ARCHAEOLOGICAL SERVICES WYAS

Land at Cock Hill Farm
Trowbridge
Wiltshire

Geophysical Survey

Report no. 2615

May 2014

Client: Foundations Archaeology Ltd

REGISTERED ORGANISATION IfA

Land at Cock Hill Farm
Trowbridge
Wiltshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering approximately 42 hectares was carried out on agricultural land at Trowbridge, Wiltshire, to inform the determination of an outline planning application for a proposed solar farm development. Anomalies have been identified which locate service pipes, former field boundaries, ridge and furrow cultivation, field drains and a former pond. A linear band of magnetic disturbance aligned east-west across the centre of the site locates an area where modern material has been used to infill a valley and water course to level the land. Three rectilinear trends have been recorded in the north of the survey area, which may be associated with archaeological remains, although an agricultural cause is deemed equally plausible. On the basis of the magnetic survey, the archaeological potential of the site is considered to be low.

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Report Information

Client:	Foundations Archaeology
Address:	1 Shaftesbury Centre, Percy Street, Swindon, Wiltshire, SN2 2AZ
Report Type:	Geophysical Survey
Location:	Trowbridge
County:	Wiltshire
Grid Reference:	ST 8460 5920
Period(s) of activity:	post medieval? /modern?
Report Number:	2615
Project Number:	4231
Site Code:	COK14
OASIS ID:	archaeol11- 179420
Museum Accession No.:	n/a
Date of fieldwork:	April 23rd 2014 – May 2nd 2014
Date of report:	May 2014
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Research:	n/a

Authorisation for distribution: --

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1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Roy King of Foundations Archaeology, on behalf of Gaiger Solar Ltd, to undertake a geophysical (magnetometer) survey of land at Cock Hill Farm, Trowbridge, Wiltshire (see Fig. 1), in order to support a planning application for a proposed solar park development. The work was undertaken in accordance with a Project Design (Harrison 2014) supplied to Foundations Archaeology, following guidance contained within the National Planning Policy Framework (2012) and in line with current best practice (David *et al.* 2008). The survey was carried out between April 23rd and May 2nd 2014 in order to provide additional information on the archaeological potential of the site.

Site location, topography and land-use

The Proposed Development Area (PDA) covers approximately 42 hectares, centred at ST 8460 5920, immediately north of Trowbridge and 2km south-east of the centre of Bradford-on-Avon (see Fig. 1). The PDA comprises an irregularly shaped parcel of land, with a couple of internal divisions, and is located immediately to the south of the Kennet and Avon Canal, which borders the site to the north, and the River Avon (see Fig. 2). The Trowbridge to Bradford-on-Avon road (A363) lies to the west of the PDA with a sewage treatment and Lady Down Farm to the east of the site with the River Biss 200m further to the east of the farm (see Fig. 2). The whole site was under a young cereal crop at the time of the survey (see plates).

The topography of the site is gently undulating but generally slopes from 49m above Ordnance datum (aOD) at the western site boundary towards the northern and eastern boundaries which are at 41m aOD.

Soils and geology

The underlying bedrock comprises sandy mudstone of the Kellaways Formation. There are no superficial deposits (British Geological Survey 2014). The soils are classified in the Wickham 3 association, characterised as slowly permeable, seasonally waterlogged, fine loams over clays (Soil Survey of England and Wales 1983).

2 Archaeological Background

An Archaeological Assessment (Foundations Archaeology 2014) undertaken of the site and the immediate area concluded that the archaeological potential of the PDA is low, although this was considered to be due to a lack of archaeological investigation, rather than a definite absence of archaeological activity.

The site appears to have been in agricultural use from the medieval period and analysis of historic mapping indicates a number of field boundaries and a trackway have been removed in the last 200 years.

3 Aims, Methodology and Presentation

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact of the proposed development on potential sub-surface archaeological remains and for further evaluation or mitigation proposals, if appropriate, to be recommended. To achieve this aim a magnetometer survey covering all available parts of the PDA was carried out.

The general objectives of the geophysical survey were:

- 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 prepare a report summarising the results of the survey.

Magnetometer survey

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). 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 (OS) mapping, is shown in Figure 1. Figure 2 is a large scale survey location plan displaying the processed greyscale magnetometer data at a scale of 1:4000. Figure 3 is an overall data interpretation plot at the same scale. Detailed data plots (‘raw’ and processed) and full interpretative figures are presented at a scale of 1:1000 in Figures 4 to 24 inclusive.

Further technical information on the equipment used, data processing and survey methodologies is 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 2014) and guidelines outlined by English Heritage (David *et al.* 2008) and by the Institute for Archaeologists (IfA 2013). 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 and Discussion (see Figs 4 to 24 inclusive)

A varied magnetic response has been recorded across the PDA with numerous areas of enhancement, particularly to the north and centre of the site, being due to localised variations in the soils. Against this variable background numerous anomalies have been identified, falling into several different types and categories according to their origin. These are discussed below and cross-referenced to specific examples and locations within the site, where appropriate.

Ferrous Anomalies

Ferrous responses, either as individual 'spike' anomalies or more extensive areas of magnetic disturbance, are typically caused by modern ferrous (magnetic) debris, either on the ground surface or in the plough-soil, or are due to the proximity of magnetic material in field boundaries, buildings or other above ground features. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. Throughout the PDA individual iron 'spike' anomalies are common but there is no obvious pattern or clustering to their distribution to suggest anything other than a random background scatter of ferrous debris in the soil.

To the north and west of the site, three dipolar linear anomalies, **A, B** and **C**, locate a system of sub-surface service pipes. Four other pipes, identified as anomalies **D, E, F** and **G**, have been recorded in the east of the site, to the east of a trackway, identified as anomaly **H**.

A broad area of magnetic disturbance, **I,** approximately 400m east/west and 80m north/south across the centre of the site, is caused by a large dump of modern material used to infill a shallow valley and water course, which is evident on historic mapping up to and including 2006 (Foundations Archaeology 2014). The area of disturbance is defined to the south by a former field boundary, **P**. A small area of magnetic disturbance, anomaly **J**, to the south of the site locates a former pond.

Anomalies **K, L, M, N** and **O** locate a line of electricity poles that traverse the site from south-west to north-east.

Agricultural Anomalies

Analysis of historical mapping indicates that over the past 200 years the division and layout of land within the PDA has been altered by the removal of thirteen field boundaries to create larger open fields. Only seven of these former boundaries are identified as linear anomalies (**P, Q, R, S, T, U** and **V**) and most of these are extremely weak in magnitude. Six other former boundaries do not manifest as magnetic anomalies probably because there is insufficient magnetic contrast between the infilled ditch and the surrounding soils within this part of the site for the feature to be identified or possibly because later ploughing has removed all trace of the former boundaries.

To the north-west of the site, running in an east-west direction, a clear linear band of anomalies, **W**, can be seen. These anomalies are thought to be caused by the magnetic response from the remains of a trackway depicted on the 1817 Ordnance Survey map that leads to/from Lady Down Farm in the east and Widbrook in the west.

Numerous linear trend anomalies have been identified across the site which are interpreted as field drains. Towards the west and south of the survey area the field drains typically manifest as a series of linear anomalies in a fragmented herring-bone pattern. Across the rest of the site individual faint linear anomalies on varying alignments are also interpreted as field drains.

The remaining linear trend anomalies, identified throughout the site, are caused by cultivation. The closely spaced, parallel, linear anomalies prominent to the east of the site are interpreted as being due to the medieval and post-medieval agricultural practice of ridge and furrow cultivation. The characteristic striped appearance to the data is a result of the magnetic contrast between the now soil-filled furrows and the former ridges.

Geological Anomalies

Throughout the survey area discrete anomalies, characterised as localised areas of enhanced magnetic response, have been identified. These anomalies are particularly prominent in the central and northern parts of the site and are interpreted as geological in origin, being caused by variation in the composition of the soils.

Possible Archaeological Anomalies

Only three anomalies have been identified which are considered to be of archaeological potential, all in the north-eastern corner of the site. These anomalies have been assessed as of possible archaeological origin on the basis that none of them can be readily interpreted in any of the categories discussed above but an agricultural origin (possibly field drains) is considered equally plausible. All three, **X, Y** and **Z**, manifest as negative anomalies (relative to the magnetic background – see Appendix 1) and all are on the same basic alignment, being L-shaped and aligned north/south/east/west.

5 Conclusions

The geophysical survey has identified anomalies which, in the main, reflect the agricultural practices and landscape as depicted on current and historic mapping. Anomalies have been identified which locate service pipes, former field boundaries, field drains and a former pond. Evidence of ridge and furrow cultivation within the east and north of the PDA may be due to earlier medieval or post-medieval land use. Some of these anomalies may be of local historical interest, but are not thought to be of any archaeological significance. A linear band of magnetic disturbance aligned east-east across the centre of the site locates an area where modern material has been used to infill a valley and watercourse to level the land. A hard-cored trackway and seven service pipes have been identified in the east of the survey area.

Three rectilinear trends have been recorded in the north of the survey area, which may be associated with archaeological remains, although an agricultural cause is deemed equally plausible.

On the basis of the geophysical survey, the PDA is assessed as having a low archaeological potential.

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.

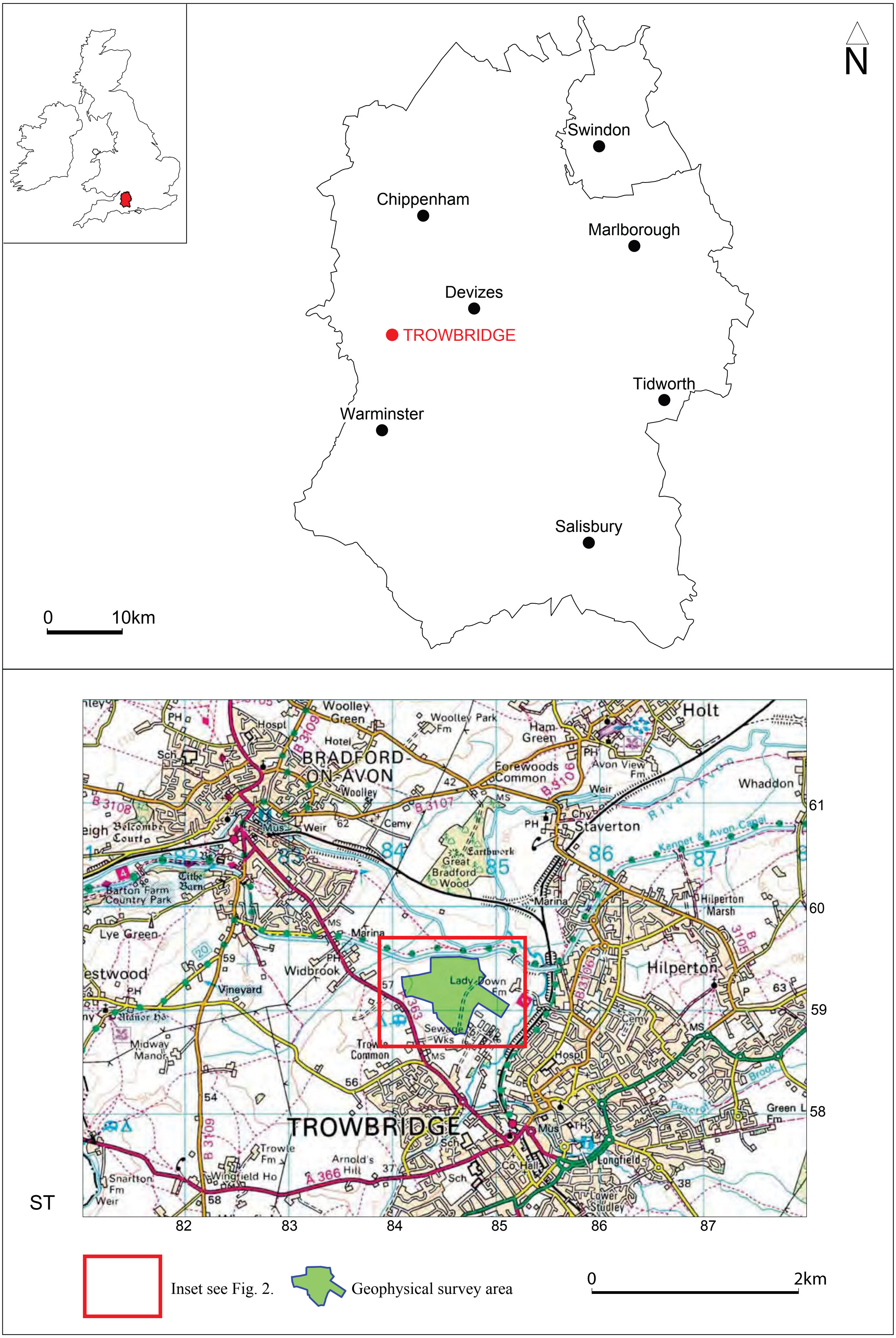

Fig. 1. Site location

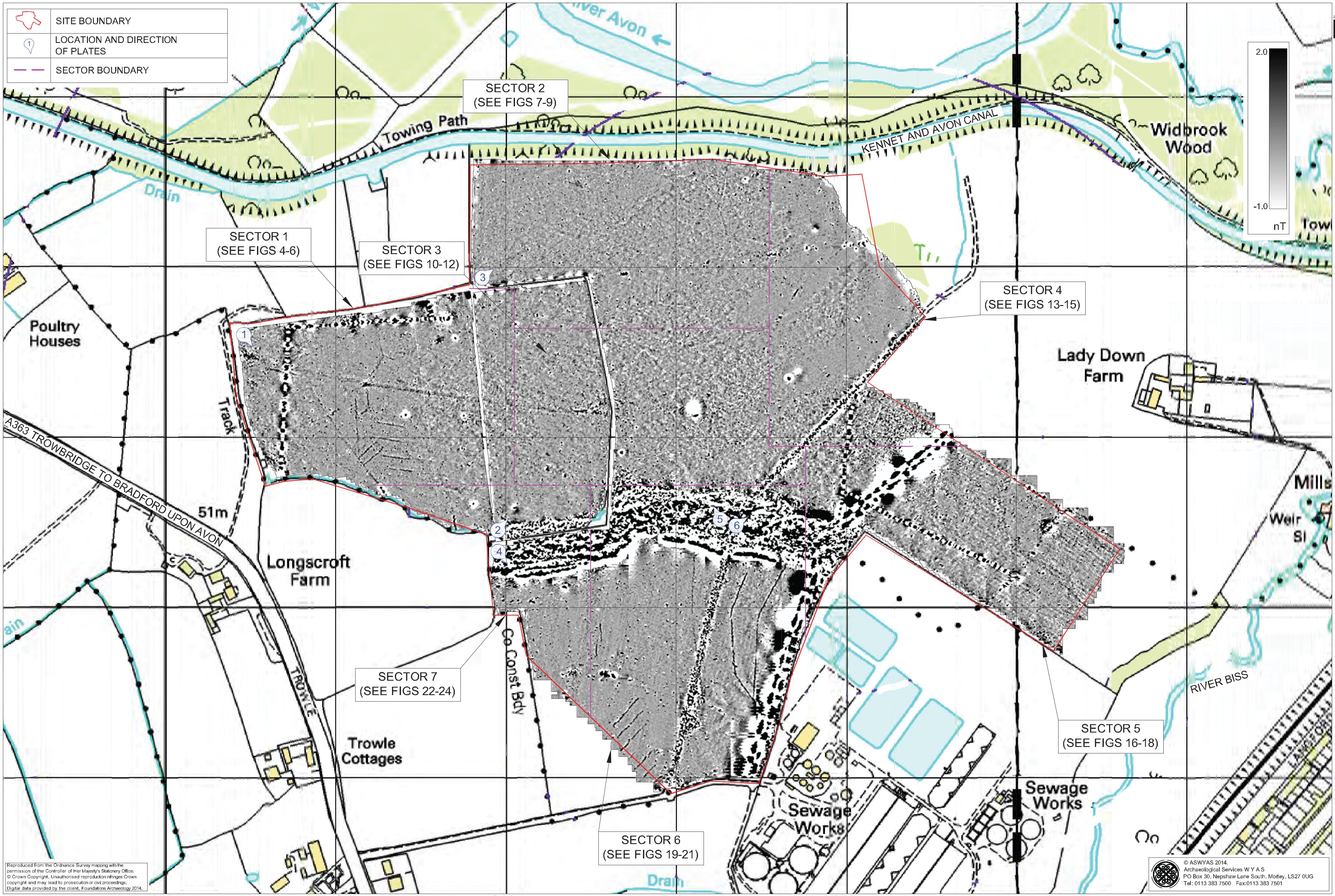

Fig. 2. Survey location showing greyscale magnetometer data (1:4000 @ A3)

0 200m

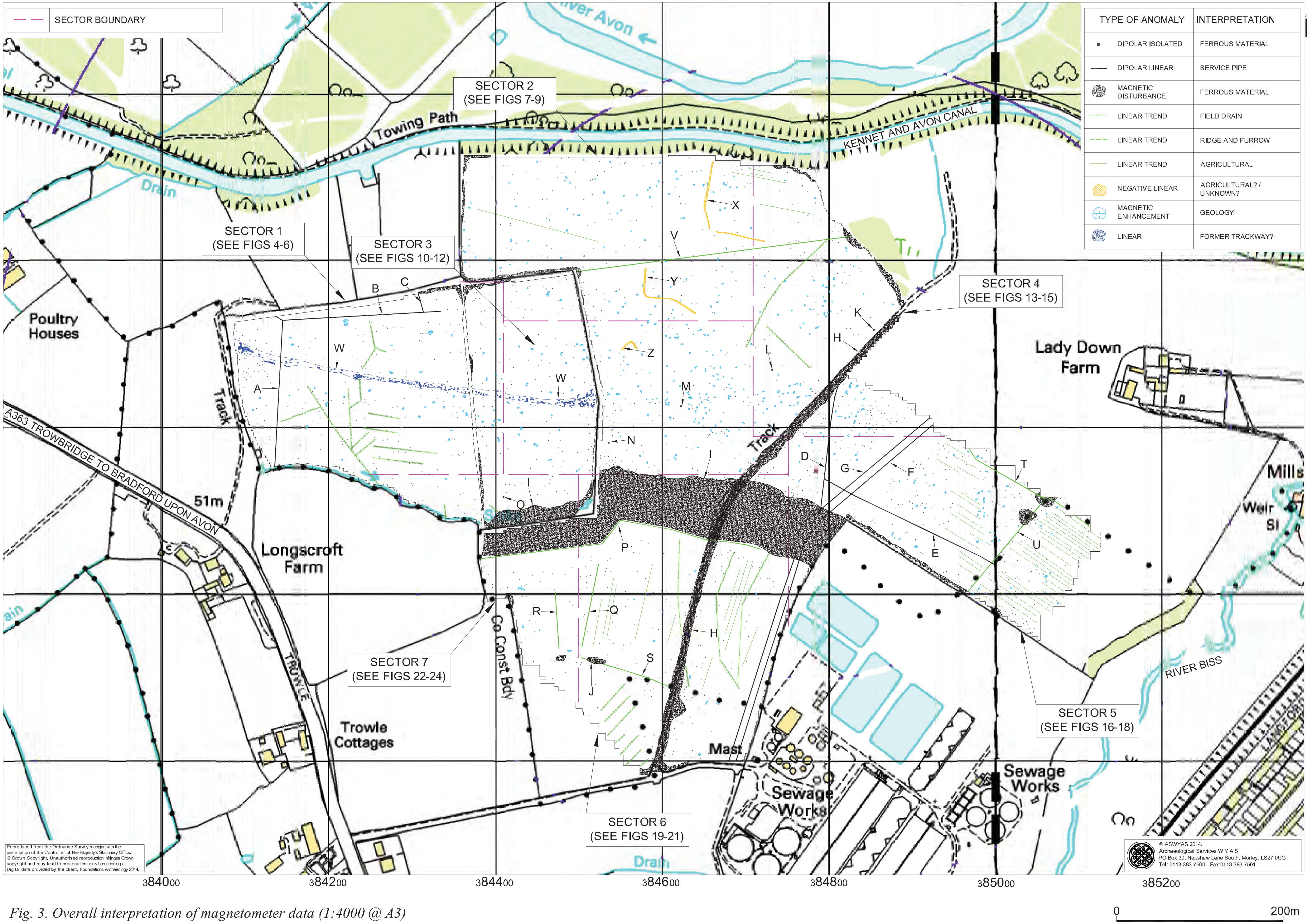

Fig. 3. Overall interpretation of magnetometer data (1:4000 @ A3)

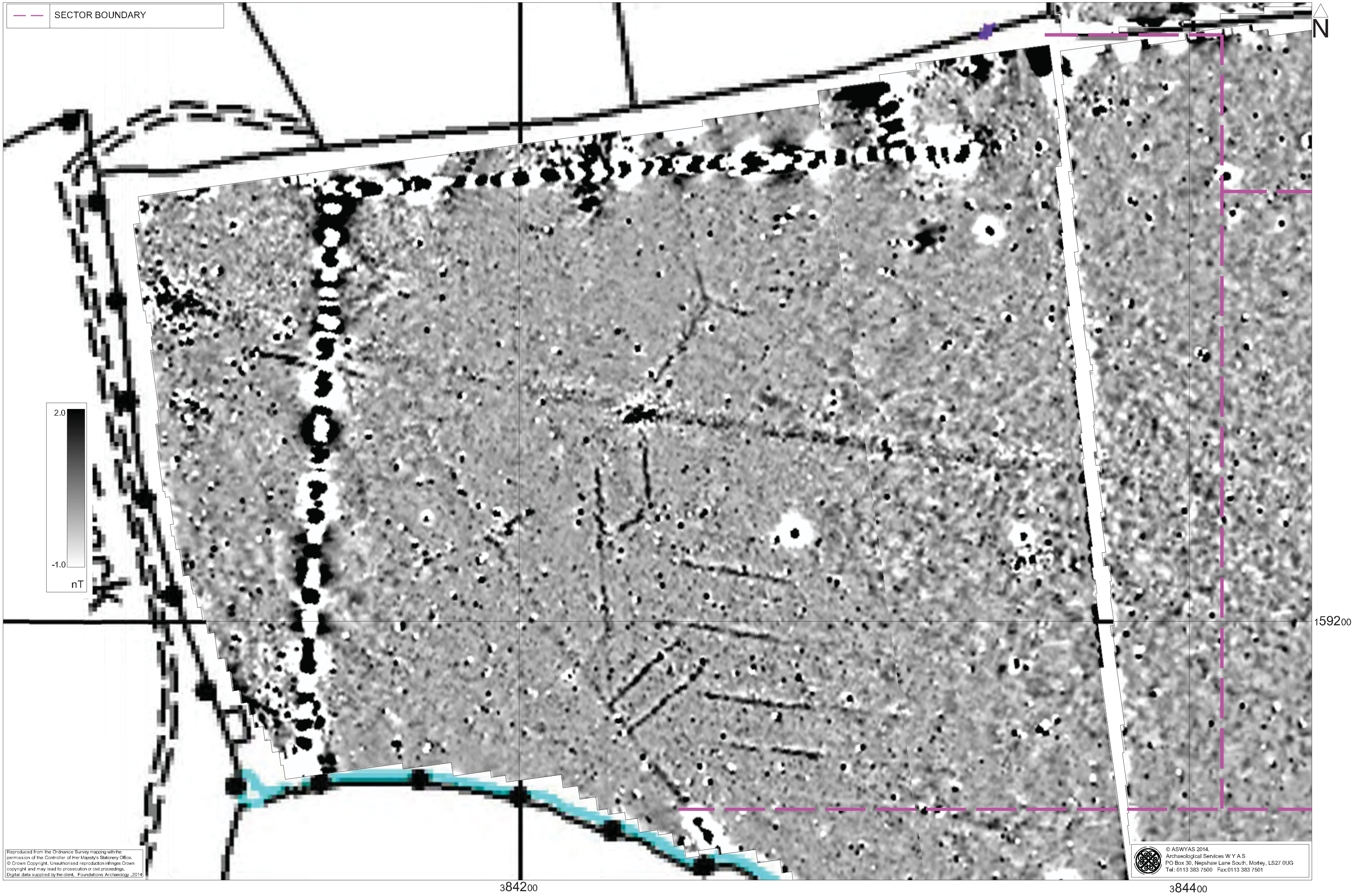

Fig. 4. Processed greyscale magnetometer data; Sector 1 (1:1000 @ A3)

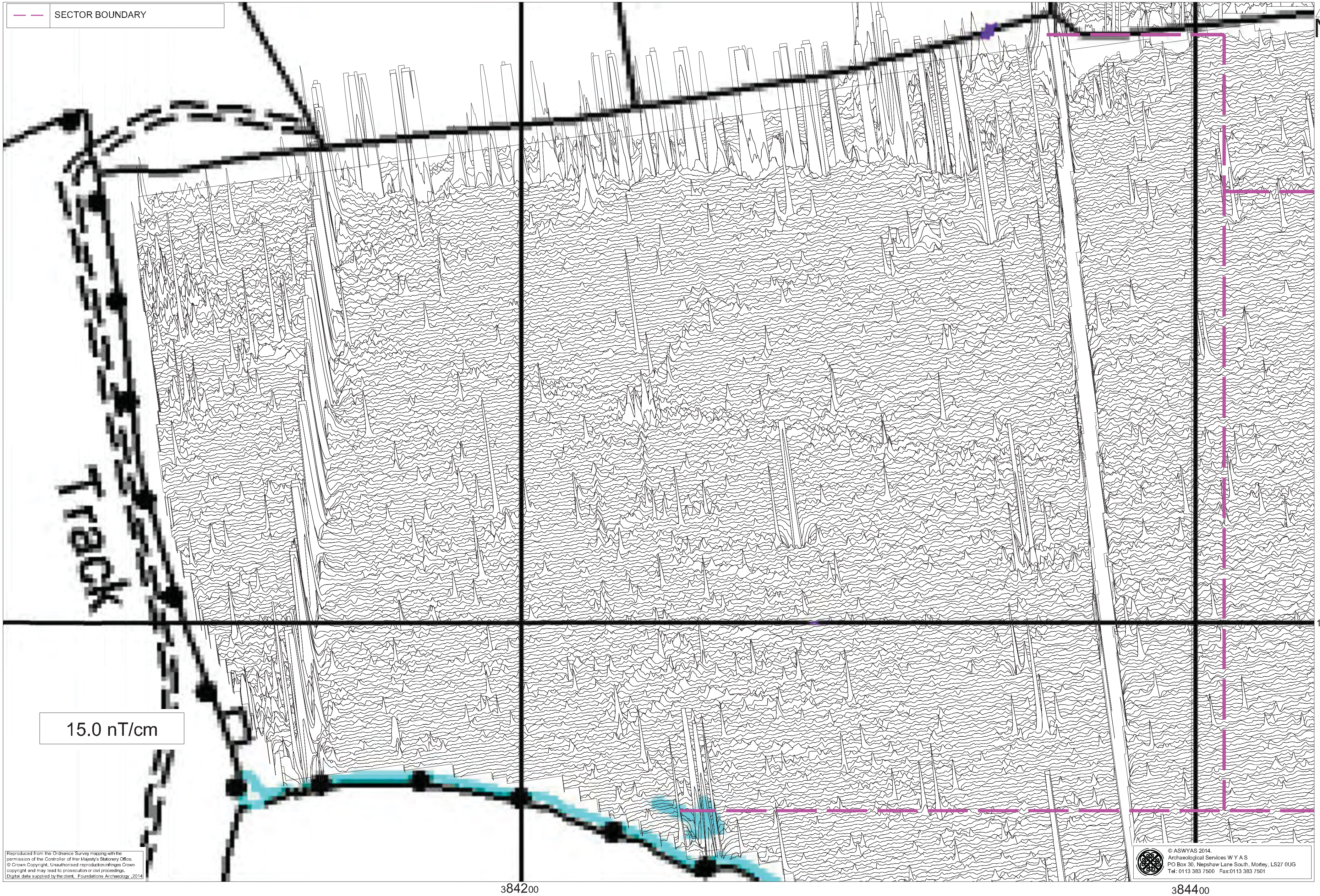

Fig. 5. XY trace plot of minimally processed magnetometer data; Sector 1 (1:1000 @ A3)

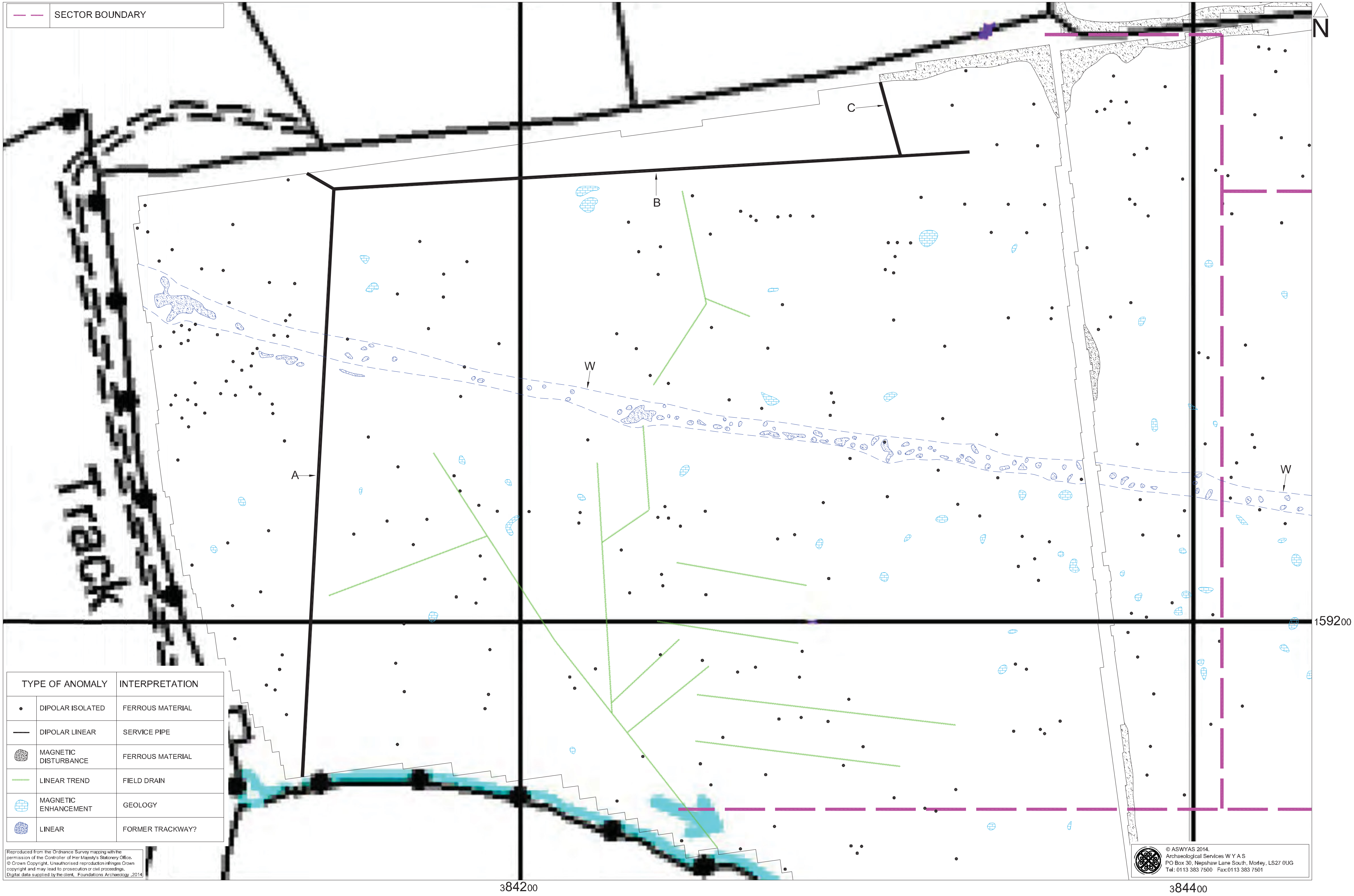

Fig. 6. Interpretation of magnetometer data; Sector 1 (1:1000 @ A3)

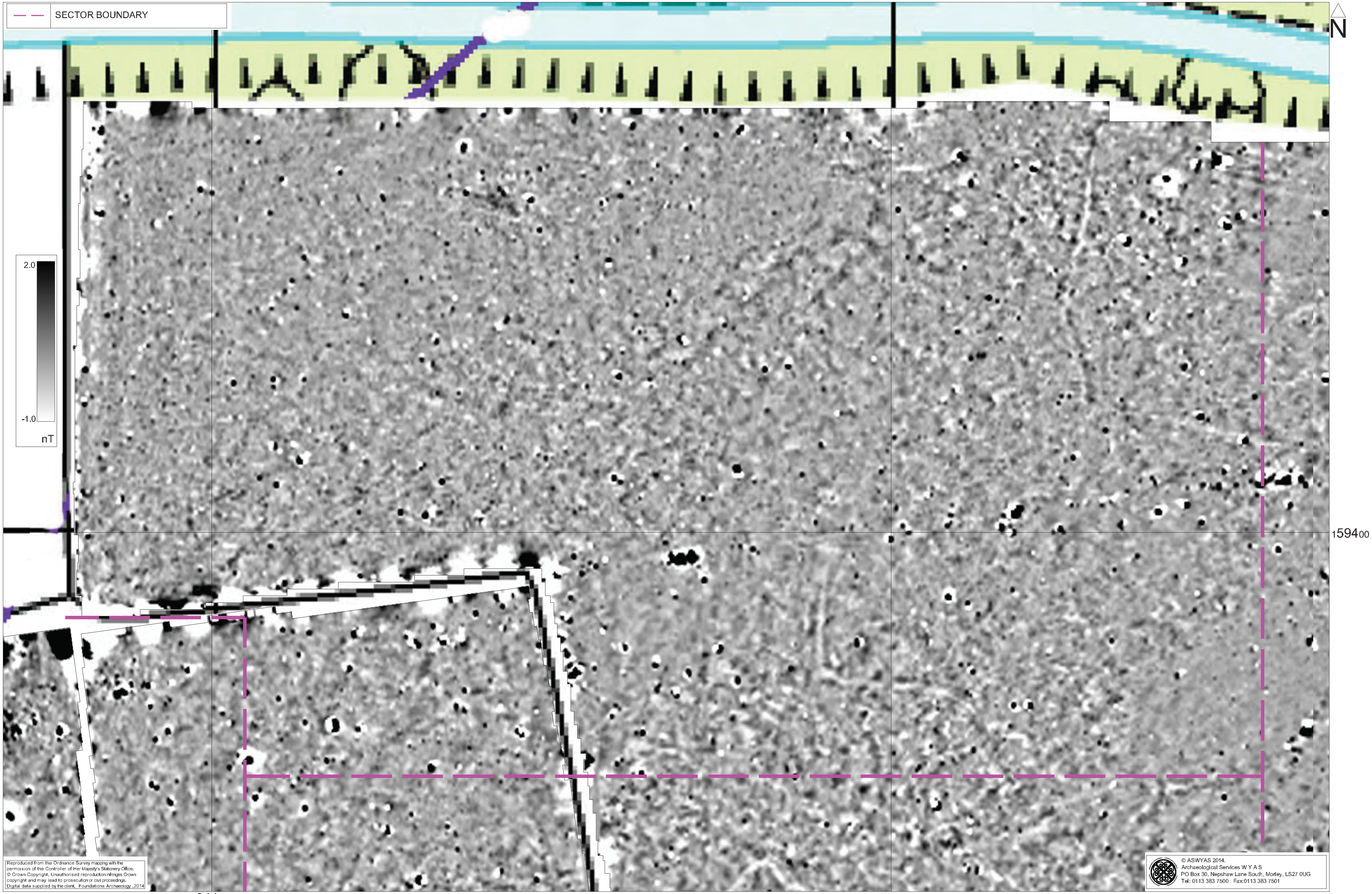

Fig. 7. Processed greyscale magnetometer data; Sector 2 (1:1000 @ A3)

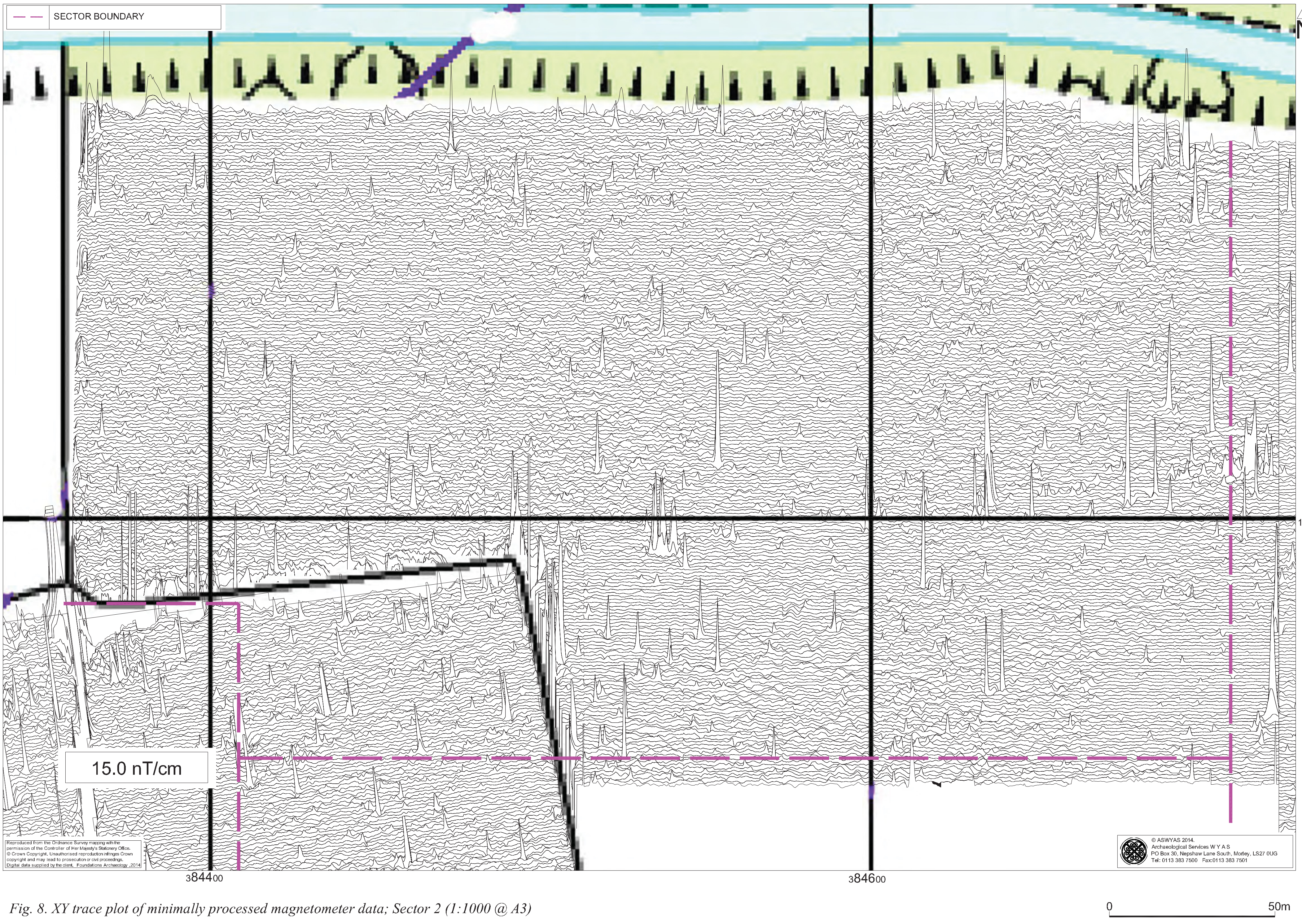

Fig. 8. XY trace plot of minimally processed magnetometer data; Sector 2 (1:1000 @ A3)

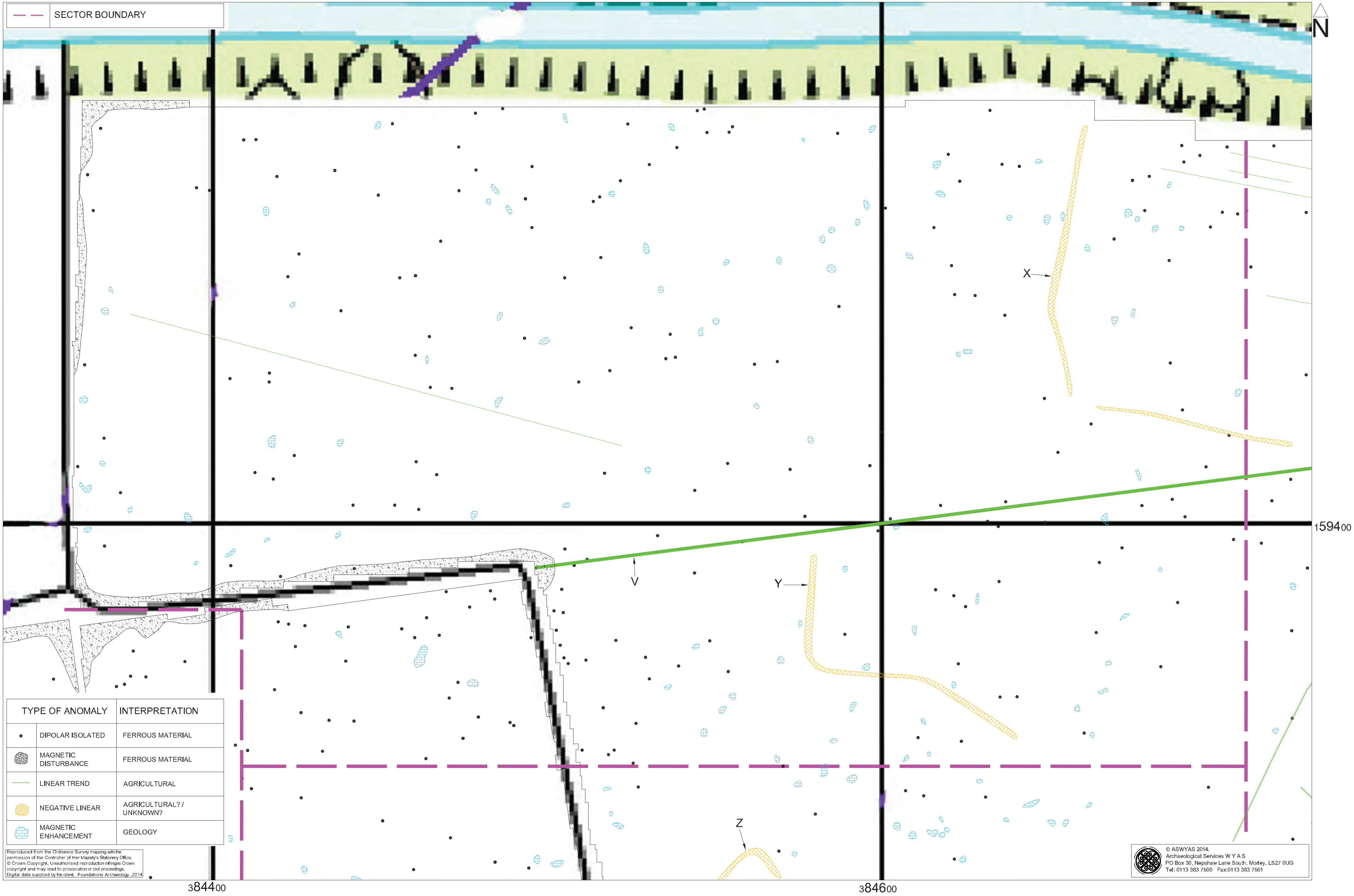

Fig. 9. Interpretation of magnetometer data; Sector 2 (1:1000 @ A3)

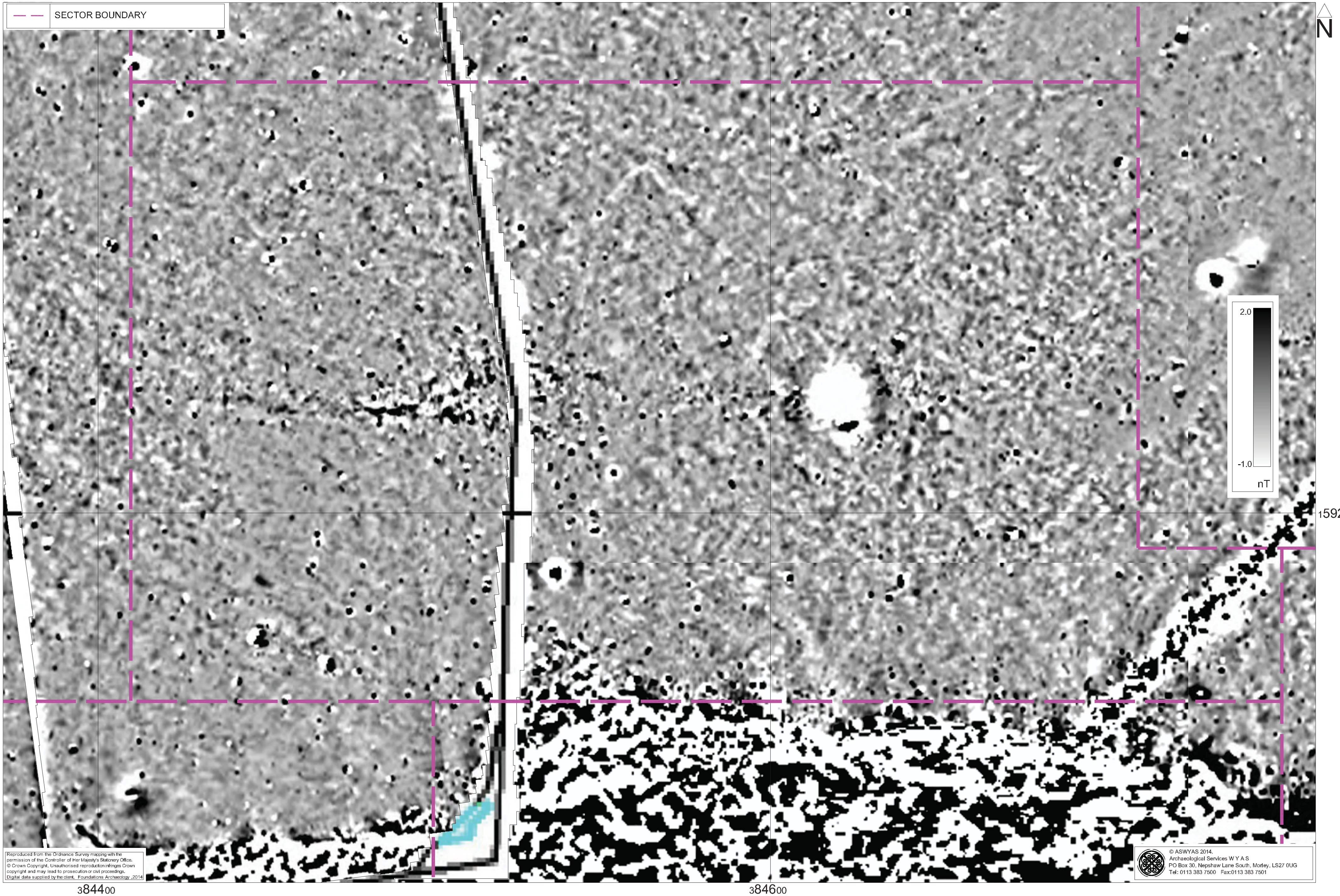

Fig. 10. Processed greyscale magnetometer data; Sector 3 (1:1000 @ A3)

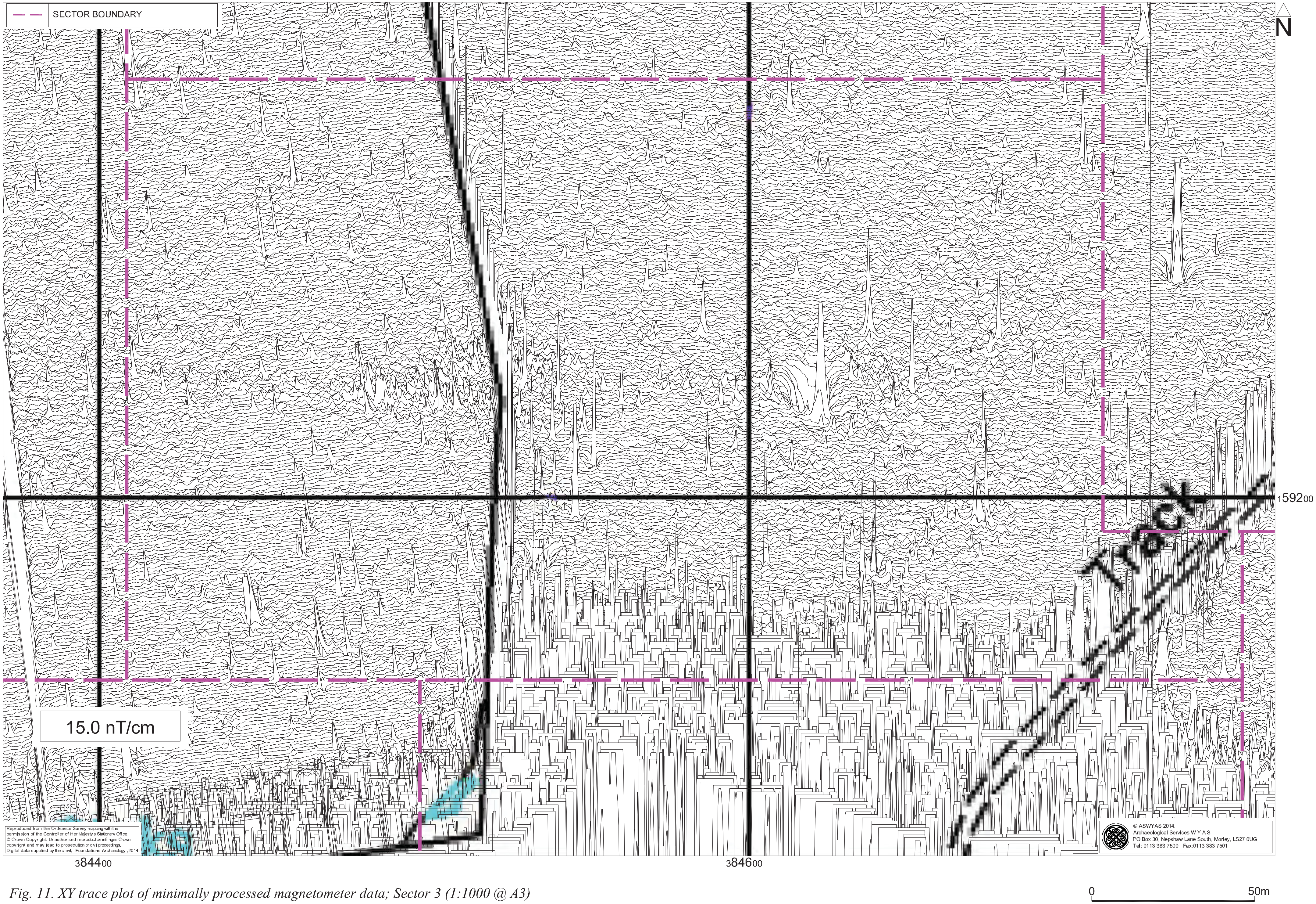

Fig. 11. XY trace plot of minimally processed magnetometer data; Sector 3 (1:1000 @ A3)

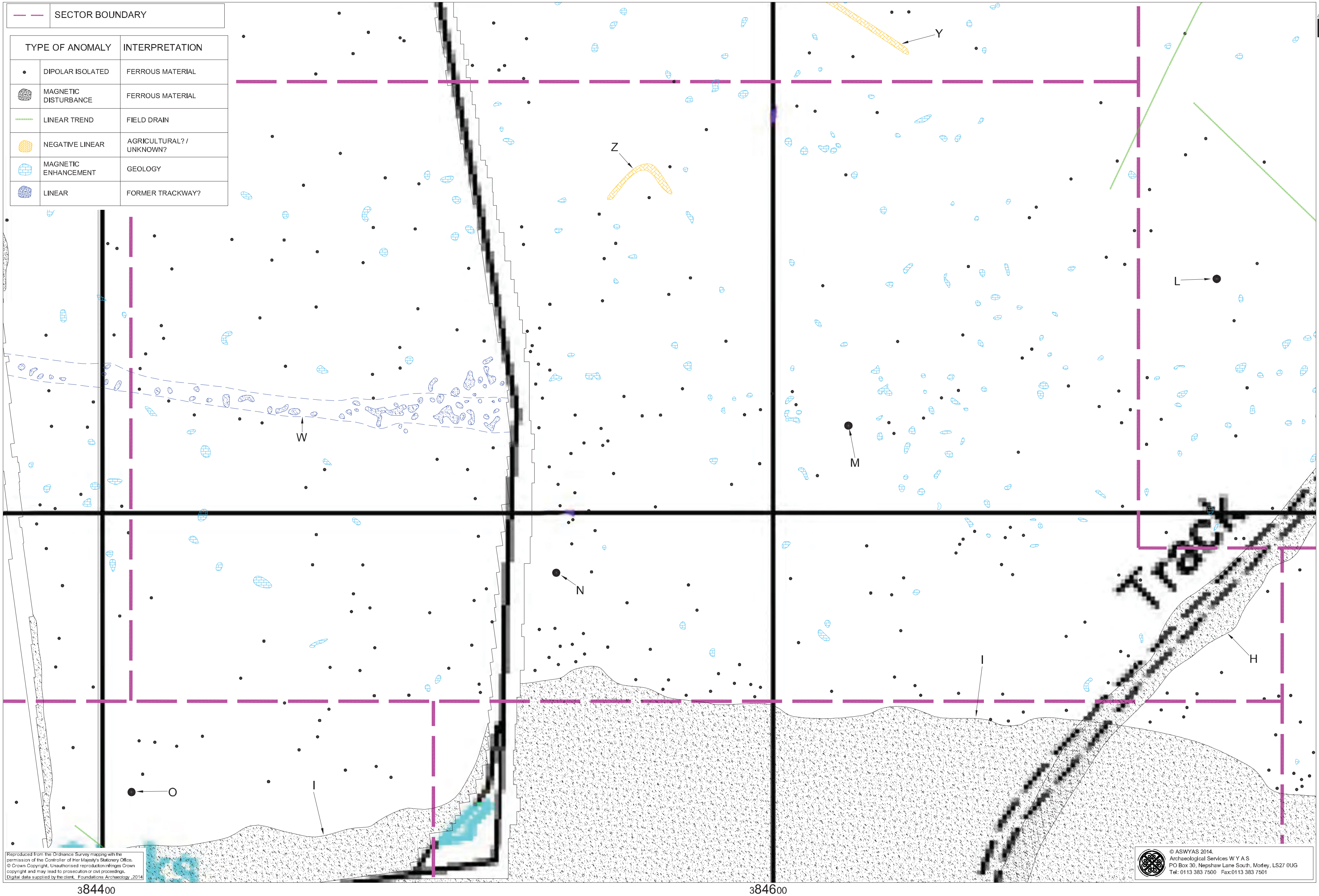

Fig. 12. Interpretation of magnetometer data; Sector 3 (1:1000 @ A3)

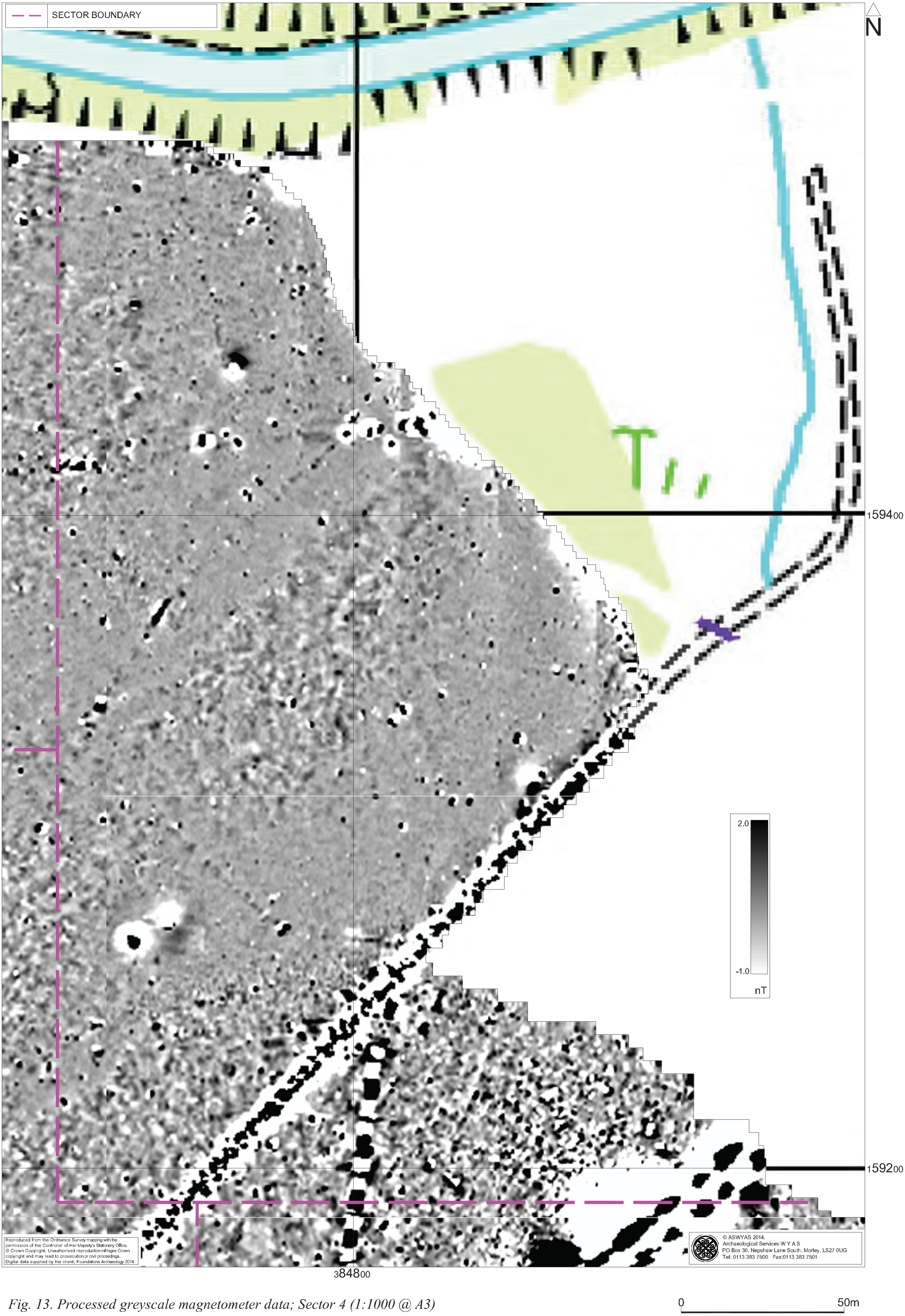

Fig. 13. Processed greyscale magnetometer data; Sector 4 (1:1000 @ A3)

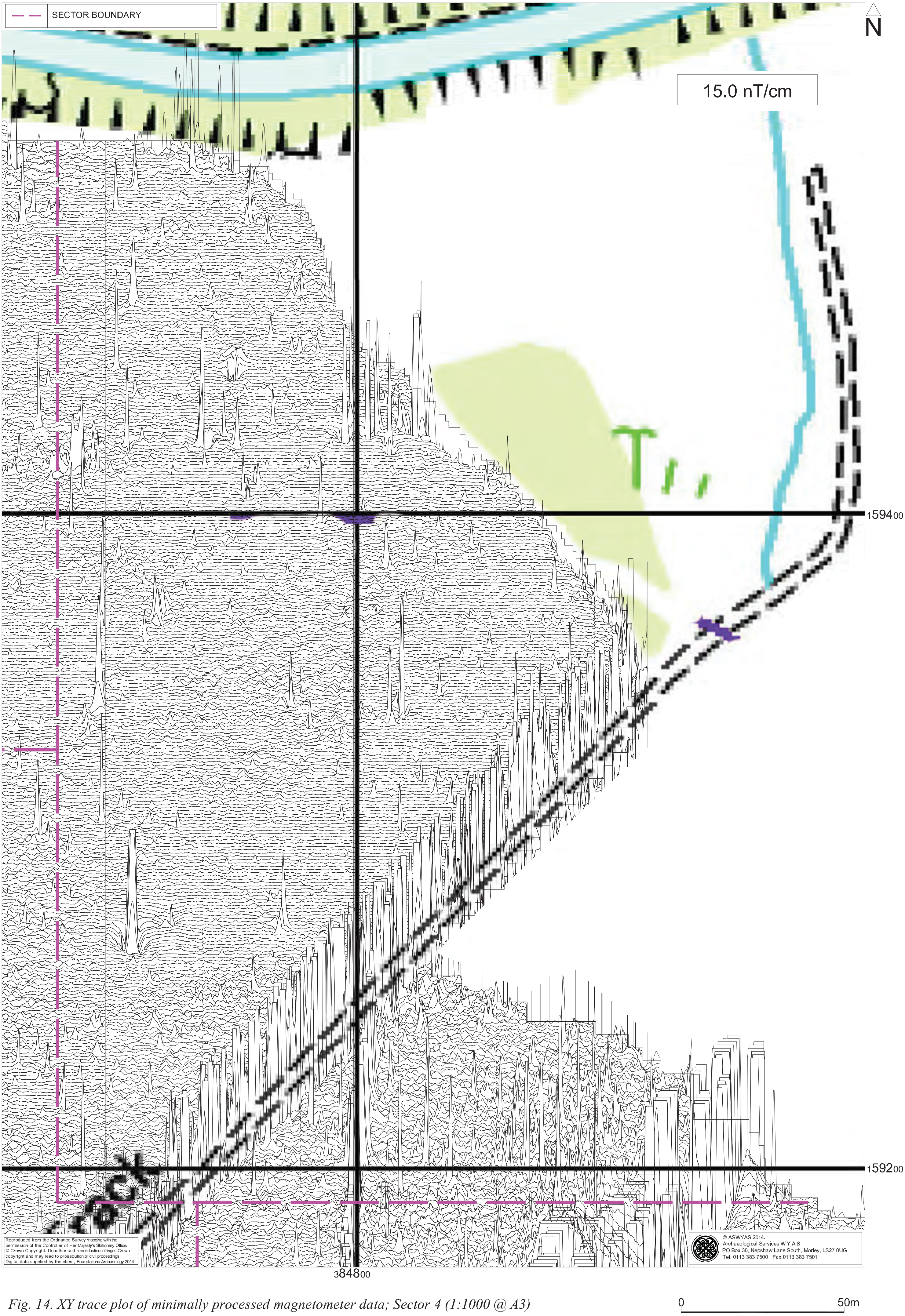

Fig. 14. XY trace plot of minimally processed magnetometer data; Sector 4 (1:1000 @ A3)

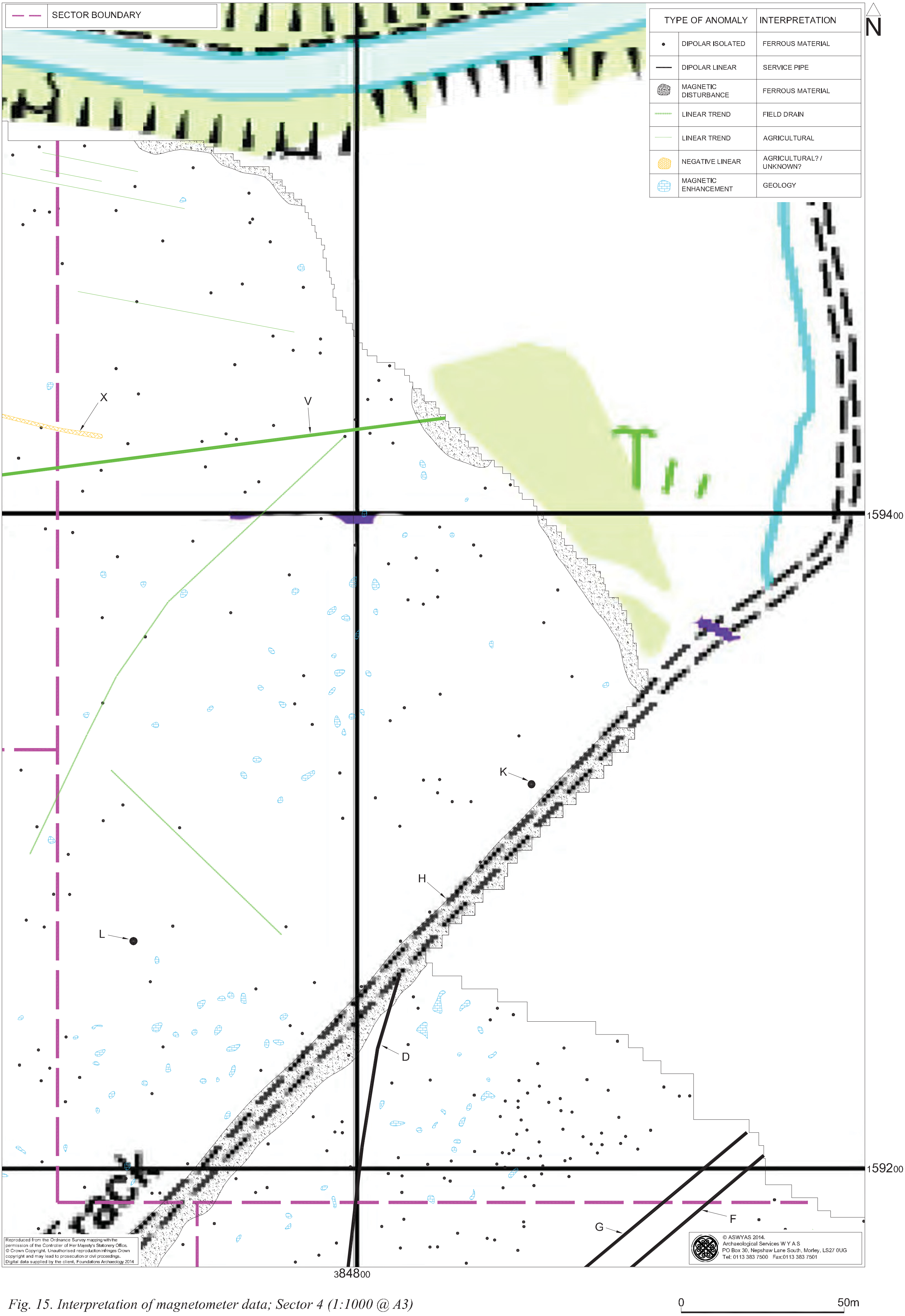

Fig. 15. Interpretation of magnetometer data; Sector 4 (1:1000 @ A3)

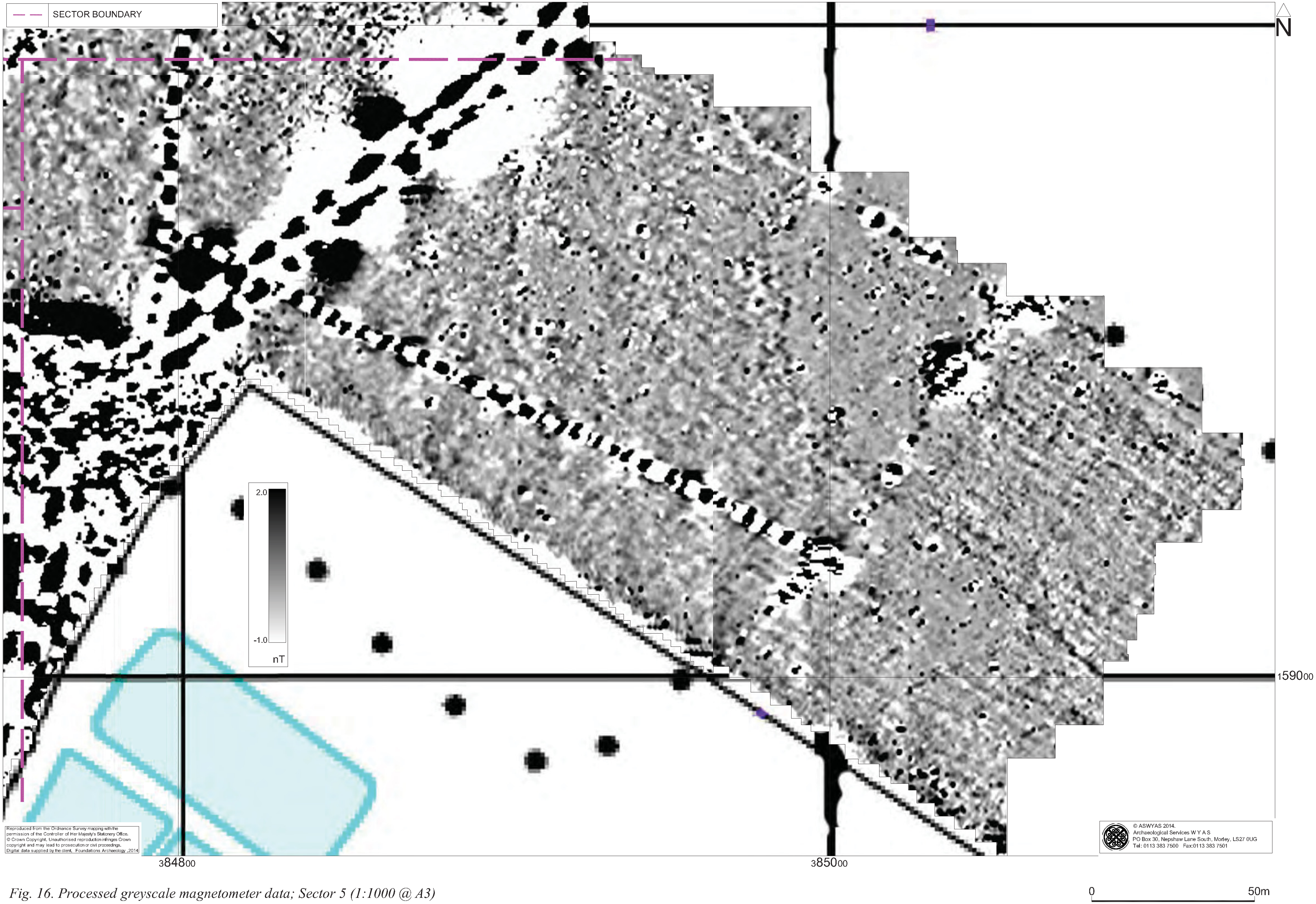

Fig. 16. Processed greyscale magnetometer data; Sector 5 (1:1000 @ A3)

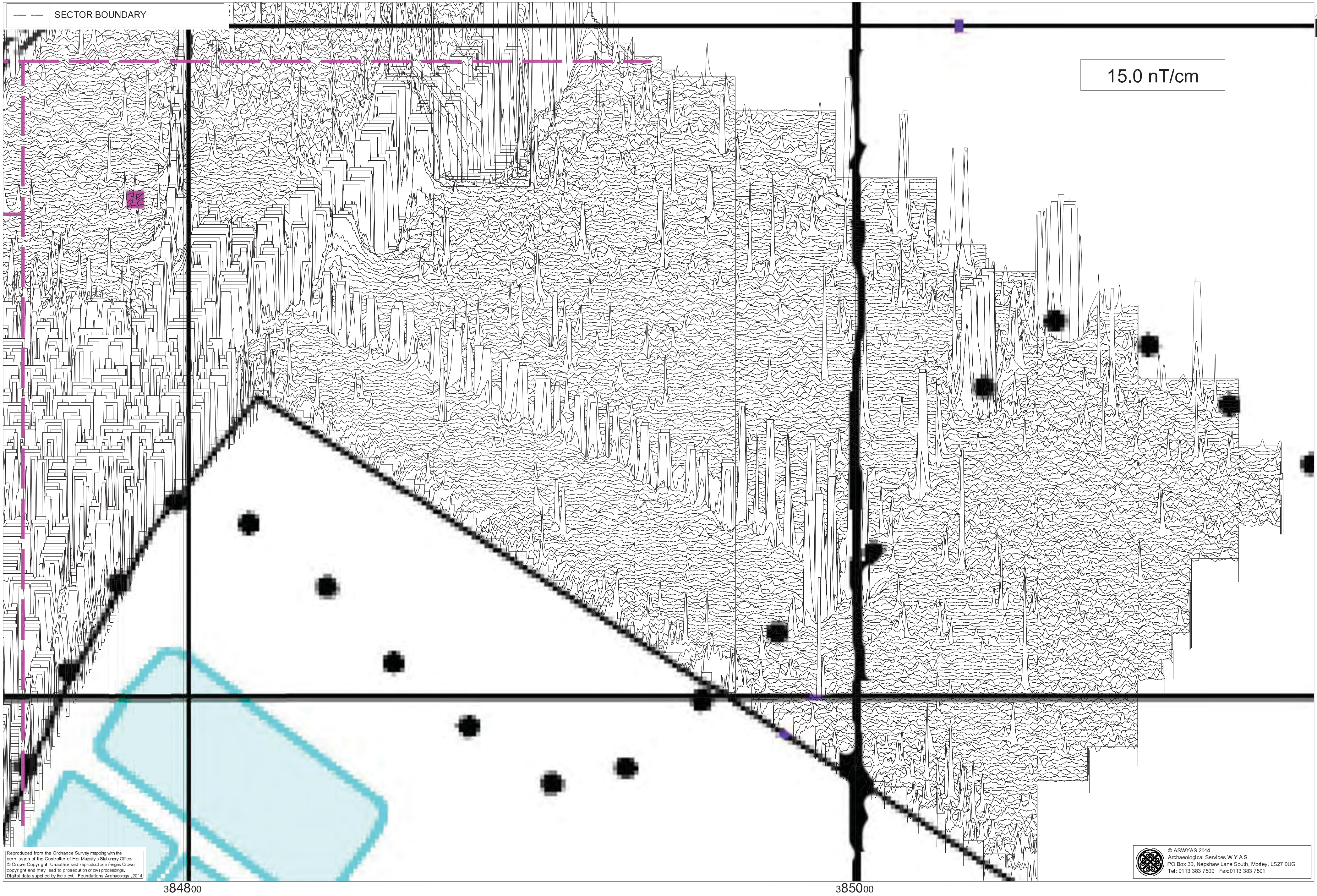

Fig. 17. XY trace plot of minimally processed magnetometer data; Sector 5 (1:1000 @ A3)

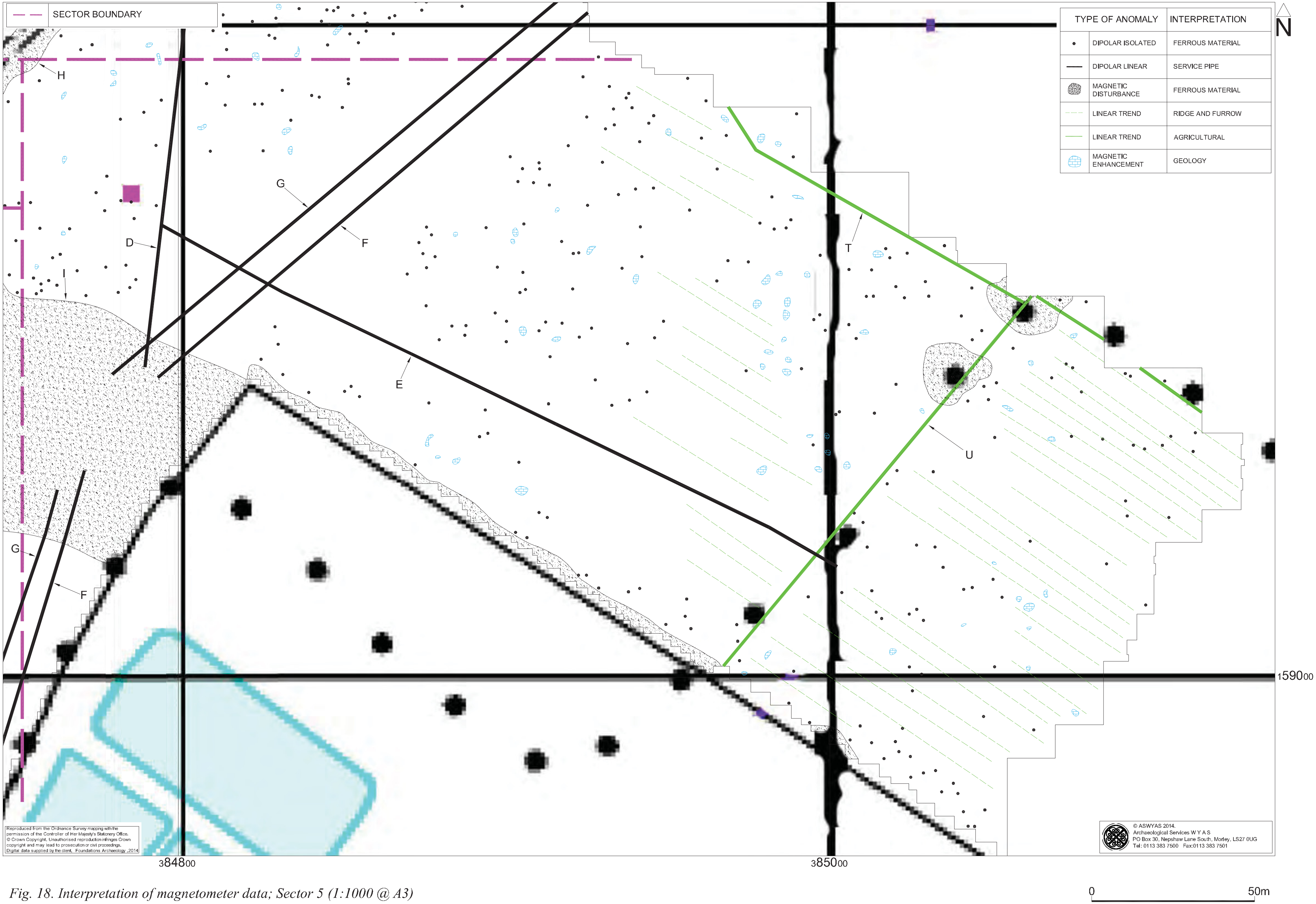

Fig. 18. Interpretation of magnetometer data; Sector 5 (1:1000 @ A3)

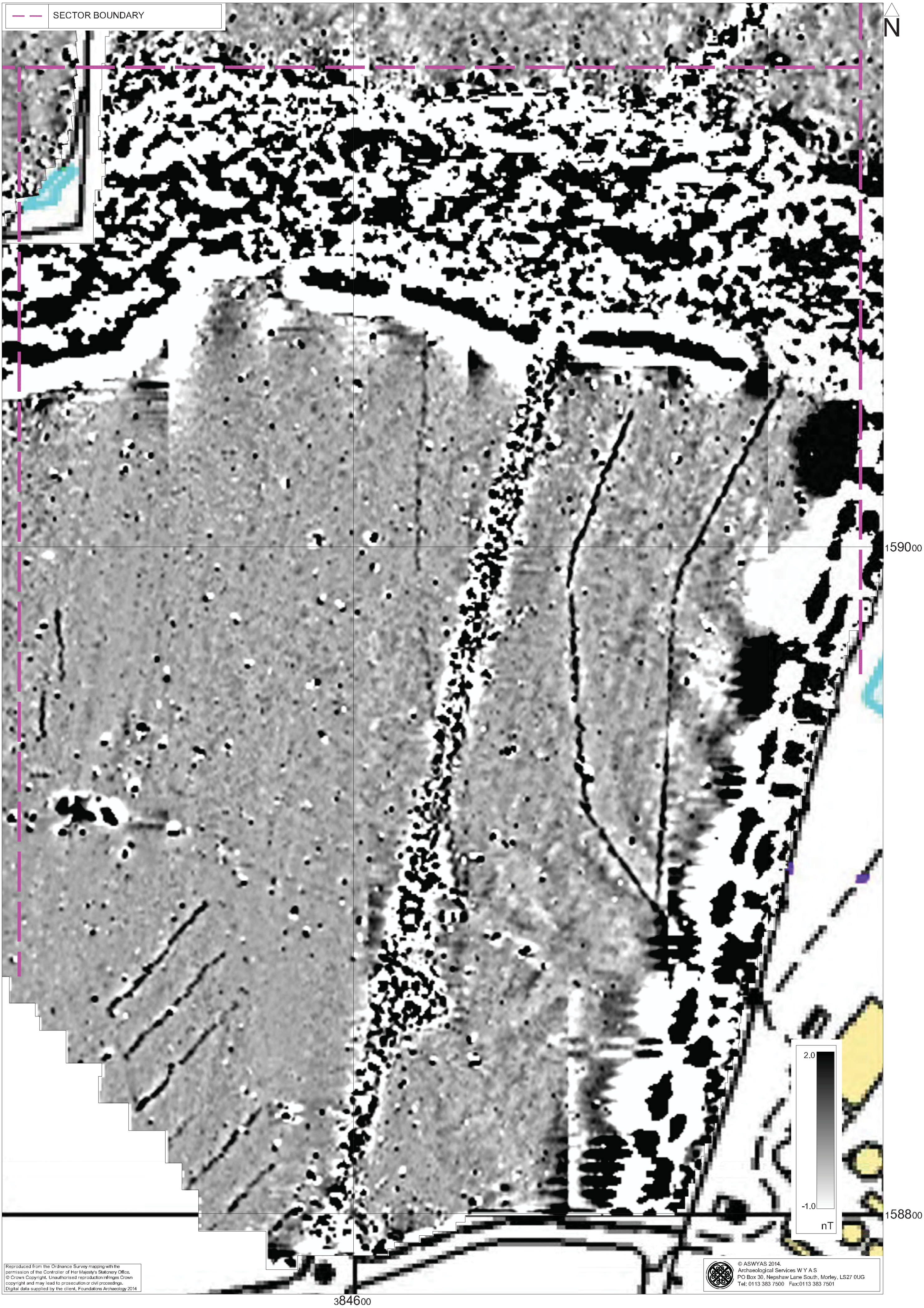

Fig. 19. Processed greyscale magnetometer data; Sector 6 (1:1000 @ A3)

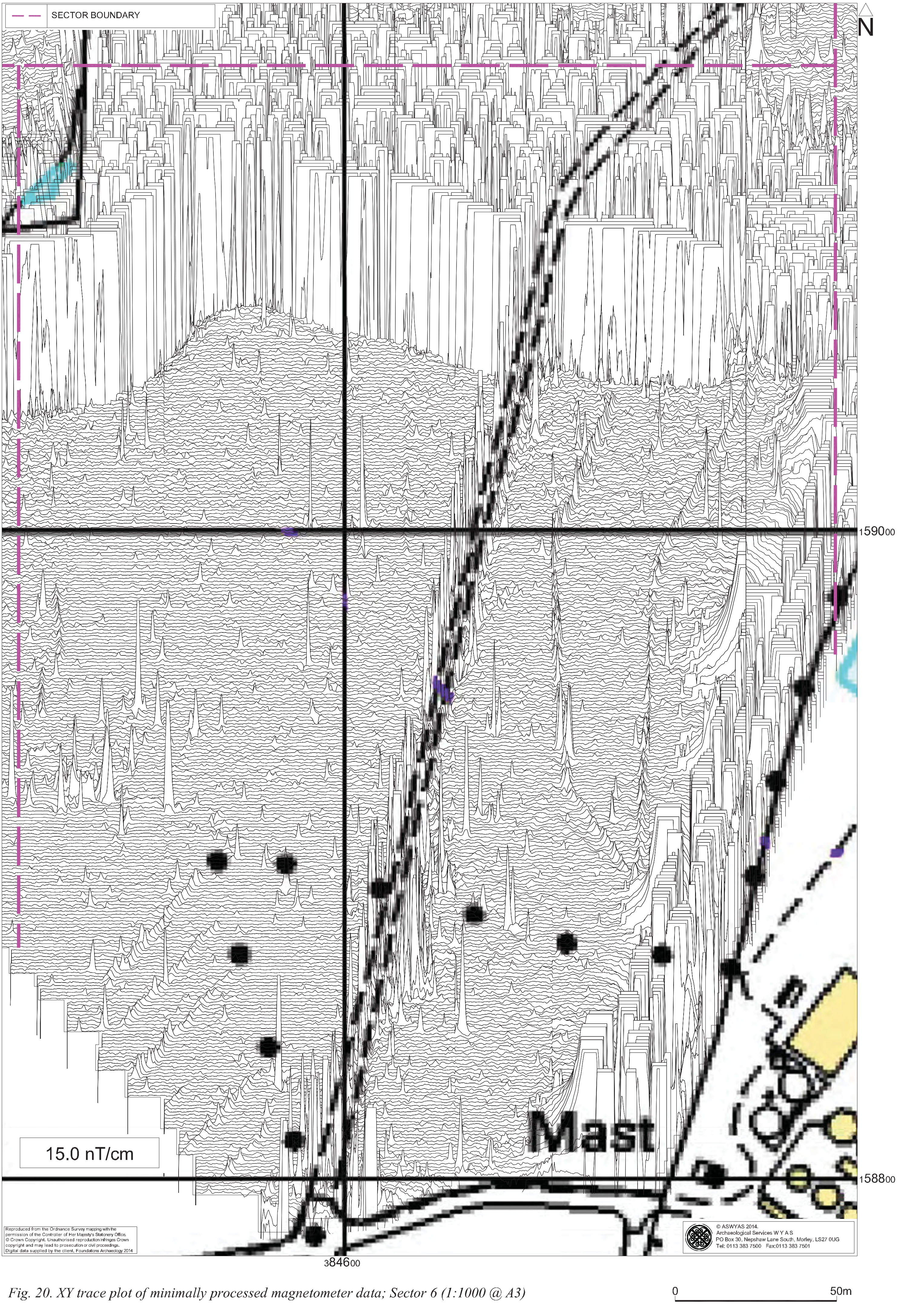

Fig. 20. XY trace plot of minimally processed magnetometer data; Sector 6 (1:1000 @ A3)

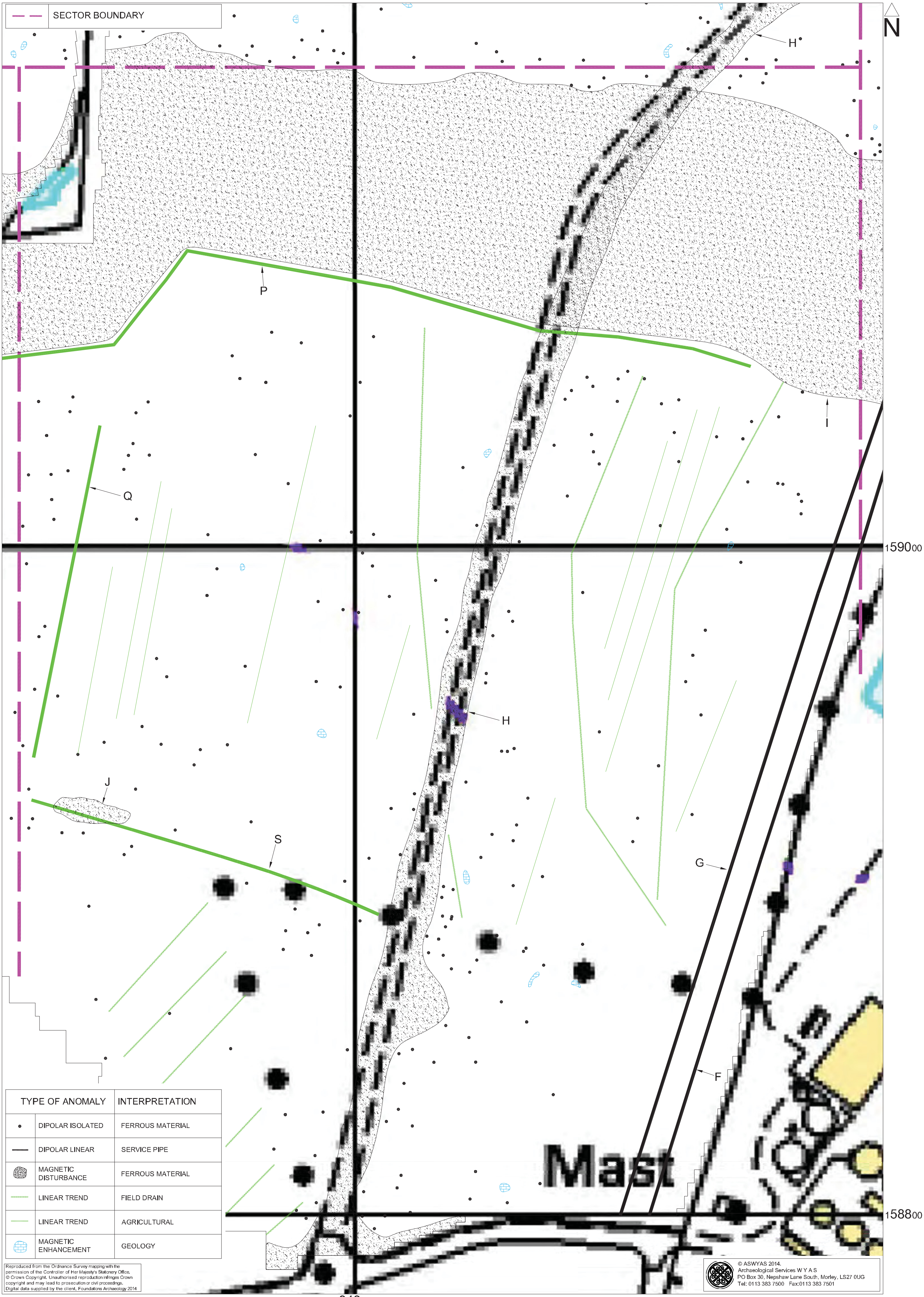

Fig. 21. Interpretation of magnetometer data; Sector 6 (1:1000 @ A3)

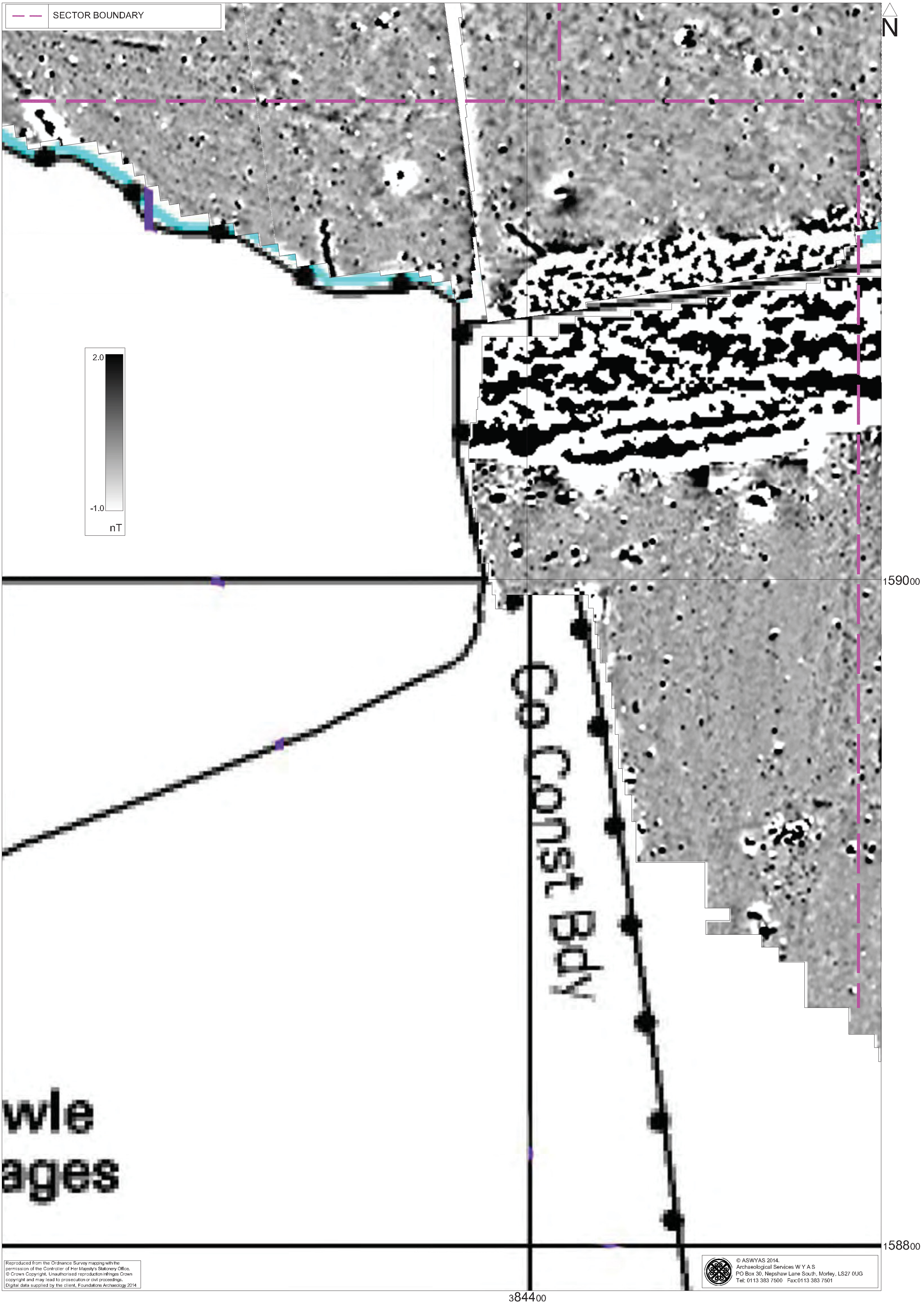

Fig. 22. Processed greyscale magnetometer data; Sector 7 (1:1000 @ A3)

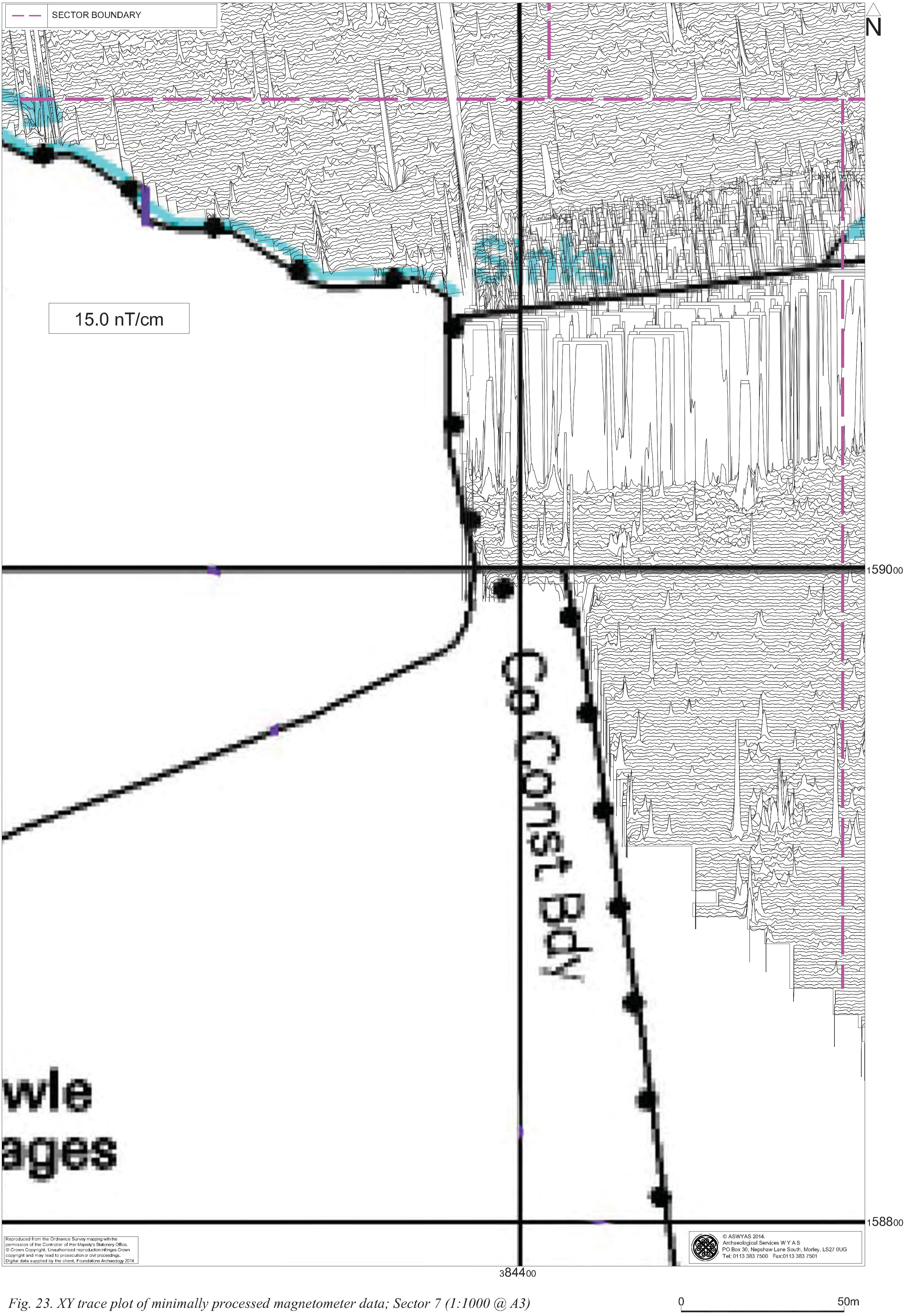

Fig. 23. XY trace plot of minimally processed magnetometer data; Sector 7 (1:1000 @ A3)

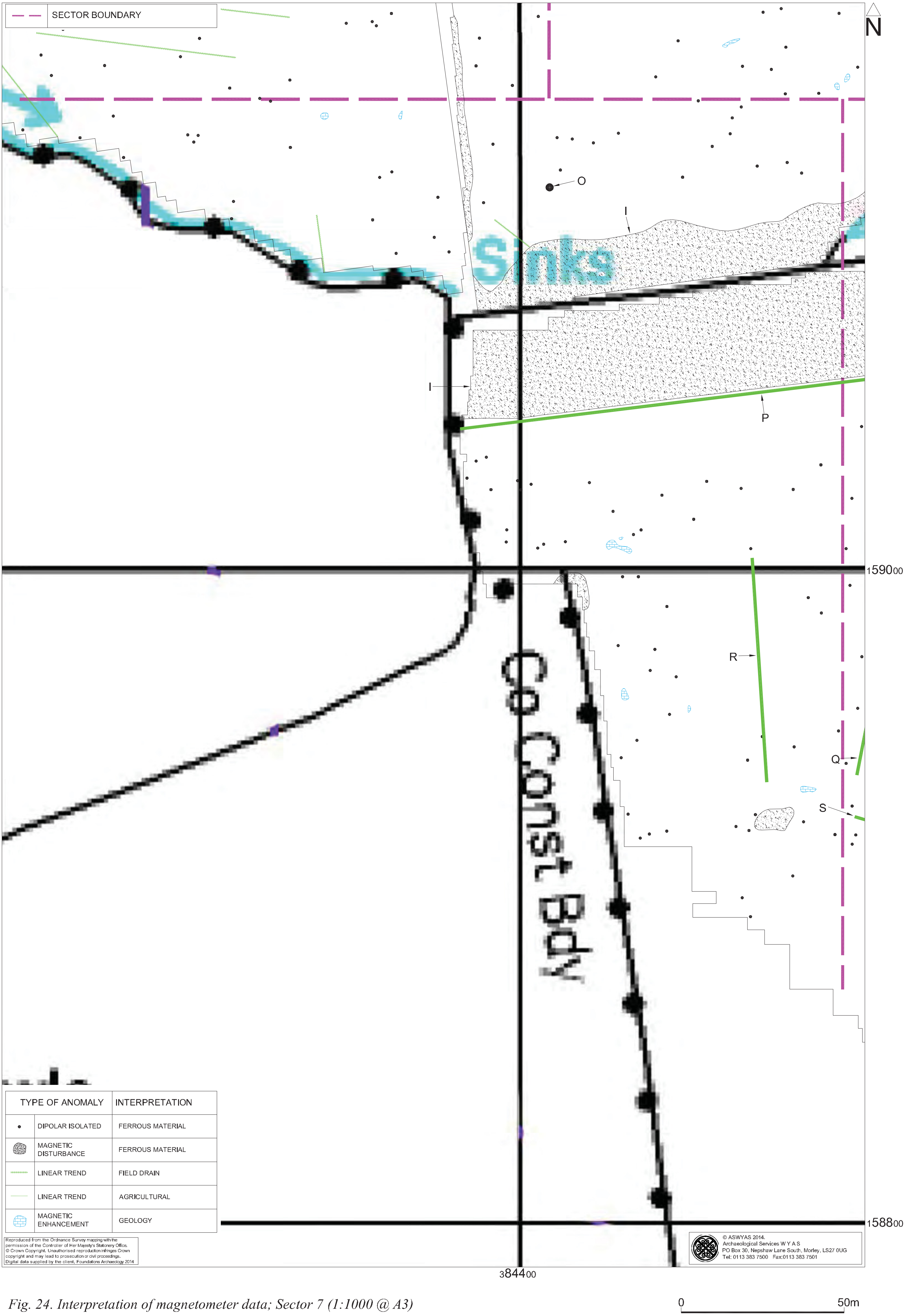

Fig. 24. Interpretation of magnetometer data; Sector 7 (1:1000 @ A3)

Plate 1. General view of western section of the PDA, looking south-east

Plate 2. General view of central section of the PDA, looking north-east

Plate 3. General view of northern section of the PDA, looking east

Plate 4. General view of southern section of the PDA, looking south-east

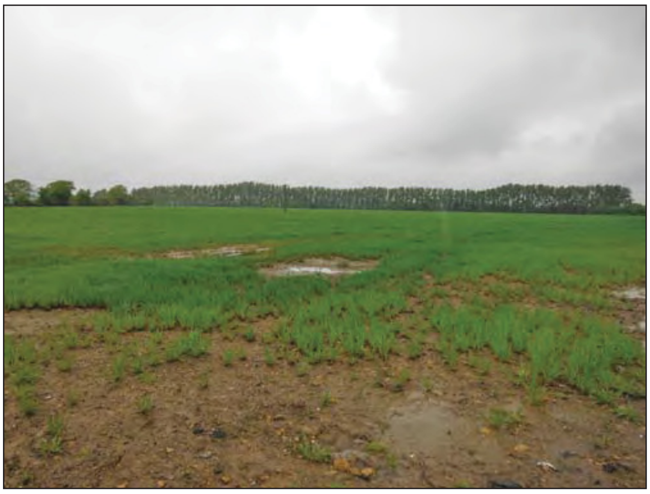

Plate 5. General view of northern section of the PDA, looking north-west

Plate 6. General view of eastern section of the PDA, 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 plough-soil.

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.

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 Wiltshire Historic Environment Record).

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