Archaeological Services WYAS

West Lodge
Ulverston
Cumbria

Geophysical Survey

Report no. 2418

December 2012

Client: Headland Archaeology UK Ltd

Registered IfA Organisation

West Lodge
Ulverston
Cumbria

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering approximately 3 hectares was carried out at the site of a proposed retail development to the west of Ulverston. Linear trend anomalies indicative of ploughing and a former field boundary have been identified. Other linear anomalies are interpreted as potentially archaeological although an agricultural or modern origin is considered equally likely. Numerous discrete anomalies are thought likely to be geological in origin due to variation in the composition of the soils and superficial deposits. Two of these more extensive anomalies have been ascribed a possible archaeological origin, although a geological or modern cause cannot be discounted. Based on the results of the geophysical survey, the archaeological potential of the site is considered to be low to moderate.

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Report Information

Client:	Headland Archaeology (UK) Ltd
Address:	13 Jane Street, Edinburgh EH6 5HE
Report Type:	Geophysical Survey
Location:	West Lodge, Ulverston
County:	Cumbria
Grid Reference:	SD 2800 7790
Period(s) of activity represented:	Modern
Report Number:	2418
Project Number:	4002
Site Code:	UGS12
Planning Application No.:	Pre-planning
Museum Accession No.:	n/a
OASIS ID:	archaeol11-139674
Date of fieldwork:	November 2012
Date of report:	December 2012
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Photography:	David Harrison
Research:	n/a

Authorisation for distribution: ---

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Cert. No. 125

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1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Sorina Spanou of Headland Archaeology Ltd., to carry out a geophysical (magnetometer) survey in advance of a proposed submission of a planning application for a retail development around West Lodge, Ulverston (see Fig. 1). The work was undertaken in compliance with a Project Design prepared by ASWYAS. The scheme of work was undertaken in accordance with the guidance contained in the National Planning Policy Framework (NPPF) and was carried out on November 26th 2012.

Site location, topography and land-use

The proposed development area (PDA) covers four adjoining fields (see Fig. 2), currently under permanent pasture (see plates) on the western edge of Ulverston, centred at SD 2800 7790. The site is bound to the north by the A590, and to the south by a railway line and covers approximately 3 hectares. The site generally slopes down from the high ground to the north-east (50m above Ordnance Datum) to the south-west (45m aOD. Small areas to the west of Field 1 and Field 4 were flooded and were consequently not surveyed (see Fig. 2)

Soils and geology

The underlying bedrock comprises Dalton Formation and Red Hill Limestone Formation, overlain by glaciofluvial sands and gravels, till and alluvial superficial deposits (British Geological Survey 2012). The soils in this area are classified in the Denbigh 1 association, characterised as well-drained fine loams and silts over rock (Soil Survey of England and Wales 1983).

2 Archaeological and Historical Background

A desk-based heritage appraisal (Headland Archaeology 2012) reported that there are no known sites or finds recorded on the Cumbria Historic Environment Record. Sporadic isolated finds, including prehistoric axe-heads and Roman coins, have been recovered from the wider landscape, and a prehistoric cremation burial located 300m to the west of the site.

3 Aims, Methodology and Presentation

The aim of the geophysical survey was to gather sufficient information to establish the presence/absence, character and extent of any archaeological remains within the specific areas to be impacted by the proposed development, and to inform further strategies should they be necessary.

The specific objectives were to:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to produce a comprehensive site archive and report.

Magnetometer survey

Bartington Grad601 instruments were used to take readings at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m grids so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and Appendix 2.

The survey methodology, reporting standards and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the Institute for Archaeologists (IfA 2010), and are in compliance with the Project Design (ASWYAS 2012). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The figures in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey mapping is shown in Figure 1. Figure 2 shows the greyscale magnetometer data along the pipe corridor at a scale of 1:1250. The data are presented in greyscale, X-Y trace plot and interpretation formats, at a scale of 1:1000, in Figures 3, 4 and 5.

4 Results and Discussion

Ferrous anomalies

Ferrous anomalies, either as individual 'spikes' or more extensive areas of magnetic disturbance, are typically caused by ferrous (magnetic) debris, either on the ground surface or mixed in with the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as ferrous debris is common on rural sites, often being present as a consequence of manuring or tipping/infilling. There is no apparent clustering and therefore these anomalies are not considered to have any archaeological significance.

Areas of magnetic disturbance identified around the periphery of all the fields are due either to the presence of wire mesh or barbed wire in the field boundary or to the proximity of other ferrous materials.

A linear dipolar anomaly, **A**, extending in a north-easterly direction from West Lodge is caused by a buried service pipe.

Agricultural anomalies

Weak, vague linear trend anomalies have been identified throughout the site. Those in Field 1 are aligned north-north-west/south-south-west whilst the trends in Field 4 are aligned north-west/south-east. These are thought to be agricultural in origin being caused by modern ploughing. Both sets of anomalies are aligned parallel with the extant field boundaries.

One of the linear trends, **B**, correlates with a former field boundary thought to have been removed sometime before the publication of the 1932 Ordnance Survey map (see Headland Archaeology 2012).

Geological anomalies

The magnetic background across the whole of the survey area is variable with numerous localised areas of enhanced magnetic response that manifest as discrete anomalies. These types of anomaly are interpreted as being due to variations within the soils and may particularly be due to the presence of localised clusters of gravels which are commonly magnetic. The highly variable geology makes the confident interpretation of the cause of these anomalies difficult as it is impossible to discriminate between anomalies which have an underlying geological cause and those which may be due to non-linear archaeological features.

?Archaeological anomalies

To the north of Field 3 a pair of parallel, fragmented linear anomalies, **C**, are identified. The magnetic response from these anomalies is stronger than the ploughing trend anomalies although they are on the same north-west/south-east alignment, parallel with the extant boundary to the south. A possible archaeological cause is considered possible although a more recent origin is also considered plausible.

Towards the south and east of Field 4 are a cluster of anomalies, **D**, that are considered to be possibly archaeological in origin, although a geological cause cannot be dismissed. These are located at the top of a slope and could be caused by geology being closer to the surface at this part of the site. Vague linear anomalies in the same location may also have an underlying archaeological cause.

5 Conclusions

The geophysical survey has identified several anomalies for which a confident interpretation cannot be ascribed. Whilst many of the anomalies are likely to be due to variation within the soils and superficial deposits and others are clearly due to previous agricultural practice the remaining anomalies have been tentatively interpreted as possibly archaeological. However, non-archaeological causes are also considered plausible. Consequently, based on the geophysical survey, the site is considered to have a low to moderate archaeological potential.

Disclaimer

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.

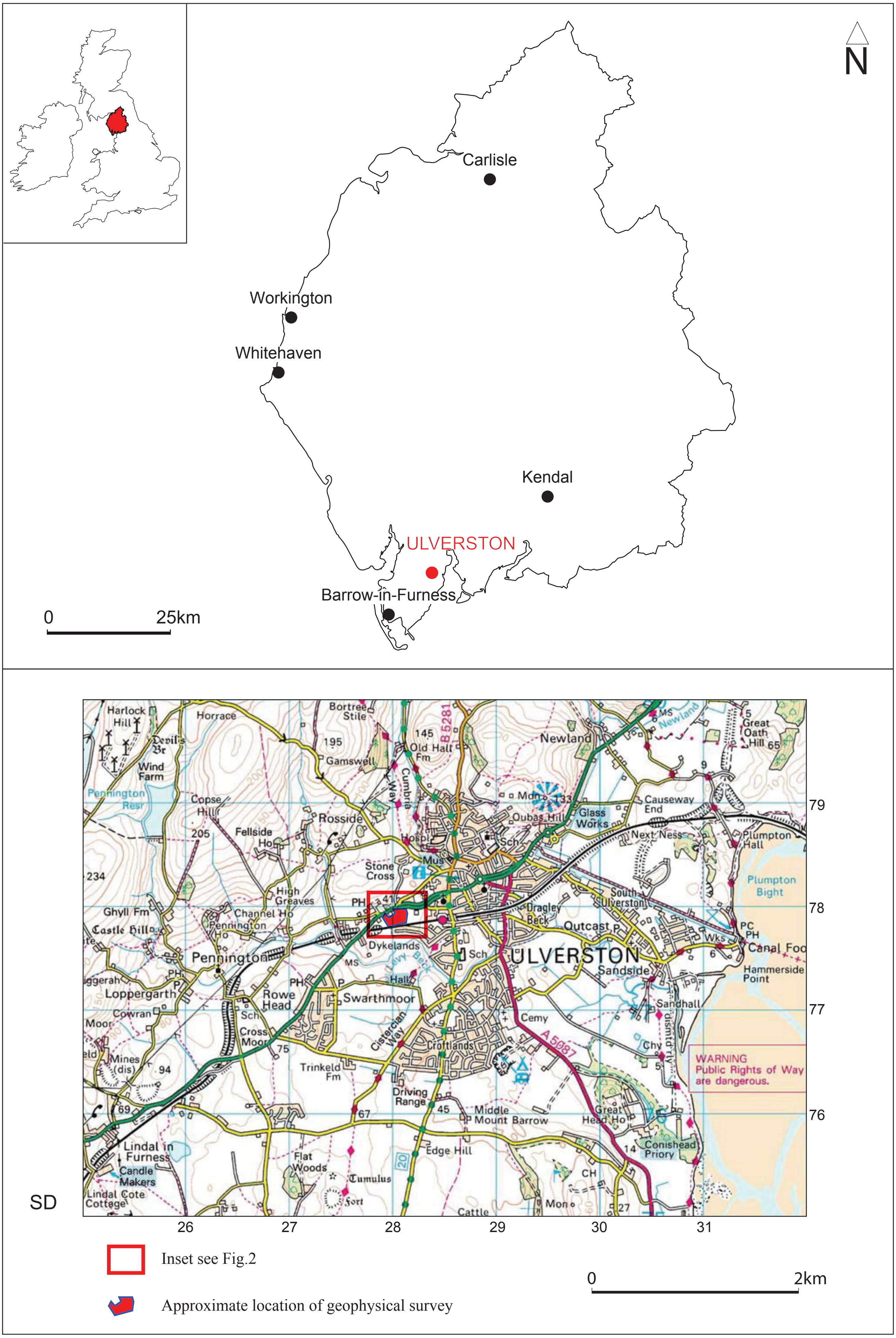

Fig. 1. Site location

Fig. 2. Site location showing greyscale magnetometer data (1:1500 @ A3)

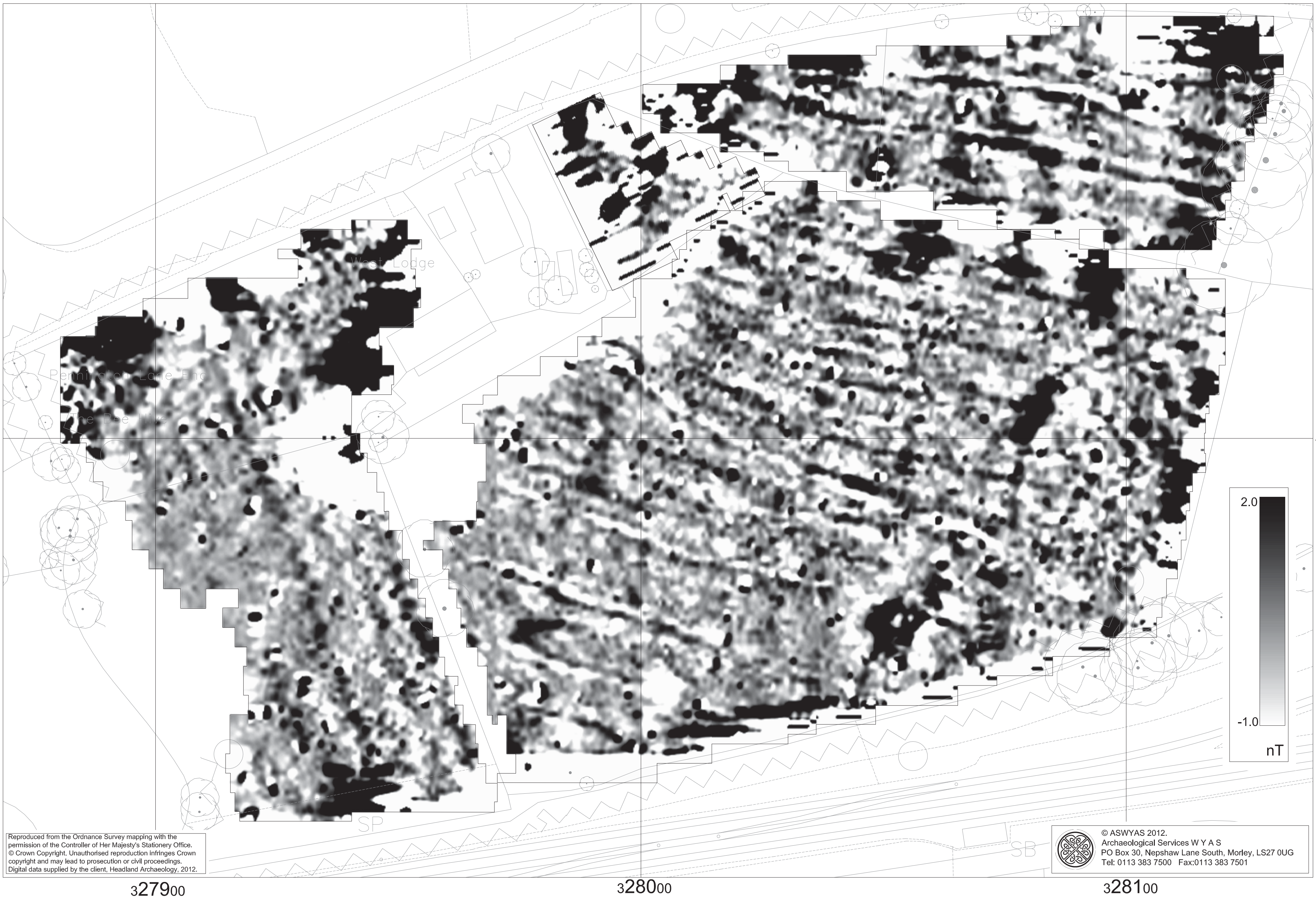

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Fig. 3. Processed greyscale magnetometer data (1:1000 @ A4)

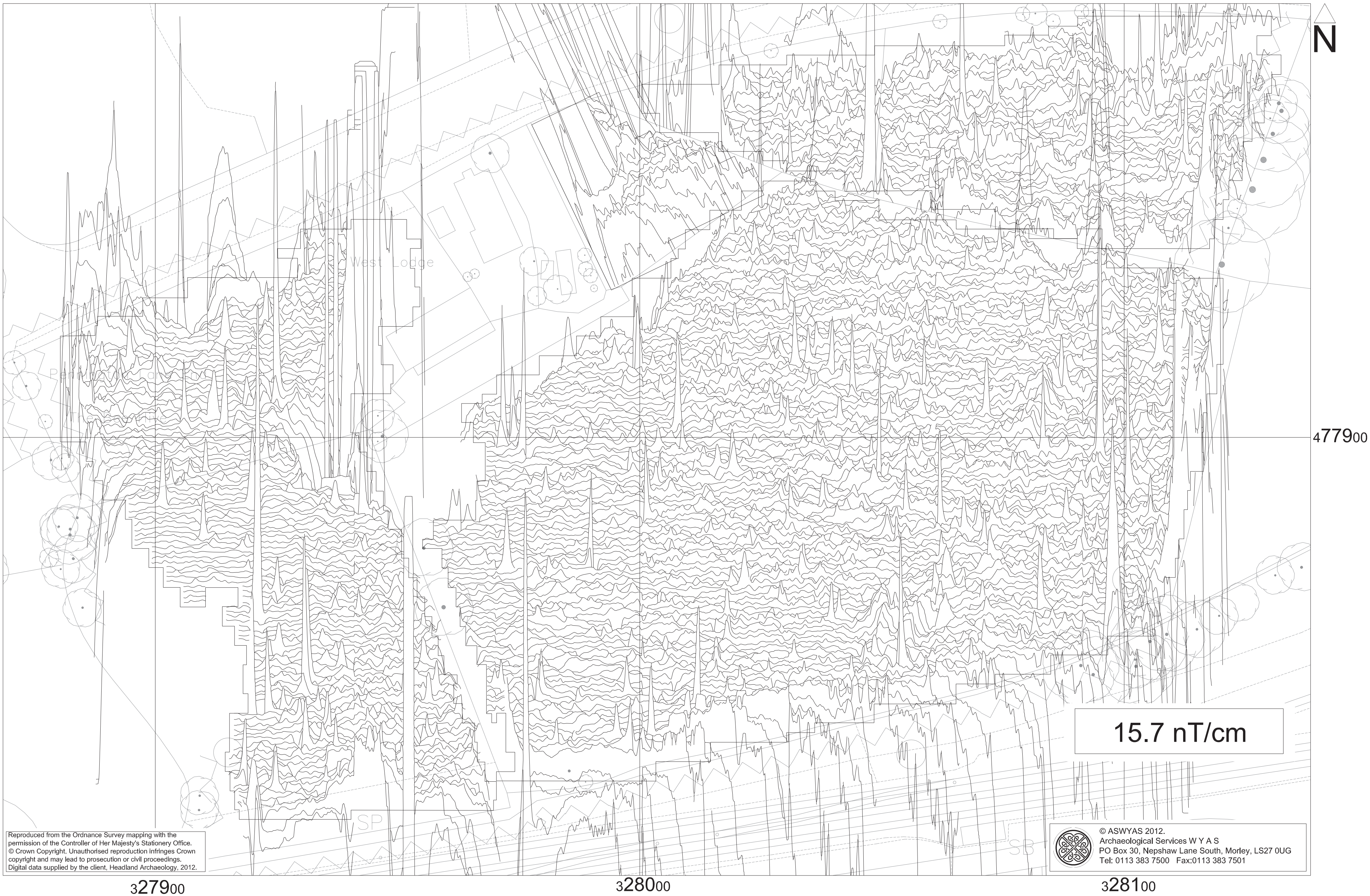

Fig. 4. XY trace plot of minimally processed magnetometer data (1:1000 @ A4)

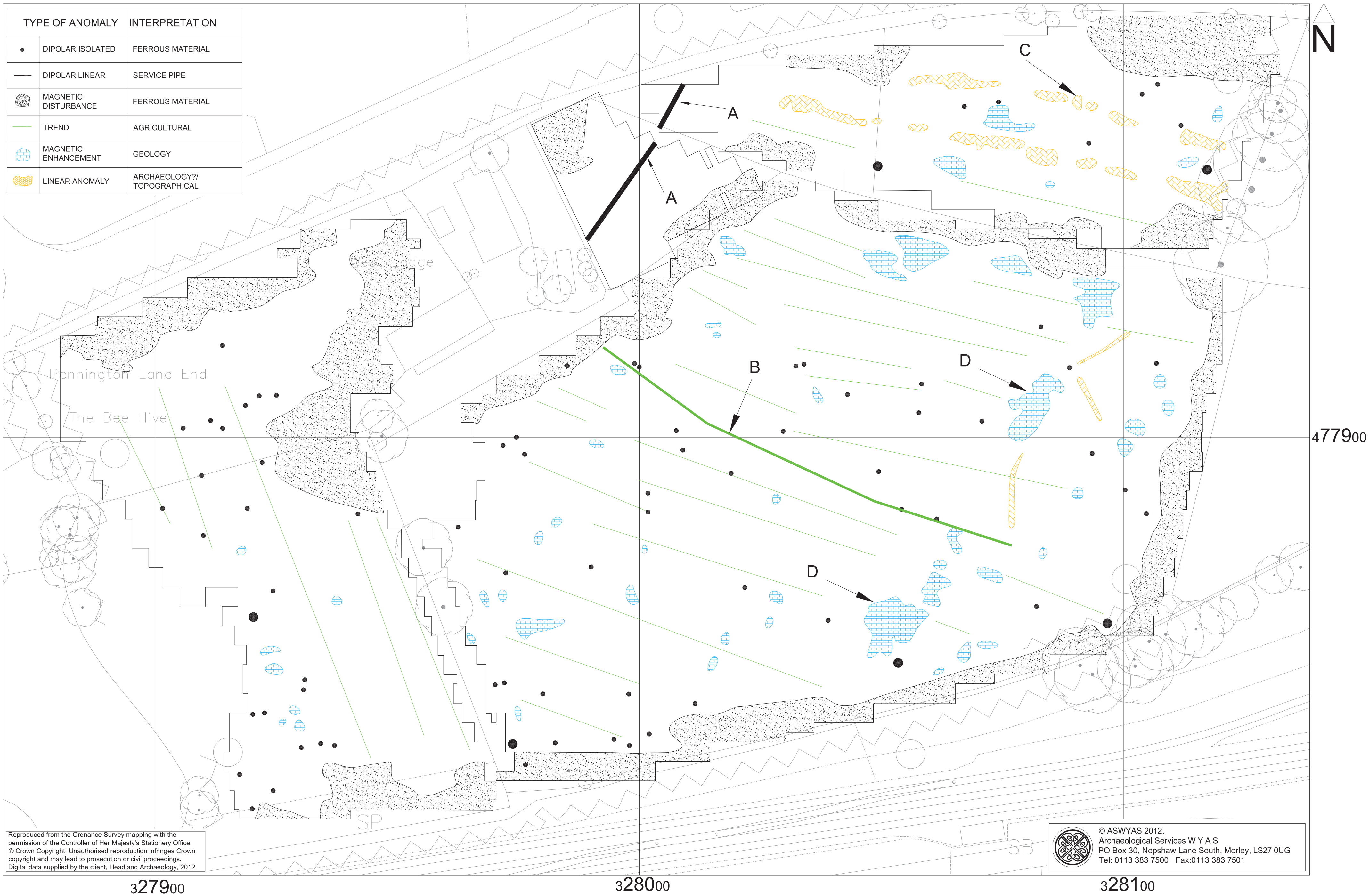

Fig. 5. Interpretation of magnetometer data (1:1000 @ A4)

Plate 1. General view of Field 4; looking north-west

Plate 1. General view of Field 3; looking north-east

Appendix 1: Magnetic survey - technical information

Magnetic Susceptibility and Soil Magnetism

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough. An advantage of magnetic susceptibility over magnetometry is that a certain amount of occupational activity will cause the same proportional change in susceptibility, however weakly magnetic is the soil, and so does not depend on the magnetic contrast between the topsoil and deeper layers. Susceptibility survey is therefore able to detect areas of occupation even in the absence of cut features. On the other hand susceptibility survey is more vulnerable to the masking effects of layers of colluvium and alluvium as the technique, using the Bartington system, can generally only measure variation in the first 0.15m of ploughsoil.

Types of Magnetic Anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes)

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic ‘spiky’ trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Linear trend

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an ‘iron spike’ anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

Methodology: Magnetic Susceptibility Survey

There are two methods of measuring the magnetic susceptibility of a soil sample. The first involves the measurement of a given volume of soil, which will include any air and moisture that lies within the sample, and is termed volume specific susceptibility. This method results in a bulk value that it not necessarily fully representative of the constituent components of the sample. For field surveys a Bartington MS2 meter with MS2D field loop is used due to its speed and simplicity. The second technique overcomes this potential problem by taking into account both the volume and mass of a sample and is termed mass specific susceptibility. However, mass specific readings cannot be taken in the field where the bulk properties of a soil are usually unknown and so volume specific readings must be taken. Whilst these values are not fully representative they do allow general comparisons across a site and give a broad indication of susceptibility changes. This is usually enough to assess the susceptibility of a site and evaluate whether enhancement has occurred.

Methodology: Gradiometer Survey

There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as ***magnetic scanning*** and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10m apart. The instrument logger is not used and there is therefore no data collection. Once anomalous responses are identified they are marked in the field with bamboo canes and approximately located on a base plan. This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey.

The disadvantages of magnetic scanning are that features that produce weak anomalies (less than 2nT) are unlikely to stand out from the magnetic background and so will be difficult to detect. The coarse sampling interval means that discrete features or linear features that are parallel or broadly oblique to the direction of traverse may not be detected. If linear features are suspected in a site then the traverse direction should be perpendicular (or as close as is possible within the physical constraints of the site) to the orientation of the suspected features. The possible drawbacks mentioned above mean that a ‘negative’ scanning result should be validated by sample detailed magnetic survey (see below).

The second method is referred to as ***detailed survey*** and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

Data Processing and Presentation

The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data shown is ‘raw’ with no processing other than grid biasing having been done. The data in the greyscale images has been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a ‘stacked’ plot. A hidden line algorithm has been employed to block out lines behind major ‘spikes’ and the data has been clipped. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the ‘shape’ of individual anomalies can be discerned and potentially archaeological anomalies differentiated from ‘iron spikes’. Geoplot 3 software was used to create the XY trace plots.

Geoplot 3 software was used to interpolate the data so that 3600 readings were obtained for each 30m by 30m grid. The same program was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

Appendix 2: Survey location information

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The accuracy of this equipment is better then 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party or for the removal of any of the survey reference points.

Appendix 3: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the Cumbria Historic Environment Record).

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