Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at Sandy Park Farm, Newcourt, Exeter, Devon

Ordnance Survey (E/N): 296220,90350 (point)

Report: 140613

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13 June 2014

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Contents

Figures

Tables

Accompanying CD-ROM

Report ..... Adobe PDF format
Copies of report figures ..... Adobe PDF format
Raw and processed grid & composite files ..... DW Consulting TerraSurveyor 3 formats
Minimal processing data plots and metadata ..... Adobe PDF format
GIS project, shape files and classification schema
- GIS project ..... Manifold 8 '.map' file
- GIS shape files ..... ESRI standard
- GIS classification schema ..... Adobe PDF format

AutoCAD version of the survey interpretation ..... AutoCAD DXF

1 Survey description and summary

Type of survey:	twin-sensor fluxgate gradiometer
Date of survey:	June 2014
Area surveyed:	10.43 ha
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 Sandy Park Farm, Newcourt
District:	Exeter
County:	Devon
Nearest Postcode:	EX2 7AS
NGR:	SX 962 904
Ordnance Survey E/N:	296220,90400 (point)
OASIS number:	substrata1-181384
Archive:	At the time of writing, the archive of this survey will be held by Substrata.

Summary
This report was commissioned by AC Archaeology Ltd on behalf of clients. The location of the site is shown in figure 3.

The magnetic contrast across the survey area was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses.

Twenty-three magnetic anomaly groups were identified as pertaining to archaeological deposits or structures. Of these, three represent former field boundaries recorded on historical Ordnance Survey maps. One group is likely to relate to a possible Bronze Age ring ditch recorded as a cropmark from aerial photographs and a second group within this structure may be associated with it. A further group may represent a possible pit or earth-filled hollow. The remaining groups are linear and curvilinear deposits or structures that may relate to former fields or other enclosure boundaries not recorded on historical Ordnance Survey maps.

2 Survey aims and objectives

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.

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

Landscape
The survey area was situated within four fields, designated Fields A to D as shown in Figure 3.

Land use at the time of the survey
Grass pasture and recently sown crops.

Geology
The site is located on a solid geology of Permian Dawlish Sandstone Formation sandstones. These rocks comprise Reddish brown sands and sandstones, cross-bedded, with intercalated thin lenses and beds of breccia and mudstone.

The superficial geology is not recorded in the source used (British Geological Survey, undated).

5 Archaeological background

The following is a short summary of information obtained from the National Heritage List for England and the Devon and Dartmoor Historic Environment Record (HER) within 500m of the proposed development site and relevant to the understanding of the gradiometer survey. Except where specifically cited, this information was obtained using the Heritage Gateway (English Heritage, undated 1). The field designations are shown in Figure 3.

The reader is advised that this summary should not be used outside the context of this report and is referred to the Devon HER for informed provision of the record.

Historical landscape characterisation
All fields within the proposed development site have been classified as:

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)

Heritage assets within or immediately bordering the survey area
HER Number: MDV13730. ARTEFACT SCATTER (Early Neolithic to Late Bronze Age - 4000 BC to 701 BC (Between)). A scatter of 17 Neolithic/Bronze Age worked flints was found within a 30m radius after mechanical scraping in construction of M5 motorway in 1973-4.
Grid Reference: SX 963 905 (point, approximately 128m northeast of survey centre in field A).
A west-east trending linear anomaly pattern was recorded in the survey data close to the given location of the flint scatter.

HER Number: MDV28623. RING DITCH (Bronze Age - 2200 BC to 701 BC (Between)). Clyst St. George, east of railway. Ring ditch. Recorded as cropmark. Linear feature to south (aerial).
Grid Reference: SX 961 903 (point, approximately 156m southwest of the survey centre in field B – see note below regarding this grid reference).
English Heritage Pastscape monument number 1048110
Magnetic anomaly groups 13 and 14 recorded during the survey are likely to represent such a feature at SX 96158 90367 which corresponds to the position on the aerial photograph and is approximately 70m west-south-west of the survey centre in field B).

HER Number: MDV28624. ENCLOSURE (Bronze Age - 2200 BC to 701 BC (Between)). Clyst St. George, east of railway. South east corner of rectilinear enclosure recorded as cropmark.
Grid Reference: SX 962 905 (point, approximately 102m north-north-east of the survey centre in field B)

No evidence of this feature was recorded in the survey data.

HER Number: MDV60431. ARTEFACT SCATTER (Prehistoric - 698000 BC to 42 AD (Between)). Fourteen flint flakes from a ploughed field near Blue Ball, Old Rydon Lane, Clyst St. Mary. The collection consists of a mixture of damaged and undiagnostic debitage and utilised flakes. Grid Reference: SX 964 907 (point, approximately 350m northeast of survey centre, in field A).

Pastscape Monument number: 1048112. RECTILINEAR ENCLOSURE (Uncertain). Rectilinear enclosure, of uncertain date, seen as a cropmark. No associated HER entry.
Grid Reference: not recorded but placed in field B.
No evidence of this feature was recorded in the survey data.

Heritage assets within approximately 500m of Ordnance Survey E/N: 296220,90400 (point)
HER Number: MDV19838. PARISH BOUNDARY (Unknown date). The 11c charter (see above) describes the boundary of the manor of Topsham in 937. The route of 'the way' may therefore be even older in origin. Its course was eventually deflected when the fields in this part of the parish were created. The line of the earlier route is not certain, but was probably north of the present line.
Grid Reference: SX 959 904 (point, approximately 320m west of survey centre).

HER Number: MDV19839. PARISH BOUNDARY (Unknown date). Parish boundary in Heavitree parish.
Grid Reference: SX 959 904 (point, approximately 320m west of survey centre).

HER Number: MDV60789. ENCLOSURE (Early Bronze Age to Late Iron Age - 2200 BC to 42 AD (Between)). A rectilinear enclosure of probable prehistoric date is visible as a cropmark ditch on oblique aerial photographs of 1984 and 1989, to the west of Newcourt Barton.
Associated events: EDV6127 - Rapid Coastal Zone Assessment Survey National Mapping Programme (NMP) for South-West England - South Coast Devon.
Grid Reference: SX 963 900 (point, approximately 408m southeast of survey centre).

HER Number: MDV61429. FINDSPOT (Roman - 43 AD to 409 AD (Between)). Base of Roman Samian vessel from Old Rydon Lane.
Grid Reference: SX 955 904 (point, approximately 720m west of survey centre).

HER Number: MDV72690. FIELD BOUNDARY (XIX - 1801 AD to 1900 AD (Between)). Newcourt, Former Field Boundaries. Former field boundaries identified during geophysical survey in 2006.
Grid Reference: SX 958 907 (point, approximately 516m northwest of survey centre).

HER Number: MDV81192. SETTLEMENT (Lower Palaeolithic to I - 698000 BC to 100 AD (Between)). Settlement, between A379 and Old Rydon Lane. The evaluation confirmed the presence of a substantial enclosure, first identified by aerial photographs, and dated to the Bronze Age. Within it a single hut circle was recorded, this was a large structure with a double ring of postholes. Possible contemporary structures were also noted external to the enclosure.
Associated monuments:
MDV103430 Parent of: Hut circle, east side of Newcourt Way
MDV81249 Related to: Archaeological Features between A379 and Old Rydon Lane
MDV29091 Related to: Enclosure
Associated events: EDV5743 - Evaluation, A379 to Old Rydon Lane (Ref: 1928)
Grid Reference: SX 956 906 (point, approximately 651m northwest of survey centre).

HER Number: MDV81239. FINDSPOT (Roman - 43 AD to 409 AD (Between)). A single abraded sherd, dated to the Romano-British period was recovered during an evaluation.
Associated events: EDV5743 - Evaluation, A379 to Old Rydon Lane.
Grid Reference: SX 956 907 (point, approximately 690m northwest of survey centre).

HER Number: MDV81240. ARCHAEOLOGICAL FEATURE (Early Medieval to XXI - 1066 AD to 2009 AD (Between)). Site of post-medieval field boundaries and fence lines indicated by several ditches and rows of postholes. Modern features also noted.
Associated monuments: MDV81249 Archaeological Features between A379 and Old Rydon Lane
Associated events: EDV5743 - Evaluation, A379 to Old Rydon Lane (Ref: 1928)
Grid Reference: SX 956 906 (point, approximately 651m northwest of survey centre).

HER Number: MDV81249. ARCHAEOLOGICAL FEATURE (Unknown date). Undated features recorded during an evaluation between A379 and Old Rydon Lane. The features consisted of clusters and isolated pits and postholes.
Associated monuments:
MDV81240 Related to: Archaeological Features between A379 and Old Rydon Lane
MDV81192 Related to: Settlement, between A379 and Old Rydon Lane
Associated events: EDV5743 - Evaluation, A379 to Old Rydon Lane (Ref: 1928)
Grid Reference: SX 956 906 (point, approximately 651m northwest of survey centre).

HER Number: MDV103430. HUT CIRCLE (Bronze Age - 2200 BC to 701 BC (Between)). Hut circle, east side of Newcourt Way. Hut circle, east side of Newcourt Way. The evaluation of 11 trenches confirmed the presence of a substantial enclosure, first identified by aerial photography and dated to the Bronze Age. Within it a single hut circle was recorded, this was a large structure with a double ring of postholes.
Associated monuments: MDV81192 Part of: Settlement, between A379 and Old Rydon Lane
Associated events:
EDV5312 - Archaeological Evaluation of the Old Rydon Lane Site, South Exeter
EDV5743 - Evaluation, A379 to Old Rydon Lane (Ref: 1928)
EDV5983 - Geophysical Survey on Land between Old Rydon Lane and A379
EDV5957 - Site Walkover of Development Sites in Newcourt Area: Lower RNSD Site and Land off Old Rydon Lane and A379
Grid Reference: SX 957 906 (point, approximately 560m northwest of survey centre).

HER Number: MDV106162. OCCUPATION SITE (Unknown date). Geophysical survey identified a possible rectilinear enclosure along with other linear anomalies and one circular anomaly. Rectilinear enclosure of possible archaeological origin has been identified in the south of the northern field. This rectilinear enclosure has also been identified in aerial photography and is thought to be Romano-British in origin. Further evidence for archaeological activity can be identified in a number of positive linear anomalies situated mainly in the centre and western parts of the survey area. However a number of these anomalies may be agricultural in origin due to their orientation. A possible circular cut feature has been identified in the east of the survey area that may be archaeological in origin. Areas of magnetic disturbance of modern origin situated in the south and east of the survey area may obscure subtle features of possible archaeological origin.
Associated events:
EDV5306 - Archaeological Evaluation of ORLN Site and Langdon Site, South Exeter
EDV5312 - Archaeological Evaluation of the Old Rydon Lane Site, South Exeter
EDV5743 - Evaluation, A379 to Old Rydon Lane (Ref: 1928)
EDV5957 - Site Walkover of Development Sites in Newcourt Area: Lower RNSD Site and Land off Old Rydon Lane and A379
EDV5958 - An Archaeological Evaluation of the Proposed Road Linking A379 to Old Rydon Lane, Topsham, Exeter
EDV5983 - Geophysical Survey on Land between Old Rydon Lane and A379
Grid Reference: SX 956 905 (point, approximately 610m west-north-west of survey centre)

HER Number: MDV29091. ENCLOSURE (Prehistoric - 698000 BC to 42 AD (Between)). North-east of St. Bridget's Nurseries. Rectangular single ditched enclosure, (west side not visible) of side 60-70m. Recorded as cropmark.
Associated monuments: MDV81192: Settlement, between A379 and Old Rydon Lane.
Associated events: EDV5743 - Evaluation, A379 to Old Rydon Lane (Ref: 1928).
Grid Reference: SX 955 906 (point, approximately 628m east-north-east of survey centre).

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

The reader is referred to section 7.

6.1 Results

The three fields comprising the survey area were designated fields A to D as shown in figure 3.

Figure1 shows the interpretation of the survey across all fields. It includes the anomaly groups identified as pertaining to archaeological deposits along with their numbers. 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 along with table 1 comprises the analysis of the survey data.

A plot of the processed data is provided in figure 2 (appendix 1).

Site: An archaeological gradiometer survey
Land at Sandy Park Farm, Newcourt, Exeter, Devon
Ordnance Survey (E/N): 296220,90400 (point)
Report: 140613

field number	anomaly group	associated anomalies	anomaly characterisation certainty & class	anomaly form	additional archaeological characterisation	comments	supporting evidence
A	1		possible positive	linear		anomaly group represents either an archaeological deposit or recent vehicle ruts	
	2		possible positive	disrupted linear			
	3		likely positive	linear	field boundary	anomaly group coincides with a field boundary mapped between 1889-90 and 1906 but not by 1933	Ordnance Survey maps between 1889-90 1:2500 and 1933 1:10560
	4		possible positive	linear		anomaly group represents either an archaeological deposit or recent vehicle ruts	
	5		possible positive	linear			
	6		possible positive	linear		anomaly group represents either an archaeological deposit or recent vehicle ruts	
B	7	8 9	possible positive	oval	pit or filled hollow	anomaly group may be associated with a curvilinear group of deposits	
	8	7 9	possible positive	linear		anomaly group may be associated with a curvilinear group of deposits	
	9	7 8	possible positive	disrupted linear		anomaly group may be associated with a curvilinear group of deposits	
	10		possible positive	curvilinear			
	11		possible positive	oval	pit or filled hollow		
	12		likely positive	linear	field boundary	anomaly group coincides with a field boundary mapped between 1889-90 and 1963-64 but not by 1969-91	Ordnance Survey maps between 1889-90 1:2500 and 1969-91 1:2500
	13	14	likely positive	sub-circular	ring ditch	anomaly group coincides with a ring ditch recorded as a cropmark from aerial photograph	Devon and Dartmoor HER entry MDV28623
	14	13	possible positive	curvilinear		anomaly groups lies within a ring ditch (group 13) and may be associated with it archaeologically	
	15		likely positive	linear		anomaly group coincides with a field boundary mapped between 1889-90 and 1906 but not by 1933	Ordnance Survey maps between 1889-90 1:2500 and 1933 1:10560
	16		possible positive	linear			
C	17		possible positive				
	18		possible positive				
	19		possible positive				
D	20		possible positive	disrupted linear	field boundary	anomaly groups represent the remains of a possible Devon bank (a field boundary with a central stone flanked earthen bank and flanking ditches)	
	21		possible positive	linear			
	22		possible positive	linear			
	23		possible negative	disrupted linear		anomaly groups may represent an archaeological deposit or, more likely, are associated with the adjacent M5	

Table 1: data analysis

295900 m 296000 m 296100 m 296200 m 296300 m 296400 m 296500 m 296600 m

90700 m 90600 m 90500 m 90400 m 90300 m 90200 m 90100 m 90000 m 89900 m

Gantry

N

Builder's Yard

Pond

ESS

1 2 3 4 5 6 7 8 9 10 11 12 13 & 14 15 16 17 18 19 20 21 22 23

0 100 m

survey area

Potential archaeology

certainty, anomaly type

likely positive (2)

possible positive

possible negative

British Grid
centre X: 296230.02 m, centre Y: 90339.07 m

Scale: 1:3000 @ 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 deposit

An archaeological gradiometer survey
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Figure 1: survey interpretation

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6.2 Discussion

Refer to Figure 1 (this section) and Figures 2 and 3 (appendix 1).

Not all anomalies or anomaly groups identified in the survey dataset are necessarily 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 the data analysis (Table 1).

General points
There is a distinct patterning of the magnetic response in field B as shown in Figure 2. This reflects relatively deep ploughing and crop sowing undertaken in the field just prior to the survey.

Anomalies though to relate to natural features were not mapped.

An east-west trending high magnetic anomaly in the north of field A reflects a recent service pipe or cable.

Recent man-made objects such as manholes, water management equipment or drains have not been mapped except where they comprise significant magnetic responses across the dataset.

Data collection along the field edges was restricted as shown in figures 1 and 2 due to the presence of magnetic materials and objects in and adjacent to the field boundaries. Strong magnetic responses mapped close to the field boundaries are likely to relate to these items except where indicated otherwise in figure 1.

Data relating to historical maps and other records
Groups **3, 12 and 15** reflect field boundaries mapped by the Ordnance Survey between 1889-90 and 1933 (groups 3 and 15) and between 1889-90 and 1969-91 (group 12).

Anomaly group **13** coincides with a ring ditch, thought to be Bronze Age by its form, recorded as a cropmark on an aerial photograph (Devon and Dartmoor Historic Environment entry MDV28623; see section 5 for further details). Group **14** lies within the ring ditch and may be associated with it.

Data with no previous provenance
Groups **1, 4 and 6** may relate to linear archaeological deposits or to relatively recent vehicle ruts. The proximity of magnetic material in the field boundaries precludes a detailed analysis of these anomalies.

Groups **7** is close to the edge of the survey area and magnetic material in the adjacent field boundary and group **9** is very faint but there is a possibility that, along with group **8**, these anomalies represent a curvilinear archaeological deposit.

Group **11** stands out in the dataset and may represent a large pit of filled hollow.

Anomaly group **20** has a pattern often associated with former Devon banks which are field boundaries with a stone-lined earthen bank and flanking ditches to each side. No field boundary is recorded here on any historical Ordnance Survey map.

Group **23** is recorded here as potential archaeology but its proximity to the M5 and its trend suggests that the anomalies may reflect activities associated with the construction of the motorway.

The remaining magnetic anomaly groups recorded during the survey are most likely to relate to former field or other enclosure boundaries not recorded on historical Ordnance Survey maps.

6.3 Conclusions

The magnetic contrast across the survey area was sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses.

Twenty-three magnetic anomaly groups were identified as pertaining to archaeological deposits or structures. Of these, three represent former field boundaries recorded on historical Ordnance Survey maps. One group is likely to relate to a possible Bronze Age ring ditch recorded as a cropmark from aerial photographs and a second group within this structure may be associated with it. A further group may represent a possible pit or earth-filled hollow. The remaining groups are linear and curvilinear deposits or structures that may relate to former fields or other enclosure boundaries not recorded on historical Ordnance Survey maps.

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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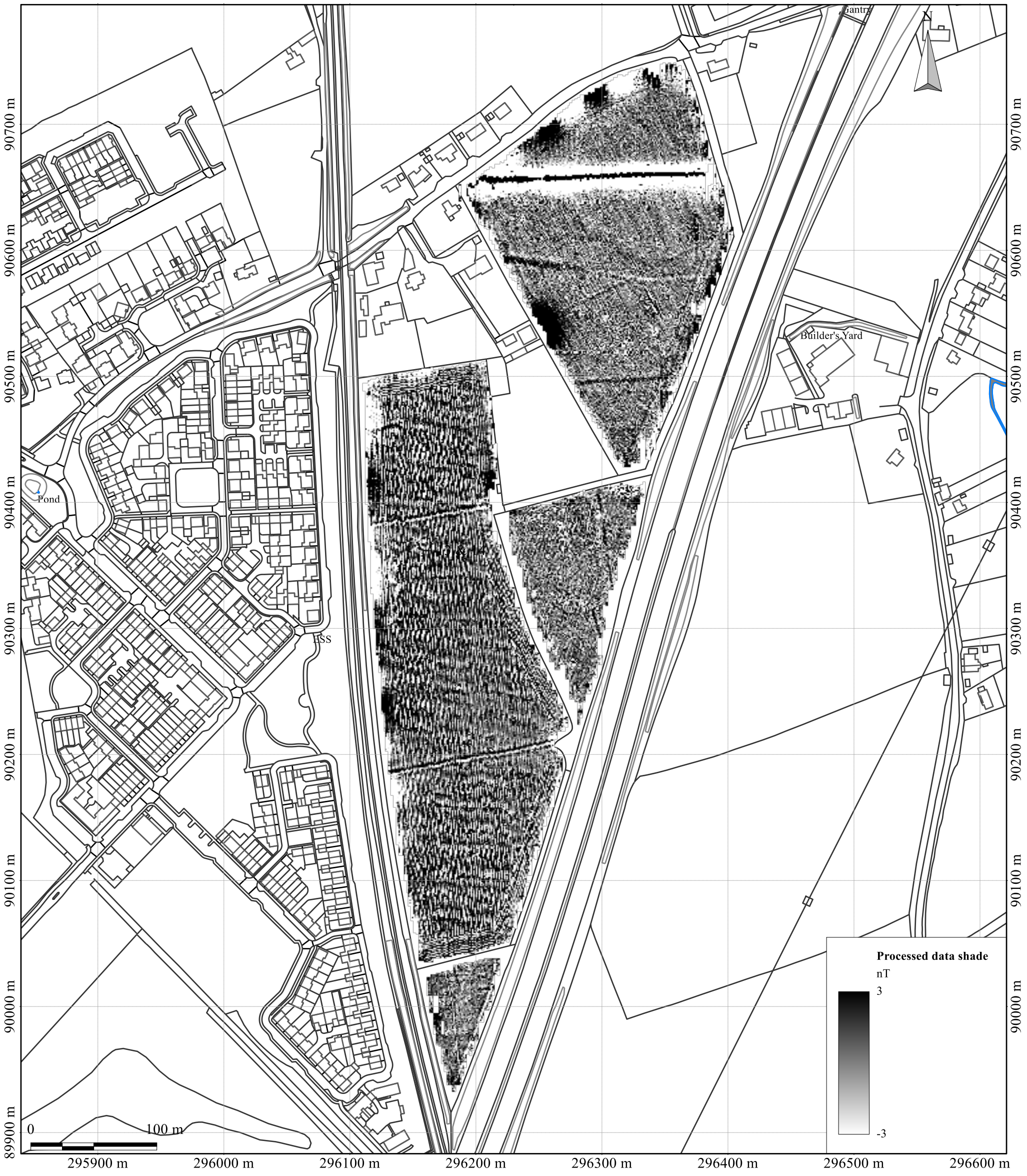
Institute for Archaeologists (2008) *Code of approved practice for the regulation of contractual arrangements in archaeology*. Reading: Author [Online], Available: http://www.archaeologists.net/sites/default/files/node-files/ifa_code_practice.pdf [March 2014]

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.



British Grid
centre X: 296230.02 m, centre Y: 90339.07 m

Scale: 1:3000 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 2: shade plot of processed data

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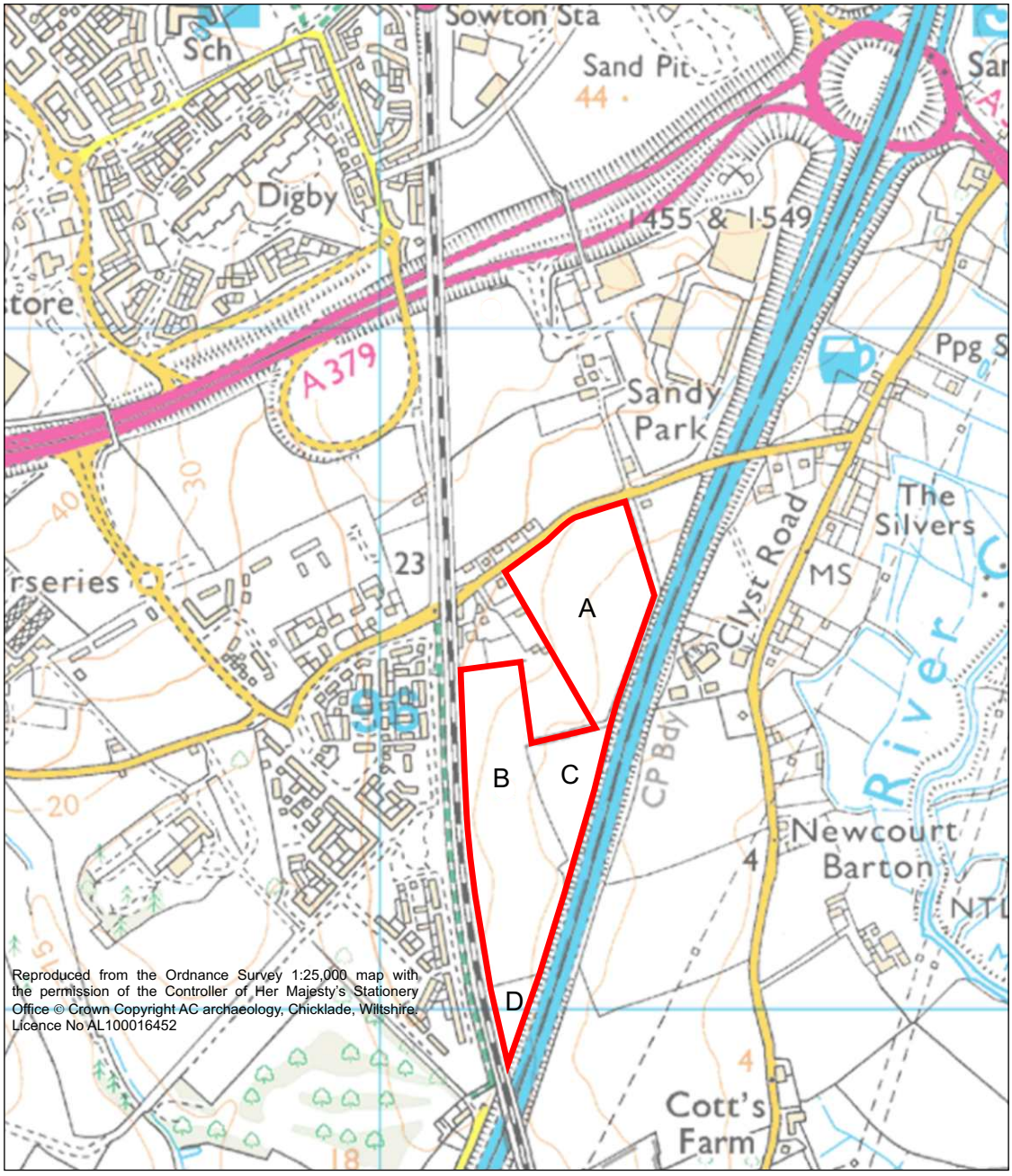

PROJECT

Land at Newcourt, Exeter

TITLE

Fig. 3: Location of site

AC archaeology

Appendix 2 Methodology Summary

<table>
<tr><th colspan="2">Table 2: 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: GN</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 3: 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: 3.0.22.1

Stats
Max: 487.35
Min: -547.46
Std Dev: 15.47
Mean: -0.34
Median: 0.15
Surveyed Area: 10.426 ha

Processes: 15

1 Base Layer
2 Clip at 1.00 SD
3 De Stagger: Grids: nfa21.xgd nfb14.xgd nfa20.xgd nfa22.xgd nfb13.xgd nfb15.xgd nfa19.xgd nfa23.xgd nfb12.xgd nfb16.xgd nfa6.xgd nfa18.xgd nfa24.xgd nfb11.xgd nfb17.xgd nfb31.xgd nfa7.xgd nfa17.xgd nfa25.xgd nfb10.xgd nfb18.xgd nfb30.xgd nfa5.xgd nfa8.xgd nfa16.xgd nfa26.xgd nfb9.xgd nfb19.xgd nfb29.xgd nfa4.xgd nfa9.xgd nfa15.xgd nfa27.xgd nfb8.xgd nfb20.xgd nfb28.xgd nfa2.xgd nfa10.xgd nfa14.xgd nfa28.xgd nfb7.xgd nfb21.xgd nfb27.xgd nfa3.xgd nfa11.xgd nfa13.xgd nfb1.xgd nfb6.xgd nfb22.xgd nfb26.xgd nfa12.xgd nfb2.xgd nfb5.xgd nfb23.xgd nfb25.xgd nfb3.xgd nfb4.xgd nfb24.xgd Mode: Both By: -6 intervals
4 De Stagger: Grids: nfd11.xgd nfd10.xgd nfd12.xgd nfd1.xgd nfd9.xgd nfd13.xgd nfd2.xgd nfd8.xgd nfd14.xgd nfd3.xgd nfd7.xgd nfd15.xgd nfd20.xgd nfd4.xgd nfd6.xgd nfd16.xgd nfd19.xgd nfd5.xgd nfd17.xgd nfd18.xgd Mode: Both By: -3 intervals
5 De Stagger: Grids: nfd25.xgd nfd27.xgd nfd21.xgd nfd24.xgd nfd28.xgd nfd22.xgd nfd23.xgd nfd29.xgd Mode: Both By: -3 intervals
6 DeStripe Median Sensors: nfd25.xgd nfd27.xgd nfd21.xgd nfd24.xgd nfd28.xgd nfd22.xgd nfd23.xgd nfd29.xgd nfd11.xgd nfd10.xgd nfd12.xgd nfd1.xgd nfd9.xgd nfd13.xgd nfd2.xgd nfd8.xgd nfd14.xgd nfd3.xgd nfd7.xgd nfd15.xgd nfd20.xgd nfd4.xgd nfd6.xgd nfd16.xgd nfd19.xgd nfd5.xgd nfd17.xgd nfd18.xgd
7 DeStripe Median Sensors: nfa21.xgd nfb14.xgd nfa20.xgd nfa22.xgd nfb13.xgd nfb15.xgd nfa19.xgd nfa23.xgd nfb12.xgd nfb16.xgd
8 DeStripe Median Sensors: nfa24.xgd nfb11.xgd nfb17.xgd nfb31.xgd nfa25.xgd nfb10.xgd nfb18.xgd nfb30.xgd nfa26.xgd nfb9.xgd nfb19.xgd nfb29.xgd nfa27.xgd nfb8.xgd nfb20.xgd nfb28.xgd
9 DeStripe Median Sensors: nfa5.xgd nfa8.xgd nfa16.xgd nfa4.xgd nfa9.xgd nfa15.xgd
10 DeStripe Median Sensors: nfb1.xgd nfb6.xgd nfb22.xgd
11 DeStripe Median Sensors: nfb6.xgd nfb22.xgd nfb5.xgd nfb23.xgd
12 De Stagger: Grids: nfg6.xgd nfg8.xgd nfh12.xgd nfg5.xgd nfg9.xgd nfh11.xgd nfg4.xgd nfg10.xgd nfh10.xgd nfg3.xgd nfg11.xgd nfh9.xgd nf1.xgd nfg2.xgd nfg12.xgd nfh8.xgd nf2.xgd nfg1.xgd nfg13.xgd nfh7.xgd nf3.xgd nff18.xgd nfg14.xgd nfh6.xgd nf4.xgd nff17.xgd nfg15.xgd nfh5.xgd nff1.xgd nff16.xgd nfg16.xgd nfh4.xgd nff2.xgd nff15.xgd nfg17.xgd nfh3.xgd nff3.xgd nff14.xgd nfg18.xgd nfh2.xgd nff4.xgd nff13.xgd nfg19.xgd nfh1.xgd nff5.xgd nff12.xgd nfg20.xgd nfg27.xgd nff6.xgd nff11.xgd nfg21.xgd nfg26.xgd nff7.xgd nff10.xgd nfg22.xgd nfg25.xgd nff8.xgd nff9.xgd nfg23.xgd nfg24.xgd Mode: Both By: -2 intervals
13 De Stagger: Grids: nfh13.xgd nfh14.xgd nfh15.xgd nfh16.xgd nfh17.xgd nfh18.xgd nfh19.xgd nfh20.xgd Mode: Both By: -2 intervals
14 De Stagger: Grids: nfh27.xgd nfh26.xgd nfh25.xgd nfd11+nfh24.xgd Mode: Both By: -2 intervals
15 Interpolate: Match X & Y Doubled.

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.