ARCHAEOLOGICAL SERVICES WYAS

Crewe Green Link Road (South)
Crewe
Cheshire

Geophysical Survey

Report no. 2430

January 2013

Client: Jacobs (UK) Limited

REGISTERED ORGANISATION IA

Crewe Green Link Road (South)
Crewe
Cheshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering approximately 16 hectares was carried out along the proposed route of the Crewe Green Link Road (South). The proposed route runs immediately adjacent to Basford Brook and consequently much of the survey data are dominated by anomalies caused by alluvial flood deposits. Anomalies caused by service pipes, field drains and agricultural activity are also identified. No anomalies of probable archaeological origin have been identified.

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Report Information

Client:	Jacobs UK Limited
Address:	1 City Walk, Leeds, LS11 9DX
Report Type:	Geophysical survey
Location:	Crewe
County:	Cheshire
Grid Reference:	SJ 722 521 (south) to SJ 722 537 (north)
Period(s) of activity: represented	-
Report Number:	2430
Project Number:	3939
Site Code:	CLR12
OASIS ID:	archaeol11-143264
Planning Application No.:	pre-planning
Museum Accession No.:	n/a
Date of fieldwork:	July and December 2012
Date of report:	January 2013
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Authorisation for distribution: ---

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1 Introduction

Archaeological Services WYAS was commissioned by Jacobs UK Ltd., on behalf of Cheshire East Council (hereafter CEC), to carry out a programme of non-intrusive geophysical (magnetometer) survey on land to the south-east of Crewe, between the A543 and A500, in advance of the construction of the proposed Crewe Green Link Road (South) (see Fig. 1). The work was undertaken in accordance with a written scheme of investigation agreed with the Historic Environment Planning Officer of CEC (Jacobs 2012a). The survey was carried out in two phases between August 30th and December 20th 2012 to allow for the varying cropping regimes along the corridor. The results of the survey will be incorporated into the Cultural Heritage chapter of an Environmental Impact Assessment which will be submitted to support the planning application.

Site location, topography and land-use

The survey area covered the footprint of the proposed Crewe Green Link Road (South). The proposed route is approximately 1.1km long and will complete the southern section of the link road to the east of Crewe, between the A534 and A500; joining the A500 to the south (SJ7229 5369) with the A5020 at the Western Gate roundabout to the north (SJ 7263 5283) (see Fig. 2). The location of a proposed borrow pit to the south-west of the scheme (centred at SJ 7223 5246) was also surveyed (see Fig. 2), giving a combined area of 20.7 hectares.

The proposed route will extend for approximately 1km and is aligned broadly north/south. The corridor crosses relatively flat (between 50m above Ordnance Datum (aOD) and 55m aOD), and mostly agricultural land (a mixture of pasture and arable), and follows the course of Basford Brook and a tributary stream for its entire length. The location of the borrow pit is also immediately adjacent to Basford Brook. The area to the north of the railway line was severely overgrown and could not be surveyed (see Plate 3). Ground conditions throughout the survey area were poor due to waterlogging caused by heavy rain and some parts were under standing water and could not be surveyed.

Geology and soils

The underlying bedrock geology comprises Sidmouth Mudstone overlain by till and alluvium (British Geological Survey 2013). The soils are classified in the Crewe association which are described as slowly permeable, seasonally waterlogged reddish clays and fine loams over clays (Soil Survey of England and Wales 1983).

2 Archaeological background

Research undertaken by the client for an Environmental Statement (Jacobs 2012b) established that there are nine known cultural heritage assets in the vicinity of the proposed corridor. These include find spots of waterlogged timbers, flint and copper artefacts and ridge and furrow earthworks.

3 Aims, Methodology and Presentation

As set out in the Written Scheme of Investigation (Jacobs 2012a), the general objectives of the geophysical survey were:

- to determine (so far as possible) the presence or absence of buried archaeological remains in the survey area;
- to clarify the extent and layout of known sites of archaeological interest within or a adjacent to the survey area;
- to clarify the extent and layout of previously unknown buried remains within the survey area; and
- to interpret any geophysical anomalies identified by the survey.

The main aim of the geophysical survey was to determine the presence or absence of potential unknown archaeological remains, and to provide sufficient information to enable an assessment to be made of the impact of the new link road and borrow pit on them and for mitigation proposals, if appropriate, to be recommended. To achieve this aim it was determined that a geophysical (magnetometer) survey covering the road corridor and borrow pit should be carried out, an area of approximately 20 hectares (Jacobs 2012a). Waterlogged and flooded ground, areas of overgrown vegetation and unharvested crop reduced the overall survey area to approximately 16 hectares.

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 map is shown in Figure 1. Large scale (1:4000) plans showing the magnetometer data and overall interpretation are presented in Figure 2 and Figure 3. The data are presented in greyscale, XY trace plot and interpretation formats in Figures 4 to 21 inclusive at a scale of 1:1000.

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 geophysical survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the Institute for Archaeologists (IfA 2010). 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 21 inclusive)

The anomalies identified during the survey can be divided into several categories according to their cause and probable origin.

Ferrous anomalies - modern

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. Ferrous debris is common on rural sites, often being present as a consequence of manuring or tipping/infilling. On this site there is no clustering to these anomalies and they are therefore assumed to be due to the random distribution of ferrous debris.

Larger areas of magnetic disturbance anomalies have been recorded around the periphery of some of the surveyed areas. The largest of these is in Sector 1 (see Figs 4, 5 and 6) and is almost certainly associated with the pipe that crosses this part of the survey area (see below). Other less extensive areas of magnetic disturbance are located adjacent to boundaries and will be due to either ferrous material accumulated along the field edges or to the presence of barbed wire or mesh forming the boundary.

Linear dipolar anomalies caused by buried pipes have been identified at the northern end of the corridor in Sector 1 and also extending into Sector 3. In the extreme north-west two parallel pipes aligned north-west/south-east are noted. A third pipe aligned broadly east/west, and apparently intersecting with one of the other pipes, is also clearly visible.

Agricultural anomalies – post-medieval/modern

Linear trend anomalies have been identified on varying alignments throughout the site. All are considered to be caused by relatively recent agricultural activity.

To the north of the corridor in Sectors 1, 2 and 3 parallel linear anomalies aligned north-north-west/south-south-east have been identified. These anomalies are interpreted as being due to ridge and furrow (or possibly later) ploughing – ridge and furrow earthworks in this location are one of the nine cultural heritage assets previously identified (Jacobs 2012a, Asset 3). The anomalies are due to the magnetic contrast between the infilled furrows and levelled ridges.

In Sector 4 two curvilinear trends are probably due to former field boundaries. The easternmost anomaly is still shown on the most recent Ordnance Survey map (see Fig. 3) whilst the second anomaly, to the west, is shown on Ordnance Survey maps from the first edition up until the 1962 edition (Old-maps 2013). A third possible boundary is noted near the eastern edge of Sector 6.

The remainder of these anomalies are interpreted as field drains. Particularly noticeable is the system of drains at the southern end of Sector 3 and the northern end of Sector 4 which were presumably intended to drain the area between the cluster of five ponds to the immediate east of the proposed route and the stream to the west. Although different in response the four individual linear trend anomalies in Sector 2 are also considered likely to be caused by land drains.

Geological anomalies

Throughout the survey numerous anomalies characterised as localised, relatively small, areas of enhanced magnetic response have been identified. These anomalies are particularly prevalent adjacent to Basford Brook in Sector 1 and Sector 2 although they occur throughout the site. These anomalies are interpreted as being of geological origin and are caused by variation in the composition of the soils which will be exacerbated by the deposition of silts and alluvium following periods of flooding, thus accounting for why these anomalies are more common and extensive close to the brook.

Possible archaeological anomalies

Only a single short linear anomaly has been interpreted as being possibly archaeological. In the absence of any known archaeological remains in the vicinity the ascribed potential is on the basis that the anomaly cannot be obviously included within any of the other categories described above, and particularly that the anomaly (towards the east of Sector 1) is located in an area with very few geological anomalies. However, on the balance of probability a non-archaeological cause is considered equally likely.

5 Conclusions

The geophysical survey has not identified any anomalies of probable archaeological potential and only a single anomaly of unknown, and therefore possibly archaeological origin. The corridor flanks streams and the numerous ponds and poor drainage suggest an area of little obvious merit for either settlement or agriculture. Therefore it is perhaps not surprising that neither the desk-based research or the geophysical survey have identified anything more than the slightest hint of archaeological activity within the proposed scheme footprint.

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.

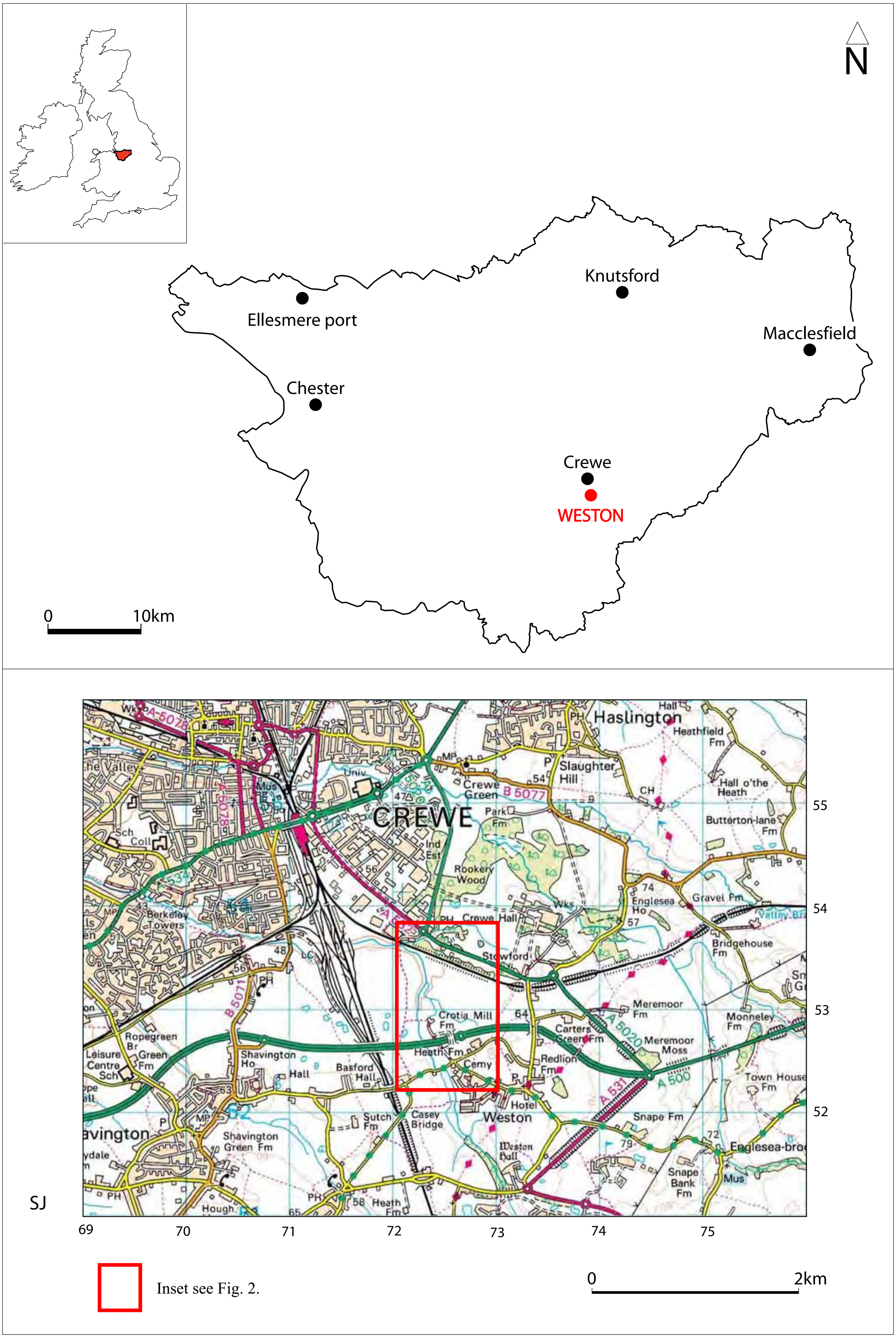

Fig. 1. Site location

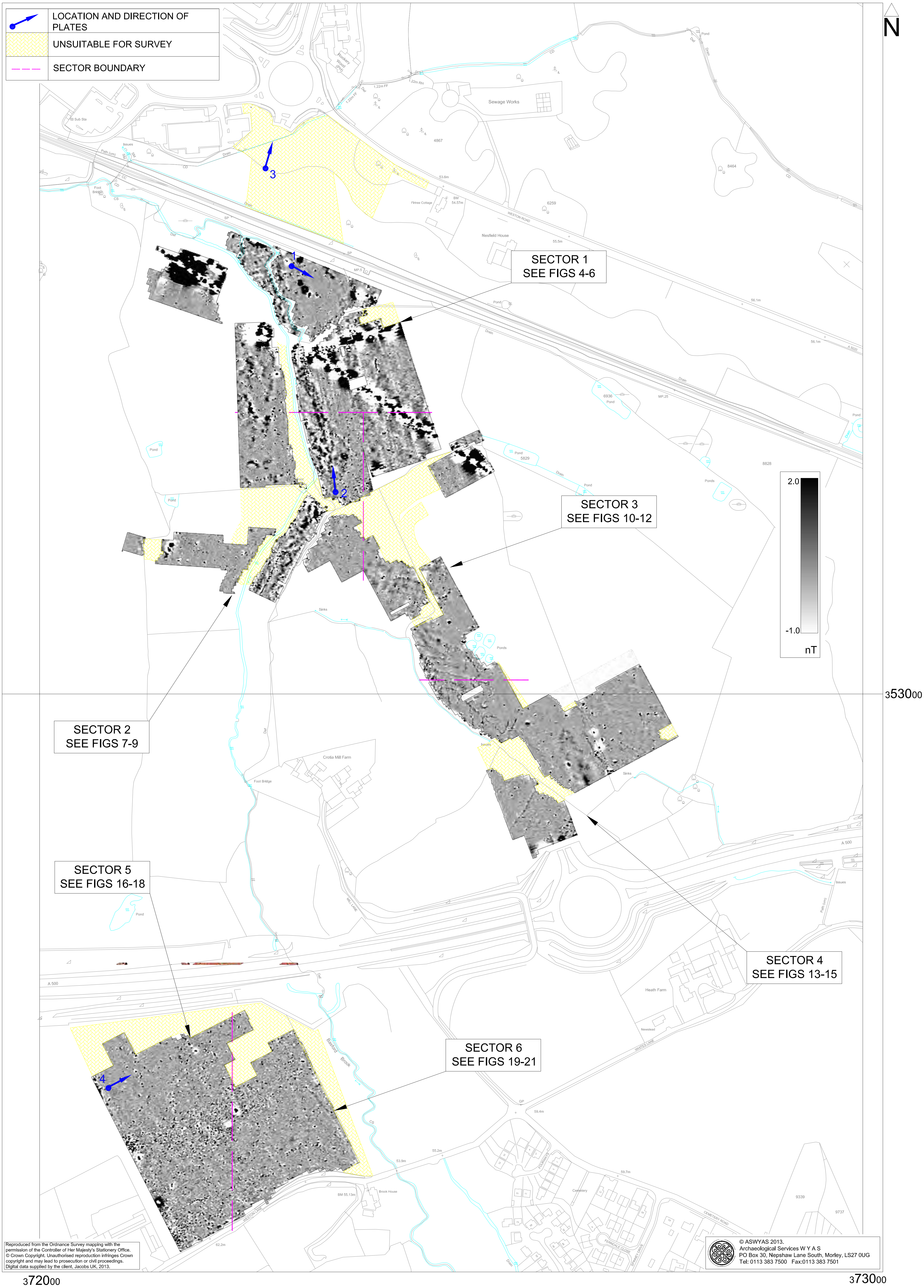

Fig. 2. Site location showing greyscale magnetometer data (1:4000 @ A3)

0 100m

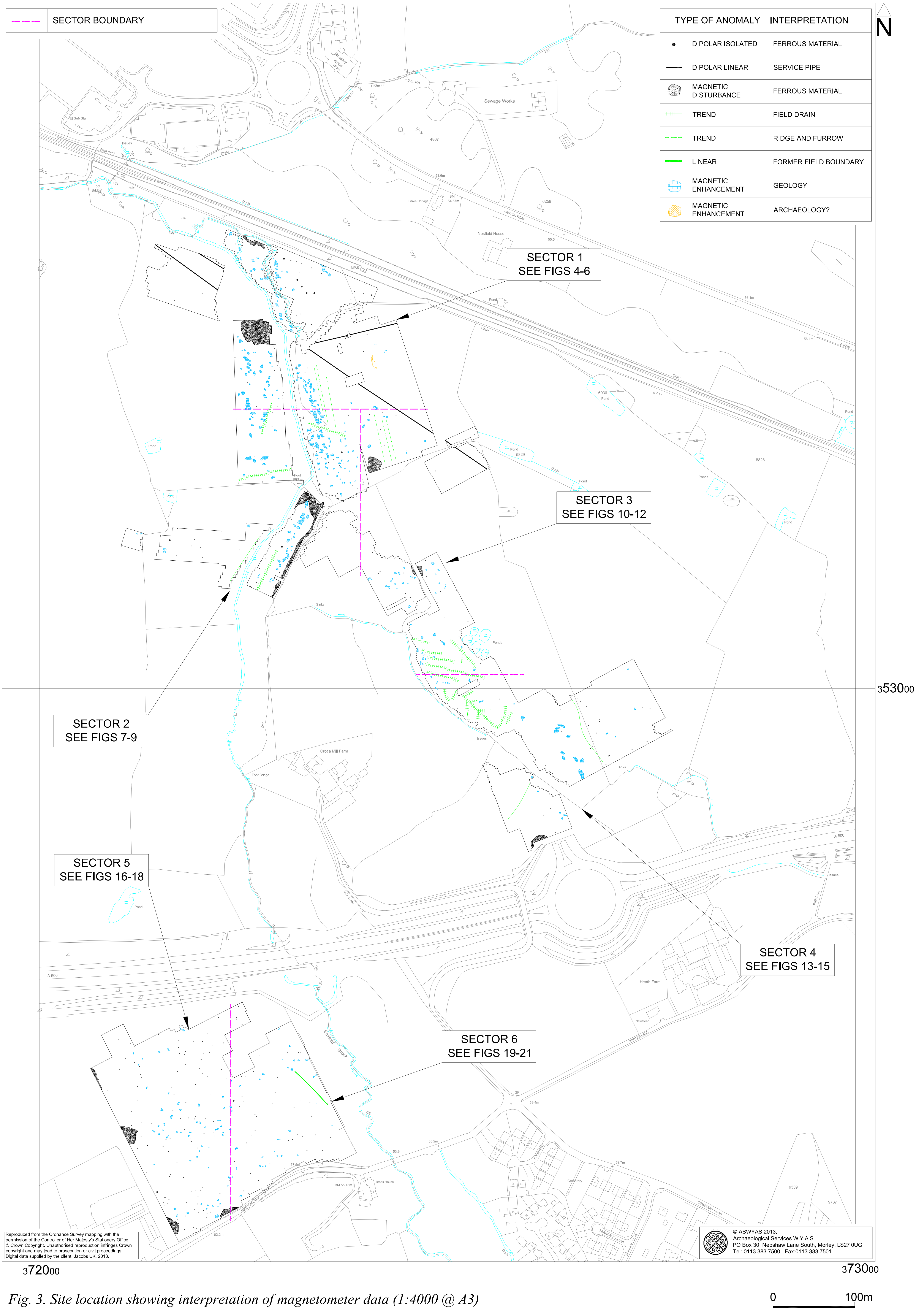

Fig. 3. Site location showing interpretation of magnetometer data (1:4000 @ A3)

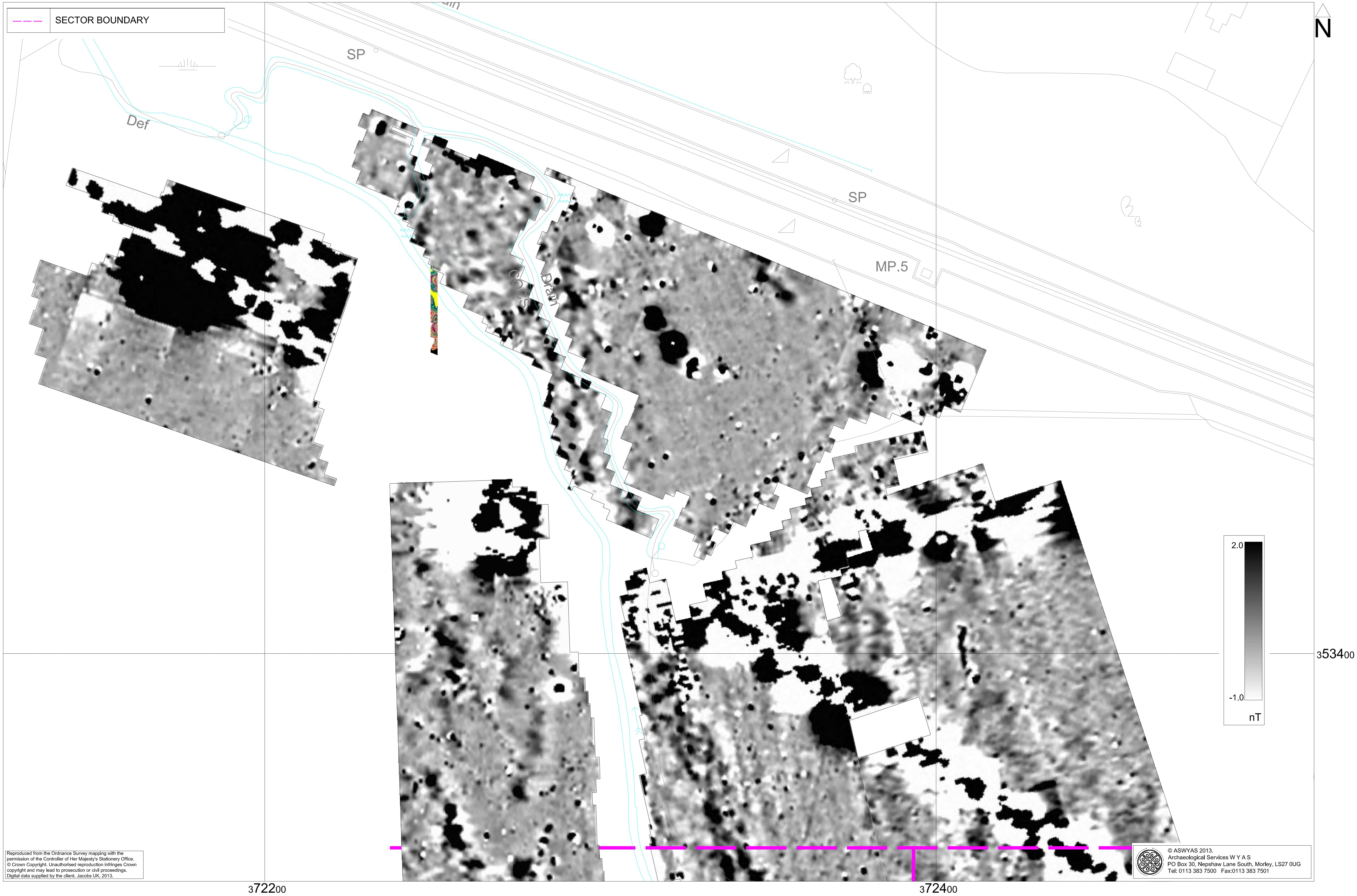

Fig. 4. Processed greyscale magnetometer data; Sector 1 (1:1000 @ A3)

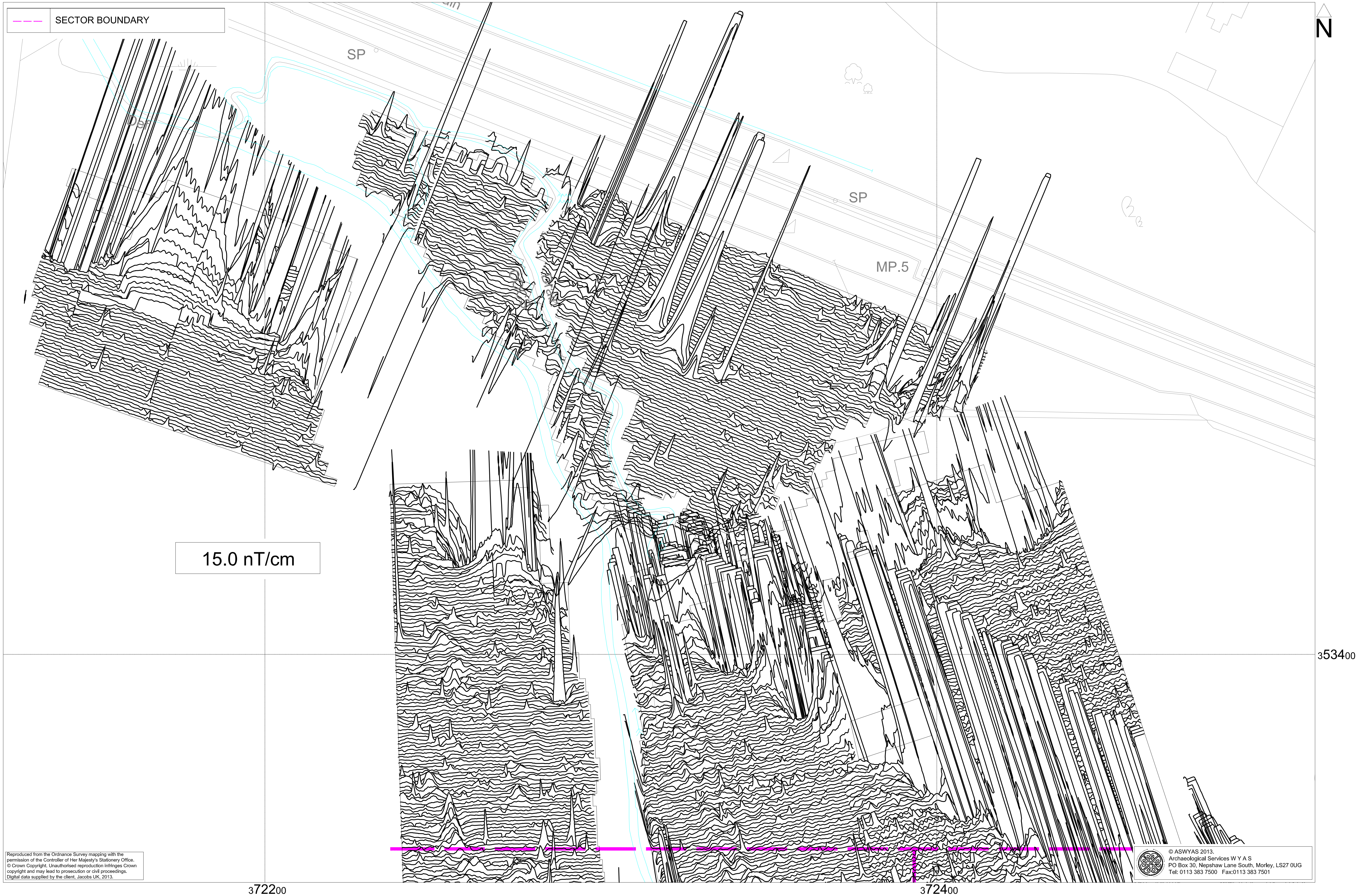

Fig. 5. XY trace plot of minimally processed magnetometer data; Sector 1 (1:1000 @ A3)

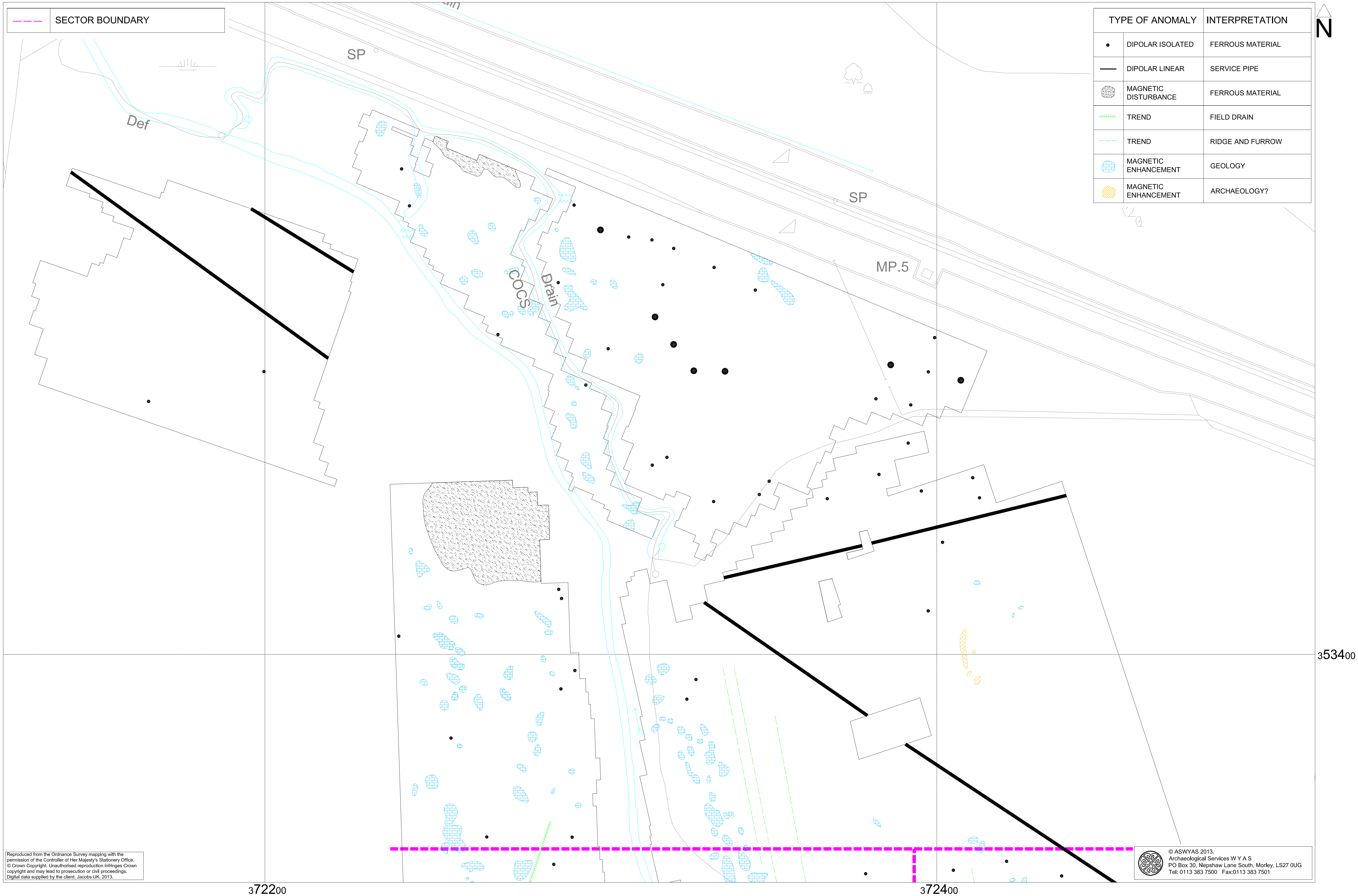

Fig. 6. Interpretation ofmagnetometer data; Sector 1 (1:1000 @ A3)

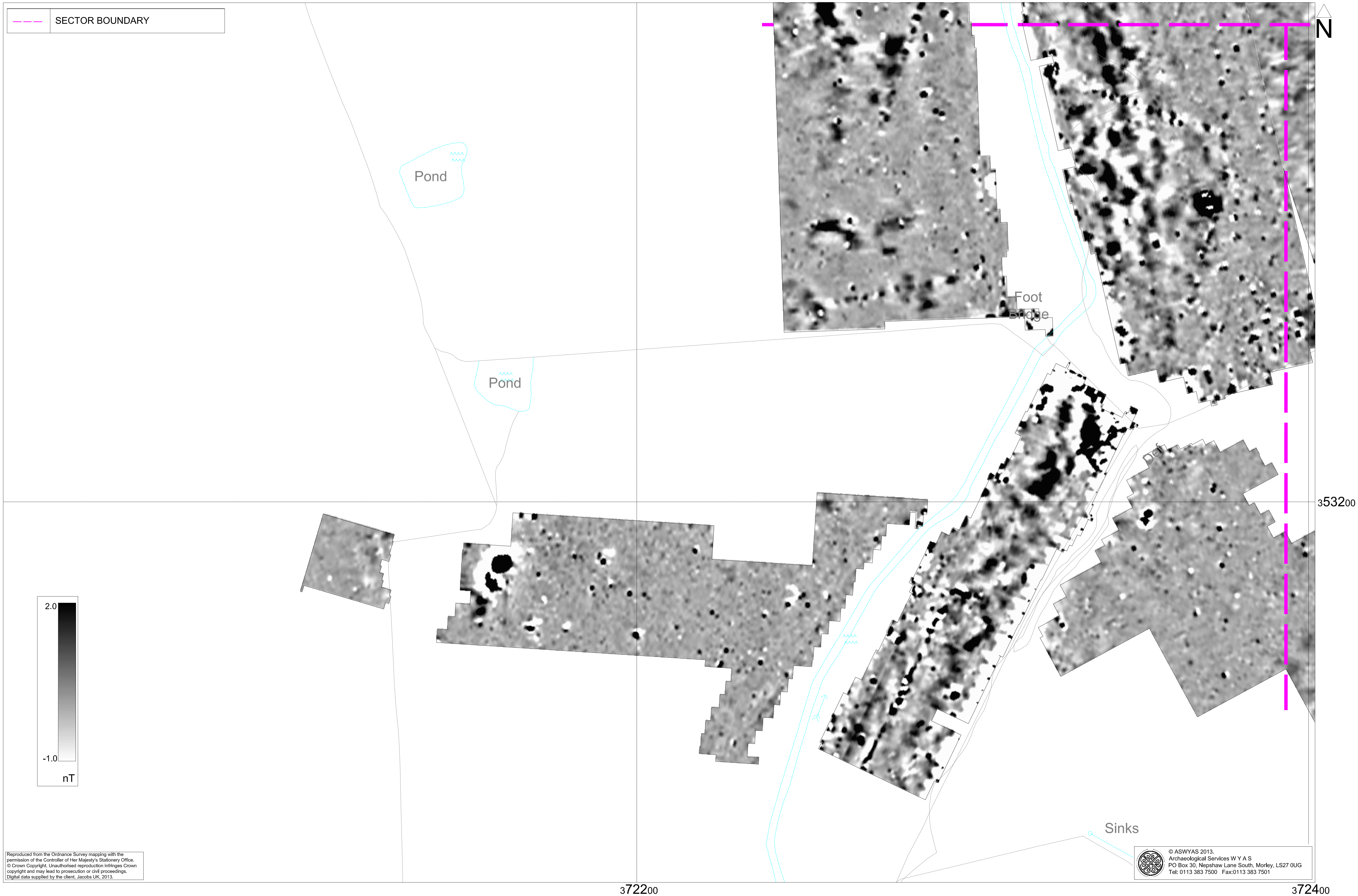

Fig. 7. Processed greyscale magnetometer data; Sector 2 (1:1000 @ A3)

0 25m

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

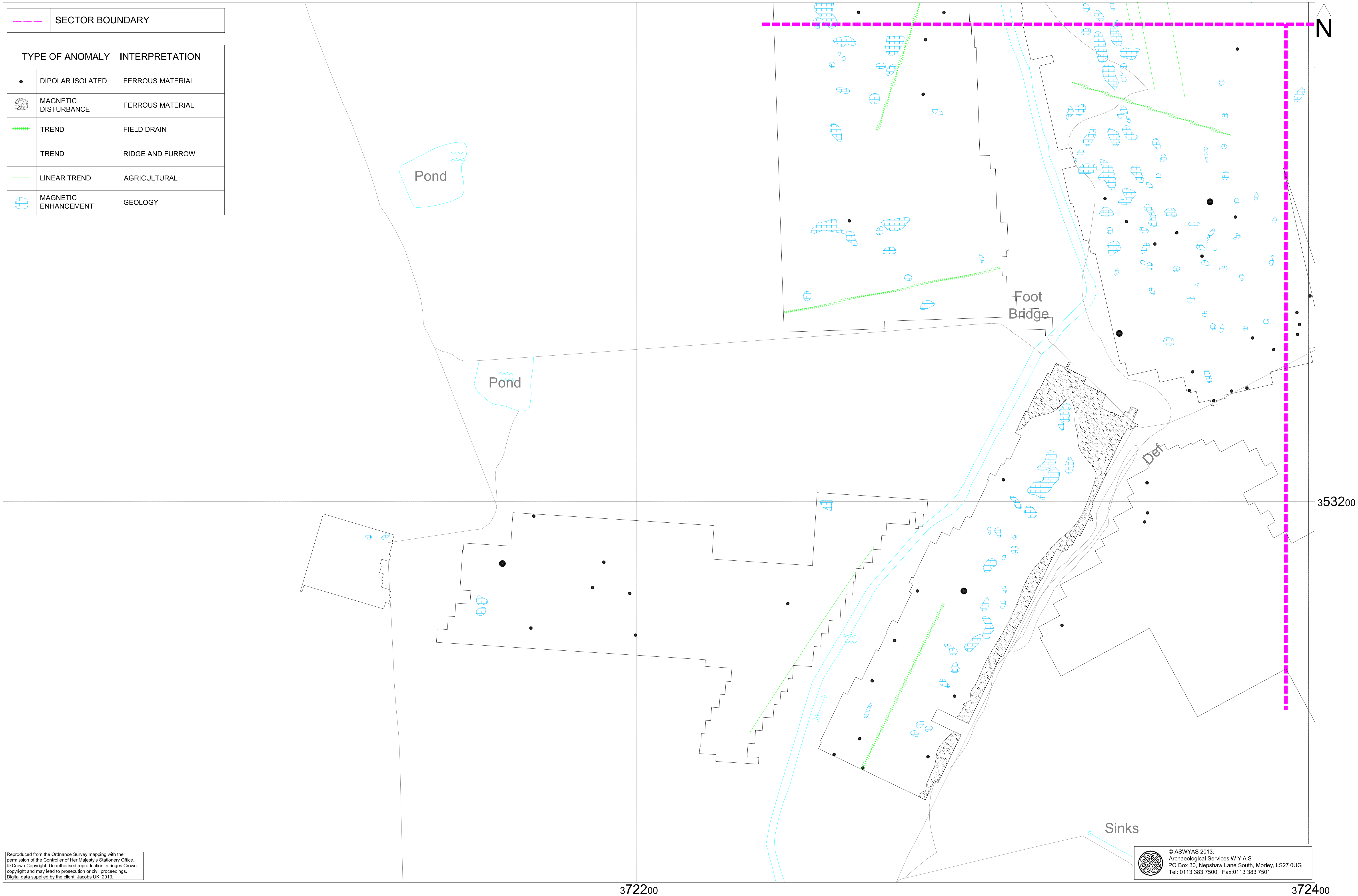

Fig. 9. Interpretation of magnetometer data; Sector 2 (1:1000 @ A3)

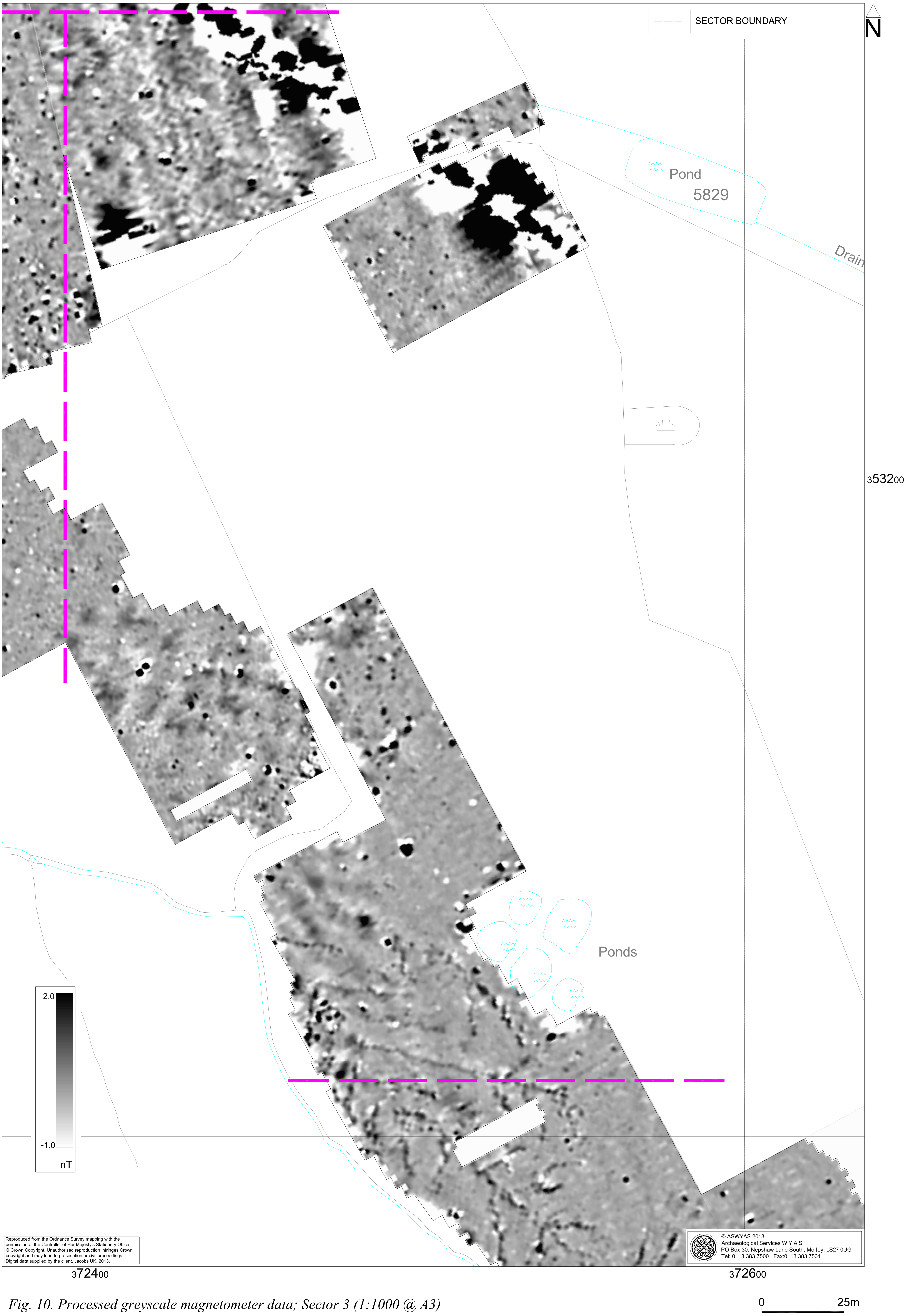

Fig. 10. Processed greyscale magnetometer data; Sector 3 (1:1000 @ A3)

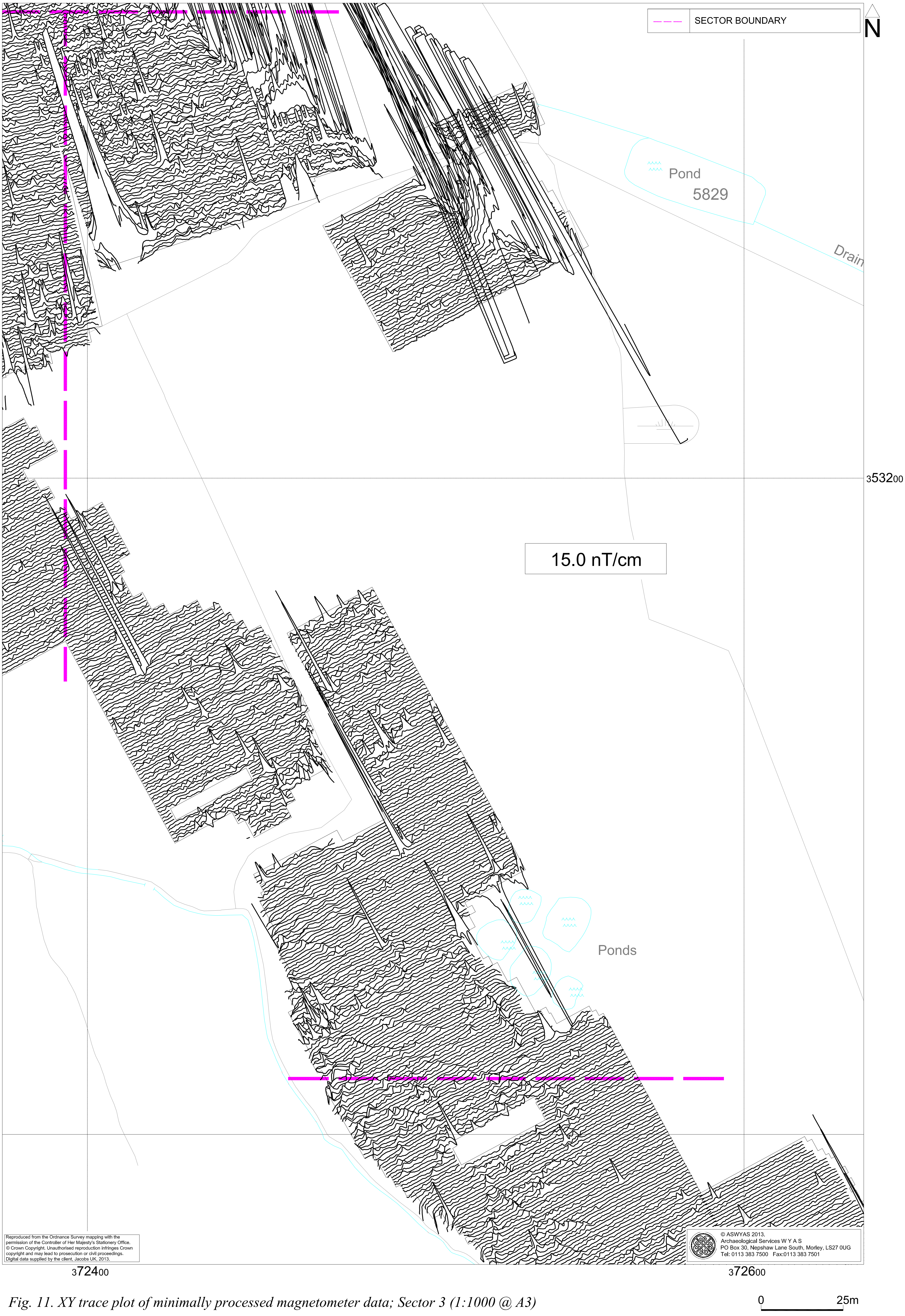

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Fig. 11. XY trace plot of minimally processed magnetometer data; Sector 3 (1:1000 @ A3)

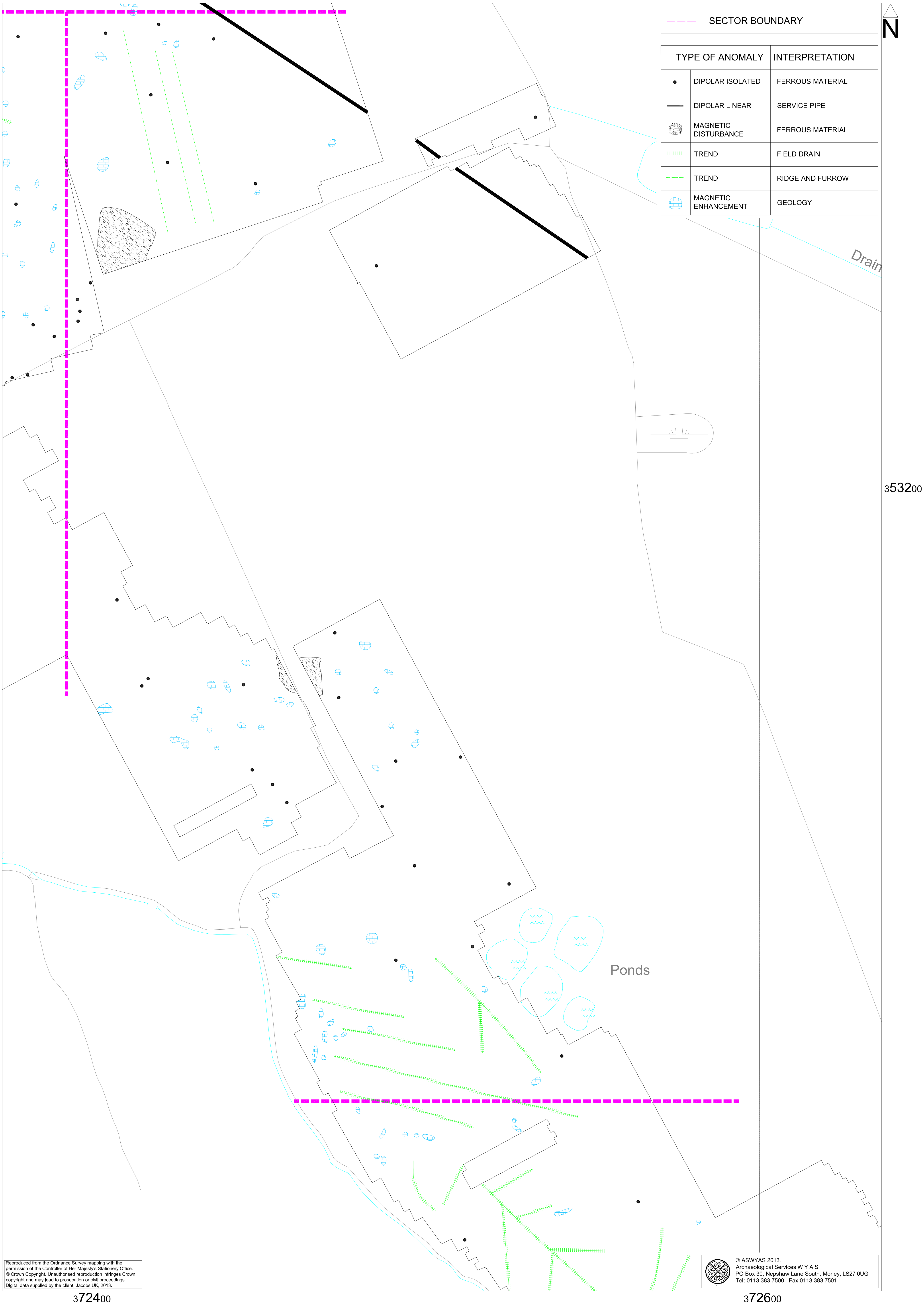

Fig. 12. Interpretation of magnetometer data; Sector 3 (1:1000 @ A3)

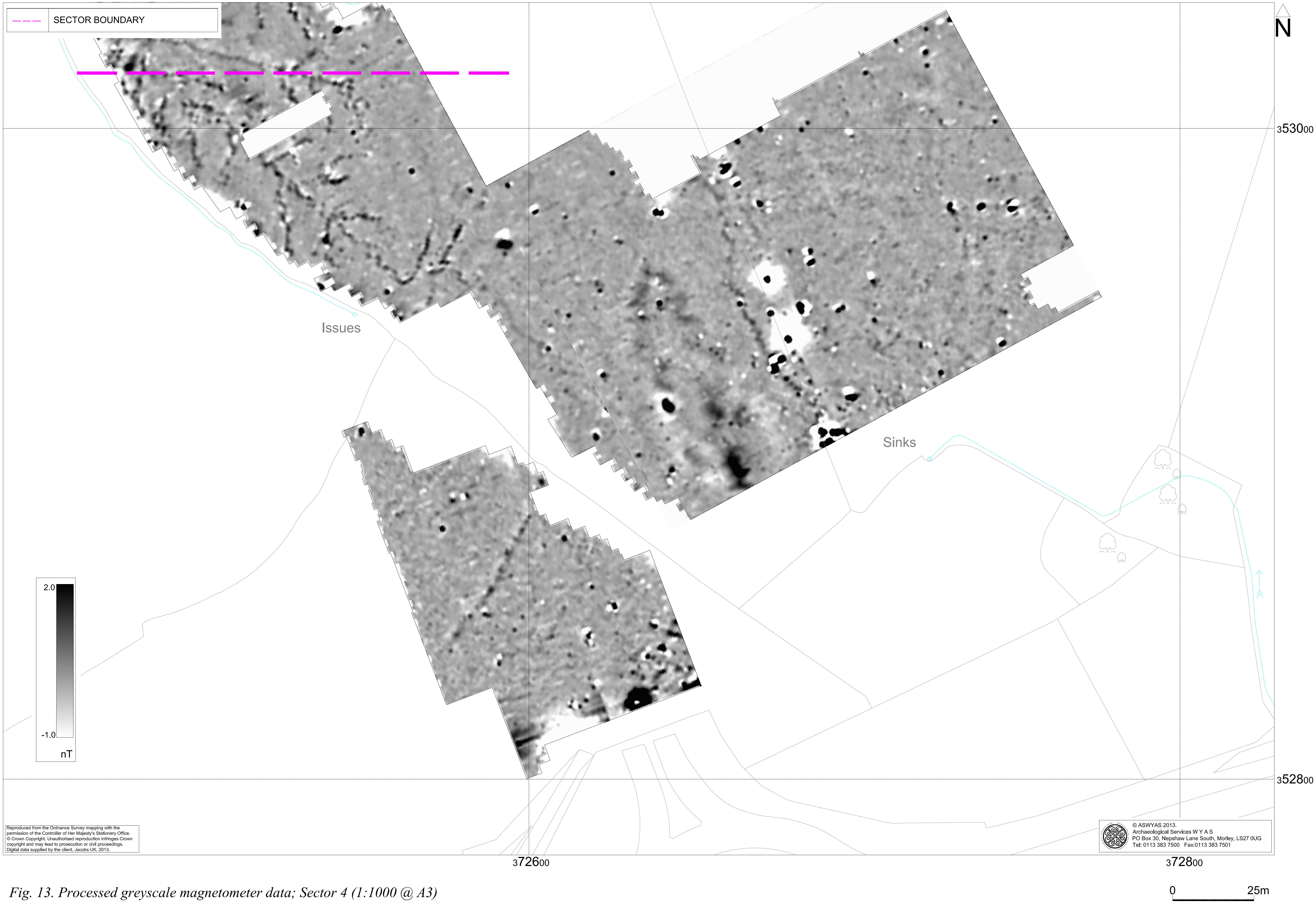

Fig. 13. Processed greyscale magnetometer data; Sector 4 (1:1000 @ A3)

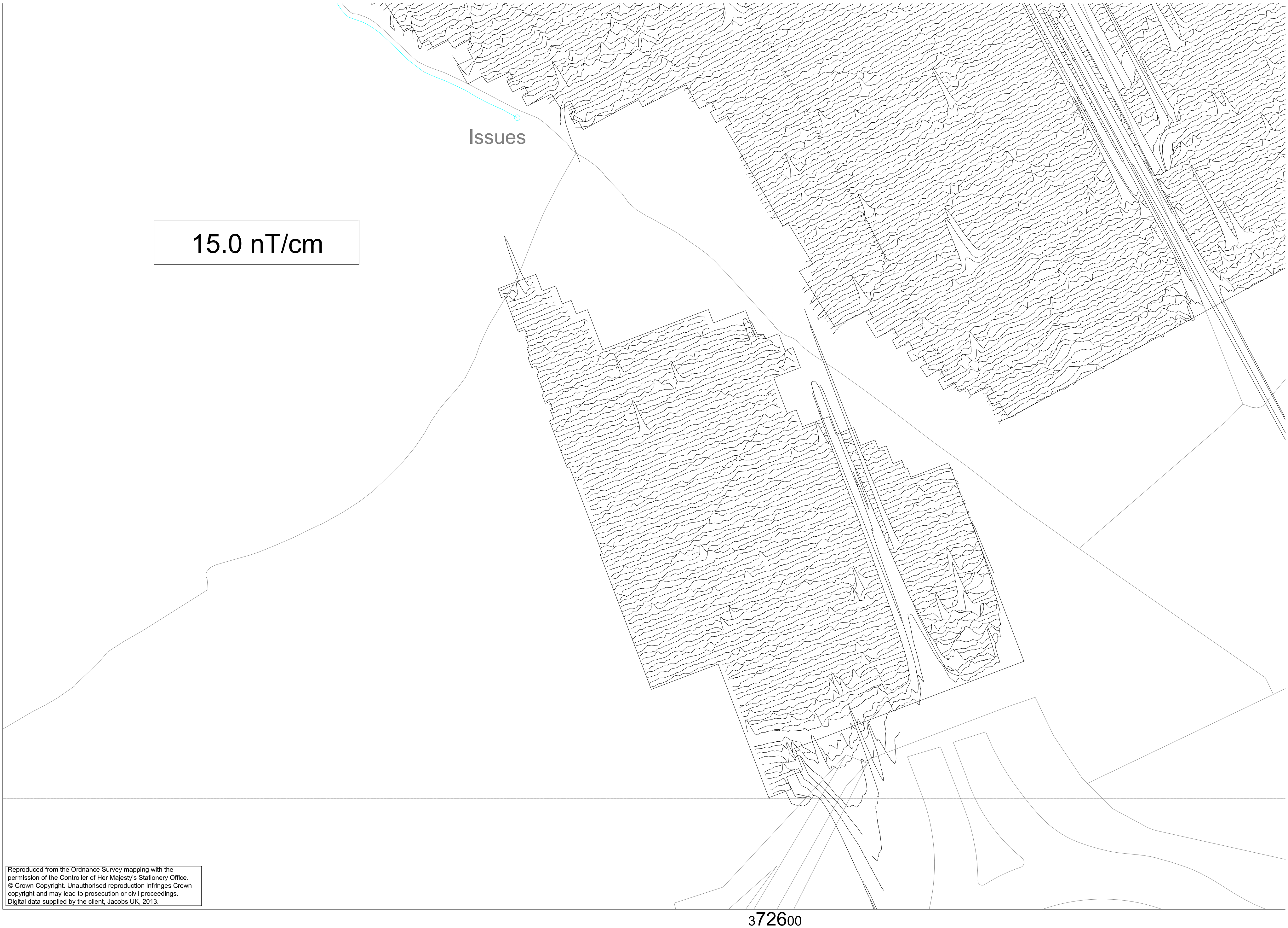

Fig. 14. XY trace plot of minimally processed magnetometer data; Sector 4 (1:1000 @ A3)

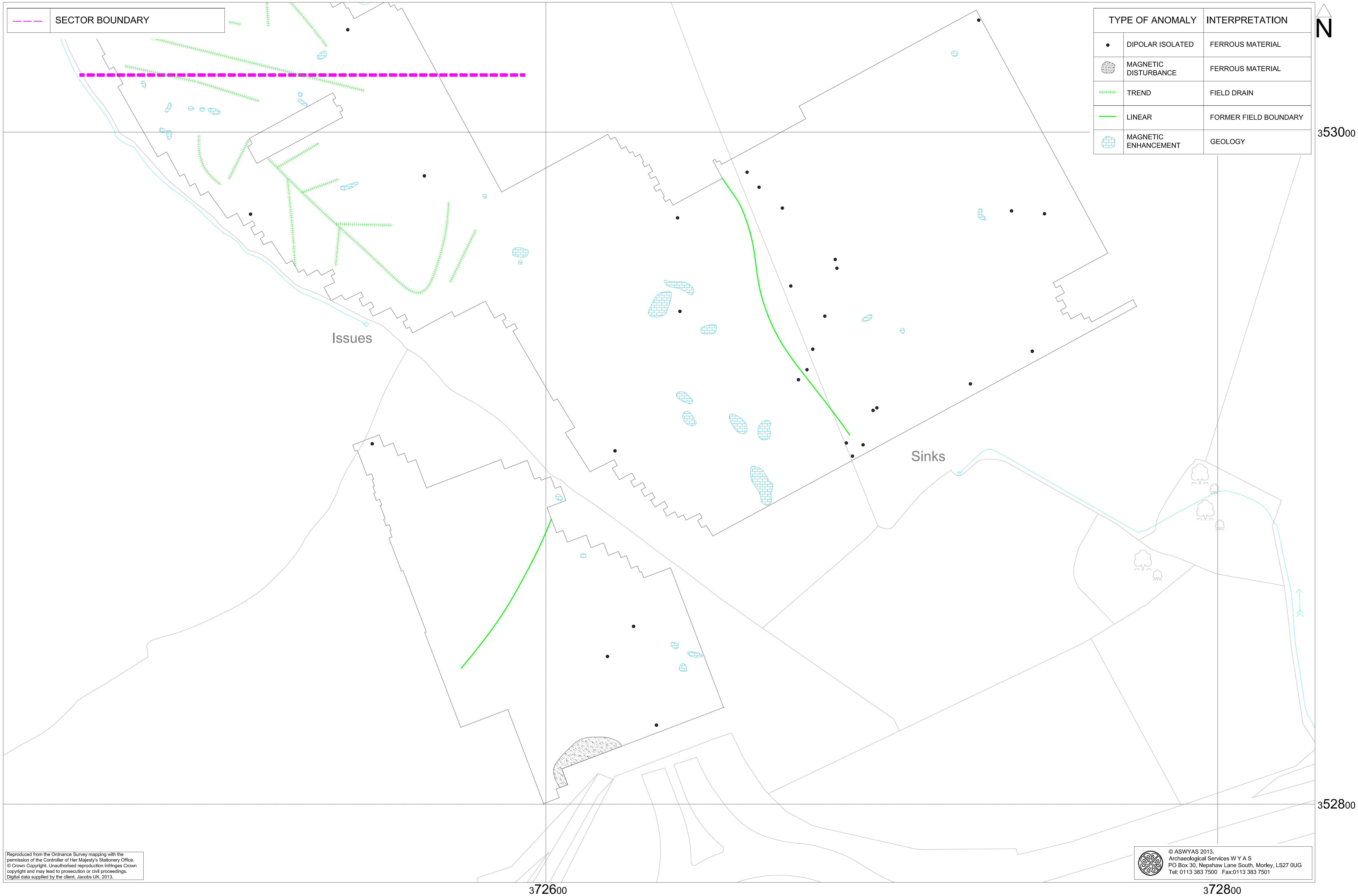

Fig. 15. Interpretation of magnetometer data; Sector 4 (1:1000 @ A3)

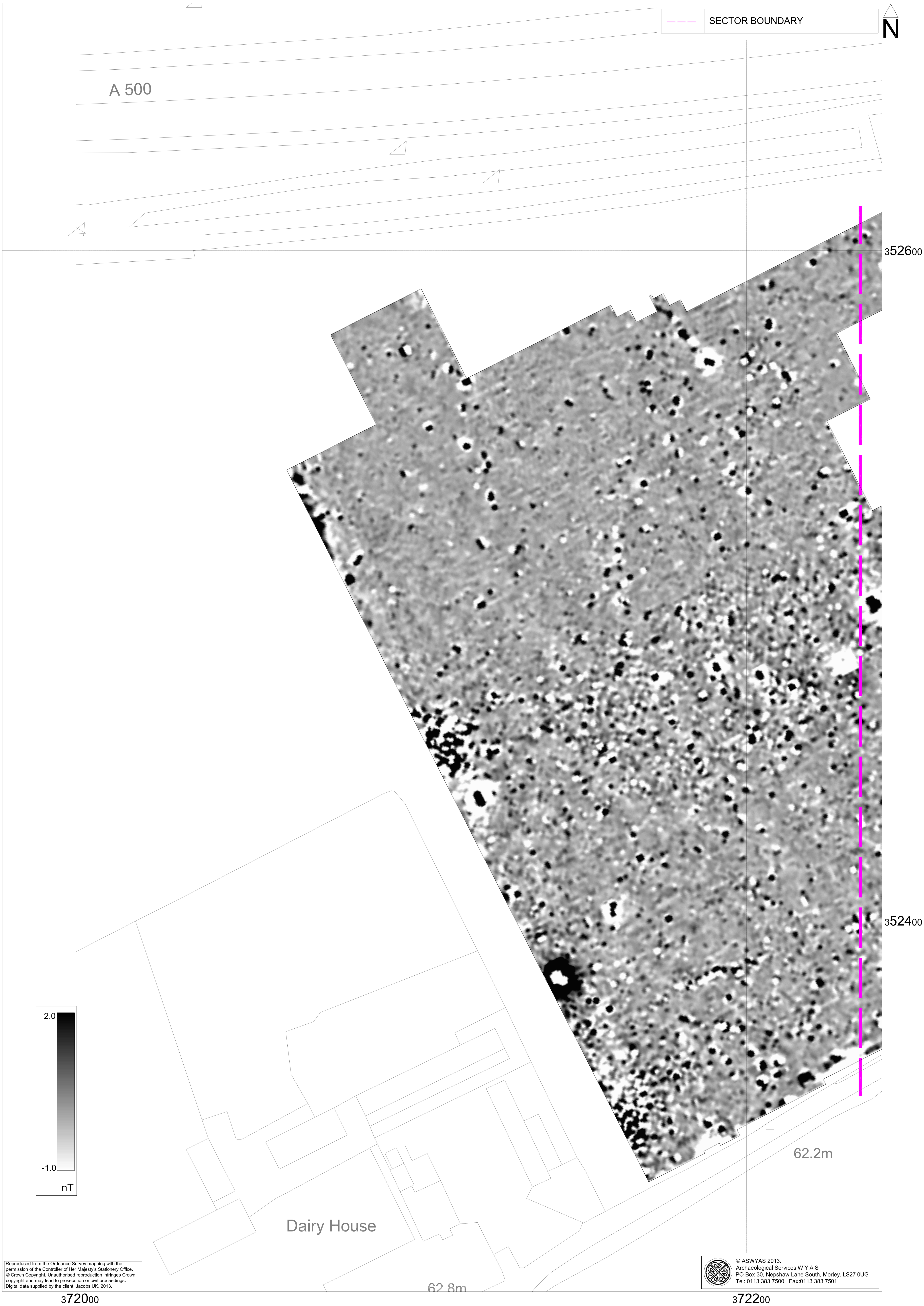

Fig. 16. Processed greyscale magnetometer data; Sector 5 (1:1000 @ A3)

0 25m

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

0 25m

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)

0 25m

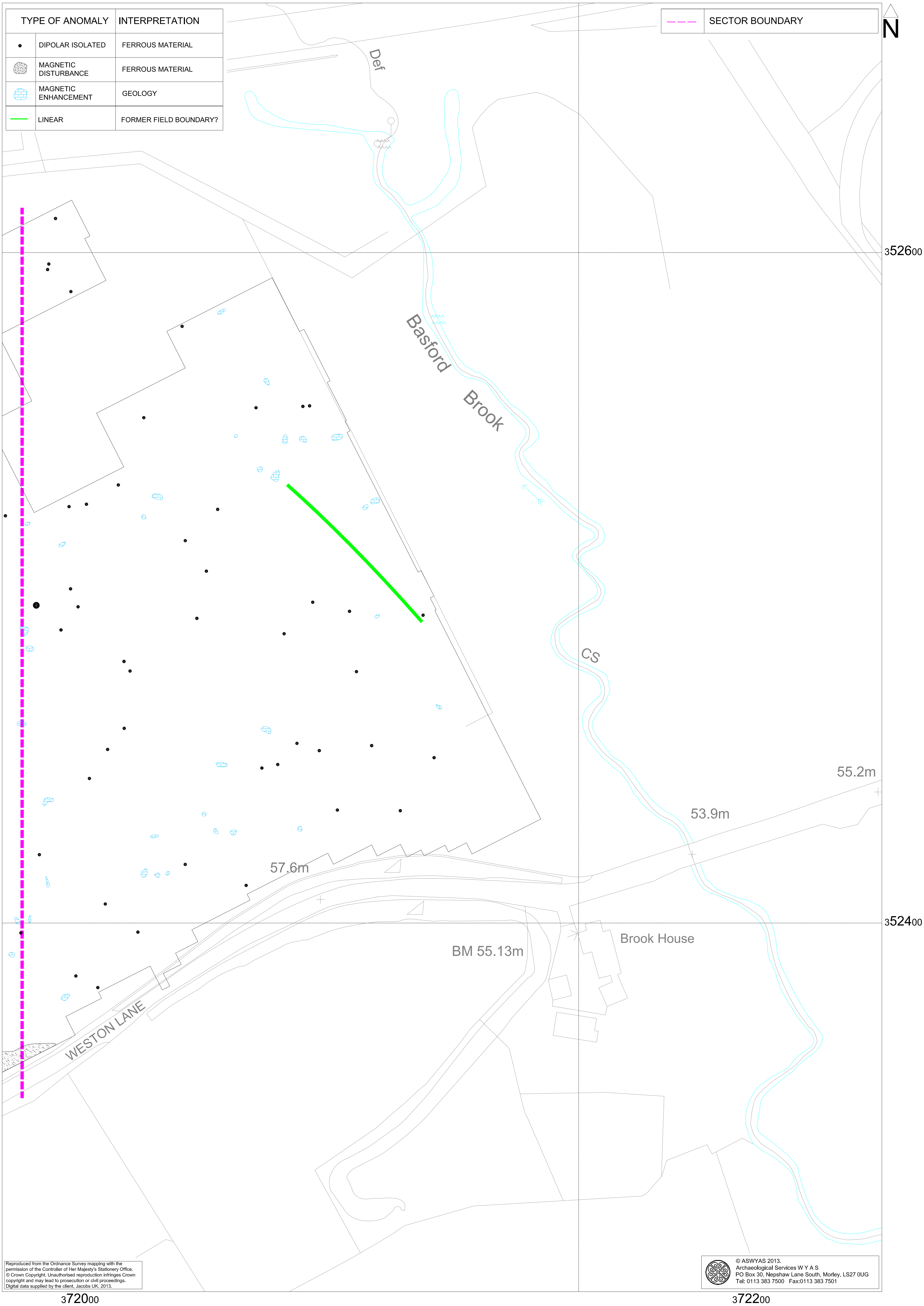

Fig. 21. Interpretation of magnetometer data; Sector 6 (1:1000 @ A3)

0 25m

Plate 1. General view of Sector 1 north, facing east

Plate 2. General view of Sector 2 south, facing north

Plate 3. General view of area unsuitable for survey north of the railway

Plate 4. General view of Sector 5, facing 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 relevant Historic Environment Record).

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