Replace From: -8000 To: 8000 With: Dummy (Area: Top 88, Left 1884, Bottom 119, Right 2000)
5 Search & Replace From: -8000 To: 8000 With: Dummy (Area: Top 120, Left 1778, Bottom 176, Right 1954)
6 Search & Replace From: -8000 To: 8000 With: Dummy (Area: Top 186, Left 1656, Bottom 191, Right 1840)
7 Search & Replace From: -8000 To: 8000 With: Dummy (Area: Top 16, Left 2532, Bottom 26, Right 2924)
8 Search & Replace From: -8000 To: 8000 With: Dummy (Area: Top 408, Left 1238, Bottom 414, Right 2066)
9 De Stagger: Grids: All Mode: Both By: -2 intervals
10 De Stagger: Grids: se02.xgd se01.xgd se03.xgd se04.xgd se05.xgd Mode: Both By: -4 intervals
11 De Stagger: Grids: se17.xgd Mode: Both By: -4 intervals
12 De Stagger: Grids: se37.xgd se39.xgd se43.xgd se36.xgd se40.xgd se42.xgd Mode: Both By: -4 intervals
13 De Stagger: Grids: se18+se38.xgd se44.xgd Mode: Both By: -4 intervals
14 De Stagger: Grids: se52.xgd se53.xgd se54.xgd se55.xgd se56.xgd se57+se49.xgd Mode: Both By: -4 intervals
15 DeStripe Median Sensors: All
16 DeStripe Median Traverse: Grids: All (vertical)

Note: interpolation match x & y doubled is completed during export from ArcheoSurveyor to georeferenced ERSI format

Appendix 4: Related historical data

Historic Environment Record, Devon County Council Historic Environment Service

Data provided on 10 February 2012

Tables 4 and 5 are a summary of the information provided by Devon County Council Historic Environment Service.
The reader is referred to the Devon Historic Environment Record which can be accessed by contacting the Historic Environment Service, Devon County Council, Matford Offices, County Hall, Topsham Road, Exeter, Devon EX2 4QW

UID	Monument Type	NGR	Period List	Summary
14046	DESERTED SETTLEMEN	SY2489991650	Medieval	Site of deserted medieval village in Flete Meadow to the northeast of Seaton
14985	TOOL	SY249-915-	Mesolithic	Triangular petit tranchet derivative, a fishtail shaped scraper. Found near Seaton
29691	GRAVEL PIT	SY24679124	Unknown	Old gravel pit on 1880s-1890s 25 inch OS map
80065	RING DITCH			Circular ring ditch approximately 7m diameter, identified by geophysical survey and partly revealed by trench evaluation
80071	DITCH	SY2427391826	Unknown	A network of ditches and gullies; field division and land drainage from prehistoric to post-medieval periods
80964	FLINT	SY2485791552	Early Bronze AgeLate Neolithic, Mesolithic,	Twelve worked flints recovered during an archaeological trench evaluation
80966	POT	SY2486691561	Early Bronze Age, Late Neolithic	eight sherds of grog-tempered pottery and a sherd possibly from a collared urn found during an archaeological evaluation
81020	FARMSTEAD	SY2434991992	Medieval, Modern, Post Medieval, Saxon	Harepath Farm is situated on the Roman road from Exeter to Lyme Regis and its name derives from the Saxon name of the road
81021	FINDSPOT	SY2429491699	Prehistoric	Polished stone axe found in garden

Table 4: historic environment record - summary of entries

UID	Event Type	NGR	Date	Summary
5071	Geophysical survey	SY2427391826	3-4 July 2008	Identified linear, curvilinear and a well defined circular feature
5072	Archaeological trench evaluation	SY2427391826	1-31 August 2008	585m of trenching revealed ditches, gullies and a possible prehistoric ring ditch
5342	Geoarchaeological survey	SY2547591274	1-30 April 2008	104ha survey found evidence for prehistoric freshwater marsh and saltmarsh deposits beneath marine sand in the area of historically attested Axe Haven
5589	Archaeological appraisal, evaluation and monitoring	SY2487991508	1-31 January 2011	Field evaluation revealed two intercutting Late Neolithic/Early Bronze Age ditches, a post hole, stake holes and a buried soil horizon. No evidence of nearby DMV was found
tba	Geophysical survey	SY2490091700	10 to 28 October 2011	Identified a number of possible linear features, the site of a well and an area of possible industrial/craft deposits that may relate to salt production

Table 5: previous archaeological investigations near the site - summary of entries

Appendix 5 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.