ARCHAEOLOGICAL SERVICES WYAS

Pickering Beck Bunded Flood Storage Scheme
Pickering
North Yorkshire

Geophysical Survey

April 2011

Report No. 2205

CLIENT
Environment Agency

Pickering Beck Bunded Flood Storage Scheme
Pickering
North Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering approximately 6 hectares was carried out on behalf of the Environment Agency along a section of Pickering Beck in Newtondale prior to the commencement of groundworks for a bunded flood storage scheme, part of a project to protect Pickering from major flood events. Broad anomalies indicative of the former course of the beck or the deposition of alluvial material in episodes of flooding have been identified. Anomalies due to ploughing and a former field boundary are also present. No anomalies of probable archaeological origin have been identified and the site is consequently assessed as having a low archaeological potential.

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Report Information

Client:	Environment Agency
Address:	Coverdale House, Aviator Court, Amy Johnson Way, Clifton Moor, York, YO30 4GZ
Report Type:	Geophysical survey
Location:	Newtondale, near Pickering
County:	North Yorkshire
Grid Reference:	SE 814 856
Period(s) of activity represented:	
Report Number:	2205
Project Number:	3720
Site Code:	PBP11
Planning Application No.:	Pre-application
Museum Accession No.:	n/a
Date of fieldwork:	March 2011
Date of report:	April 2011
Project Management:	Alistair Webb BA MIfA
Fieldwork:	Sam Harrison BSc Marina Rose
Report:	Alistair Webb
Illustrations:	Sam Harrison
Photography:	Sam Harrison
Research:	n/a
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1 Introduction

Archaeological Services WYAS was instructed by Emma Morrish, Senior Environmental Project Manager at the Environment Agency, to carry out a geophysical (magnetometer) survey along a corridor of land adjacent to Pickering Beck (see Fig. 1), where it is proposed to construct earth bunds as part of flood control measures on the beck upstream from Pickering. All work was undertaken in compliance with current best practice and in line with the guidance outlined in Planning and Policy Statement 5: Planning for the Historic Environment.

Site location, topography and land use

The site, centred at SE 814 856, is located approximately 2km north-east of Pickering in Newtondale and is situated immediately adjacent to Pickering Beck, a tributary of the river Derwent. The North Yorkshire Moors Railway runs alongside the beck and forms the northern boundary of one of the two survey areas (see Fig. 2). The site is flat being on the narrow grassed floodplain of the beck at approximately 90m above Ordnance Datum.

Geology and soils

The solid geology comprises Osgodby formation sandstone overlain by alluvium.

2 Archaeological background

Research undertaken for the Scoping Consultation Document (Environment Agency 2010) identified five scheduled monuments (all barrows) within 1km of the study area but none within the study area itself, although a single barrow (not scheduled) is located within the search area. Closer to the survey area is the possible location of a Roman bath house, presumably associated with a villa/farmstead as yet unidentified, which has been partially investigated by a single trial trench. This is located just to the south of Park Gate Farm, approximately 300m north-west of the site. It can therefore be seen that the site lies within a landscape of moderate to high archaeological potential.

3 Aims, Methodology and Presentation

The principal objectives of the survey were:

- to characterise as far as possible the nature of any anomalies identified and thereby,
- to determine the location and extent of any archaeological features within the defined survey areas,
- to prepare a report summarising the results of the survey.

In order to achieve these aims detailed (recorded) magnetometer survey was undertaken over those areas where bunds are to be constructed and any other areas that may be impacted by groundworks necessary for their creation.

Magnetometer survey

Bartington Grad601 magnetic gradiometers were used during the survey taking 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 details are given in Appendix 1.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey mapping is shown in Figure 1. Figure 2 shows the location of the site and the processed data at a scale of 1:2500 overlain on the first edition mapping. Detailed data plots ('raw' and processed) and full interpretative figures are presented at a scale of 1:1000 in Figures 3 to 11 inclusive.

Further technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and Appendix 2. Appendix 3 describes the composition and location of the site archive.

The survey methodology, report and any recommendations comply with the Project Design (Harrison 2011), with guidelines outlined by English Heritage (David *et al* 2008) and by the IfA (Gaffney, Gater and Ovenden 2002). 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.

4 Results

The anomalies identified on this site are divided into three categories according to their interpreted origin.

Agricultural anomalies

Vague, parallel, linear trend anomalies aligned south-west/north-east can be seen towards the southern boundary of Sector 1. These trends are parallel with the edge of Featherhaugh Wood and reflect the alignment of a former ploughing regime.

Perpendicular to these ploughing trends is a line of discrete ferrous responses which correlate with the position of a former field boundary which is shown on the first edition mapping.

Geological anomalies

A cluster of strong, broad, discrete anomalies can be seen throughout the data set but are particularly prevalent in Sector 1 adjacent to the beck. These anomalies are geological in origin and are due to localised variation in the alluvium/soils possibly related to former fluvial channels or perhaps to the deposition of silts or sands following episodes of flooding.

Modern anomalies

Dipolar, isolated, anomalies (iron 'spikes') have been identified in the data set. These anomalies are typically caused by ferrous (magnetic) material, either on the ground surface or in the topsoil. Little importance is normally given to such anomalies unless there is any supporting evidence for an archaeological interpretation, as modern ferrous objects or material are common on rural sites, often being present as a consequence of manuring, deliberate tipping/infilling or modern landscaping. These anomalies are not considered to have any archaeological significance.

A small area of magnetic disturbance on the northern edge of the boundary between Sector 1 and Sector 2 is due to an accumulation of modern material probably associated with the construction of the small bridge crossing the beck.

The linear band of disturbance along the northern edge of Sector 3 is due to a combination of the magnetic effects of the railway line and the wire strand fencing bordering it.

5 Discussion and Conclusions

The geophysical survey has identified anomalies that relate to former agricultural usage of the site and to the deposition of material either in former fluvial channels or as a result of flooding. No anomalies of archaeological potential have been identified during the survey. As a result the archaeological potential of the site is assessed as being low.

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.

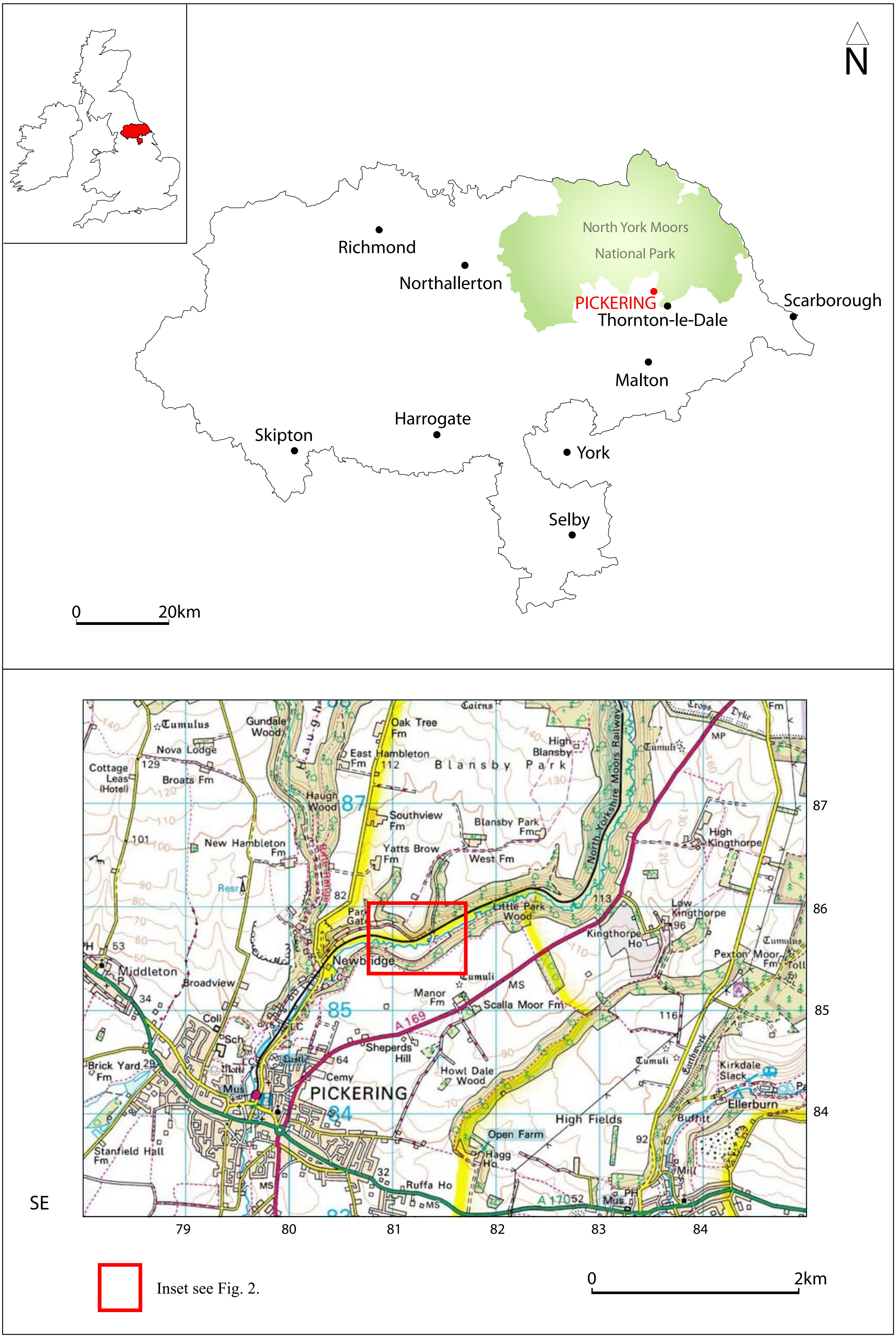

Fig. 1. Site location

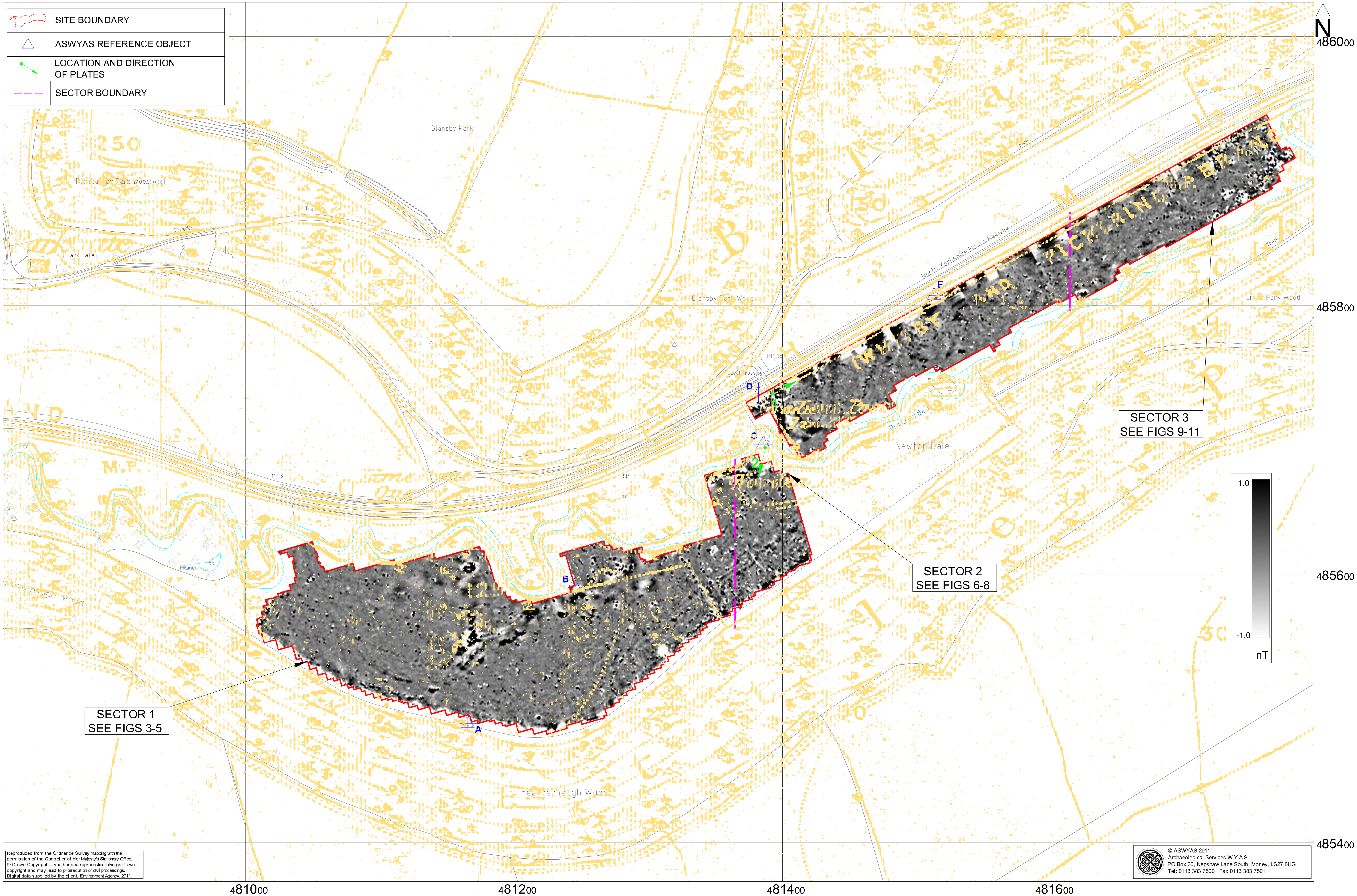

Fig. 2. Site location showing greyscale magnetometer data showing first edition Ordnance Survey mapping of 1854 (1:2500 @ A3)

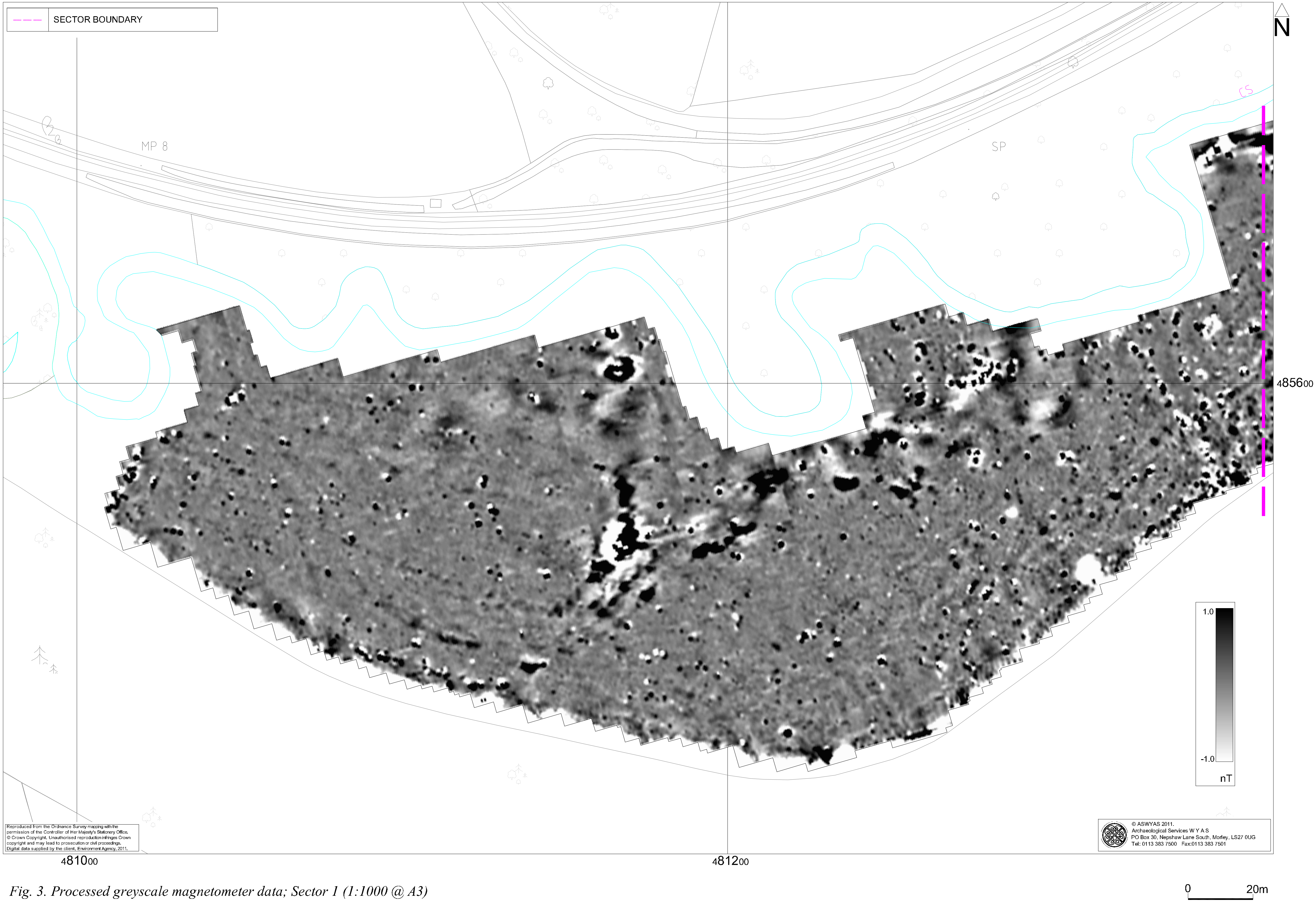

Fig. 3. Processed greyscale magnetometer data; Sector 1 (1:1000 @ A3)

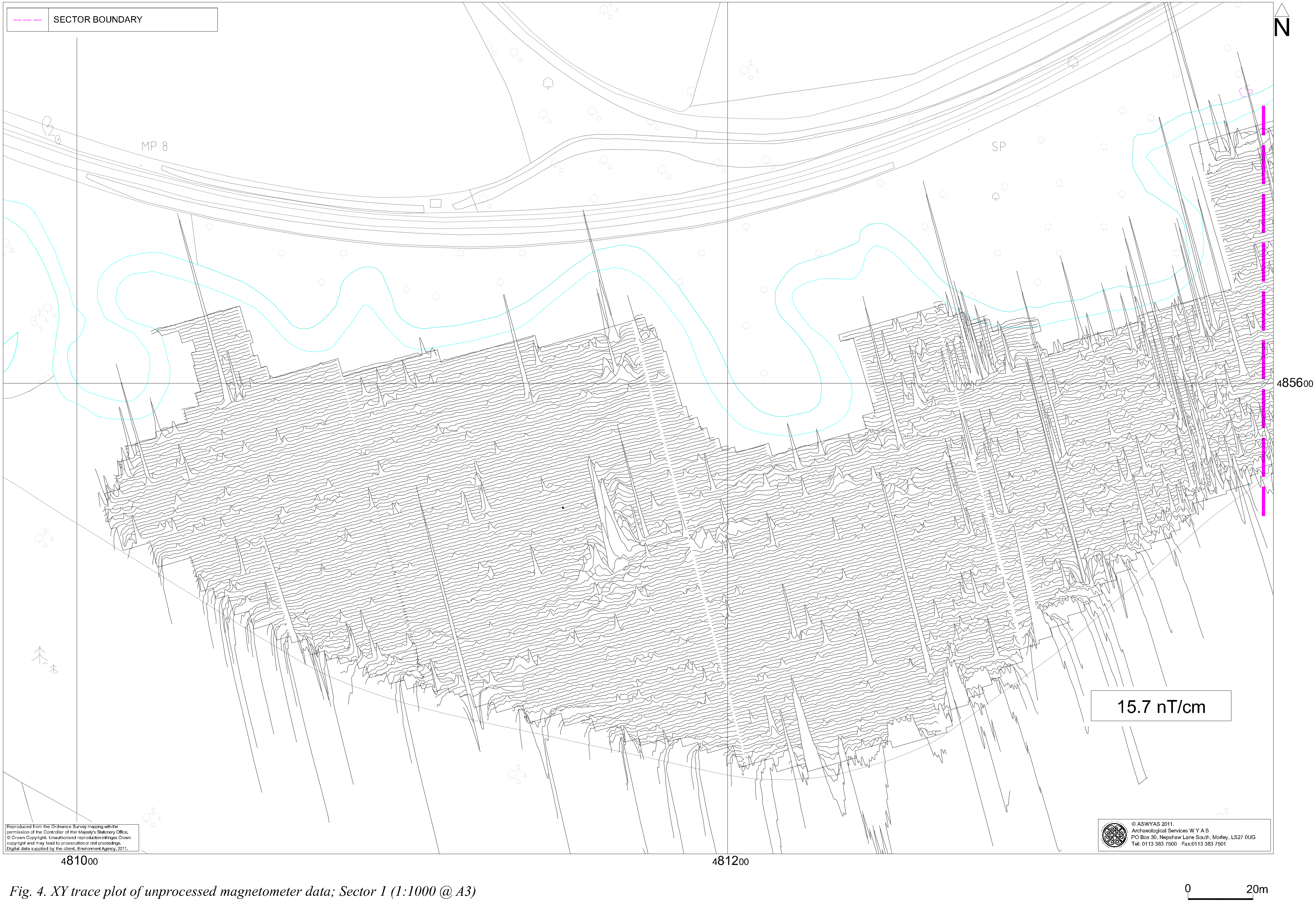

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Fig. 4. XY trace plot of unprocessed magnetometer data; Sector 1 (1:1000 @ A3)

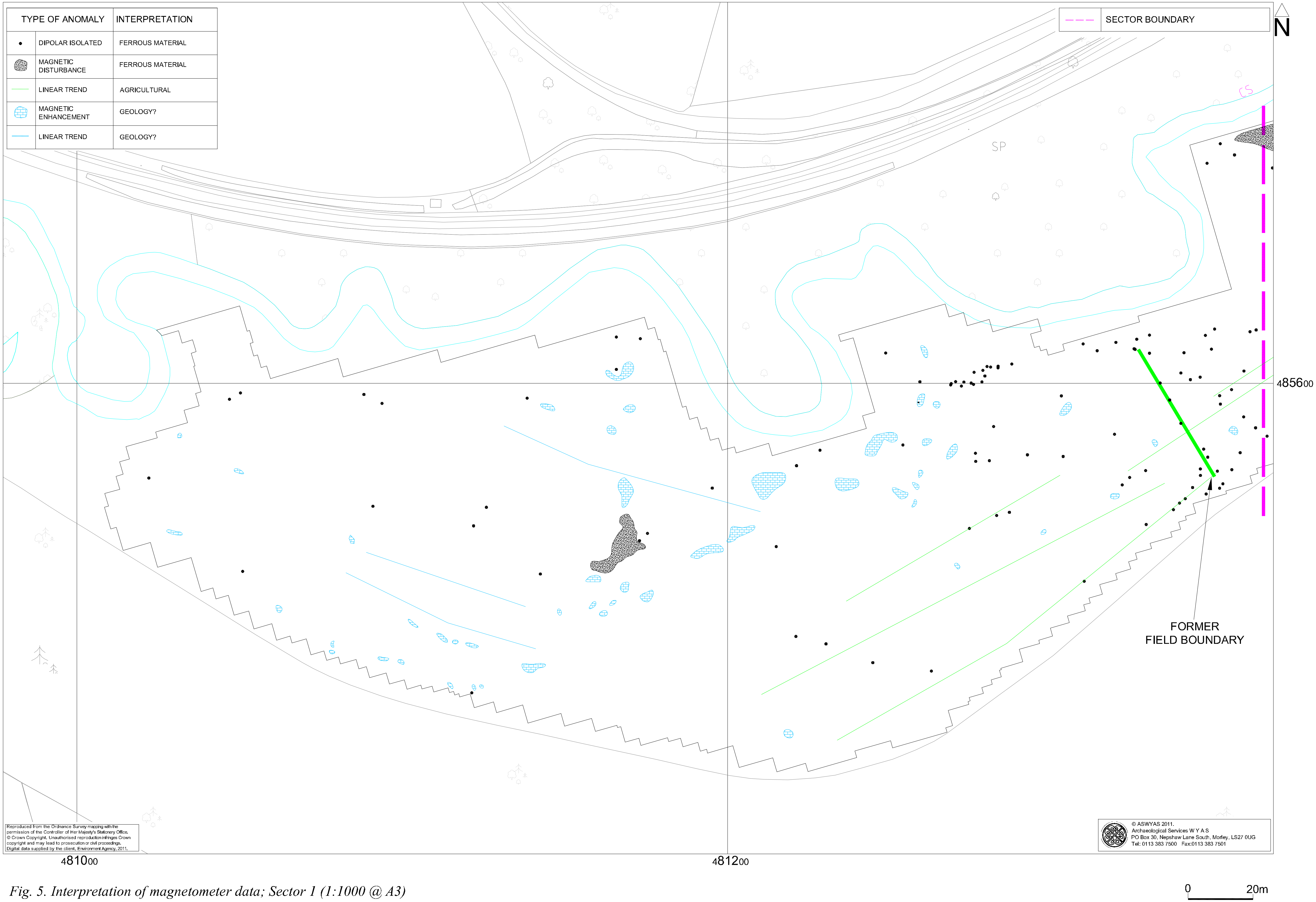

Fig. 5. Interpretation of magnetometer data; Sector 1 (1:1000 @ A3)

Fig. 6. Processed greyscale magnetometer data; Sector 2 (1:1000 @ A3)

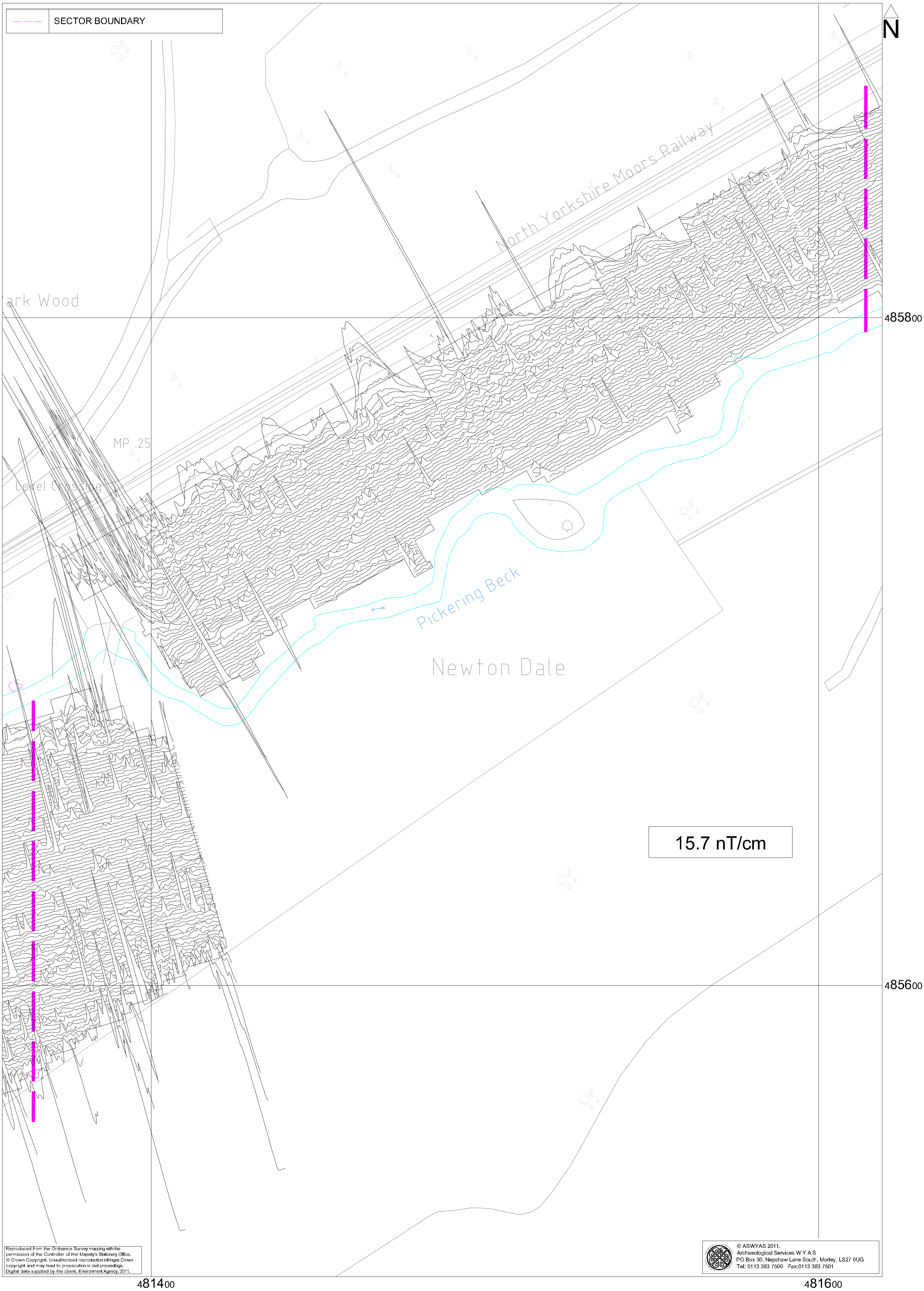

Fig. 7. XY trace plot of unprocessed magnetometer data; Sector 2 (1:1000 @ A3)

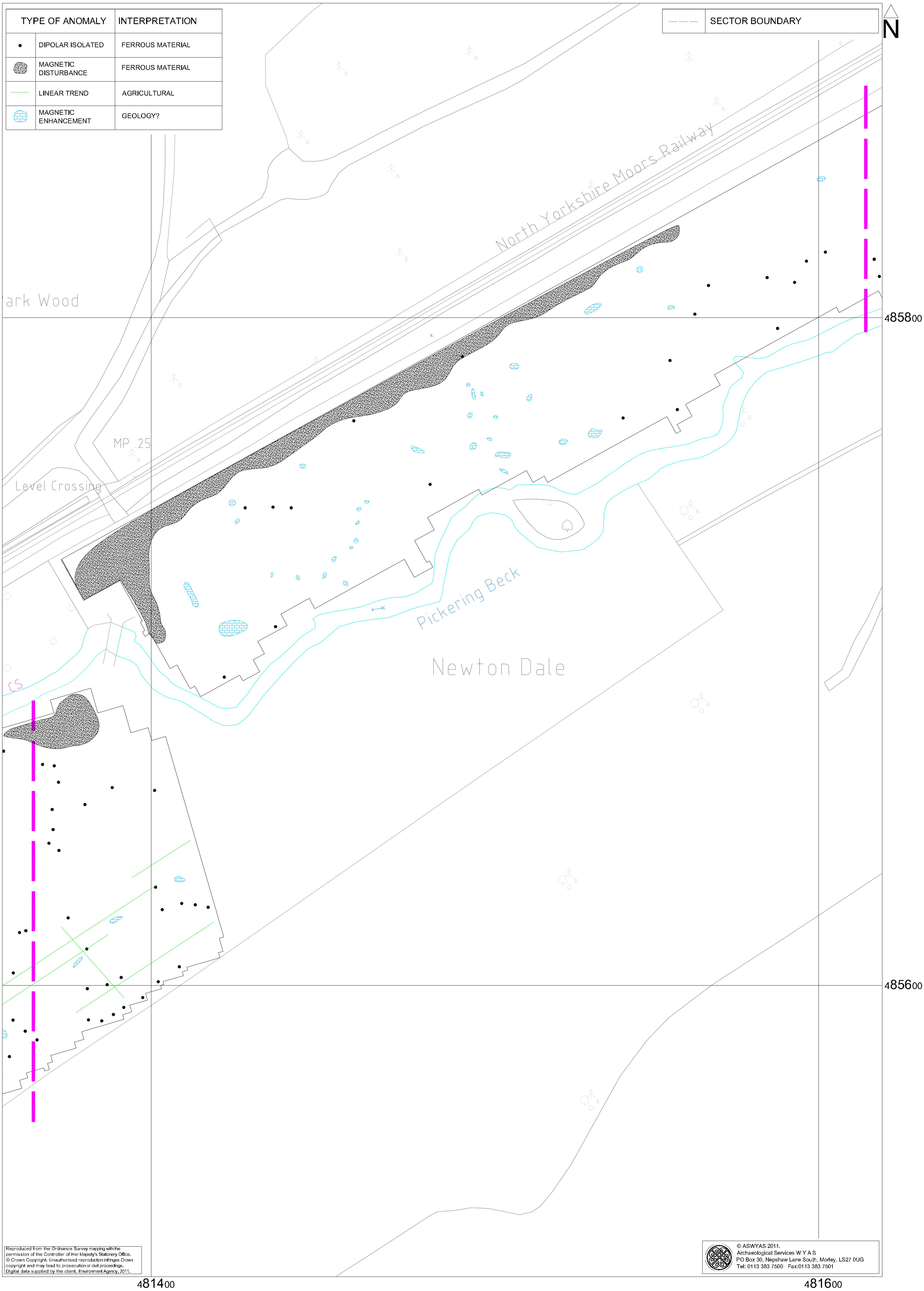

Fig. 8. Interpretation of magnetometer data; Sector 2 (1:1000 @ A3)

0 20m

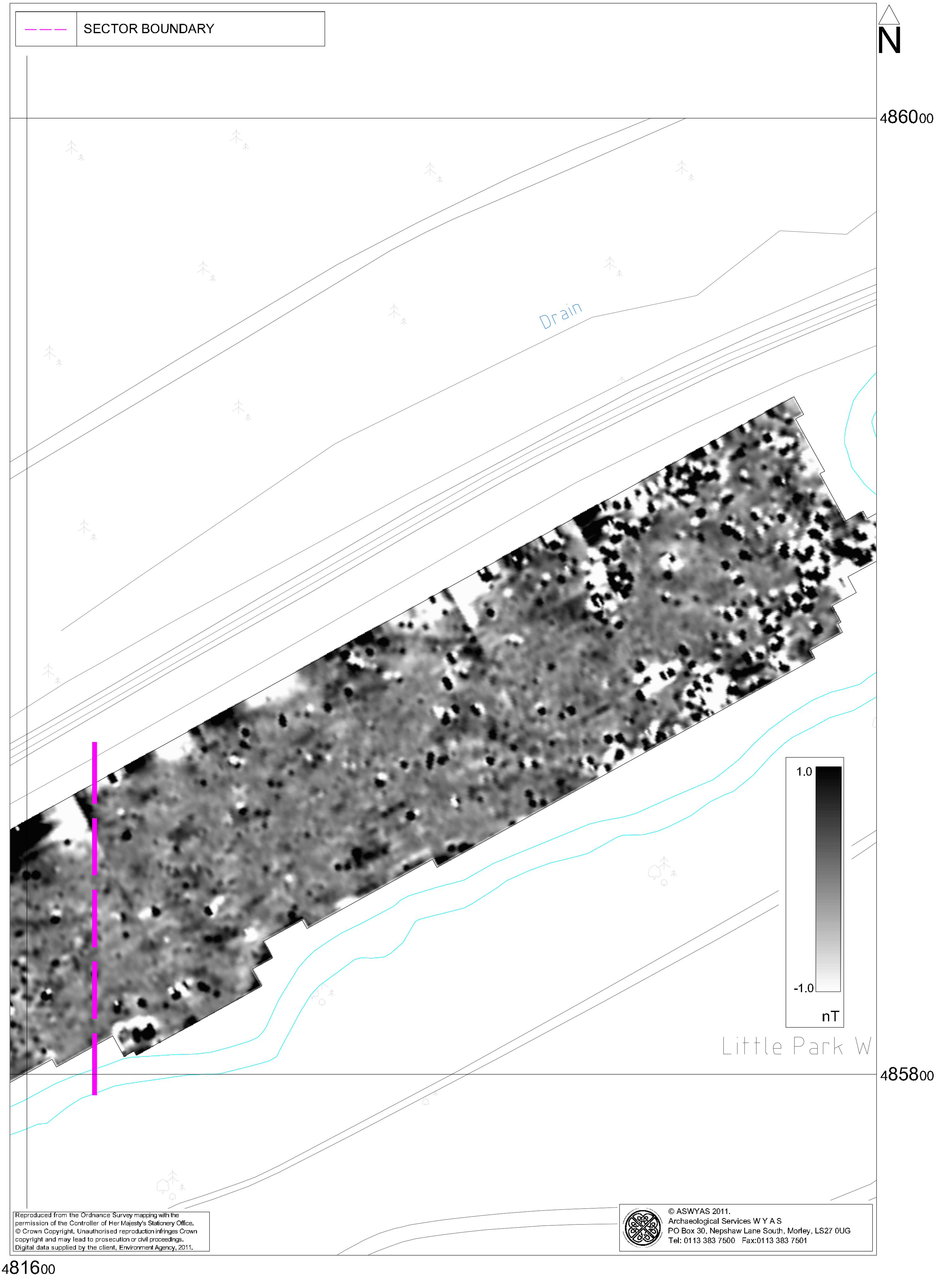

Fig. 9. Processed greyscale magnetometer data; Sector 3 (1:1000 @ A3)

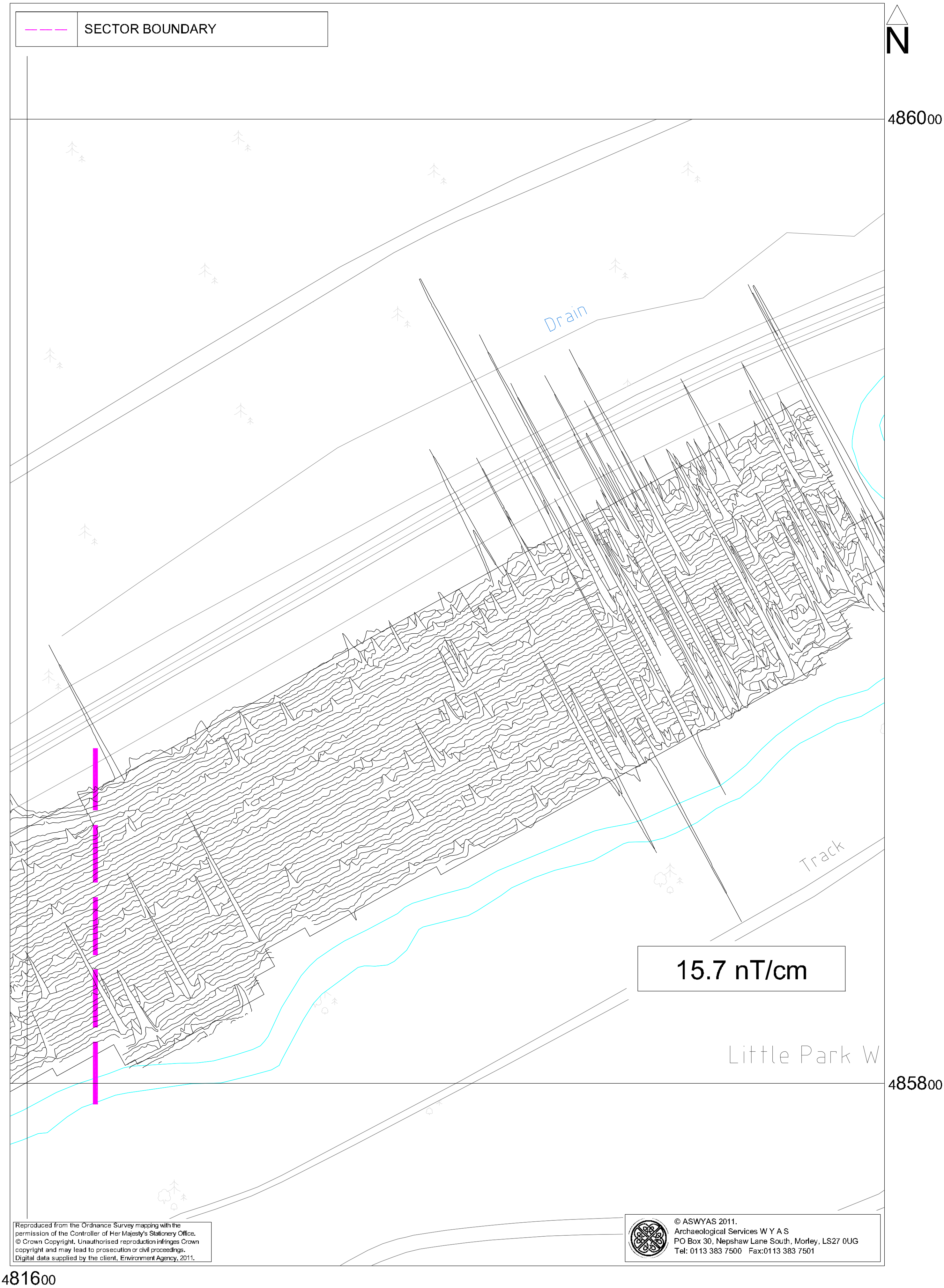

Fig. 10. XY trace plot of unprocessed magnetometer data; Sector 3 (1:1000 @ A4)

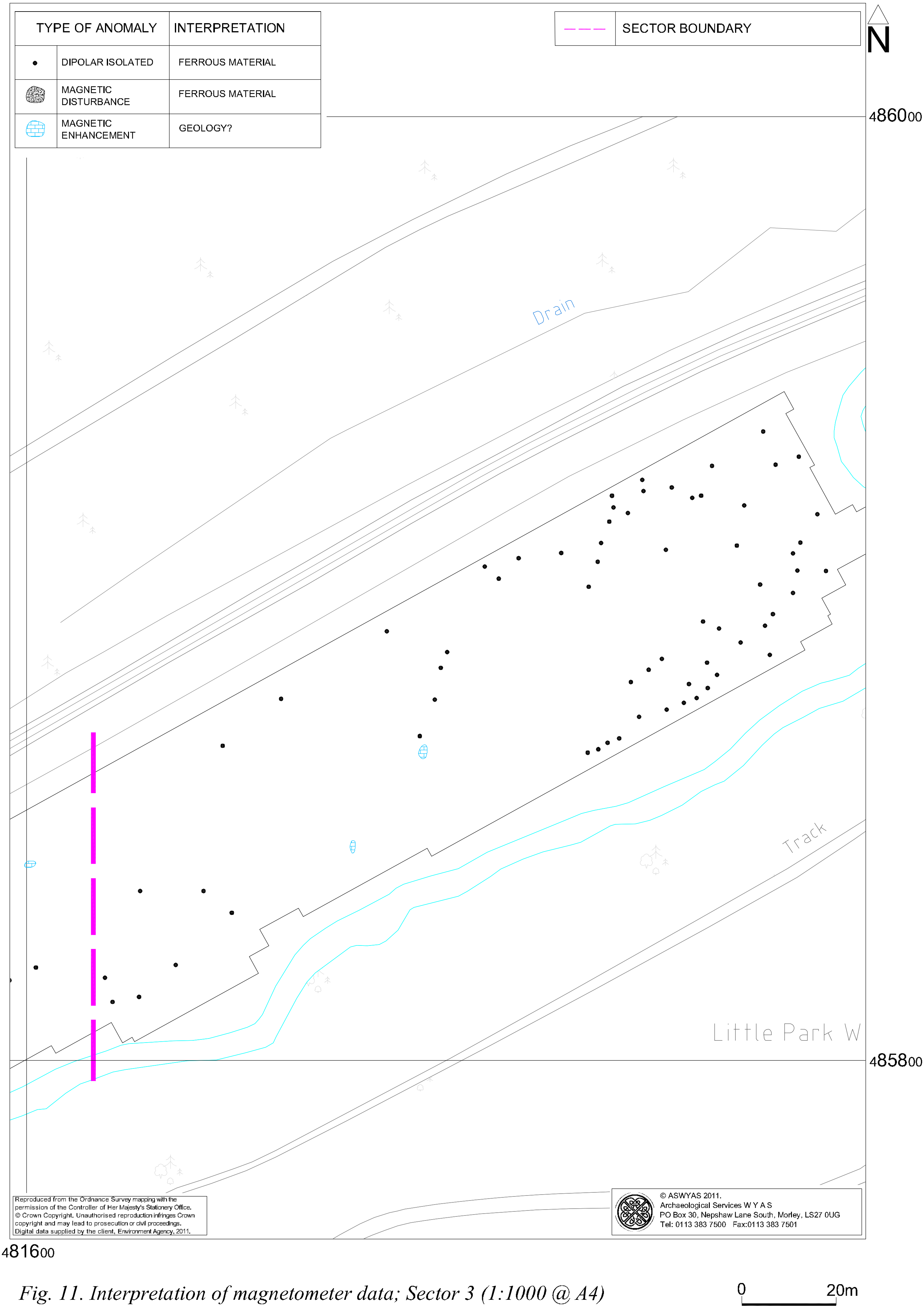

Fig. 11. Interpretation of magnetometer data; Sector 3 (1:1000 @ A4)

Plate 1. General view of area north of the Pickering Beck, looking north-east

Plate 2. General view of area south of the Pickering Beck, looking south-west

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 Geodimeter 600s total station theodolite and tied in to the corners of buildings, fields and other permanent landscape features and to temporary reference objects (survey marker stakes) that were established and left in place following completion of the fieldwork for accurate geo-referencing. The locations of the temporary reference points are shown on Figure 2 and the Ordnance Survey grid co-ordinates tabulated below. The internal accuracy of the survey grid relative to these markers is better than 0.05m. The survey grids were then superimposed onto a map base provided by the client as a 'best fit' to produce the displayed block locations. Overall there was a good correlation between the local survey and the digital map base and it is estimated that the average 'best fit' error is better than ±1.5m. However, it should be noted that Ordnance Survey co-ordinates for 1:2500 map data have an error of ±1.9m at 95% confidence. This potential error must be considered if co-ordinates are measured off for relocation purposes.

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

A	481165.3945	485488.5509
B	481244.7321	485590.9495
C	481385.6100	485696.4100
D	481382.1863	485733.8002
E	481512.8211	485807.0873

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.
- 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 Cornwall Historic Environment Record).

Bibliography

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Gaffney, C., Gater, J. and Ovenden, S. 2002. *The Use of Geophysical Techniques in Archaeological Evaluations*. IFA Technical Paper No. 6