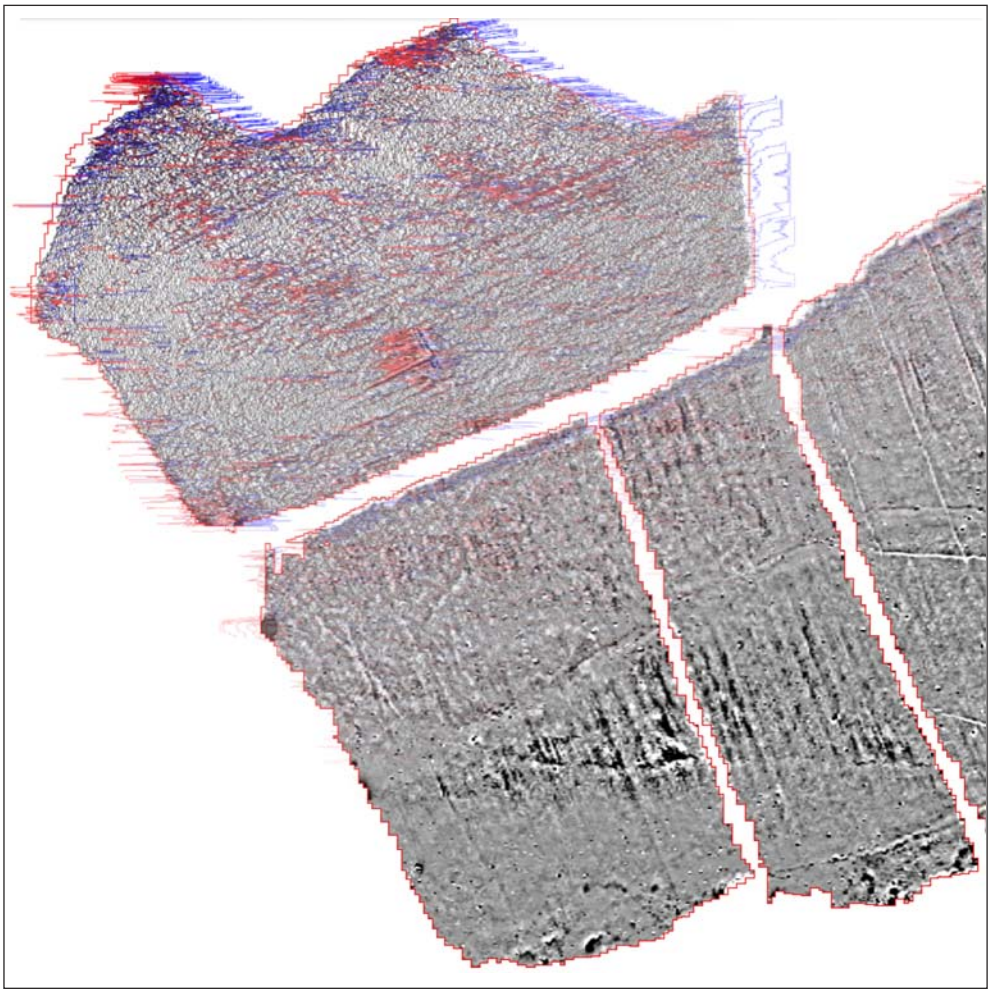
making sense of heritage

Land at Crinacott Farm Pyworthy, Devon

Detailed Gradiometer Survey Report



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geoservices

Land at Crinacott Farm
Pyworthy, Devon

Detailed Gradiometer Survey Report

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* I = Internal Draft; E = External Draft; F = Final

Land at Crinacott Farm
Pyworthy, Devon

Detailed Gradiometer Survey Report

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Summary

A detailed gradiometer survey was conducted over land at Crinacott Farm, near Pyworthy, Devon. The project was commissioned by vogt solar Ltd. with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of a proposed solar farm development and forms part of an ongoing programme of archaeological work.

The site comprises six pasture fields to the south of Pyworthy, Devon, approximately 4km southwest of Holsworthy and 11km east of Bude, Cornwall. The site is located on the southern flank of a low ridge overlooking a stream at the base of a shallow valley. The gradiometer survey covered 19.1 ha and has demonstrated the presence of anomalies of definite, probable and possible archaeological interest within the survey area, along with regions of increased magnetic response.

The clearest anomalies of archaeological interest are consistent with former field boundaries, of which several were identified within the survey areas. Many of these appear on historic mapping and were noted in a previous desk-based assessment (Wessex Archaeology 2013). A number do not appear on historic maps however, and indicate further subdivisions of the former known field systems.

Several clusters of anomalies have been identified at the northern and southern extents of the survey areas. The proximity of these anomalies to the existing boundaries and their limited extents within the survey area have made the interpretation less conclusive, although it is possible that they are of archaeological interest. A possible sub-circular anomaly has been identified towards the eastern extent

Numerous regions of increased magnetic response appear throughout the survey areas and it is considered likely that they are geological in origin; it is interesting to note the relative enhancement of ploughing trends in these regions. Clusters of linear and pit-like anomalies are closely associated with these regions; although they have been interpreted as being of possible archaeological interest, a geological origin cannot be discounted entirely.

Elsewhere within the survey area, numerous linear and curvilinear trends are visible on differing orientations to local ploughing trends. Although the origin of these trends is unclear, it is possible that some may be archaeological in origin; it is considered that many will relate to changes in the near-surface geology or agricultural activity.

A network of linear anomalies within one of the survey areas is likely to relate to field drainage.

Land at Crinacott Farm
Pyworthy, Devon

Detailed Gradiometer Survey Report

Acknowledgements

The detailed gradiometer survey was commissioned by vogt solar Ltd. The assistance of Debbie Marriage of Parker Dann on behalf of vogt solar UK is gratefully acknowledged in this regard. Wessex Archaeology would also like to thank the landowner Mark Burnard for granting access.

The fieldwork was directed by Ben Urmston and assisted by Laura Andrews, Rachel Chester, Clara Dickinson and Jen Smith. Ben Urmston processed and interpreted the geophysical data in addition to writing this report. The geophysical work was quality controlled by Dr. Paul Baggaley. Illustrations were prepared by Linda Coleman. The project was managed on behalf of Wessex Archaeology by Chloe Hunnisett.

Land at Crinacott Farm
Pyworthy, Devon

Detailed Gradiometer Survey Report

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by vogt solar Ltd. to carry out a geophysical survey of land at Crinacott Farm, Pyworthy, Devon (**Figure 1**), hereafter "the Site" (centred on NGR 230815 101634). The survey forms part of an ongoing programme of archaeological works being undertaken ahead of proposed solar farm development at the Site.

1.1.2 The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the survey area.

1.1.3 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 The Site

1.2.1 The survey area comprises six pasture fields adjacent to Crinacott Farm, some 4km southwest of Holsworthy, Devon, and 11km ESE of Bude, Cornwall (**Figure 1**). Detailed gradiometer survey was undertaken over all accessible parts of the Site, a total of 19.1 ha.

1.2.2 The Site is situated on the southern flank of a low ridge, sloping from 120m above Ordnance Datum (aOD) in the north to 100m aOD along the southern edge, and overlooks a shallow valley. The survey area lies within a wider landscape of largely pasture fields with occasional arable plots; the buildings forming Crinacott Farm lie to the west of the Site.

1.2.3 The soils underlying the Site are likely to be pelo-stagnogleys of the 712d (Hallsworth 1) association (SSEW 1983). Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed magnetometer survey was conducted using a Bartington Grad601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team between 13th and 20th December 2012. Field conditions at the time of the survey were reasonable, with the ground largely saturated due to prolonged rainfall.

2.2 Method

2.2.1 Individual survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS system, which is precise to approximately 0.02m and therefore exceeds English Heritage recommendations (2008).

2.2.2 The magnetometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1m between sensors. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with EH guidelines (2008). Data were collected in the zigzag method.

2.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (±5nT thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied to all survey areas, with no interpolation applied.

2.2.4 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

3 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

3.1 Introduction

3.1.1 The gradiometer survey has been successful in identifying anomalies of definite, probable and possible archaeological interest across the Site, along with a number of modern services. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:2000 (**Figures 2** and **3**). The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT at 50nT per cm for the XY trace plots.

3.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figure 4**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.

3.1.3 Numerous ferrous anomalies are visible throughout the detailed survey dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

3.2 Gradiometer Survey Results and Interpretation

3.2.1 At the northern extent of Area A, a cluster of curvilinear anomalies **4000** lies at the corner of the field and appears to extend northwards under the boundary. As the origin of these anomalies is unclear and the surveyed extents in plan limited, they are considered to be of possible archaeological interest.

3.2.2 Linear ditch-like anomalies **4001** and **4002** are likely to relate to a former field boundary oriented NE-SW. There is an apparent orthogonal junction, with further linear anomalies extending NNW-SSE across the centre of the survey area. It should be noted that the linear band of increased magnetic response between **4001** and **4002** is due to overhead electricity cables.

3.2.3 Towards the west of Area A, two regions of increased magnetic response **4003** are coincident with strong ploughing trends. This is consistent with near-surface geological deposits having been disturbed through ploughing.

3.2.4 Rectilinear anomalies **4004** exhibit weak contrast with the magnetic background, although their form is consistent with the remnants of a former field system. It is possible that linear anomaly **4005** also relates to a former boundary.

3.2.5 Rectilinear anomalies **4006** are typical of the remnants of former field boundaries in Devon and Cornwall, and are clearly defined by strongly magnetised linear anomalies of alternating polarity. The orientation of **4006**, approximately NNW-SSE and ENE-WSW, is shared by **4001**, **4002**, **4004** and **4005**, supporting their interpretation as elements of a network of former fields.

3.2.6 A series of curvilinear trends **4007** can be seen towards the southeastern corner of Area A. The origin of these trends is unclear and, although it is possible that they are agricultural in origin, other ploughing trends nearby are more linear and regularly spaced. It is therefore possible that these are geological in origin.

3.2.7 Linear anomalies **4008** and **4009** lie close to or within regions of increased magnetic response, although they are more clearly defined from the general background. It is possible that **4009** represents part of a former boundary, although this interpretation is made less certain by the presence of ploughing trends on the same alignment.

3.2.8 Within Area B, linear anomaly **4010** extends NE-SW across a region of increased response. The origin of the linear anomaly is unclear and may therefore be of archaeological interest.

3.2.9 Towards the centre of Area B, curvilinear anomalies **4011** and **4012** extend across the survey area from west to east, with a possible break in the response near centre. These anomalies are consistent with the remnants of a former boundary. **4012** shares a similar alignment to **4017** in Area C.

3.2.10 Linear and amorphous anomalies **4013** lie within a region of increased magnetic response. Whilst the enhanced magnetic background is thought to be geological in origin, it is possible that the longer linear anomaly in particular relates to a former boundary and may be of archaeological interest.

3.2.11 Near the southern boundary of Area B, linear and pit-like anomalies **4014** and **4015** are of possible archaeological interest.

3.2.12 At the northwestern corner of Area C, linear and pit-like anomalies **4016** are coincident with a region of increased response and strong ploughing trends. It is therefore possible that these anomalies reflect local enhancement of the soils through geological material being ploughed to the surface, although they have been tentatively interpreted as being of possible archaeological interest.

3.2.13 Linear ditch **4017** is relatively poorly defined from the magnetic background although it shares an orientation similar to that of **4012** in Area A and **4025** in Area C. It is consistent with the remnants of a field boundary.

3.2.14 To the south of **4017**, linear and amorphous anomalies **4018**, **4019** and **4020** are coincident with regions of increased response and ploughing trends. It is considered that they may be of geological origin as with **4016**, although this is not conclusive.

3.2.15 Near the southern boundary of Area C, linear anomaly **4021** is consistent with a former boundary or ditch and is relatively well defined from the magnetic background. Region of increased response **4022** is likely to be geological in origin, given its proximity to the stream to the south; it is possible that the pit-like anomalies seen within reflect alluvial or fluvial deposits.

3.2.16 Near the northern corner of Area D, linear anomalies **4023** may be archaeological interest, although they are not clearly defined and their proximity and orientation with respect to the ploughing trends nearby suggests that they may be agricultural in origin.

3.2.17 Linear anomaly **4024** is parallel with strong ploughing trends, although it is more clearly defined.

3.2.18 Linear anomaly **4025** is on a similar orientation to **4017** in Area C and **4032** in Area E and is consistent with the remnants of a field boundary.

3.2.19 Complex of negative linear anomalies **4026** is likely to be associated with field drainage. Although difficult to ascertain conclusively, these are likely to be relatively modern in origin given their form; the responses suggest that they may be of plastic or gravel backfill construction.

3.2.20 Small region of increased magnetic response **4027** lies towards the southern boundary of Area D. Its origin is uncertain although it is possibly geological in nature.

3.2.21 Complex of anomalies **4028** and **4029** borders the southernmost extent of Area D and is of possible archaeological interest. The interpretation has been made less conclusive through the presence of magnetic disturbance and their proximity to the boundary.

3.2.22 Within Area E, regions of increased magnetic response **4030** and **4031** lie towards the northern extent. As with similar anomalies in other survey areas, these are considered likely to be geological in origin.

3.2.23 Linear anomaly **4032** is poorly defined from the magnetic background; it shares the alignment of **4025** in Area D, however, and it is likely that it represents part of a former boundary.

3.2.24 Linear anomaly **4033** is consistent with a segment of ditch, although it does not appear to relate to any other anomaly nearby; two pit-like responses lie near the southern extent of **4033**. Their origin is uncertain, although they may be of archaeological interest.

3.2.25 Region of increased magnetic response **4034** lies at the southernmost extent of Area E. Given its proximity to the stream to the south, it is possible that it is of alluvial origin.

3.2.26 Curvilinear ditch **4035**, at the northernmost extent of Area F, is likely to represent a former field boundary. A spur near its centre extends north, suggesting further subdivisions; it may also be associated with **4037**.

3.2.27 A cluster of pit-like and linear anomalies **4036** is coincident with a region of increased response and ploughing trends. It is possible that these anomalies are of archaeological interest, but a geological origin is also conceivable.

3.2.28 Linear anomaly **4037** extends NNW-SSE between **4035** to the north and **4038** to the south. Given the linear anomalies **4038** and **4039** are consistent with a former field boundary, it is considered probable that **4035** and **4037** to **4039** represent a system of small fields across the northern portion of the survey area.

3.2.29 Sub-annular anomaly **4040** exhibits very weak contrast with the magnetic background and has been interpreted as being of possible archaeological interest largely based upon its form in plan.

3.2.30 Region of increased magnetic response **4041** lies in close proximity to a pit-like anomaly. Their origins are uncertain however.

3.2.31 Several curvilinear and sub-circular trends can be seen within Area F, e.g. **4042**. Their lack of contrast with the magnetic background makes it difficult to interpret them with confidence, although their lack of definition suggests that they may be natural or agricultural in origin.

3.2.32 At the southernmost extent of Area F, linear and pit-like anomalies **4043** are of uncertain origin. Whilst it is possible that they may be of archaeological interest, it is equally possible that they relate to agricultural activity or changes in the near-surface geology.

4 CONCLUSION

4.1.1 The detailed gradiometer survey has been successful in detecting anomalies of definite, probable and possible archaeological interest within the Site, in addition to regions of increased magnetic response ploughing trends.

4.1.2 The most clearly defined anomalies within the survey areas are the remnants of former field boundaries. A series of rectilinear anomalies within Area A (**4001**, **4002**, **4006**) correspond with boundaries marked on the 1838 Tithe map and parts existed until at least 1907 (WA 2013). Anomalies identified within Areas B to E (**4011**, **4012**, **4017**, **4025**, **4032**) correspond with a former boundary, parts of which survived until the 1950s. A further boundary was identified in Area F (**4038**, **4039**), which appears on the 1885 Ordnance Survey map (WA 2013). Strong ploughing trends can be seen within each of the survey areas, typically oriented parallel with the longest axis of each field, although it is not possible to determine the relative phasing of the ploughing and the former boundaries.

4.1.3 Several other anomalies consistent with former boundaries were identified within Areas A (**4004**, **4005**, **4009**), B (**4013**) and F (**4035**, **4037**). Whilst these do not appear on historic mapping, it is likely that they are associated with further subdivisions of the known field systems. Curvilinear **4013** in Area B lies near the base of the slope and marks a change in the texture of the magnetic background, which is markedly quieter to the south; it is also possible that linear trends on the same alignment in Area C may be associated with **4013**.

4.1.4 A linear anomaly close to the southern extent of Area C (**4021**) may extend to the east into Area D (**4028**, **4029**). The origin of these anomalies is difficult to determine given their proximity to the extant boundary and limited extent within the survey areas.

4.1.5 Linear and pit-like responses appear throughout the dataset, frequently associated with regions of increased response. It is considered likely that many of these represent magnetically enhanced geological material disturbed through ploughing and accumulating in former plough furrows; linear anomalies appearing within regions of strong ploughing trends may therefore be geological in nature, although an archaeological origin cannot be discounted given their form in plan.

4.1.6 A cluster of anomalies (**4000**) at the northern extent of Area A may be archaeological in origin, although it is difficult to interpret these responses with confidence. They are somewhat different in character to other anomalies considered more likely to be geological in origin.

4.1.7 Several curvilinear anomalies and trends can be seen within the dataset, e.g. **4040**. Given the responses seen over former boundaries and regions of probable near-surface geological changes, it is considered likely that substantial archaeological features would produce magnetic anomalies of sufficient magnitude to be clearly visible. However, if these anomalies represent archaeological features, it is possible that the lack of magnetic contrast is due to truncation through ploughing.

4.1.8 It should be noted that small, weakly magnetised features may produce responses that are below the detection threshold of magnetometers; this is particularly the case in areas under greater colluvial or alluvial overburden. It may therefore be the case that more archaeological features may be encountered than have been identified through geophysical survey.

5 REFERENCES

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation*. Research and Professional Service Guideline No 1, 2nd edition.

Soil Survey of England and Wales, 1983. Soil Survey of England and Wales: *Sheet 5, Soils of South West England*. Ordnance Survey, Southampton.

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APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a ±100nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. Both types depend upon the establishment of an accurate 20m or 30m site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25m intervals along transects spaced 10m apart, acquiring a minimum of 80 data points per transect. Due to the relatively coarse transect interval, scanning surveys should only be expected to detect extended regions of archaeological anomalies, when there is a greater likelihood of distinguishing such responses from the background magnetic field.

The detailed surveys consist of 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m grid respectively, and are the recommended methodologies for archaeological surveys of this type (EH, 2008).

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125m intervals along traverses spaced up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by English Heritage (2008) for characterisation surveys.

Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

Typical data and image processing steps may include:

- Destripe – Applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- Destagger – Shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Despike – Filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data)

Typical displays of the data used during processing and analysis:

- XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

APPENDIX 2: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by Wessex Archaeology separates the anomalies into two main categories: archaeological and unidentified responses.

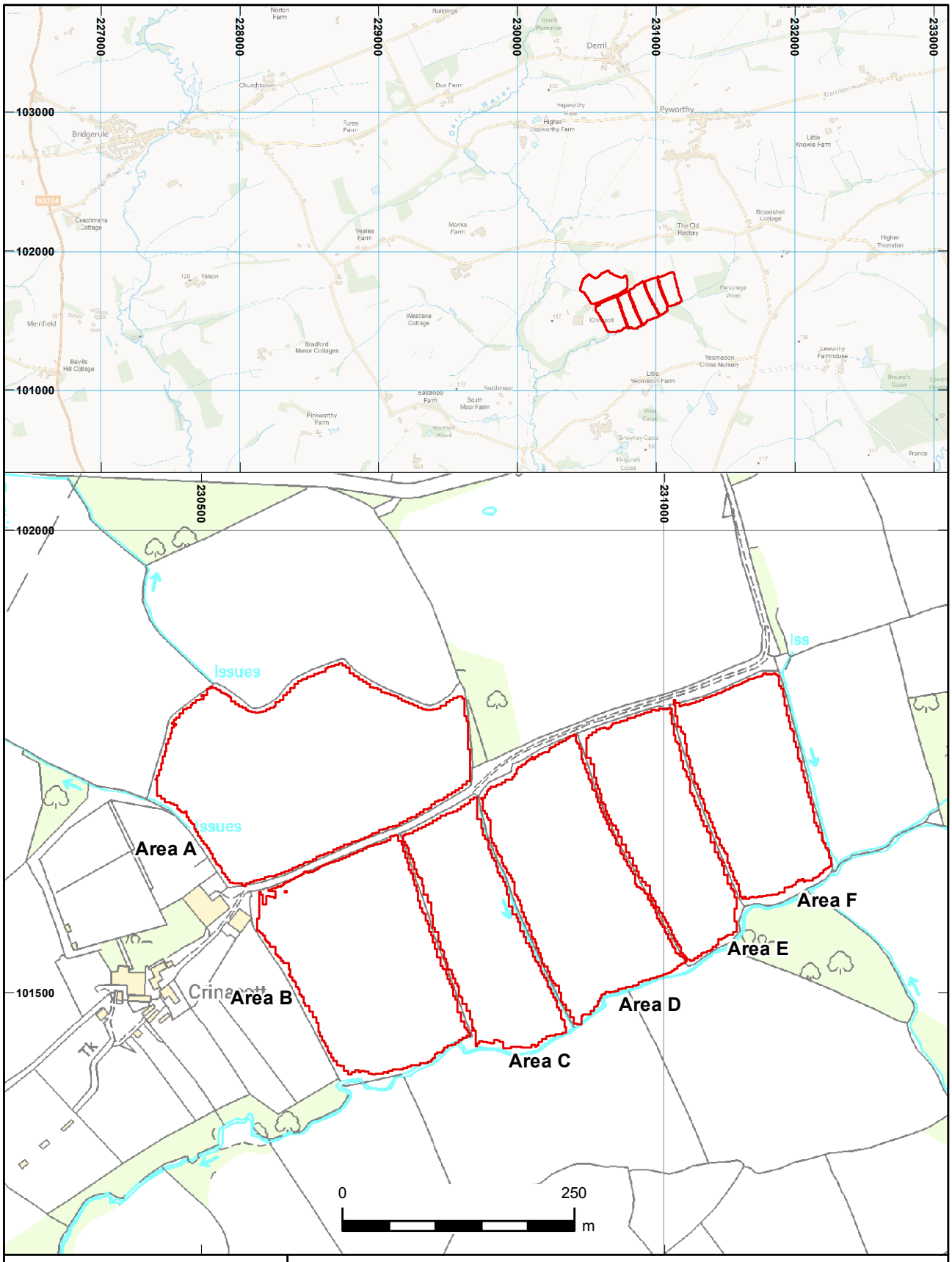
The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.
- Possible archaeology – used for features which give a response but which form no discernible pattern or trend.

The unidentified category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend – used for low amplitude or indistinct linear anomalies.
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.

Finally, services such as water pipes are marked where they have been identified.



Detailed Survey Extents

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Site location and survey extents

Figure 1

230500
230600
230700
230800
230900
231000
231100

101800
101700
101600
101500
101400

Area A
Area B
Area C
Area D
Area E
Area F

+6nT
-4nT

0
100
m

Detailed Survey Extents

Date:	11/01/13	Revision Number:	0
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Greyscale

Figure 2

230500
230600
230700
230800
230900
231000
231100

101800
101700
101600
101500
101400

Area A
Area B
Area C
Area D
Area E
Area F

+25nT
-25nT

0
100
m

Detailed Survey Extents

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XY trace

Figure 3

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Interpretation

Figure 4

salisbury rochester sheffield edinburgh

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