Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer and earth resistance survey

Land at Countisbury Castle, Wind Hill, Lynmouth, Devon NGR SS 7368 4917

Report: 120321
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Accompanying CD-ROM

1 Survey description and summary

Type of survey: twin-sensor fluxgate gradiometer
twin probe earth resistance with parallel twin log mode 2(4P)
Date of survey: 22 to 29 April 2012, 6 June 2012
Area surveyed: gradiometer survey 7.29ha
resistance survey 0.50ha
Lead surveyor: Ross Dean BSc MSc MA MIfA

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Site

Location:	Land at Countisbury Castle, Wind Hill
Parish:	Lynton and Lynmouth
District:	North Devon
County:	Devon
NGR:	SS 7368 4917
Scheduled Monument:	SM 33056
HER:	MDE1236
OASIS number:	substrat1-129921

This survey was part of a programme of archaeological investigations at Countisbury Castle commissioned as part of the Unlocking Our Costal Heritage project (Horner, 2010). At the time of writing, the Unlocking Our Costal Heritage project is led by the South West Coast Path Team (SWCPT) and is a three year series of investments to conserve, enhance and interpret some 40 nationally important historic and archaeological sites along the Coast Path which are currently at risk of being irreparably damaged or lost, or which could be made more accessible for wider audiences. Other bodies working in partnership with SWCPT include the relevant Areas of Outstanding Natural Beauty, Devon County Council, English Heritage, Natural England, the National Trust and the landowners.

Countisbury Castle is an Iron Age promontory fort lies on a west-facing spur between the high sea cliff to the north and the steep sided East Lyn Valley to the south.

Survey Aims

1. Identify and accurately record the location of any magnetic and resistance anomalies that may be related to archaeological deposits, structures or artefacts known to exist within the survey area.
2. Within the limits of the techniques and dataset, archaeologically characterise and such anomalies or patterns of anomalies
3. Produce a summary based on the survey that is sufficiently detailed to inform and subsequent archaeological investigation about the location and possible archaeological character of the recorded anomalies.

To achieve these aims, a gradiometer survey was completed across the designated survey area and was followed by a resistance survey 0.5ha in extent, the areas chosen for the resistance survey being assessed as the most promising in terms of further understanding the likely archaeology.

Results Summary
The magnetic and resistance contrasts across the survey areas were sufficient to be able to differentiate between anomalies representing possible archaeology and background responses.

Fifty-three magnetic anomaly groups and fourteen resistance anomaly groups were identified as representing possible archaeological deposits or features.

Of these anomaly groups, the majority are thought to relate to former cultivation with field boundaries, strip lynchets and remnant ploughing patterns being provisionally identified. Resistance anomaly groups 50, 51 and 52 in field 2 (figure 4) may represent a north-south trending archaeological feature at the western end of the promontory fort and further archaeological investigations may determine whether or not this potential deposit or structure is related to the promontory fort itself or past agricultural activities.

Anomaly groups 15 and 16 which straddle the boundary between fields 4 and 6 (figures 2 and 3) seem to represent a sub-circular feature that is visible on Google Earth images. An archaeological origin is possible for such an anomaly group although a former quarry or natural feature cannot be ruled out. Further archaeological investigations are required if this is to be resolved.

Magnetic anomaly groups 26, 42 and 43, and resistance anomaly groups 53, 54 and 55 (figures 3 and 5) hint at possible archaeological deposits or structures adjacent to the extant earthworks at the eastern end of the promontory fort.

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 and land use

Countisbury Hillfort is a Scheduled Monument owned by the National Trust. The South West Coast Path crosses through the northern tip of the earthwork rampart and the site as a whole is part of a larger Site of Special Scientific Interest. The land lies between 207 and 240m O.D. and was under permanent pasture with some scrub encroachment at the time of the survey.

Geology

The site is located on a solid geology of Middle Devonian undifferentiated, interbedded sandstones and conglomerate (fields 1, 3, 4, 5, 6, 7 and 8) and Lower Devonian undifferentiated mudstones, siltstone and sandstone (field 2 and the south-western part of field 4). A fault running north-west to south-east across fields 1, 2 and 4 separates the two rock groups (British Geological Survey, undated).

Soils

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

0 - 20cm: dark greyish brown, slightly or moderately stony sandy loam or sandy silt loam

20 - 50cm: yellowish brown, stoneless sandy loam; weak coarse subangular blocky structure

At 50cm: hard or soft sandstone or extremely stony sandy loam

(Findley et al, 1983: 266).

Known archaeological sites in the survey area

The Historic Environment Record used to create the summaries below was provided by the Exmoor National Park Authority July 2012.

MDE1236	Countisbury Castle or Wind Hill Promontory Fort with a ditch and rampart to the east with a possible bank on the west; thought to be Iron Age in date
MDE11757	Countisbury ironstone mine in operation in 1874-5
MMO1997	field boundaries or strip lynchets on west facing slopes of Wind Hill, probable medieval in date, visible on aerial photographs and extant as low, levelled earth-works centred on SS 73614920

3. Results, discussion and conclusions

The survey was designed to record magnetic and earth resistance 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 survey methodology is presented in appendix 2.

The survey area was divided into eight fields as shown in figure 6, appendix 1.

The reader is referred to section 4.

3.1 Results

3.1.1 Gradiometer survey

Figure 1 shows the interpretation of the gradiometer and resistance surveys in full.

Figures 2 and 3 provide the interpretation of fields 1 to 4 and 5 to 8 respectively. Tables 1 and 2 are extracts from a detailed analysis of the data provided in the attribute tables of the GIS project on the accompanying CD-ROM.

Figures 2 and 3 along with tables 1 and 2 comprise the analysis and interpretation of the gradiometer survey data.

The processed gradiometer data is presented in figures 7 and 8 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. Fifty-three anomaly groups representing potential archaeological features or deposits were recorded as shown in figures 2 and 3.

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N

Legend

resistance potential archaeology

certainty, class

- likely archaeology, high anomaly (supporting evidence)
- possible archaeology, high anomaly
- possible archaeology, low anomaly
- possible archaeology , repeated parallels
- resistance survey area

gradiometer potential archaeology

certainty, class

- likely archaeology, positive anomaly (supporting evidence)
- likely archaeology, negative spread (supporting evidence)
- possible archaeology, positive anomaly
- possible archaeology, negative anomaly
- possible archaeology, mixed linear
- possible archaeology, repeated parallels (2)

gradiometer services and modern

certainty, class

- possible service, high contrast linear
- possible service, low contrast linear
- gradiometer survey area

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 25 50 100 Meters

Figure 1: survey interpretation, potential archaeology gradiometer and resistance surveys

Survey data analysis

Site: Land at Countisbury Castle, Wind Hill, Lynmouth, Devon
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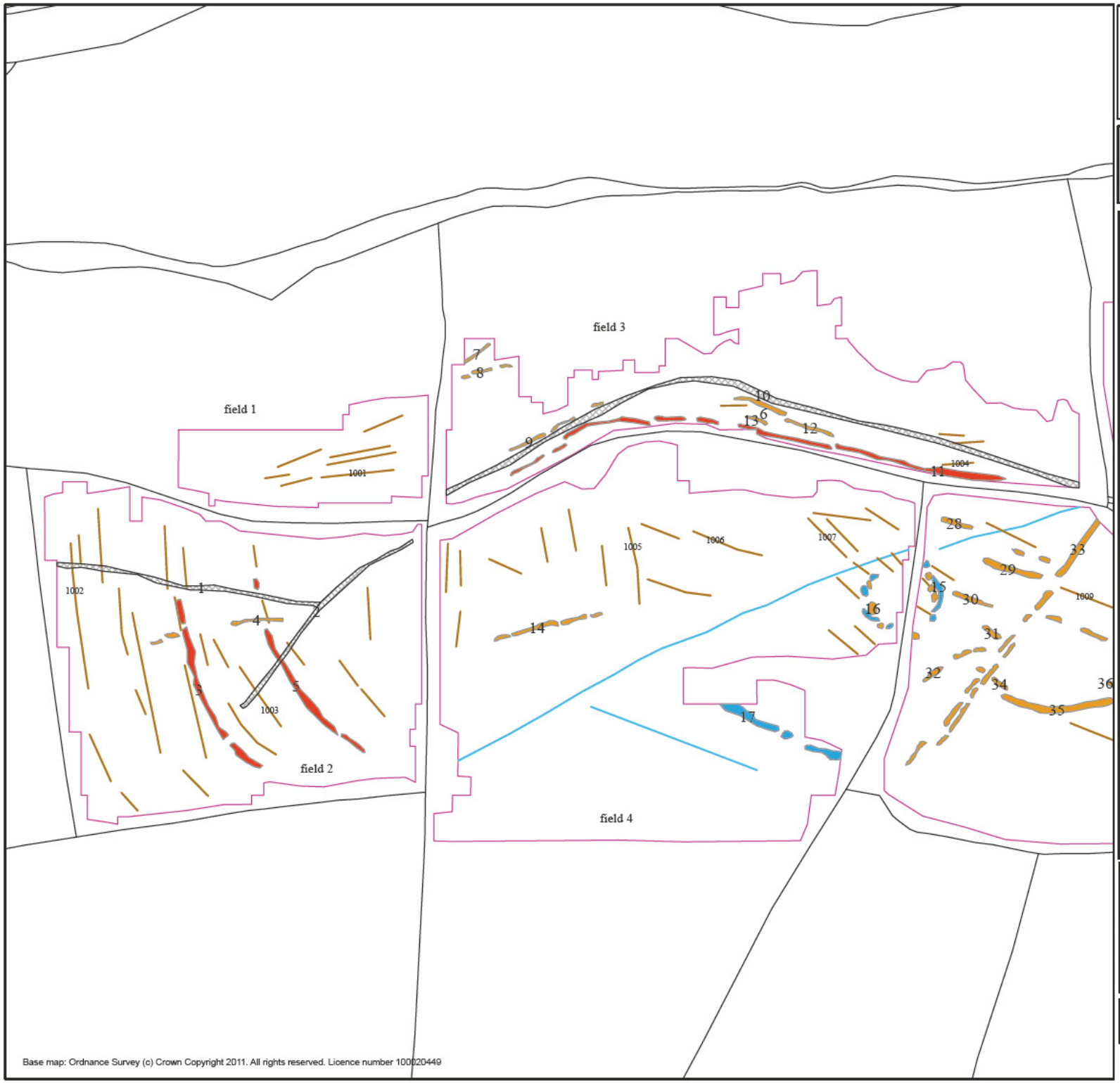
field	anomaly group	associated anomaly group(s)	characterisation certainty	anomaly class	anomaly form	archaeological characterisation	comments	period	supporting evidence
1	1001		possible	repeated parallels		cultivation traces	traces of former ploughing		
2	1		possible	mixed linear			most likely modern tracks		
2	2	47 48 49	possible	mixed linear			most likely modern tracks		
2	3	45	likely	positive	curvilinear	field lynchets	anomaly group is most likely to represent field lynchets recorded in this area	medieval	HER MMO1997
2	4		possible	positive	linear				
2	5		likely	positive	curvilinear	field lynchets	anomaly group is most likely to represent field lynchets recorded in this area	medieval	HER MMO1997
2	1002		possible	repeated parallels		cultivation traces	traces of former ploughing		
2	1003		possible	repeated parallels		cultivation traces	traces of former ploughing		
3	6		possible	positive	linear		follows line of extant path and may represent a previous incarnation of the route		
3	7		possible	positive	linear				
3	8		possible	positive	linear				
3	9		possible	positive	linear		follows line of extant path and is most likely to be associated with the current path		
3	10		possible	mixed linear			most likely modern tracks		
3	11	12	likely	positive	curvilinear		follows line of track mapped between 1891 and 1955		1891 OS 6-inch series sheet Devon 3SW 1st edition, 1955 OS 6-inch series sheet SS74NW undated, c. 1955
3	12	11	possible	positive	linear		follows line of extant path and may represent a previous incarnation of the route		
3	13		possible	positive	linear		follows line of extant path and may represent a previous incarnation of the route		
3	1004		possible	repeated parallels		cultivation traces	traces of former ploughing		
4	14		possible	positive	disrupted linear				
4	15	16	possible	negative	disrupted curvilinear	structure or traces of	also in area 6 - disrupted by cultivation, corresponds to earthworks on Google Earth image		
4	16	15	possible	positive	discrete ovals	structure or traces of	also in area 6 - disrupted by cultivation, corresponds to earthworks on Google Earth image		
4	17		possible	negative	disrupted linear	stony structure			
4	1005		possible	repeated parallels		cultivation traces	close to traverse orientation of survey but probably cultivation traces		
4	1006		possible	repeated parallels		cultivation traces	traces of former ploughing or expressions of a geological fault line on a similar orientation through this area		
4	1007		possible	repeated parallels		cultivation traces	also in area 6 - traces of former ploughing or expressions of a geological fault line on a similar orientation through this area		

Table 1: gradiometer data analysis, fields 1 to 4



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Legend

gradiometer potential archaeology

certainty, class

- likely archaeology, positive anomaly (supporting evidence)
- likely archaeology, negative spread (supporting evidence)
- possible archaeology, positive anomaly
- possible archaeology, negative anomaly
- possible archaeology, mixed linear
- possible archaeology, repeated parallels (2)

gradiometer services and modern

certainty, class

- possible service, high contrast linear
- possible service, low contrast linear
- gradiometer survey area

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 12.5 25 50 Meters

Figure 2: survey interpretation, potential archaeology gradiometer survey, fields 1 to 4

Survey data analysis
Site: Land at Countisbury Castle, Wind Hill, Lynmouth, Devon
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field	anomaly group	associated anomaly group(s)	characterisation certainty	anomaly class	anomaly form	archaeological characterisation	comments	period	supporting evidence
5	18		possible	positive	disrupted curvilinear	lynchet	anomaly groups could represent former lynchets but may just be indicative of former cultivation traces (ploughing)		
5	19		possible	positive	linear				
5	20		possible	positive	disrupted curvilinear	lynchet	anomaly groups could represent former lynchets but may just be indicative of former cultivation traces (ploughing)		
5	21		possible	positive	disrupted curvilinear	lynchet	anomaly groups could represent former lynchets but may just be indicative of former cultivation traces (ploughing)		
5	22	23 24	likely	positive	curvilinear	ditch	follows line of extant track mapped between 1891 and present		1891 OS 6-inch series sheet Devon 3SW 1st edition on
5	23	22 24	likely	positive	curvilinear	ditch	follows line of extant track mapped between 1891 and present		1891 OS 6-inch series sheet Devon 3SW 1st edition on
5	24	22 23	likely	negative spread	curvilinear	track	follows line of extant track mapped between 1891 and present		1891 OS 6-inch series sheet Devon 3SW 1st edition on
5	25		possible	positive	disrupted curvilinear	lynchet	anomaly groups could represent former lynchets but may just be indicative of former cultivation traces (ploughing)		
5	26		possible	positive	disrupted linear	ditch	anomaly groups may represent either a build up of material along the inner side of the extant rampart or, less likely, an inner ditch		HER MDE 1236
5	27		possible	positive	linear				
5	1008		possible	repeated parallels		cultivation traces	traces of former ploughing		
6	28		possible	positive	disrupted linear	lynchet	anomaly groups could represent former lynchets but may just be indicative of former cultivation traces (ploughing)		
6	29		possible	positive	linear	lynchet	anomaly groups could represent former lynchets but may just be indicative of former cultivation traces (ploughing)		
6	30		possible	positive	disrupted linear	lynchet	anomaly groups could represent former lynchets but may just be indicative of former cultivation traces (ploughing)		
6	31	36	possible	positive	linear				
6	32		possible	positive	disrupted linear				
6	33		possible	positive	disrupted linear		uncertain archaeological significance - eg track combined with vehicle tracks or phases of a ditch		
6	34		possible	positive	disrupted linear				
6	35		possible	positive	curvilinear		possibly representing archaeology but could be colluvium		
6	36	31	possible	positive	disrupted curvilinear				
6	37		possible	positive	linear				
6	38		possible	positive	disrupted linear				
6	39		possible	positive	disrupted linear				
6	40		possible	positive	linear				
6	41		possible	positive	linear	lynchet	anomaly groups could represent former lynchets but may just be indicative of former cultivation traces (ploughing)		
6	1009		possible	repeated parallels		cultivation traces	traces of former ploughing or expressions of a geological fault line on a similar orientation through this area		
7	42		possible	positive	disrupted linear				
8	43	53	possible	positive	disrupted linear				
8	44		possible	positive	linear				

Table 2: gradiometer data analysis, fields 5 to 8

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Legend

gradiometer potential archaeology

certainty, class

- likely archaeology, positive anomaly (supporting evidence)
- likely archaeology, negative spread (supporting evidence)
- possible archaeology, positive anomaly
- possible archaeology, negative anomaly
- possible archaeology, mixed linear
- possible archaeology, repeated parallels (2)

gradiometer services and modern

certainty, class

- possible service, high contrast linear
- possible service, low contrast linear
- gradiometer survey area

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 12.5 25 50 Meters

Figure 3: survey interpretation, potential archaeology gradiometer survey, fields 5 to 8

3.1.2 Earth resistance survey

Figure 1 shows the interpretation of the gradiometer and resistance surveys in full.

Figures 4 and 5 show details of the interpretation of the earth resistance survey. Table 3 is an extract from a detailed analysis of the data provided in the attribute tables of the GIS project on the accompanying CD-ROM.

Figures 4 and 5 along with table 3 comprise the analysis and interpretation of the earth resistance survey data.

The processed resistance data is presented in figures 9 and 10. A plot of the unprocessed data can be found on the accompanying CD-ROM.

The resistance contrast across the survey areas was sufficient to be able to differentiate between anomalies representing possible archaeological features and background responses. Fourteen anomaly groups representing potential archaeological features or deposits were recorded as shown in figures 4 and 5.

Survey data analysis
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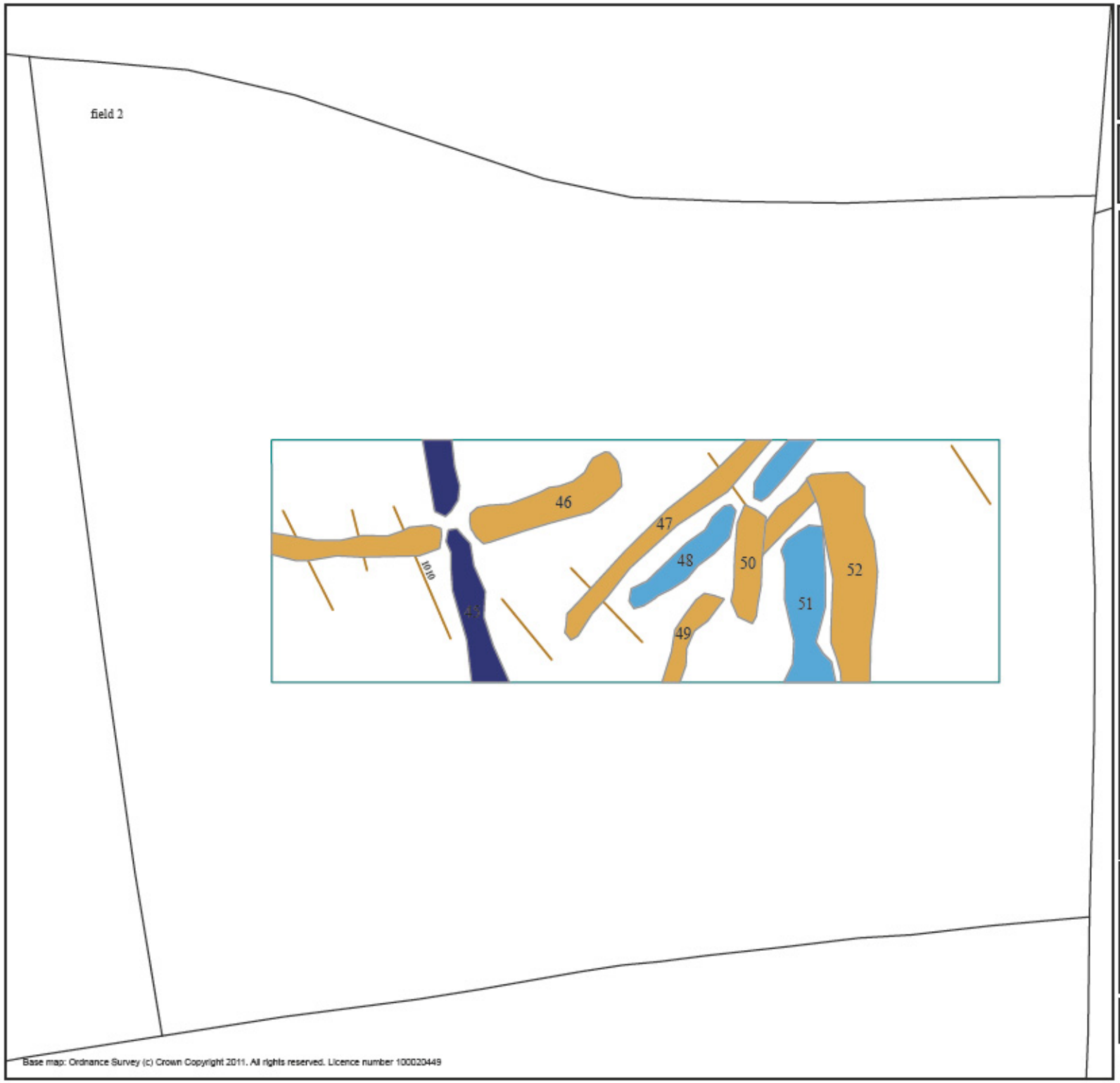
field	anomaly group	associated anomaly group(s)	characterisation certainty	anomaly class	anomaly form	archaeological characterisation	comments	period
2	45	3	likely	high	curvilinear	lynchet	anomaly group is most likely to represent field lynchets recorded in this area	medieval
2	46		possible	low	disrupted linear			
2	47	2 48 49	possible	low	linear		anomalies may be associated with a track	
2	48	2 47 49	possible	high	disrupted linear		anomalies may be associated with a track	
2	49	2 47 48	possible	low	disrupted linear		anomalies may be associated with a track	
2	50		possible	low	disrupted linear			
2	51		possible	high	linear			
2	52		possible	low	linear			
2	1010		possible	repeated parallels		cultivation traces	possible ploughing	
8	53	43	possible	high	oval			
8	54		possible	high				
8	55		possible	low				
8	1011		possible	repeated parallels		cultivation traces		
8	1012		possible	repeated parallels			possibly cultivation traces but on similar orientation to nearby geological fault line and so could reflect geology	

Table 3: resistance data analysis, fields 2 and 8



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N

Legend

resistance potential archaeology

certainty, class

- likely archaeology, high anomaly (supporting evidence)
- possible archaeology, high anomaly
- possible archaeology, low anomaly
- possible archaeology , repeated parallels
- resistance survey area

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 5 10 20 Meters

Figure 4: survey interpretation, potential archaeology resistance survey, field 2

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- possible archaeology, high anomaly
- possible archaeology, low anomaly
- possible archaeology , repeated parallels
- resistance survey area

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 5 10 20 Meters

Figure 5: survey interpretation, potential archaeology resistance survey, field 8

3.2 Discussion

The points discussed below are illustrated in figures 2, 3, 4 and 5. Figure 1 presents the combined interpretations of the gradiometer and earth resistance surveys.

Not all anomalies or anomaly groups characterised in this report are discussed below and reference should also be made to tables 1 to 3.

Field 1

Apart from possible cultivation traces, no anomalies pertaining to archaeology were found in the field 1 survey area.

Field 2

Gradiometer survey (figure 2)

Anomaly groups **1** and **2** are likely to represent tracks of unknown date and possibly in current use.

Anomaly groups **3** and **5** are most likely to represent strip lynchets or field boundaries recorded in NMR MMO1997.

Resistance survey (figure 4)

Anomaly group **45** is likely to represent the same strip lynchet or field boundary as the gradiometer group 3 discussed above.

Groups **47**, **48** and **49** may represent the track discussed in the context of gradiometer anomaly 2 above.

It is not clear whether anomaly group **46** represents archaeological or natural deposits.

Anomaly groups **51** and **52**, and possibly **50**, seem to represent a north-south trending sequence of deposits which coincide with an low raised earthwork. This group of anomalies may relate to a western boundary of the promontory fort, although this is by no means certain from the relatively small data set.

Field 3

Gradiometer survey

Anomaly groups **6**, **9** and **10** are most likely to represent the current track across the area while groups **11** and **13** probably represent a former incarnation of the track mapped on all Ordnance Survey maps between 1891 and 1955.

Field 4

Gradiometer survey (figure 2)

There is a large potential subcircular pattern of anomalies (groups **15** and **16**) straddling the boundary between fields 4 and 5. While the pattern is ephemeral, it is matched by a faint sub-circular pattern at the same location on the three-dimensional image provided by Google Earth (Google Earth, 2012). These groups of anomalies may represent an archaeological structure, a disused quarry or a natural feature and further investigation of this potential feature is recommended.

Field 5

Gradiometer survey (figure 3)

The most striking anomaly groups are the possible strip lynchets represented by groups **18**, **20**, **21** and **25**. These are complemented in the data set by similar groups of lesser contrast which are here characterised as traces of former ploughing. It is impossible to

determine with accuracy whether or not the numbered anomaly groups represent former ploughing or lynchets and their characterisation as lynchets relies on their relatively high contrast compared to surrounding anomaly groups.

Anomaly groups **22**, **24** and **25** represent the extant track mapped by the Ordnance Survey from 1891 onwards.

Group **26** is most likely to represent a build up of deposits along the western side of the extant earthworks (NMR MDE1236), the fill of a hollow-way following the earthworks or, conceivably but less likely given the accepted model of construction for such ramparts, an internal ditch.

Field 6

Gradiometer survey (figure 3)

See the discussion of field 4 above for anomaly group 15

The gradiometer data for field 6 is dominated by a series of anomalies following the contours of the field (for example, groups **28**, **29**, **30**, **31**, **34**, **35**, **36** and **41**. As with those similar anomalies in field 5, it is possible that these represent former ploughing and strip lynchets or field boundaries.

Anomaly groups **37**, **38** and **39** may represent field boundaries at right angles to the contour lines although this is not certain.

Anomaly group **33** may represent a track with modern vehicle ruts. Less likely, it could represent a sequence of linears representing a ditch or phases of ditches possibly with vehicle damage.

Fields 7 and 8

Gradiometer survey (figure 3)

Anomaly groups **42** and **43** may represent a curvilinear structure of unknown date or archaeological provenance to the west of the main extant ditch-and-bank earthworks.

Resistance survey (figure 5)

Anomaly group **53**, and possibly group **54**, may represent the same feature as groups 42 and 43 in the gradiometer survey.

Anomaly group **55** may represent part of the counterscarp bank discussed in NMR MDE1236 which fronts the ditch of the main earthwork.

3.3 Conclusions

The magnetic and resistance contrasts across the survey areas were sufficient to be able to differentiate between anomalies representing possible archaeology and background responses. Fifty-three magnetic anomaly groups and fourteen resistance anomaly groups were identified as representing possible archaeological deposits or features.

Of these anomaly groups, the majority are thought to relate to former cultivation with field boundaries, strip lynchets and remnant ploughing patterns being provisionally identified. Resistance anomaly groups 50, 51 and 52 in field 2 (figure 4) may represent a north-south trending archaeological feature at the western end of the promontory fort and further archaeological investigations may determine whether or not this potential deposit or structure is related to the promontory fort itself or past agricultural activities.

Anomaly groups 15 and 16 which straddle the boundary between fields 4 and 6 (figures 2 and 3) seem to represent a sub-circular feature that is visible on Google Earth images. An archaeological origin is possible for such an anomaly group although a former quarry or natural feature cannot be ruled out. Further archaeological investigations are required if this is to be resolved.

Magnetic anomaly groups 26, 42 and 43, and resistance anomaly groups 53, 54 and 55 (figures 3 and 5) hint at possible archaeological deposits or structures adjacent to the extant earthworks at the eastern end of the promontory fort.

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.

5 Acknowledgements

Substrata would like to thank John Valentin of AC Archaeology Ltd for commissioning us to complete this survey and Tanya James of AC Archaeology for her project management.

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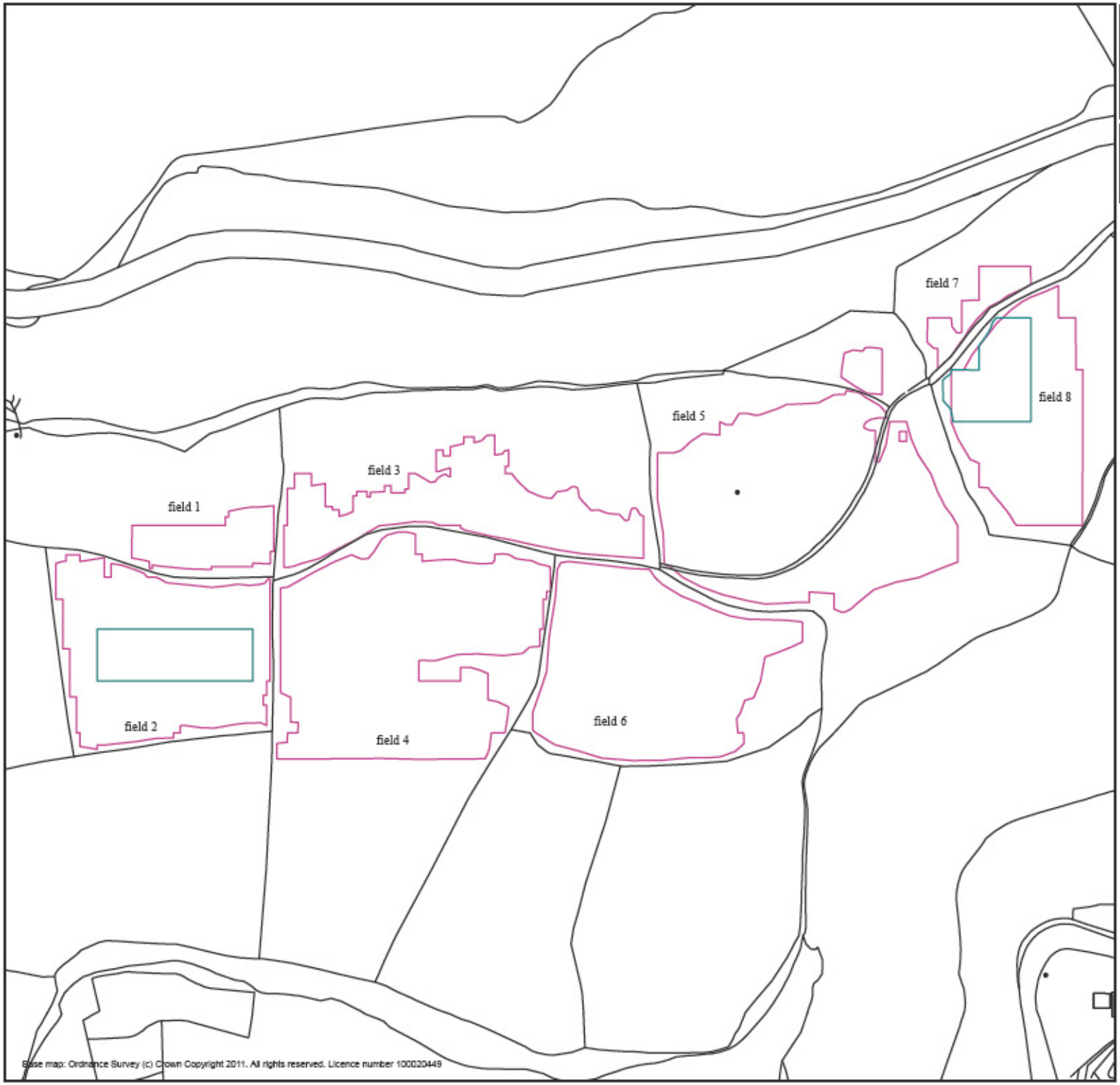
Appendix 1 Supporting plots

General Guidance

The anomalies represented in the survey plots provided in this appendix are magnetic or earth resistance 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.

A rough rule for interpreting resistance anomalies is that if an x-y trace is drawn of the resistance over an anomaly, then the width of an anomaly at half its maximum height is equal to the width of the buried feature. Caution must be applied when using this rule as it depends on the anomalies being clearly identifiable and distinct from adjacent anomalies and it should be noted that the relationship between change in resistance response and depth is not linear (Gaffney and Gater 2003, 112).



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Land at Countisbury Castle, Wind Hill, Lynmouth, Devon
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Report: 120321

N

Legend

resistance survey area

gradiometer survey area

0 25 50 100 Meters

Figure 6: survey areas and field designations

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N

Legend

processed gradiometer data

Value

High : 4
nT
Low : -4

0 12.5 25 50
Meters

Figure 7: processed gradiometer data, fields 1 to 4

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N

Legend

processed gradiometer data

Value

High : 4

nT

Low : -4

0 12.5 25 50 Meters

Figure 8: processed gradiometer data, fields 5 to 8

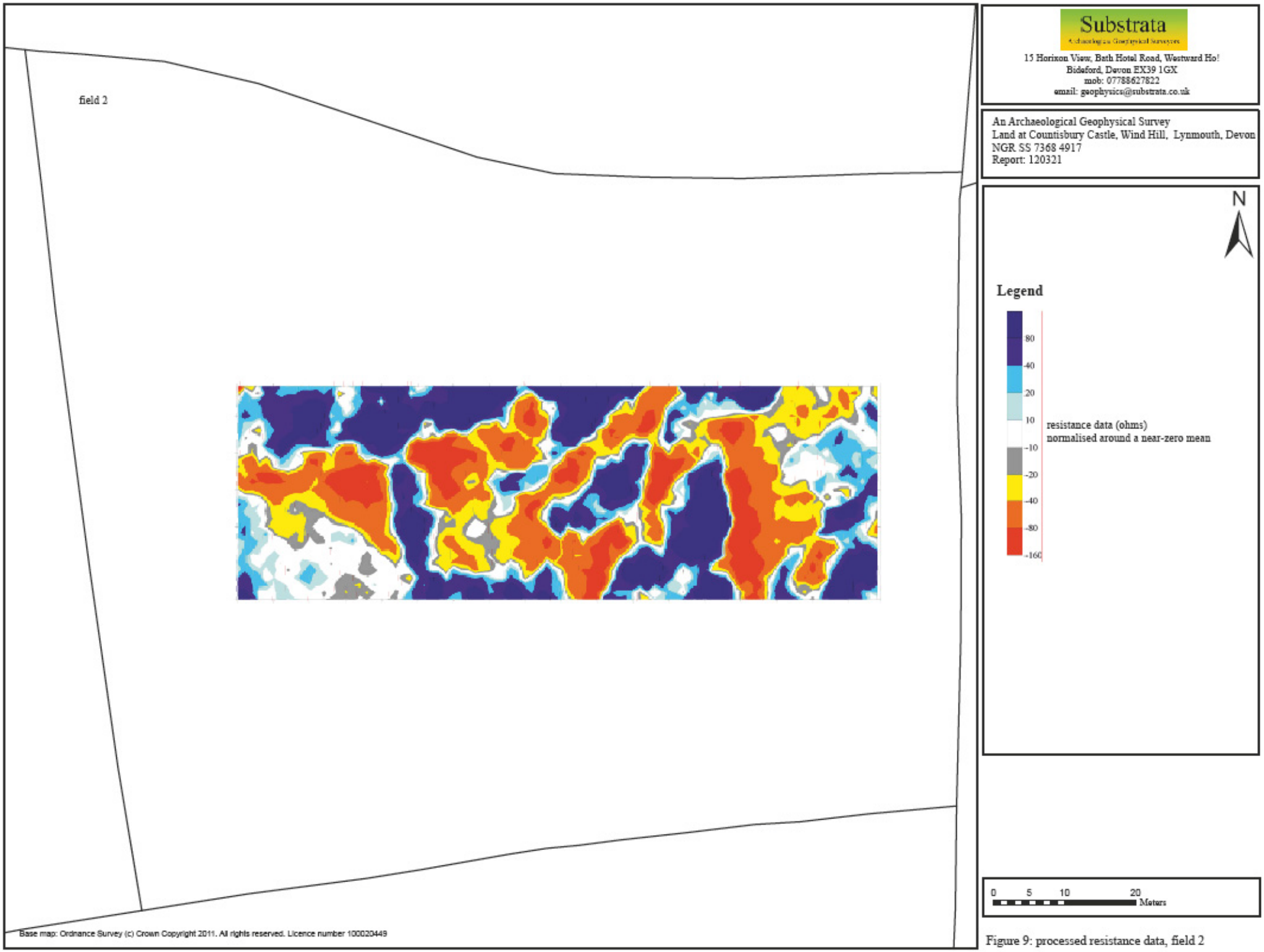

Figure 9: processed resistance data, field 2

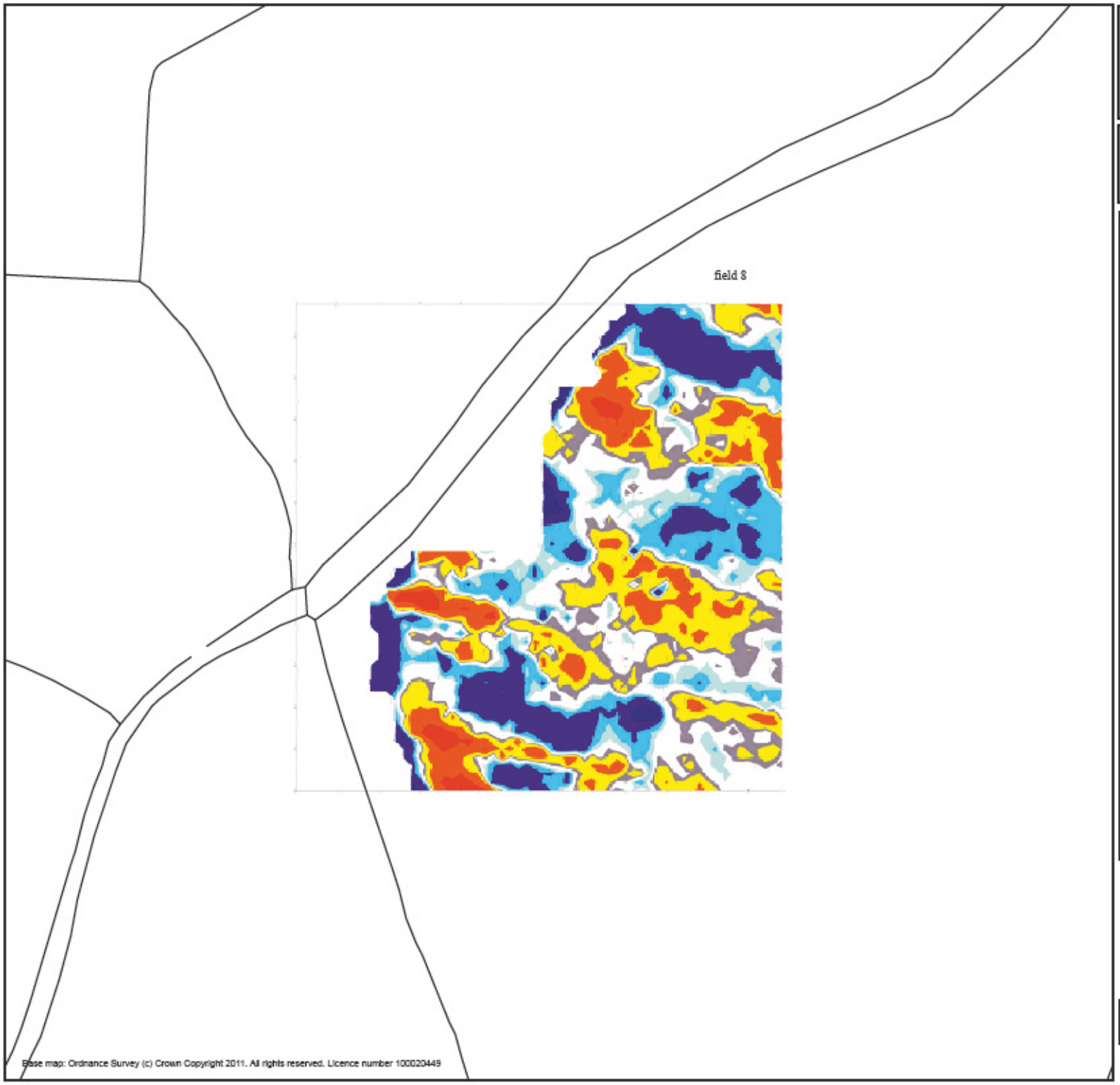

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Figure 10: processed resistance data, field 8

Appendix 2 Survey methodology

Table 4: survey methodology
Documents Brief and minimum specification: James (2011) Project design: Dean (2011)
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 used a temporary survey grid accurately positioned using a suitable DGPS system, co-registered to the Ordnance Survey National Grid using a digital map. The survey grid was composed of continuous 30m by 30m sub-grids. 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:* 30–metre by 30-metre grids *Recording:* Geo-referenced and recorded using digital map tiles. *Traverse Orientation:* grid north (gradiometer), grid east (resistance)
Data processing, analysis and presentation software DW Consulting ArcheoSurveyor2 ArcGIS 9.3 Golden Software Inc. Surfer 8 Autodesk AutoCAD 2004LT Microsoft Corp. Office Publisher 2003.
Gradiometer survey equipment and data capture *Instrument:* Bartington Instruments grad601-2, *Firmware:* version 6.1 *Sample Interval:* 0.125-metres, *Traverse Interval:* 1-metre, *Traverse Method:* zig-zag
Earth resistance survey equipment and data capture *Instrument:* Geoscan Research RM15/MPX15 twin probe earth resistance with parallel twin log mode 2(4P), *Firmware:* RM15 Adv. 30000 Version 2.00 *Sample Interval:* 1-metres, *Traverse Interval:* 1- metre, *Traverse Method:* zigzag
Earth resistance instrument settings: *Gain*: x 1 *Current:* 1 mA *Frequency:* 137 Hz *Output voltage:* 40 V *Auto-log speed:* medium *High pass filter:* 13 Hz *Mains frequency:* 50 Hz *Hardware:* PA5 *Interface:* MPX15 *Log mode:* parallel twin *Parallel reads:* 2(4P) *Baud rate:* 9600 *Data separator:* no space

Appendix 3 Data processing

Table 5: gradiometer survey - processed data metadata, figures 7 and 8
Software: DW Consulting ArcheoSurveyor v 2.5.16.0

Stats

Max:	105.51
Min:	-101.31
Std Dev:	6.57
Mean:	0.26
Median:	0.00
Surveyed Area:	7.29 ha

Processes: 9

1 Base Layer
2 Clip at 1.00 SD
3 De Stagger: Grids: All Mode: Both By: -3 intervals
4 De Stagger: Grids: cb29.xgd Mode: Both By: -3 intervals
5 De Stagger: Grids: cb46+cb45.xgd Mode: Both By: -2 intervals
6 De Stagger: Grids: cb89.xgd Mode: Both By: -4 intervals
7 DeStripe Median Sensors: All
8 De Stagger: Grids: cb104+cb88.xgd cb95+cb105.xgd cb114+cb96.xgd cb115.xgd cb125.xgd cb103.xgd cb106.xgd cb113.xgd cb116.xgd cb126.xgd cb130.xgd Mode: Both By: -3 intervals
9 De Stagger: Grids: cb71+cb99.xgd cb102.xgd cb107.xgd cb112.xgd cb117.xgd cb127.xgd cb100.xgd cb101.xgd cb108.xgd cb111.xgd cb118.xgd cb128.xgd cb109.xgd cb110.xgd cb120+cb119.xgd cb124+cb123.xgd Mode: Both By: -3 intervals

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

Table 6: resistance survey, field 2 - processed data metadata (figure 9)
Software: DW Consulting ArcheoSurveyor v 2.5.16.0
Stats Max: 347.26 Min: -158.23 Std Dev: 73.14 Mean: 8.58 Median: -1.85 Surveyed Area: 0.27 ha Processes: 3 1 Base Layer 2 Despike Threshold: 1 Window size: 3x3 3 High pass Gaussian filter: Window: 21 x 21 Note: interpolation match x & y doubled is completed during export from ArcheoSurveyor to georeferenced ERSI format

Table 7: resistance survey, field 8 - processed data metadata (figure 10)
Software: DW Consulting ArcheoSurveyor v 2.5.16.0
Stats Max: 114.99 Min: -108.45 Std Dev: 39.84 Mean: 0.30 Median: -2.51 Composite Area: 0.36 ha Surveyed Area: 0.23 ha Processes: 4 1 Base Layer 2 Despike Threshold: 1 Window size: 3x3 3 Clip from 148.00 to 350.00 Ohm 4 High pass Uniform filter: Window: 21 x 21 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.