ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

on behalf of
Wessex Solar Energy

Bidwell Solar Park
Totnes
Devon

geophysical survey

report 3016
October 2012

Durham University

Contents

Figures

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1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted in advance of proposed development at South Downs, near Totnes, Devon. The works comprised the geomagnetic survey of approximately 17.5ha.

1.2 The works were commissioned by Wessex Solar Energy and conducted by Archaeological Services Durham University.

Results

1.3 Many strong anomalies were detected on the higher ground around South Downs. It is possible that these reflect igneous geological material derived from basalt and dolerite sills within the underlying slates. However, the anomalies could equally reflect industrial waste such as iron slag from metal-working activities. Although no furnaces have been identified within the current survey areas, some iron slag and furnaces have been found close to the proposed development area.

1.4 Occasional soil-filled features of possible archaeological origin have been detected in most areas, though identification of such features has been hindered by the presence of so many strong anomalies in some areas. Some of the ditches in Area 8 could reflect former enclosures.

1.5 Former field boundaries have been identified in Areas 1, 2, 4 and 6-8.

1.6 Former ploughing has been detected across most of the surveyed areas.

1.7 A high pressure gas main crosses the proposed development area aligned broadly north-east/south-west, passing through most of the areas surveyed.

1.8 A service pipe has also been detected in Area 3.

1.9 Field drains have been identified in Areas 1, 6, 7 and 8.

2. Project background

Location (Figure 1)

2.1 The proposed development area was located on land at South Downs, Dartington parish, near Totnes in Devon (NGR centre: SX 7713 6136). Nine surveys totalling 17.5ha were conducted in nine land parcels. The site is bounded to the north by the A385 road and to the south by a stream flanked by woodland. Open farmland lies to the east and west.

Development proposal

2.2 The development proposal is for a solar farm.

Objective

2.3 The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological significance within the proposed development area, so that an informed decision may be made regarding the nature and scope of any further scheme of archaeological works that may be required in relation to the development.

Methods statement

2.4 The surveys have been undertaken in accordance with instructions from the client and in line with national standards and guidance (see para. 5.1 below).

Dates

2.5 Fieldwork was undertaken between 1st and 5th October 2012. This report was prepared for 26th October 2012.

Personnel

2.6 Fieldwork was conducted by Natalie Swann (Supervisor), Nathan Thomas and Rebecca Watson. The geophysical data were processed by Natalie Swann and Duncan Hale (the Project Manager). This report was prepared by Natalie Swann and Duncan Hale, with illustrations by David Graham and Janine Watson.

Archive/OASIS

2.7 The site code is **TBS12**, for **T**otness **B**idwell **S**olar Park 20**12**. The survey archive will be supplied on CD to the client for deposition with the project archive in due course. Archaeological Services Durham University is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (**OASIS**). The OASIS ID number for this project is **archaeol3-136379**.

3. Historical and archaeological background

Previous archaeological works

3.1 An archaeological desk-based assessment was conducted for the proposed development area (Archaeological Services 2010); the results of that assessment are summarised here.

3.2 The Fishacre to Lyneham natural gas pipeline passes through the proposed development area. It was therefore included within the area of the desk-based assessment for this pipeline (HER 4375) and also within the fieldwalking survey (HER 4391) that was conducted along the length of the pipeline route before construction

began in 2001 (Cotswold Archaeology 2001a; 2001b). Neither of these projects produced results of significance to the current proposed development area, although former field boundaries (HER 74591) were noted in the field immediately to the west of it. Archaeological monitoring was conducted during a major upgrade to the pipeline in 2010 and a post-excavation assessment report has been produced (Cotswold Archaeology 2010). The results are discussed below (paragraph 3.3).

The prehistoric and Roman Periods (up to 5th century)

3.3 Until recently there was no direct evidence of prehistoric or Roman activity in the study area, although it was anticipated that the area would have been exploited in prehistory. However, recent archaeological monitoring during the upgrade to the natural gas pipeline revealed a group of undated pits and burnt areas between 0.6m and 1.0m in diameter and 0.07-0.09m deep in Plot 16.1 of that project (the north-east corner of the current proposed development area). These were interpreted as fire pits or hearths for metal-working. Further west in Plot 16.7 (immediately west of the current proposed development area) six clay-lined bowl furnaces, 11 pits and nine ditches were found. Some of these contained iron slag. A radiocarbon sample from one furnace established its date as 391-210 cal. BC, within the Iron Age (Cotswold Archaeology 2010). It is possible that the two areas of activity are related, and that the undated deposits found at the eastern end of the proposed development area also date to the Iron Age. There is therefore potential for further unidentified archaeological resources to be present across the site

The medieval period (5th century to 1540)

3.4 There is no evidence of activity during the medieval period in the proposed development area. However, there is evidence that the wider landscape was exploited during the medieval period and there is therefore the potential that an as yet unidentified resource relating to this exploitation may survive within the proposed development area; this is most likely to relate to agricultural activity.

The post-medieval and modern periods (1541 to present)

3.5 During the post-medieval period the site was used for farming and this has remained the case through to the present day. Field boundaries removed during these periods of activity have the potential to survive as buried features.

4. Landuse, topography and geology

4.1 At the time of survey the proposed development area comprised eight fields of pasture. Area 7 was split into two fields by a fence towards the north of the field.

4.2 The proposed development area is slightly undulating and slopes gently down to a minor stream in the south and east. The site occupies elevations between approximately 54m OD in the west and 40m OD in the east.

4.3 The underlying solid geology of the area comprises Middle Devonian Slates, which are overlain by alluvial deposits along the southern boundary of the site. The slate in this general area contains igneous intrusions, both basalt and dolerite sills, which are not shown on British Geological Survey 1:50,000 maps.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation* (David, Linford & Linford 2008); the Institute for Archaeologists (IfA) *Standard and Guidance for archaeological geophysical survey* (2011); the IfA Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Guide to Good Practice: Geophysical Data in Archaeology* (Schmidt & Ernenwein 2011).

Technique selection

5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, based on the desk-based assessment and previous work in the area, it was considered likely that cut features such as ditches and pits might be present on the site, and that other types of feature such as trackways, wall foundations and fired structures (for example kilns and hearths) might also be present.

5.4 Given the anticipated depth of targets and the predominantly non-igneous geological environment of the study area a geomagnetic technique, fluxgate gradiometry, was considered appropriate for detecting the types of feature mentioned above. This technique involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

Field methods

5.5 A 30m grid was established across each survey area and related to known, mapped Ordnance Survey points and the National Grid using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections typically providing 10mm accuracy.

5.6 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad601-2 dual fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 30m grid units. The instrument sensitivity was nominally 0.03nT, the sample interval was 0.25m and the traverse interval was 1m, thus providing 3,600 sample measurements per 30m grid unit.

5.7 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.8 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (minimally processed) data. The greyscale images and interpretations are presented in Figures 2-5; the trace plots are provided in Figure 6. In the greyscale images, positive magnetic anomalies are displayed as dark grey and negative magnetic anomalies as light grey. Palette bars relate the greyscale intensities to anomaly values in nanoTesla.

5.9 The following basic processing functions have been applied to each dataset:

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities
destagger	corrects for displacement of geomagnetic anomalies caused by alternate zig-zag traverses
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

Interpretation: anomaly types

5.10 A colour-coded geophysical interpretation is provided. Three types of geomagnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches
negative magnetic	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths

Interpretation: features

General comments

5.11 A colour-coded archaeological interpretation is provided.

5.12 Except where stated otherwise in the text below, positive magnetic anomalies are taken to reflect relatively high magnetic susceptibility materials, typically sediments in cut archaeological features (such as ditches or pits) whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning.

5.13 A chain of intense dipolar magnetic anomalies has been detected traversing all parts of the site except Areas 1 and 5. This anomaly reflects a high pressure gas main.

5.14 Small, discrete dipolar magnetic anomalies have been detected in each of the survey areas. These may reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments, and in most cases have little or no archaeological significance. However given the discovery of features associated with metal-working both in the north-east of, and to the west of, the proposed development area it is possible that some of the discrete dipolar magnetic anomalies detected in these surveys could reflect ferrous and fired debris from this industrial activity. A sample of these anomalies is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation plans and the following discussion.

Area 1

5.15 The northern part of this survey is covered by a spread of strong magnetic anomalies, generally irregular in shape. In this instance it is possible that the anomalies reflect near-surface intrusive igneous material such as basalt and/or dolerite. The local geology of Middle Devonian Slates is known to contain intrusions of basalt and dolerite sills. The two very strong linear anomalies aligned broadly east-west could reflect dykes or the edges of sills and could be the source of the smaller igneous debris across this part of the site.

5.16 Alternatively, given the known presence of Iron Age metal-working features immediately west of the survey area, it is possible that some of these anomalies could reflect metal-working waste such as iron slag. None of the anomalies has the magnetic characteristics of a clay-lined bowl furnace or other *in situ* fired structure.

5.17 The presence of so many strong anomalies has hindered the detection and identification of weaker anomalies, which might reflect potential archaeological pits and ditches. However, a few potential linear and curvilinear ditch features have been identified. These could possibly reflect parts of former boundaries or enclosures.

5.18 Two linear positive magnetic anomalies detected in the south-east corner of this area correspond to a former field boundary shown on historic maps.

5.19 Three linear negative magnetic anomalies were detected in the south-east part of this survey area. Given the length of two of these anomalies (up to 40m), they are considered more likely to reflect stone drains than stone wall-footings.

Area 2

5.20 An intense linear positive magnetic anomaly was detected aligned north-west/south-east in the north-east corner of this survey area. The anomaly is so strong that it probably reflects another geological dyke, as opposed to a man-made soil-filled ditch feature.

5.21 The remains of a few possible soil-filled features have been identified, which could possibly have archaeological origins.

5.22 A series of narrow, parallel positive magnetic anomalies was detected across this survey area aligned approximately north-west/south-east; this probably reflects former ploughing.

5.23 An intense linear magnetic anomaly across the southern part of this survey corresponds to a former field boundary shown on historic maps.

Area 3

5.24 A linear positive magnetic anomaly was detected aligned approximately east-west in this area, which may reflect a soil-filled ditch.

5.25 Weak linear positive magnetic anomalies were detected aligned approximately north-south which probably reflect former ploughing of this area.

5.26 A narrow chain of dipolar magnetic anomalies was detected aligned north-south in the western part of this area. This almost certainly reflects a service pipe.

5.27 An intense dipolar anomaly just south of the high pressure gas main could reflect a buried tank or chamber.

Area 4

5.28 Two series of linear positive magnetic anomalies were detected in this area, one aligned north-west/south-east and the other approximately north-east/south-west. These sets of anomalies are separated by a linear anomaly aligned approximately north-south and almost certainly reflect former plough regimes in fields either side of a former field boundary shown on historic maps of the area.

5.29 A short linear positive magnetic anomaly, which may reflect a soil-filled ditch, was detected in the south-east corner of the survey area aligned approximately north-south.

5.30 A concentration of irregular dipolar and positive magnetic anomalies was detected in the southern part of the survey area. These anomalies could reflect another spread of igneous material.

Area 5

5.31 A number of intense linear and discrete positive magnetic anomalies have been detected in this area which may reflect soil-filled ditches and pits or variations in the underlying geology.

Area 6

5.32 Two parallel positive magnetic anomalies were detected in the north-west corner of this area aligned approximately north-west/south-east; these could reflect the remains of a double-ditched track.

5.33 A series of parallel positive magnetic anomalies was detected across much of the northern part of this area, aligned north-east/south-west. These anomalies are likely to reflect former ploughing of the area. A linear anomaly south of and parallel to the ploughing corresponds to a former field boundary.

5.34 To the south of the former field boundary, another series of weak positive magnetic lineations almost certainly reflects land drains.

5.35 A concentration of dipolar magnetic anomalies was detected in the southern part of the area, which, although likely to reflect recent ferrous debris, could possibly indicate a concentration of metal-working debris as recorded during the construction of the gas pipeline.

Areas 7 and 7a

5.36 The northernmost part of this field was separated from the rest by a wire fence and so was surveyed separately (Area 7a).

5.37 Two series of parallel alternate positive and negative magnetic anomalies were detected in this area, one series in the north of the area and one in the south; both series were aligned north-west/south-east. These anomalies are likely to reflect former ploughing of the area.

5.38 A number of straight and narrow negative magnetic anomalies were detected in the north and south of the area, which almost certainly reflect land drains.

5.39 Two comparatively smooth bands of data were detected across the central part of the field. These bands correspond to boggy, linear hollows; one was too boggy to walk through. A tithe map of *c*.1840 shows these as field boundaries, which were removed prior to the first Ordnance Survey edition of 1887.

Area 8

5.40 A number of linear and rectilinear positive magnetic anomalies have been detected across this survey area which could reflect soil-filled ditches and appear to form a series of irregular enclosures and boundary ditches.

5.41 A curvilinear positive magnetic anomaly was detected in the southern corner of the survey area which may reflect a soil-filled ring-ditch approximately 8-9m in diameter.

5.42 A series of parallel positive magnetic anomalies, which are likely to reflect former ploughing, were detected in the southern part of the survey area aligned approximately east-west.

5.43 Two series of parallel negative magnetic anomalies were also detected, one aligned approximately north-south and the other north-west/south-east, which are likely to reflect land drains.

5.44 The northern part of this filed is characterised by relatively strong magnetic variations. This could again be due to the presence of igneous material in the soil, or the presence of metal-working waste.

6. Conclusions

6.1 17.5ha of geomagnetic survey was undertaken at South Downs, near Totnes in Devon, prior to the proposed development of Bidwell Solar Farm.

6.2 Many strong anomalies were detected on the higher ground around South Downs. It is possible that these reflect igneous geological material derived from basalt and dolerite sills within the underlying slates. However, the anomalies could equally reflect industrial waste such as iron slag from metal-working activities. Although no furnaces have been identified within the current survey areas, some iron slag and furnaces have been found close to the proposed development area.

6.3 Occasional soil-filled features of possible archaeological origin have been detected in most areas, though identification of such features has been hindered by the presence of so many strong anomalies in some areas. Some of the ditches in Area 8 could reflect former enclosures.

6.4 Former field boundaries have been identified in Areas 1, 2, 4 and 6-8.

6.5 Former ploughing has been detected across most of the surveyed areas.

6.6 A high pressure gas main crosses the proposed development area aligned broadly north-east/south-west, passing through most of the areas surveyed.

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6.8 Field drains have been identified in Areas 1, 6, 7 and 8.

7. Sources

Archaeological Services 2010 *Land at South Downs, near Totnes, Devon; archaeological desk-based assessment*. Unpublished report **2528**, Archaeological Services Durham University

Cotswold Archaeology 2001a *Fishacre to Lyneham Natural Gas Pipeline: Cultural Heritage Assessment*. Unpublished report **1084**

Cotswold Archaeology 2001b *Fishacre to Lyneham Natural Gas Pipeline: Archaeological Fieldwalking and Field Reconnaissance Survey*. Unpublished report **1224**

Cotswold Archaeology 2010 *South-West Reinforcement Project: Ottery St Mary to Aylesbeare; Aylesbeare to Kenn; Fishacre to Choakford gas pipelines, Devon: Post-excavation assessment and updated project design.* Unpublished report

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IfA 2011 *Standard and Guidance for archaeological geophysical survey*. Institute for Archaeologists

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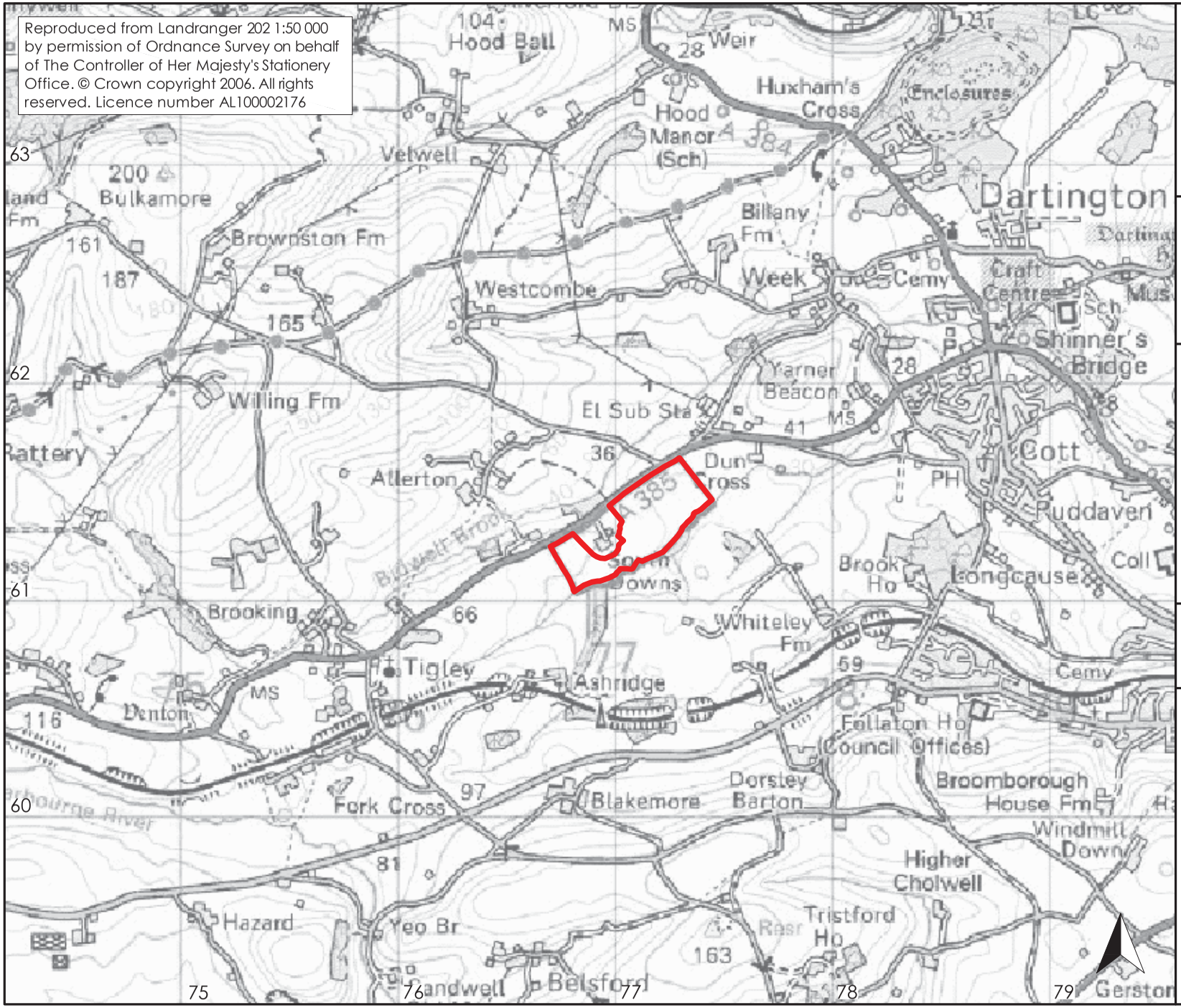

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Figure 1: Site location

0 1km
scale 1:25 000 for A4 plot

site location

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Figure 2: Geophysical survey overview

0 150m
scale 1:3000 for A3 plot

magnetic survey
-20 nT 20


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Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7a
Area 8
Area 7
South Downs
A385
magnetic survey
-20 nT 20
0 50m
scale 1:1000 for A0 plot
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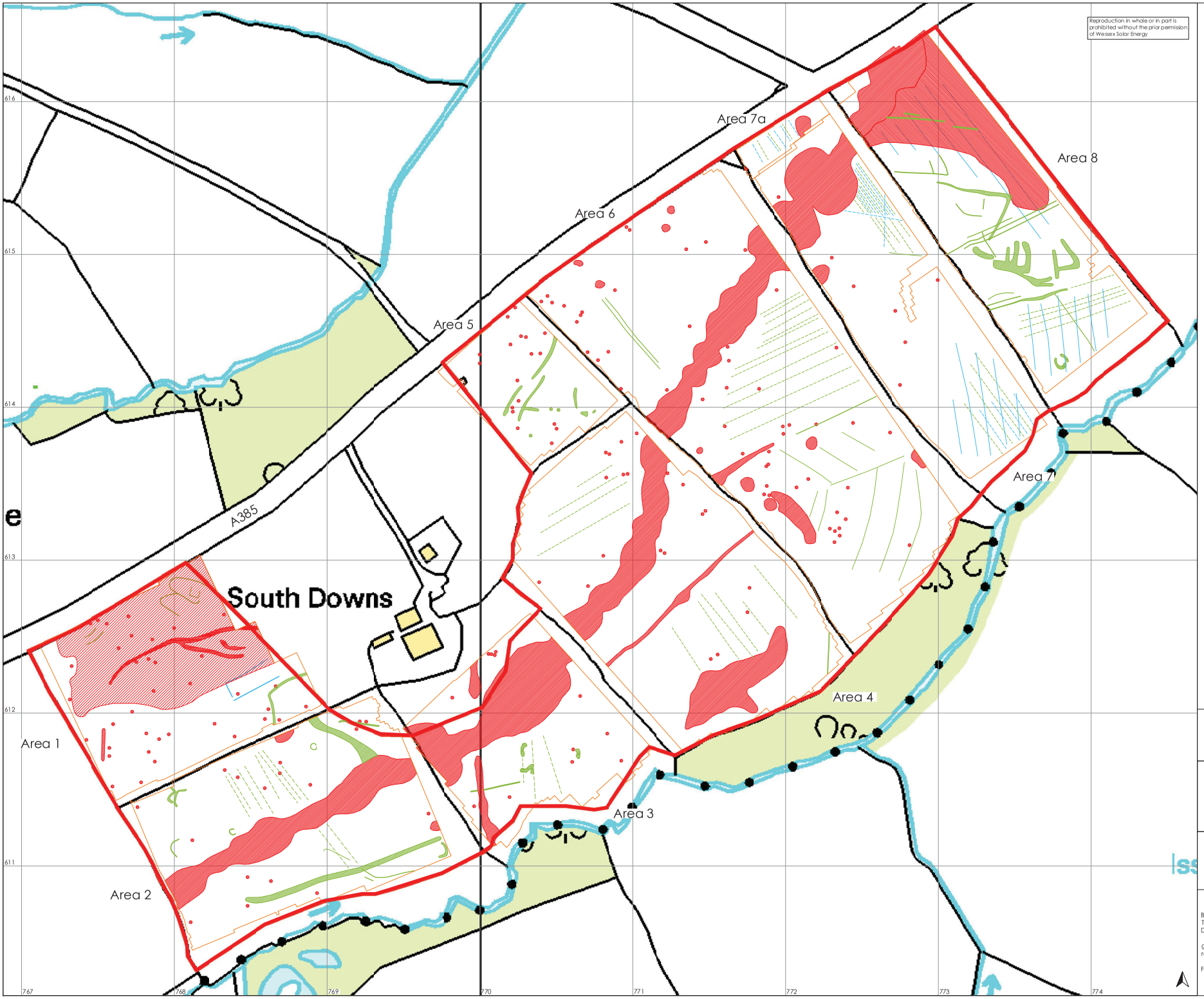
Figure 3: Geophysical survey



magnetic survey
dipolar magnetic anomaly
positive magnetic anomaly
negative magnetic anomaly

0 50m
scale 1:1000 for A0 plot

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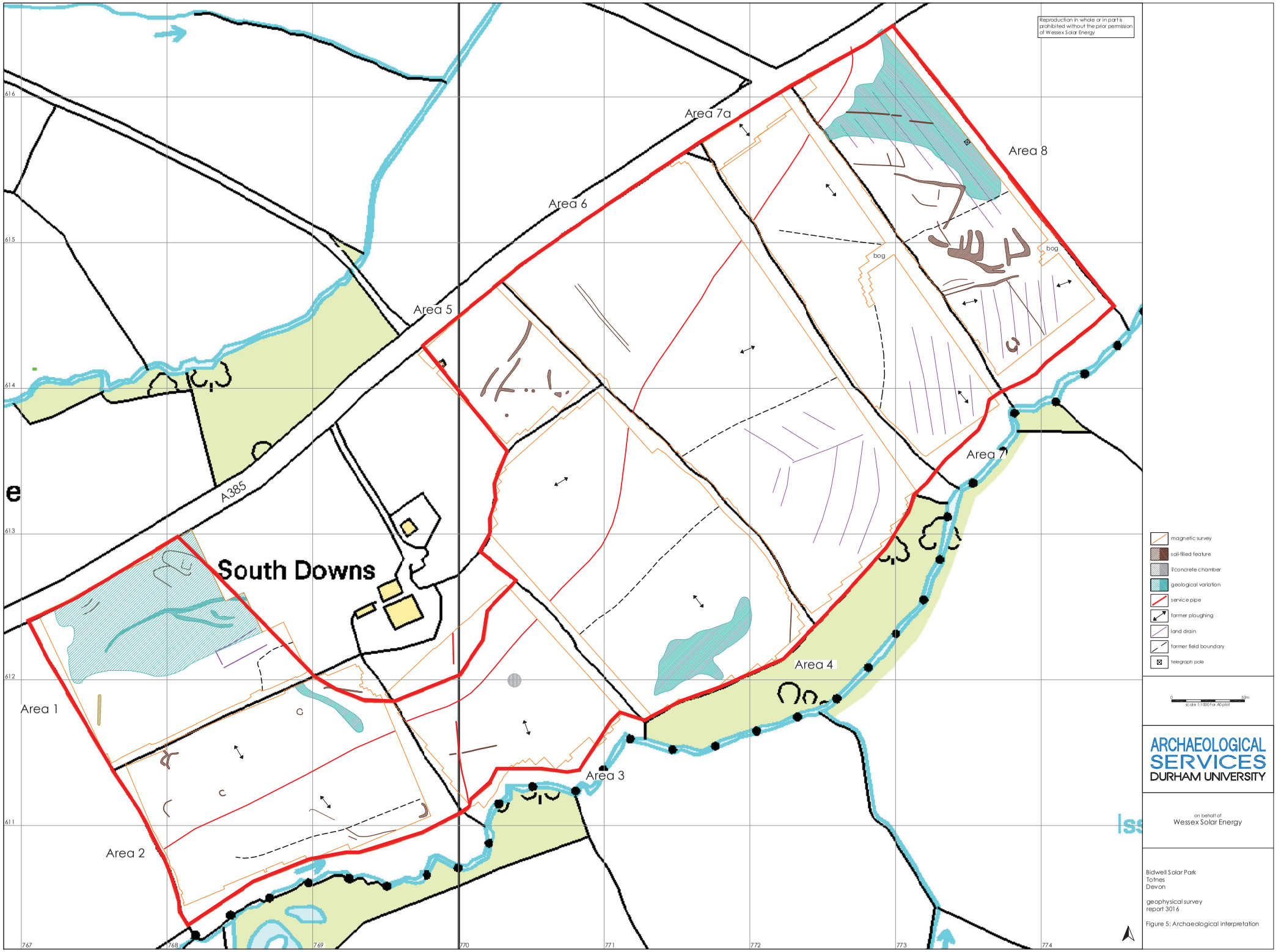
Figure 4: Geophysical interpretation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Area 7a
Area 8
Area 6
Area 5
Area 7
Area 4
Area 3
Area 1
Area 2
South Downs
A385
bog
bog
magnetic survey
soil-filled feature
?concrete chamber
geological variation
service pipe
former ploughing
land drain
former field boundary
telegraph pole
scale 1:1000 for A0 plot
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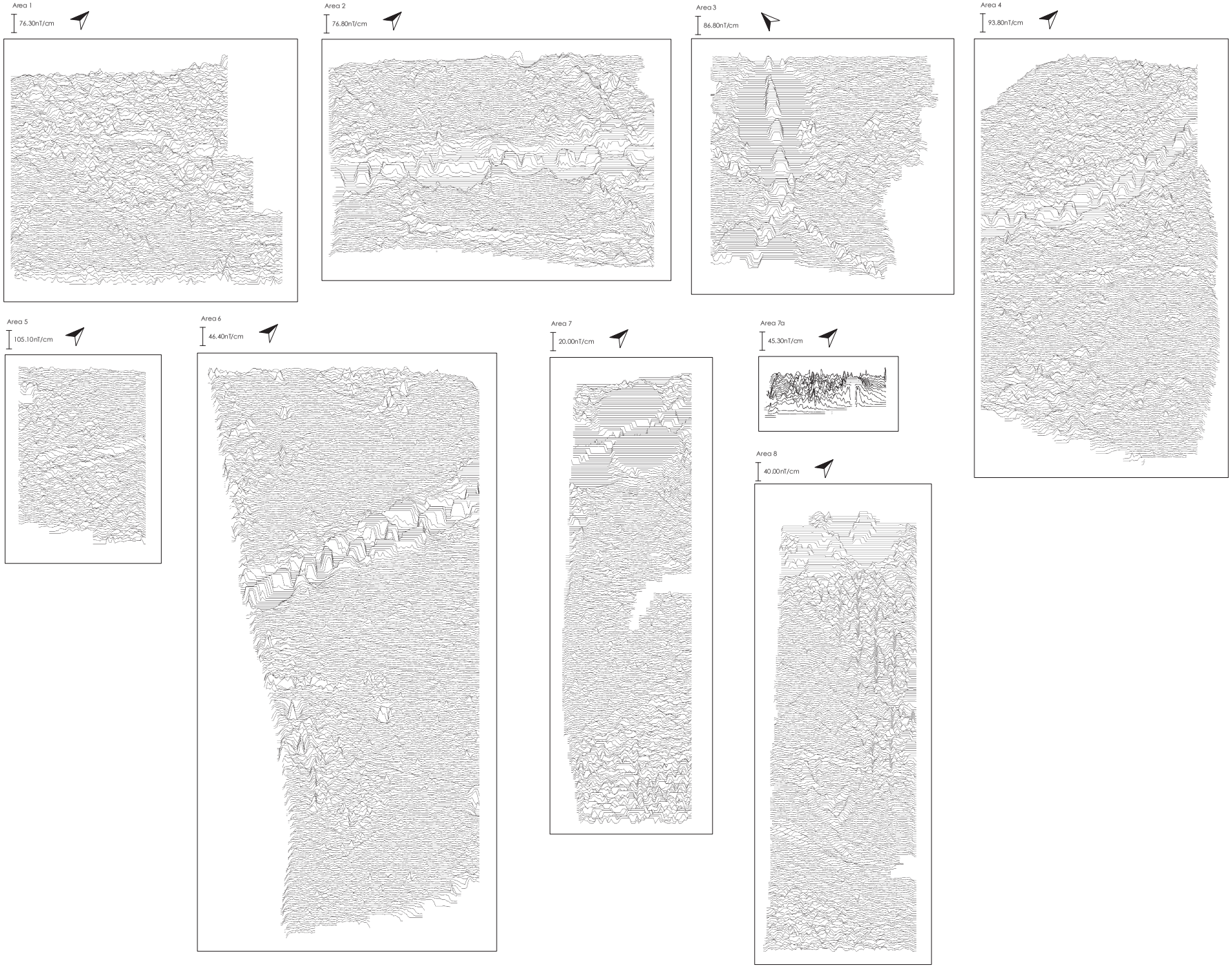
Figure 5: Archaeological interpretation



0 50m
scale 1:1000 for A1 plot

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Figure 6: Trace plots of geomagnetic data