ARCHAEOLOGICAL SERVICES WYAS

Moor Lane
York

Geophysical Survey

Report no. 2653

October 2014

Client: Barwood Strategic Land LLP

REGISTERED ORGANISATION IfA

Moor Lane
York

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 93 hectares, was carried out on agricultural land on the south-western periphery of York, to support its promotion for residential and mixed use development. Overall, the results indicate that the site has a low potential for significant archaeology as most of the site is situated on low lying ground adjacent to an area of wetland (Askham Bogs). Here most of the anomalies are due to fairly recent agricultural or modern activity. One field on the eastern edge of the site has been infilled and landscaped following clay extraction and clearly has no archaeological potential. However, one area of clear archaeological potential has been identified on higher ground towards the northern end of the site. Here a cluster of, albeit weak and fragmented, anomalies are interpreted as soil-filled ditches comprising enclosures of likely prehistoric or Romano-British date. Features within the enclosures, including at least one roundhouse, indicate settlement activity. A smaller cluster of linear and discrete anomalies located to the south-western corner of the site may also have some archaeological potential, although this interpretation is much more tentative. In addition, geological anomalies around the southern site boundary close to Askham Bog could locate natural features with the potential for the presence of waterlogged deposits of palaeo-environmental interest.

ARCHAEOLOGICAL
SERVICES
WYAS

Report Information

Client:	Barwood Strategic Land LLP
Address:	Grange Park Court, Roman Way, Northampton, NN4 5EA
Report Type:	Geophysical Survey
Location:	Moor Lane
District:	York
County:	North Yorkshire
Grid Reference:	SE 570 485
Period(s) of activity:	prehistoric/Roman/post-medieval
Report Number:	2653
Project Number:	4253
Site Code:	MLK14
OASIS ID:	archaeol11-197773
Museum Accession No.:	n/a
Date of fieldwork:	July – September 2014
Date of report:	October 2014
Project Management:	Sam Harrison BSc MSc MIfA
Fieldwork:	Mark Evans BA
	Tom Fildes BA
	Rowan Kendrick
	Christopher Sykes MSc BA
	Alex Schmidt BA
	Dan Waterfall BA
Report:	Alistair Webb BA MIfA
Illustrations:	David Harrison BA MSc MIfA
Photography:	Site Staff
Research:	n/a

Authorisation for distribution: ---

PO Box 30, Nepshaw Lane South, Morley, Leeds
LS27 0UG
Telephone: 0113 383 7500.
Email: admin@aswyas.com

Contents

List of Figures

List of Plates

1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Andrew Crutchley of the Environmental Dimension Partnership (EDP – the Consultant), on behalf of Barwood Strategic Land LLP – the Client, to undertake a geophysical (magnetometer) survey of land on the south-western edge of York (see Fig. 1), in order to support its promotion for residential and mixed use development. The work was undertaken in accordance with a Project Design (Harrison 2014) supplied to and approved by the Local Authority's Archaeological Advisor, with 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 June 9th and September 8th 2014 in order to provide additional information on the archaeological interest and/or potential of the site.

Site location, topography and land-use

The Proposed Development Area (PDA), centred at SE 570 485, comprises a large block of agricultural land on the south-western edge of York, 3km south-west of the centre of York, between Woodthorpe to the north, Copmanthorpe to the south and Askham Bryan to the west. Moor Lane forms the northern boundary of the PDA, although there is a single block to the north of the lane, and the East Coast Mainline railway the eastern boundary. Askham Bogs borders the site to the south, with the A1237 and farmland to the west. The site covers about 95 hectares, which includes Marsh Farm and Eastfield Farm, of which about 93 hectares was suitable for survey.

All of the surveyable land was under agricultural production, with a mixture of permanent pasture primarily to the east and arable crops to the west. The survey was carried out in two phases, with the pasture being surveyed in June and the arable fields following harvest in August and early September.

Most of the site is on flat, low lying land to the west of the River Ouse situated at between approximately 12.5m above Ordnance Datum and 15m aOD. However, the land does rise steadily to the north of Moor Lane to about 27m aOD on Acomb Moor at the highest part of the site (see Fig. 2).

Soils and geology

The solid geology comprises Interbedded Sandstone and Conglomerate, but superficial deposits overlie the bedrock across all parts of the site (see Fig. 4). In the eastern half of the site and in a narrow band to the west glaciolacustrine clays and silts of the Alne Formation predominate. To the west of the site and in the south-western corner sands, clays and gravels of the York Moraine Member are present, whilst on the higher ground to the north of Moor Lane sands and gravels of the York Moraine Member prevail.

The soils that derive from these superficial deposits are classified in the Bishampton 1 association, being characterised as deep fine loams with slowly permeable subsoils that are prone to slight seasonal waterlogging (Soil Survey of England and Wales 1983).

2 Archaeological Background

A Historic Environment and Landscape Assessment report (Crutchley 2014) concluded that there are no designated assets within the PDA and only '*very limited evidence for the presence of significant archaeological features or deposits within the site, based on the contents of the City of York HER*'. These assets primarily comprise evidence of ridge and furrow cultivation. However, it was also acknowledged that there is evidence in the area for both prehistoric and Romano-British activity and that the potential for encountering features and deposits of these periods, as well as deposits of palaeo-environmental potential, meant that further field based archaeological evaluation would be required to inform the planning process.

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 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 the whole 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;
- therefore determine the presence/absence and extent of any buried archaeological features; and
- 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. Figures 2, 3, 4 and 5 (all at a scale of 1:6000) show the site in its setting overlaid with the processed magnetometer and contour data, anomaly interpretation, superficial deposits and first edition mapping respectively. Detailed data plots ('raw' and processed) and full interpretative figures are presented at a scale of 1:1000 in Figures 6 to 50 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 (Webb 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 6 to 50 inclusive)

Numerous anomalies have been identified by the survey, 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.

The data from the whole of Field 35, at the eastern periphery of the site, is dominated by extremely high magnitude readings. Early mapping shows a series of clay pits and it is understood that this field has been backfilled and levelled following mineral extraction and therefore has no archaeological interest or potential.

Other, much less extensive, areas of magnetic disturbance are identified, predominantly around Marsh Farm and Eastfield Farm. The linear bands of greatest disturbance reflect the proximity of farm buildings and equipment, whilst the less strong clusters of ‘spikes’ reflect the accumulation of ferrous material in the topsoil (the extent of some implying deliberate infilling) predominantly along field boundaries and adjacent to gateways. The general level of ferrous contamination decreases with distance away from the two farms (see Fig. 3).

Four linear dipolar anomalies are identified and interpreted as sub-surface pipes. Anomaly **A**, aligned south-west/north-east, runs to/from Marsh Farm to buildings on Moor Lane. Anomaly **B** also runs to/from the farm to Moor Lane but on a north-westerly bearing. The second pipe, **C**, runs to/from Eastfield Farm from a track to the east of the farm, whilst the fourth, **D**, runs parallel and ??m north-east of **C**.

Agricultural Anomalies

Throughout the eastern and southern parts of the site linear anomalies caused by field drains have been identified. The drains are all on the lower lying parts of the site and almost all on the glacio-lacustrine superficial deposits. The drains are on varying alignments, often in the characteristic herring-bone pattern.

Across all parts of the site, with the exception of the large field to the north-west, parallel linear trend anomalies are noted. Mostly these are closely spaced and extremely regular, for example the anomalies in Field 22 and Field 24. These anomalies are due to recent ploughing.

In the fields surrounding Eastwood Farm the anomalies are broader, slightly less regular and (generally) more widely spaced. These anomalies are due to the former agricultural practice of ridge and furrow ploughing. Here the anomalies are due to the magnetic contrast between the former ridges and infilled furrows.

Analysis of the early edition Ordnance Survey maps shows that in the late 19th century the site was split into several more fields than are present today. Some of these now removed boundaries are also identified as linear anomalies **E**, **F**, **G**, **H**, **I** and **J**. Two former boundaries do not manifest as magnetic anomalies.

Geological Anomalies

Around the southern perimeter of the site, broad areas of enhanced magnetic response have been identified in fields 27, 28, 33 and 34. These anomalies are of obvious geological origin - locating formerly waterlogged, periodically flooded areas on the edge of Askham Bogs, which lie immediately to the south. The more linear responses in Field 33 and Field 34 may indicate a former stream channel.

Archaeological Anomalies

Two clusters of anomalies of either probable or possible archaeological origin have been identified.

The first area of potential is in Field 2 which occupies the higher ground towards the northern edge of the site. Although the anomalies are fragmentary and weak, they are clearly of archaeological origin. Linear anomalies, **K**, caused by soil filled ditches forming three sides of an enclosure, can be clearly made out. Within the enclosure a sub-circular anomaly, **L**, locates a smaller enclosure or possible round-house. Immediately to the south-east a second probable circular feature, **M**, within a much more poorly defined enclosure **N**, is noted. At least three more enclosures defined by fragmentary linear anomalies, **O**, **P**, **Q** and **R** are also clearly present together with numerous discrete anomalies and vaguely ill-defined areas of generally enhanced readings which could be caused by smaller features indicative of settlement activity. The anomalies become weaker and ultimately disappear to the west and south-west. Whether these features continue but cannot be detected or whether they have been truncated by modern deep ploughing is not clear.

The second area of potential is about 750m to the south in Field 21. This part of the site is lower lying than the area of potential to the north and the anomalies much weaker, more disparate and consequently more difficult to interpret with any certainty. As such a non-archaeological cause is also plausible. The presence of linear ploughing anomalies and a former boundary makes discriminating between archaeological and non-archaeological anomalies even more difficult. However, vague linear anomaly **S** and intermittent linear anomaly, **T**, both aligned north-west/south-east, may possibly form two sides of an enclosure. A strong anomaly, **O**, just to the south-east may also be of archaeological potential. The magnetic background around these three anomalies is also enhanced relative to the background. This is possibly indicative of archaeological activity, although this could also be due to variation within the soils and superficial deposits, as this part of the site is on the boundary between the glacio-lacustrine deposits and the Vale of York Formation.

5 Conclusions

The survey has identified anomalies throughout the site for the most part indicative of activity over the last two hundred years. This includes anomalies caused by agricultural activity, such as hedgerow/boundary removal, land drainage and ploughing, and mineral extraction. These anomalies are not of any archaeological interest or potential, but may be of minor local historical interest.

Askham Bog lies immediately to the south of the site and anomalies typical of a natural origin, and indicative of a waterlogged landscape, are recorded along the southern edge of the site. The features/deposits causing these anomalies may have some potential for palaeo-environmental analysis.

The survey has also identified one area of obvious archaeological potential on the higher ground to the north-west of the site. Here, anomalies clearly forming a series of enclosures with internal features probably represents a small settlement of likely prehistoric or Romano-British origin. A second smaller cluster of anomalies to the south-west may also be of archaeological potential, although this interpretation is tentative.

Overall, the results indicate that 90% of the site has a low potential for significant archaeology being situated on low lying ground adjacent to an area of wetland. However, one area of obvious and high archaeological potential has been identified on the higher ground to the north-west.

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.

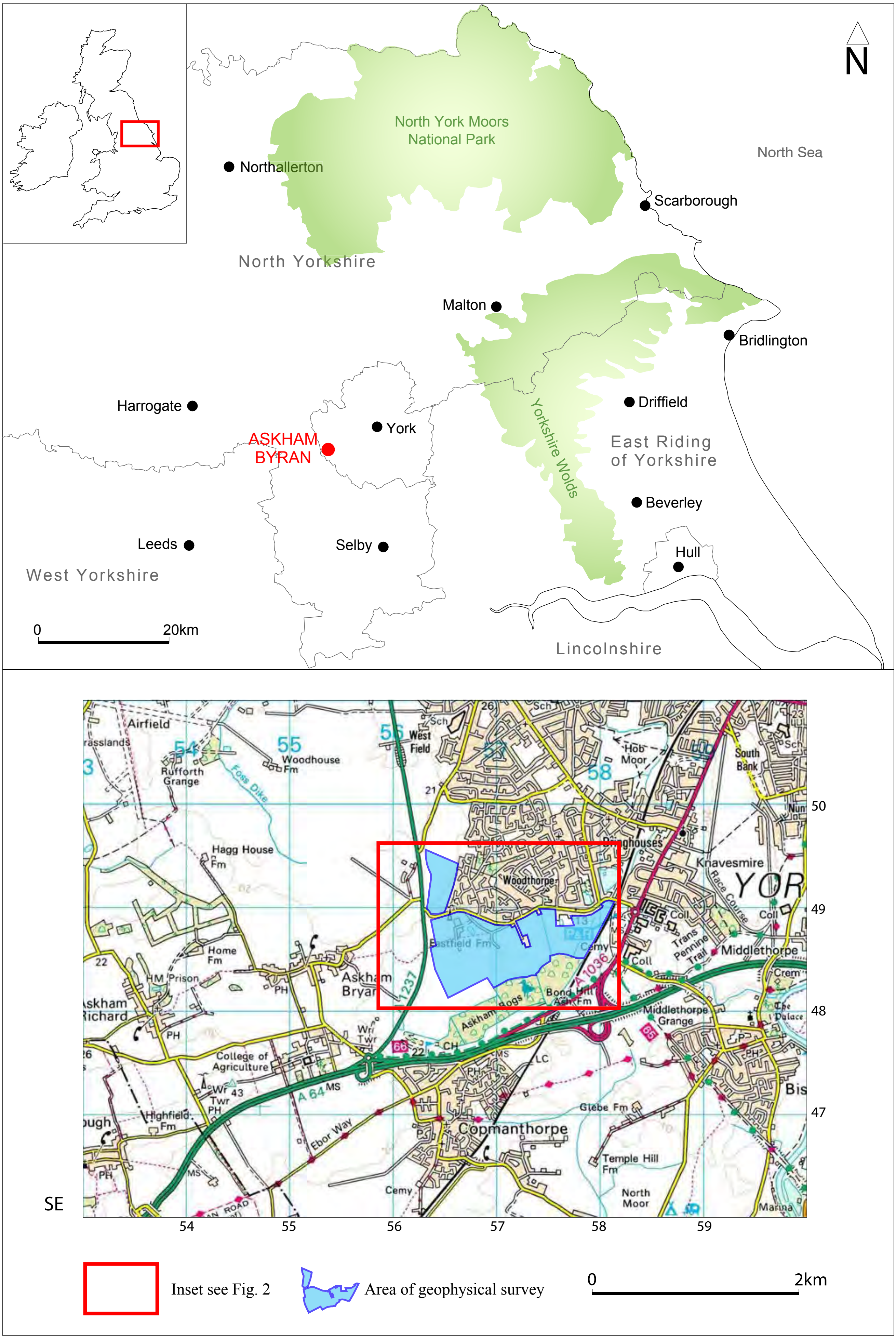


Fig. 1. Site location

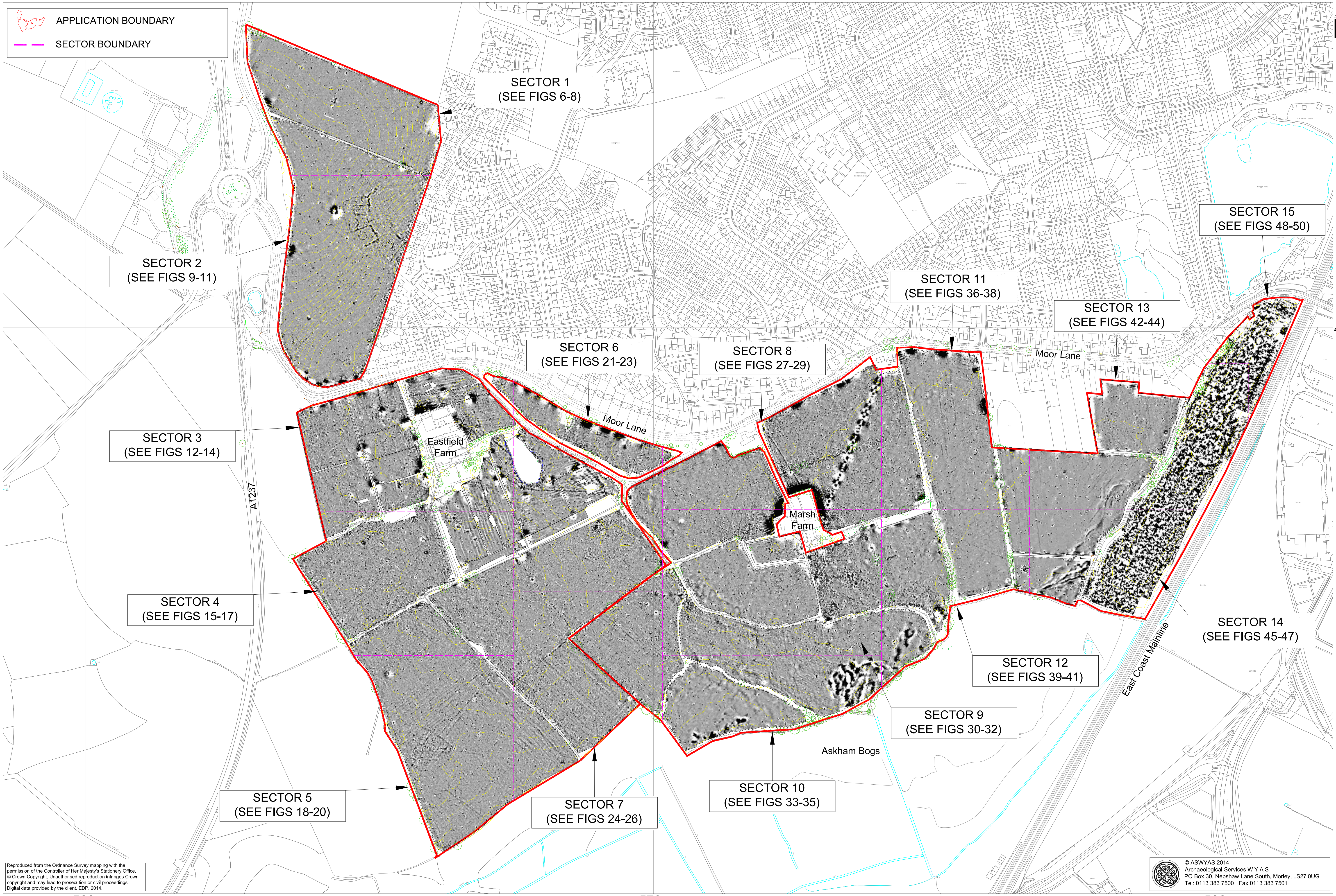


Fig. 2. Site location showing greyscale magnetometer data and contour data (1:6000 @ A3)

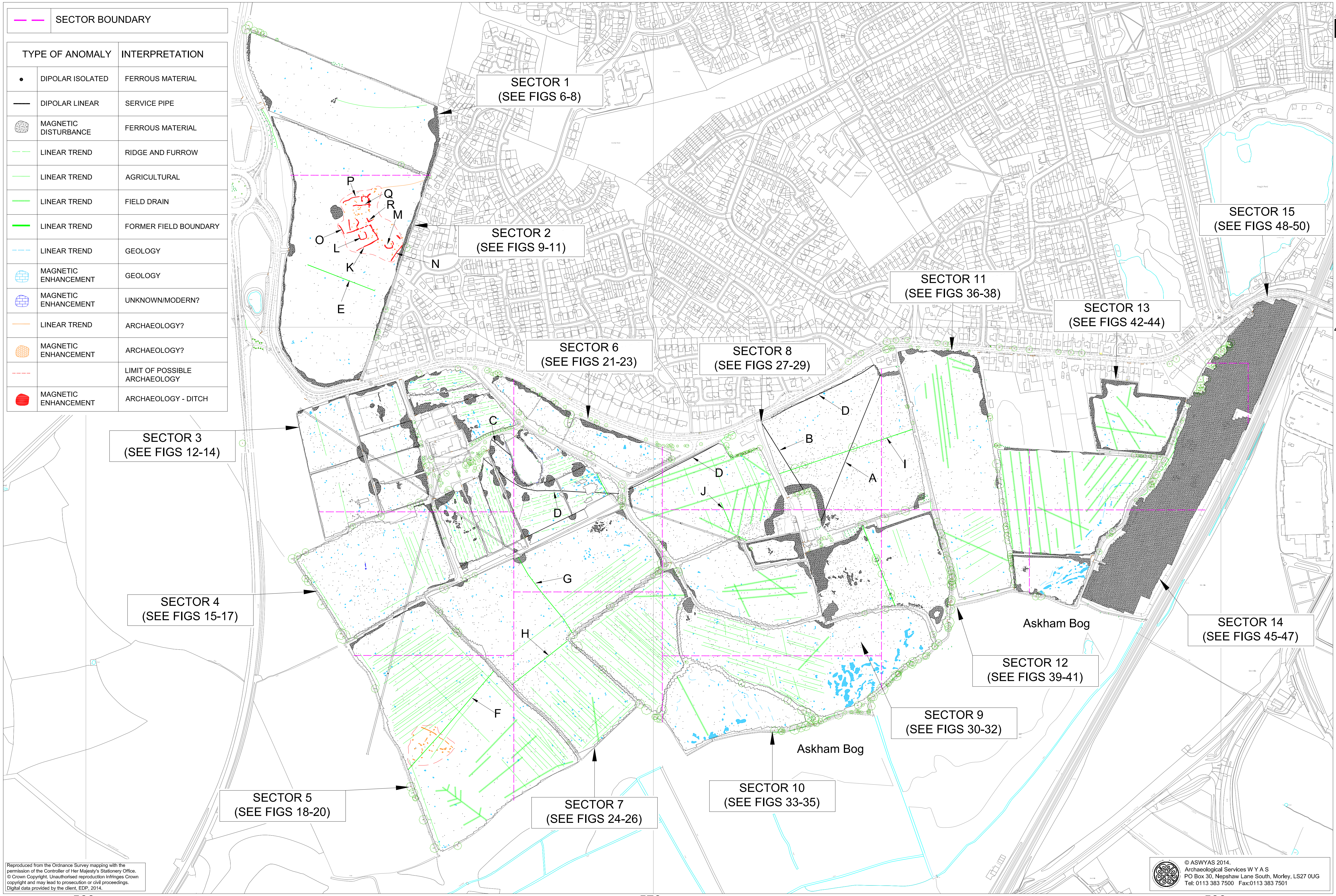


Fig. 3. Overall interpretation of magnetometer data (1:6000 @ A3)

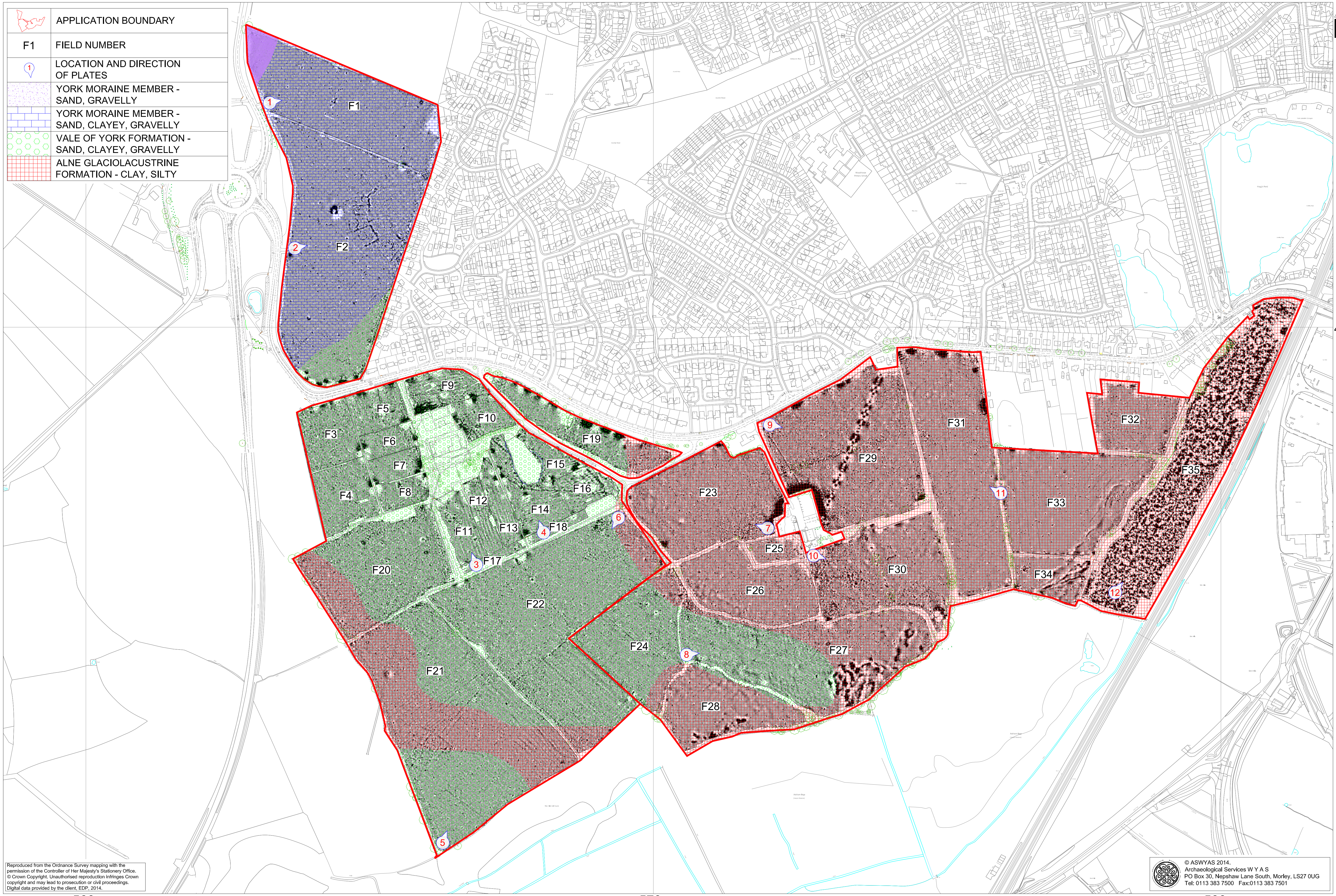


Fig. 4. Magnetometer data showing superficial geological deposits, field numbers and location of plates (1:6000 @ A3)

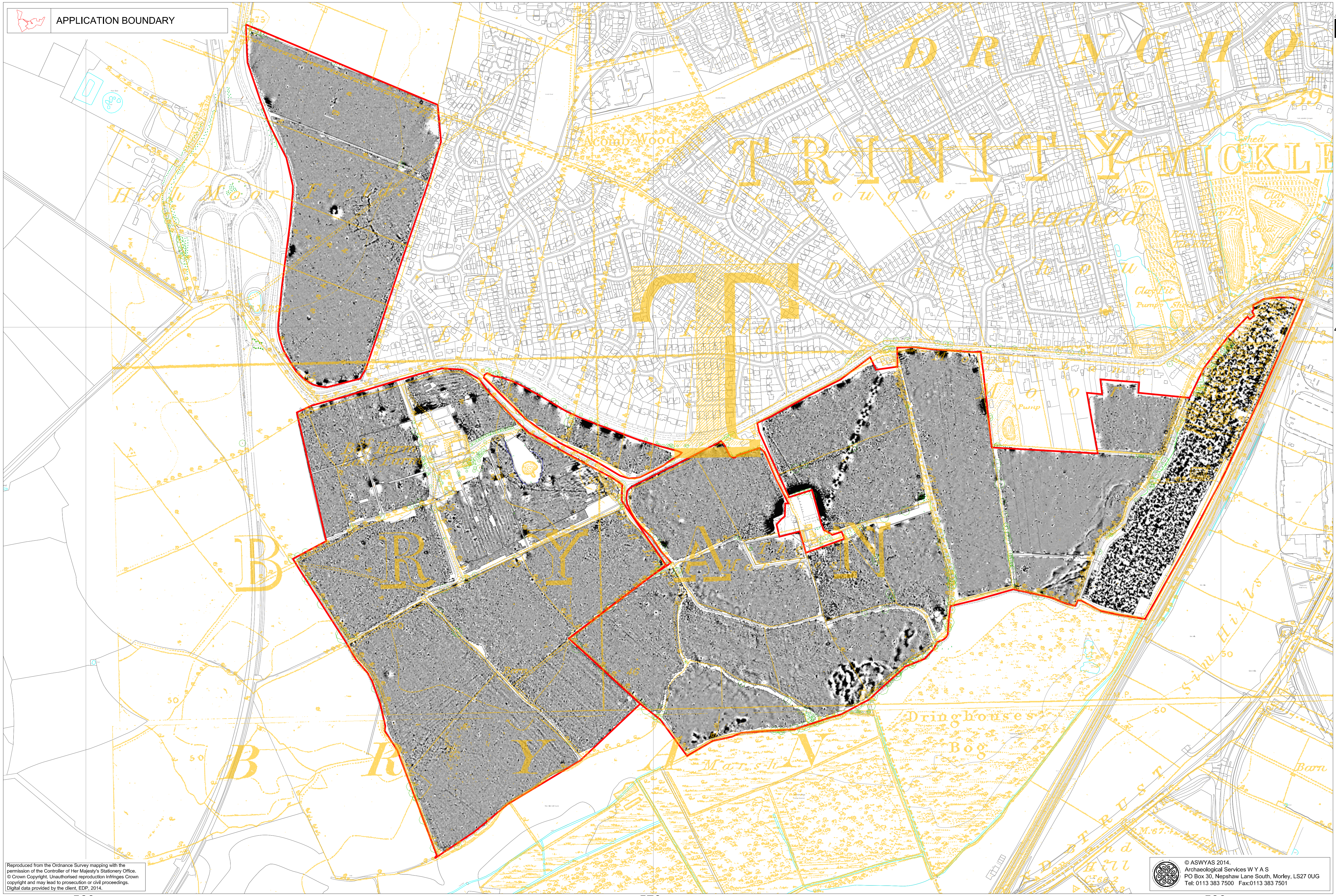


Fig. 5. Magnetometer data showing first edition Ordnance Survey mapping of 1851-1853 (1:6000 @ A3)

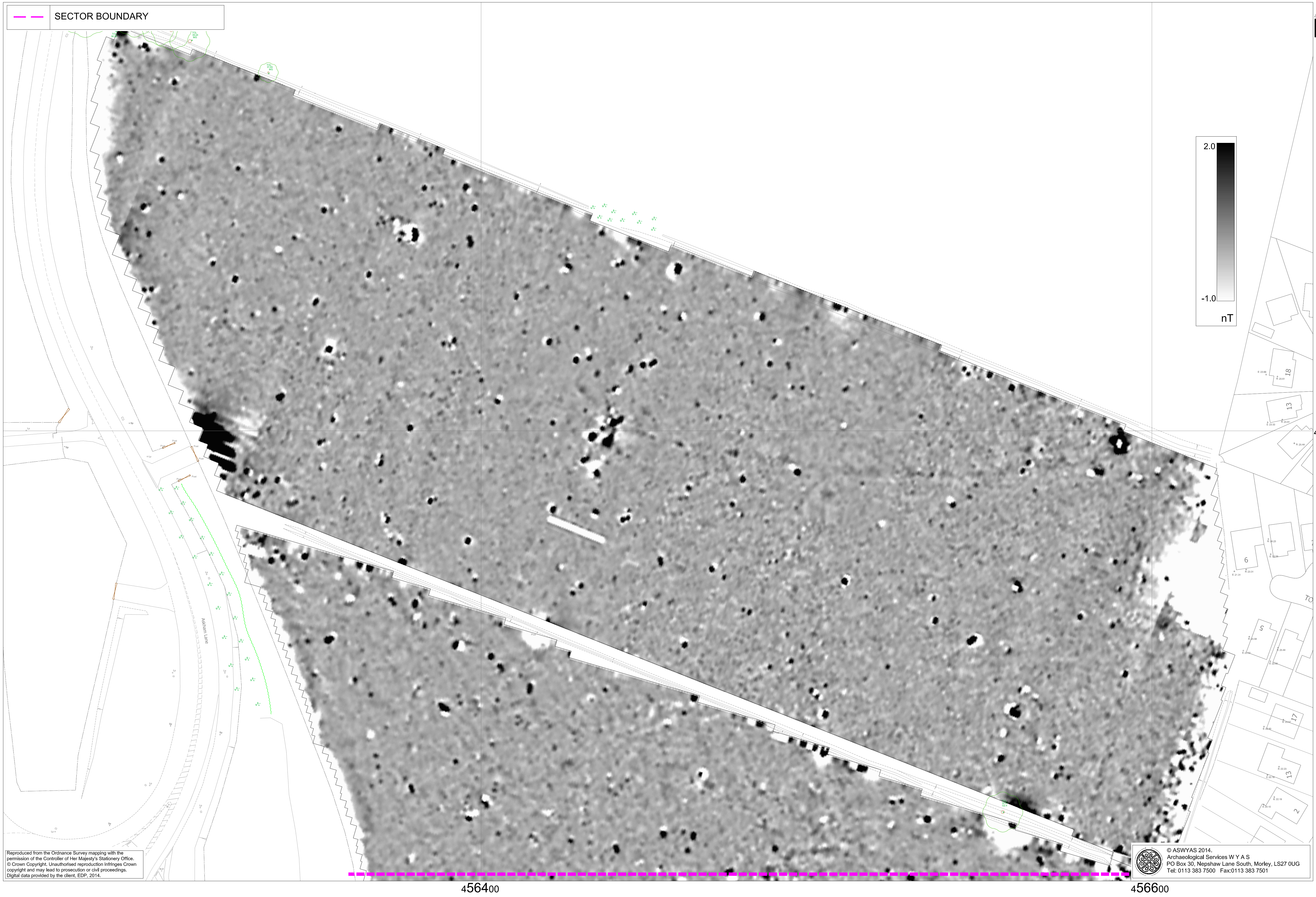


Fig. 6. Processed greyscale magnetometer data; Sector 1 (1:1000 @ A3)

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

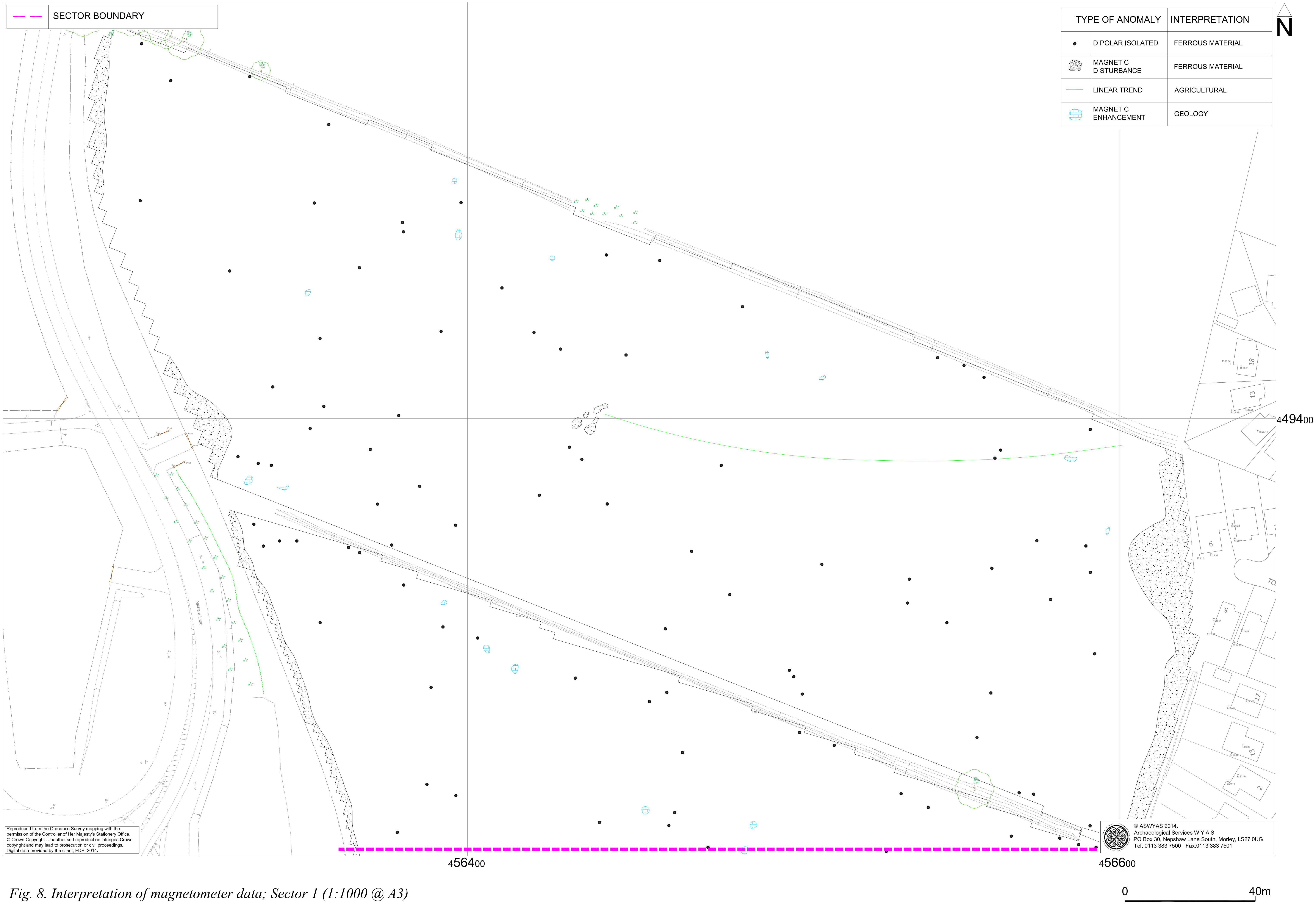
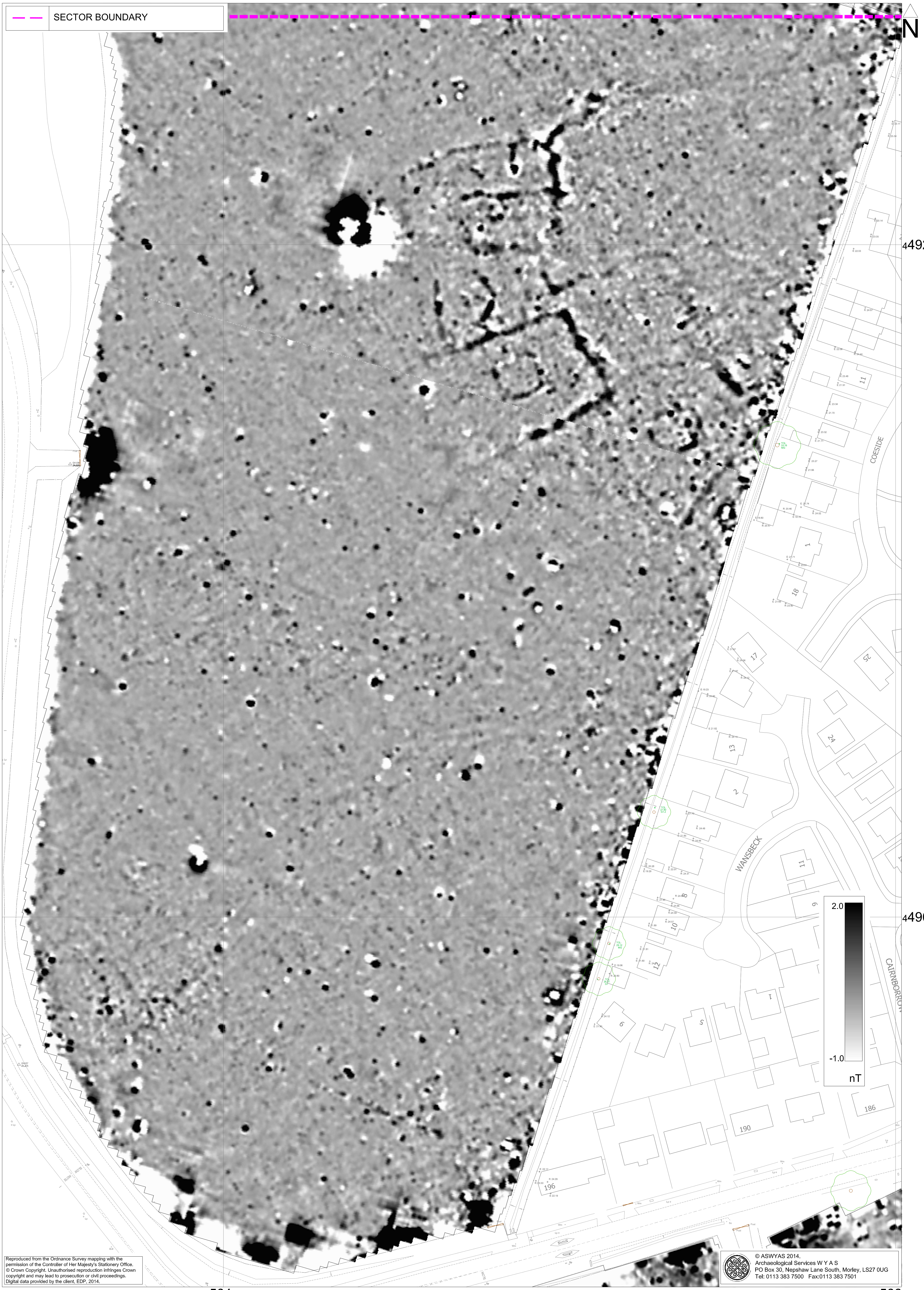


Fig. 8. Interpretation of magnetometer data; Sector 1 (1:1000 @ A3)



© ASWYAS 2014, Archaeological Services W Y A S
PO Box 30, Nepshaw Lane South, Morley, LS27 0UG
Tel: 0113 383 7500 Fax:0113 383 7501

Fig. 9. Processed greyscale magnetometer data; Sector 2 (1:1000 @ A3)

0 40m

Fig. 10. XY trace plot of minimally processed magnetometer data; Sector 2 (1:1000 @ A3)

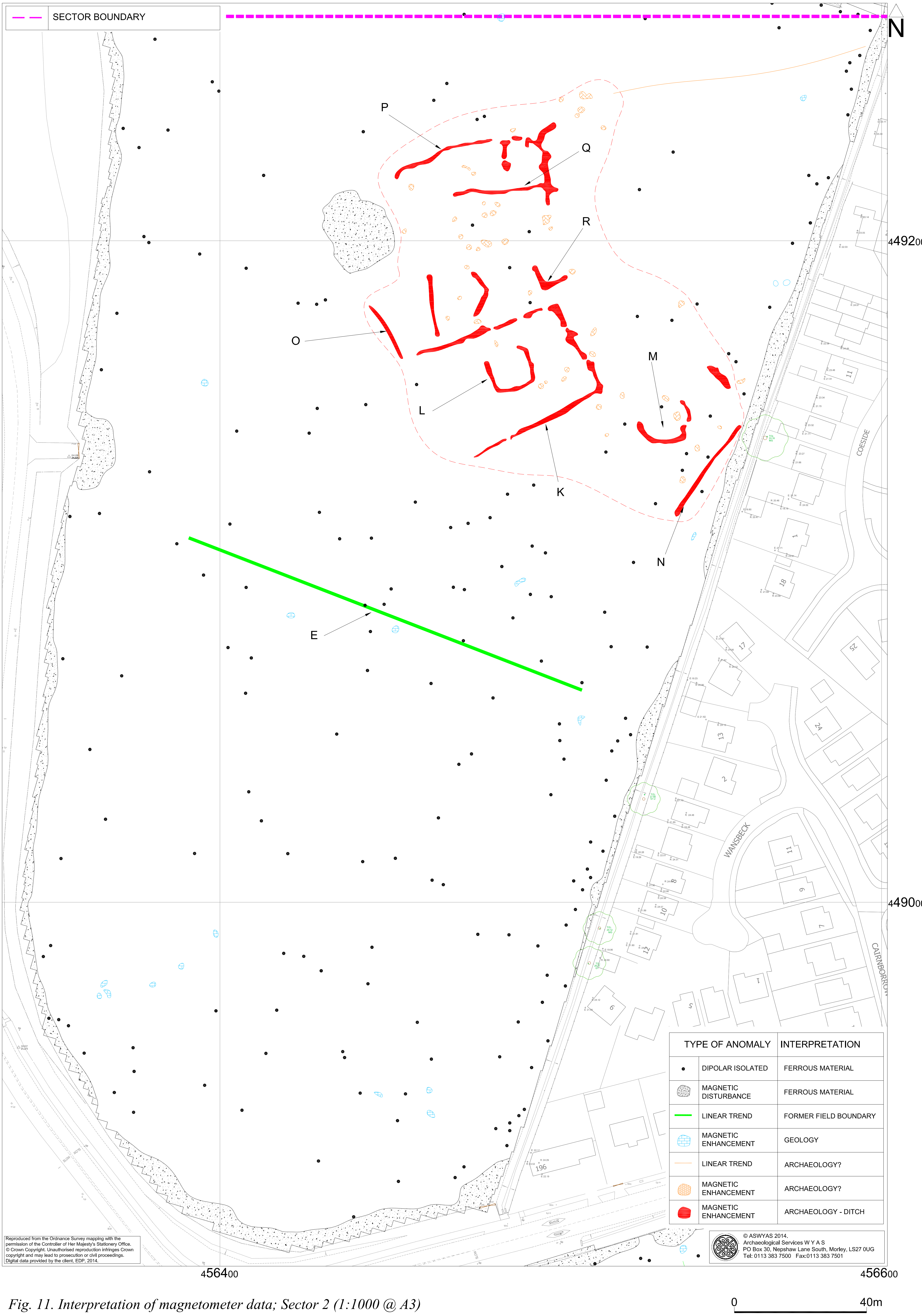


Fig. 11. Interpretation of magnetometer data; Sector 2 (1:1000 @ A3)

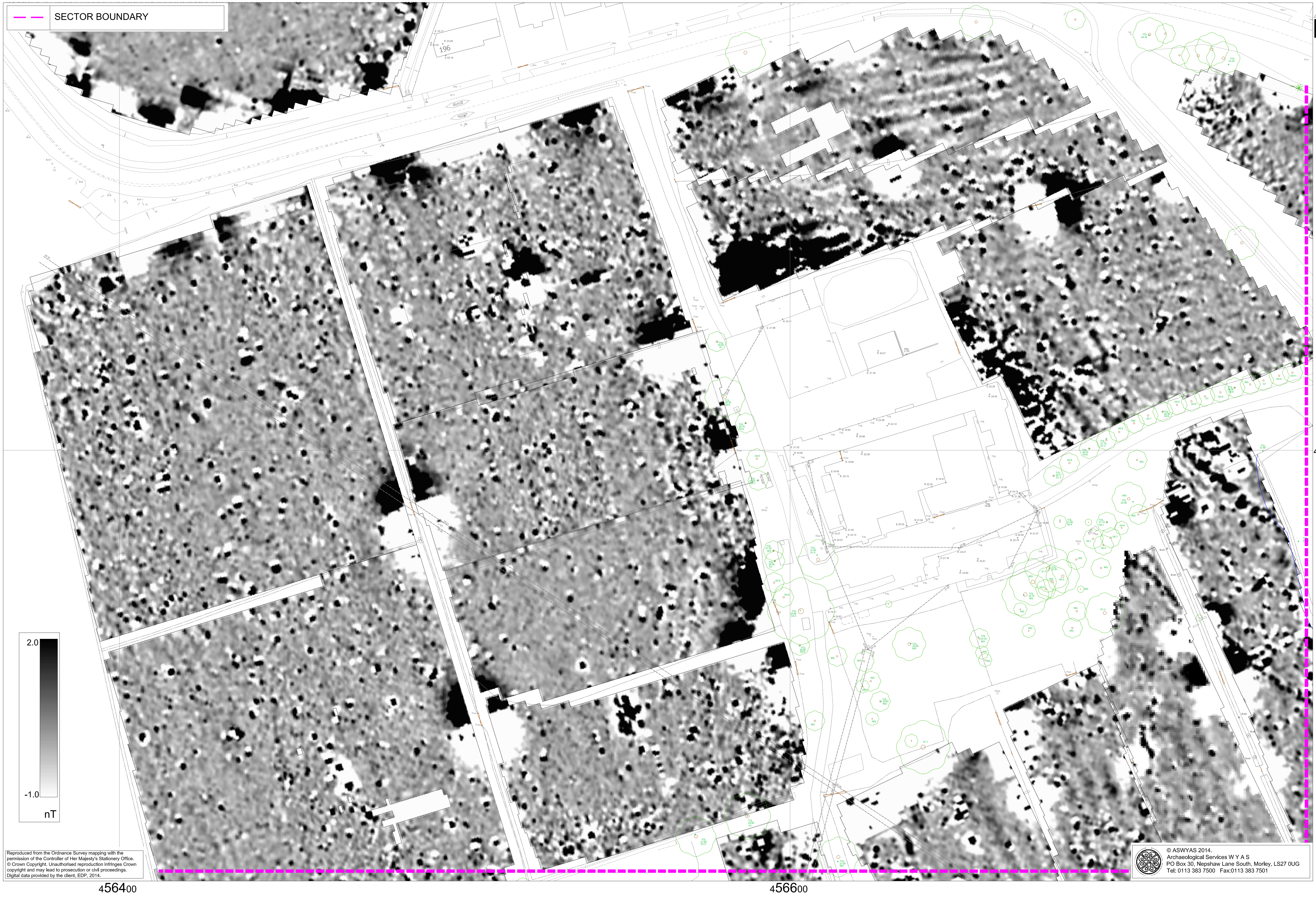


Fig. 12. Processed greyscale magnetometer data; Sector 3 (1:1000 @ A3)

Fig. 13. XY trace plot of minimally processed magnetometer data; Sector 3 (1:1000 @ A3)

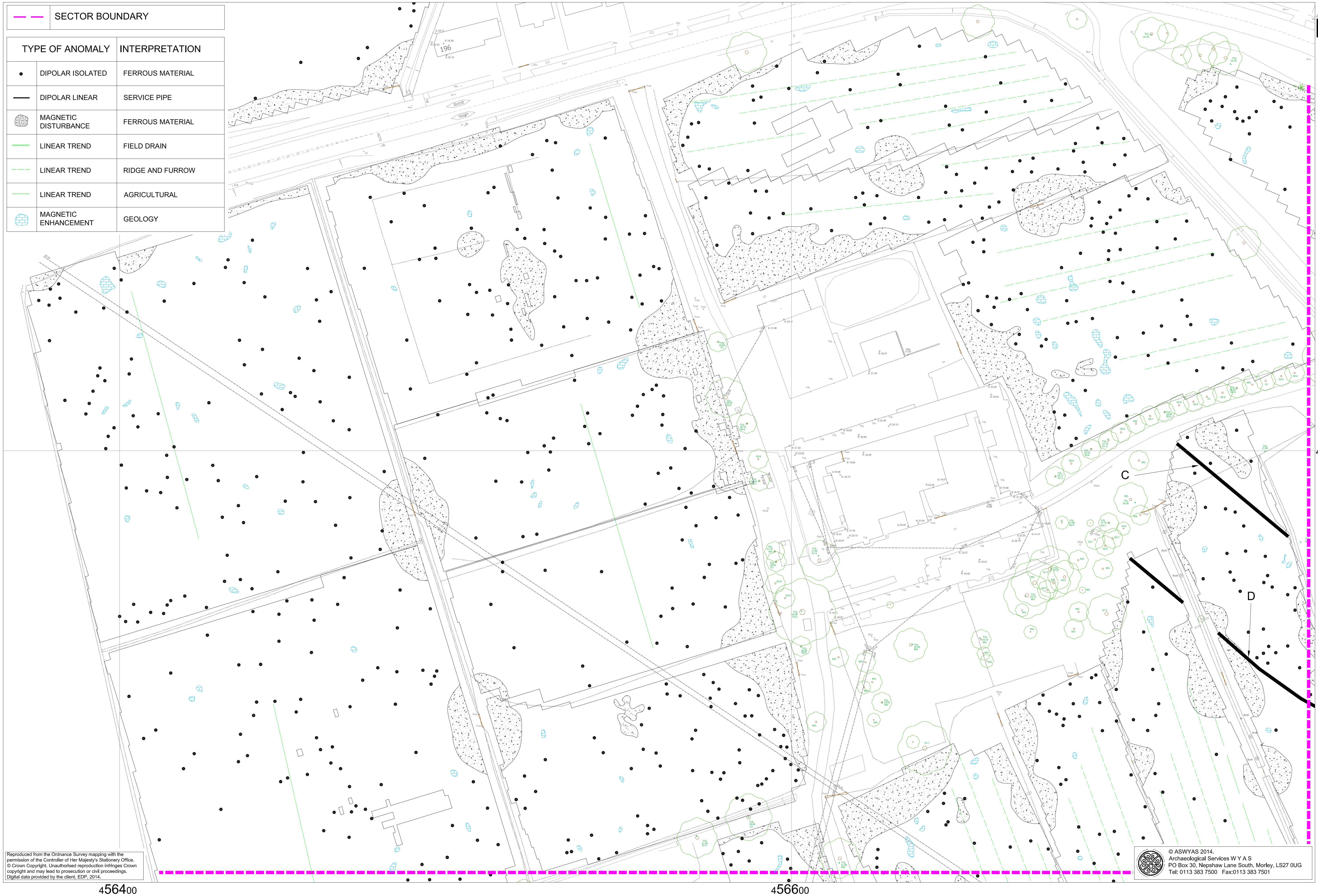


Fig. 14. Interpretation of magnetometer data; Sector 3 (1:1000 @ A3)

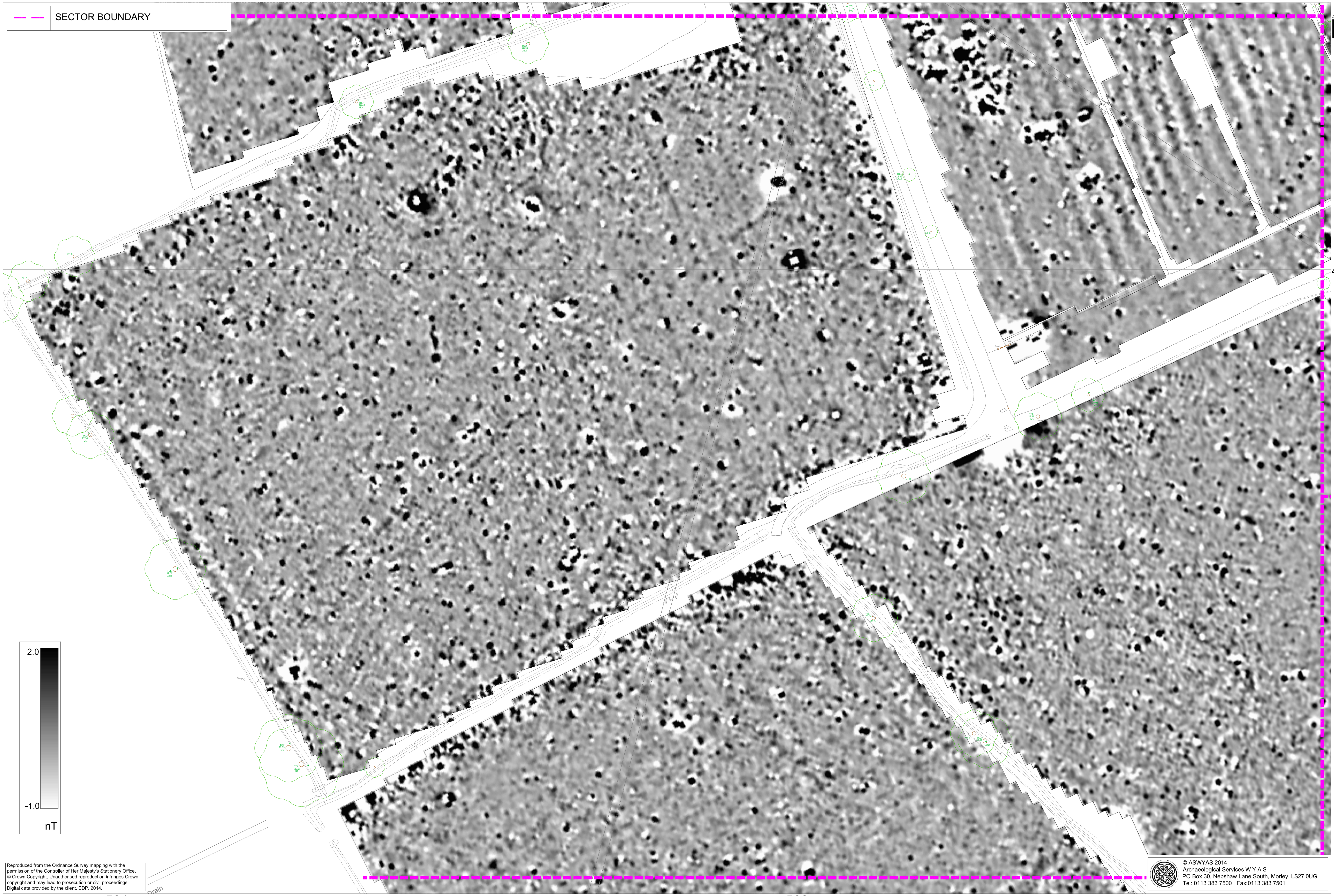


Fig. 15. Processed greyscale magnetometer data; Sector 4 (1:1000 @ A3)

Fig. 16. XY trace plot of minimally processed magnetometer data; Sector 4 (1:1000 @ A3)

0 40m

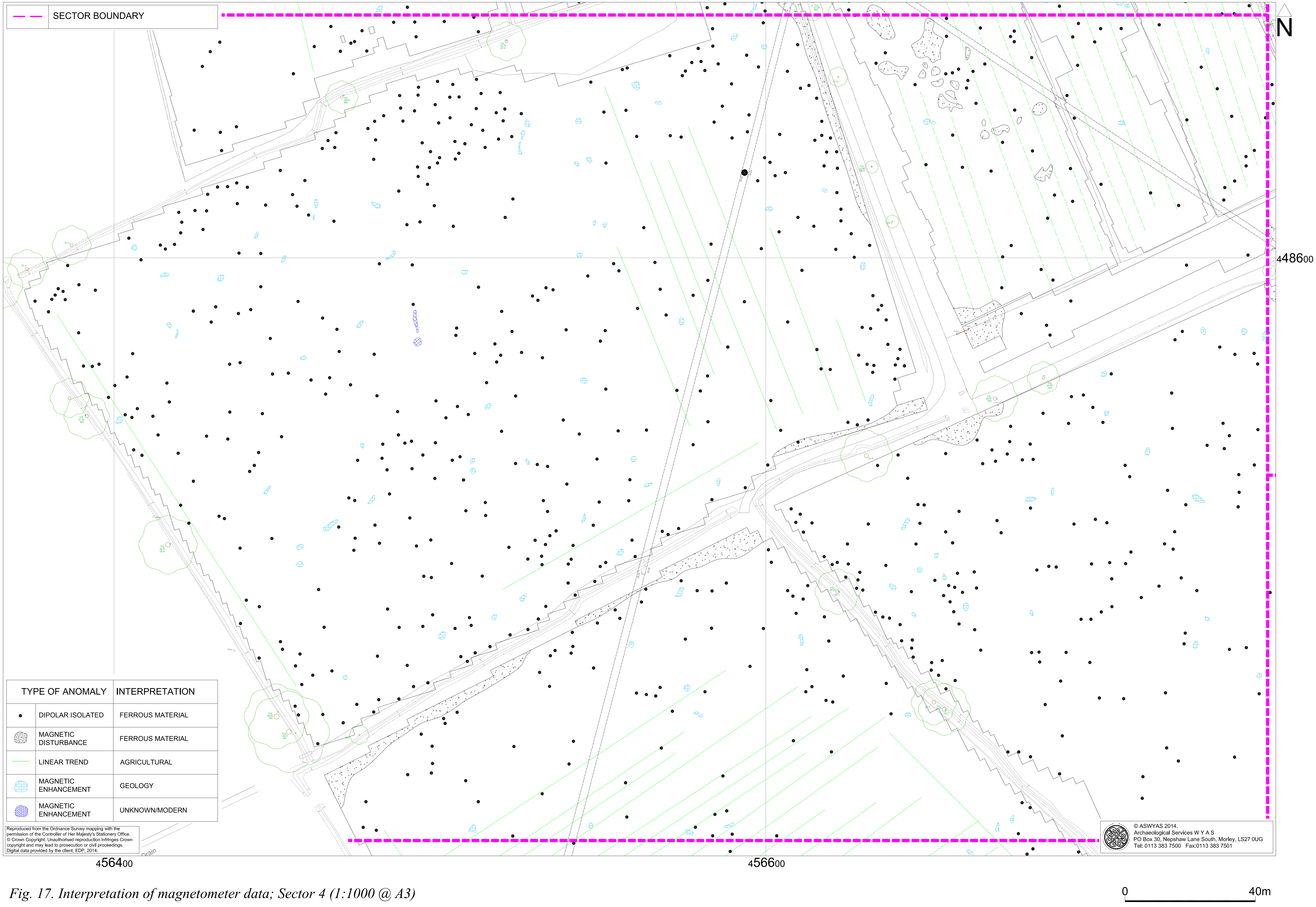


Fig. 17. Interpretation of magnetometer data; Sector 4 (1:1000 @ A3)

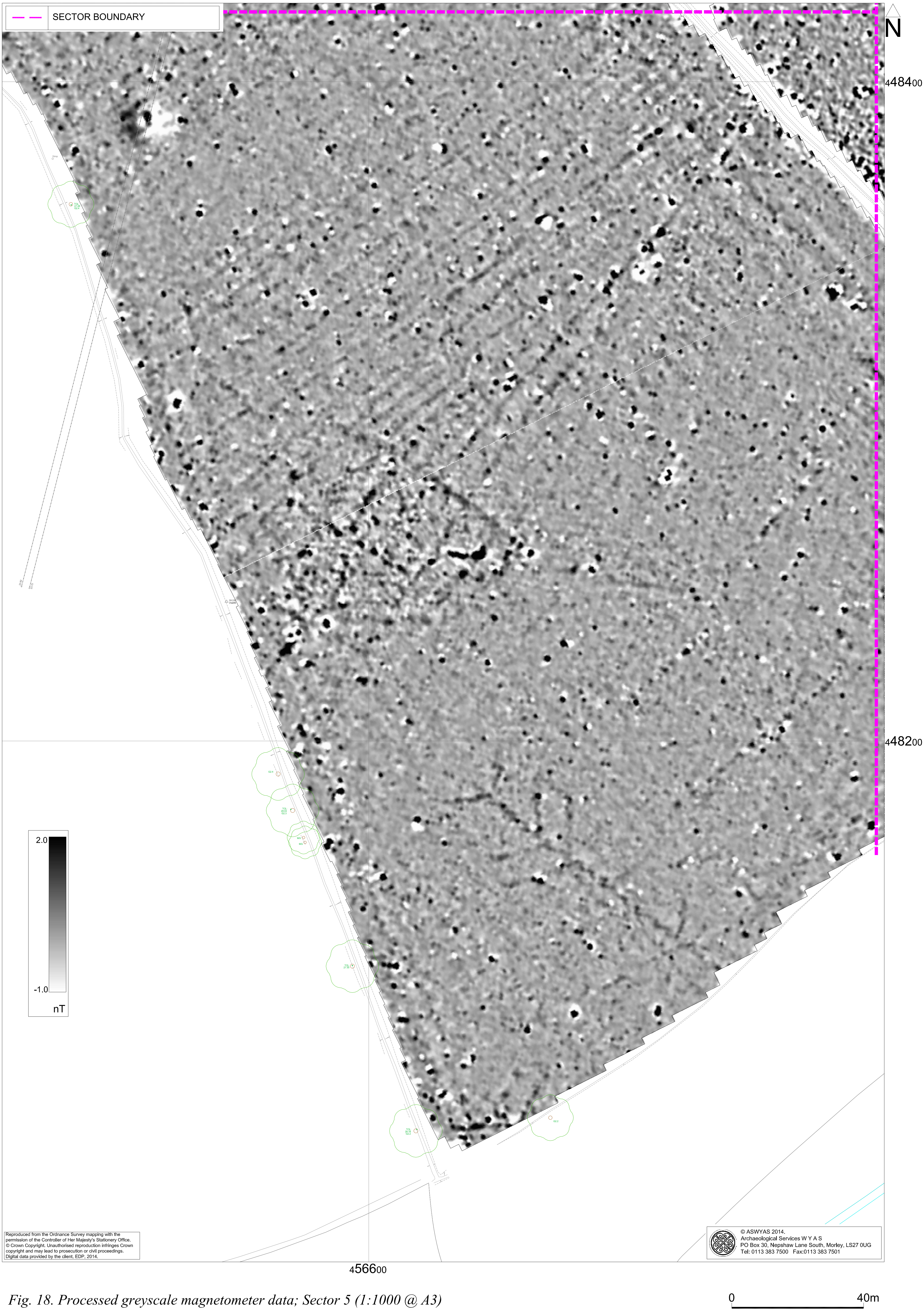


Fig. 18. Processed greyscale magnetometer data; Sector 5 (1:1000 @ A3)

Fig. 19. XY trace plot of minimally processed magnetometer data; Sector 5 (1:1000 @ A3)

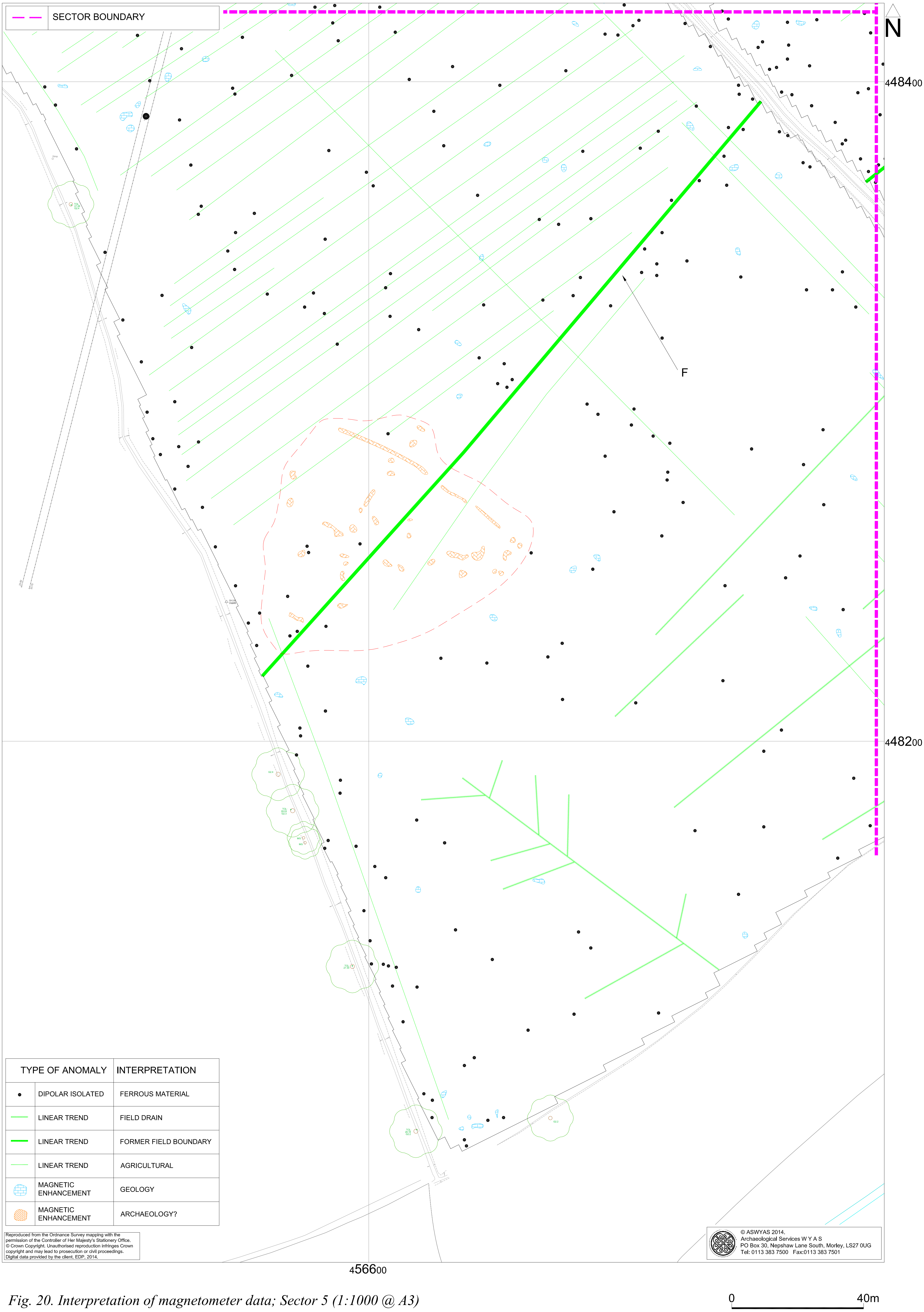


Fig. 20. Interpretation of magnetometer data; Sector 5 (1:1000 @ A3)

Fig. 21. Processed greyscale magnetometer data; Sector 6 (1:1000 @ A3)

Fig. 22. XY trace plot of minimally processed magnetometer data; Sector 6 (1:1000 @ A3)

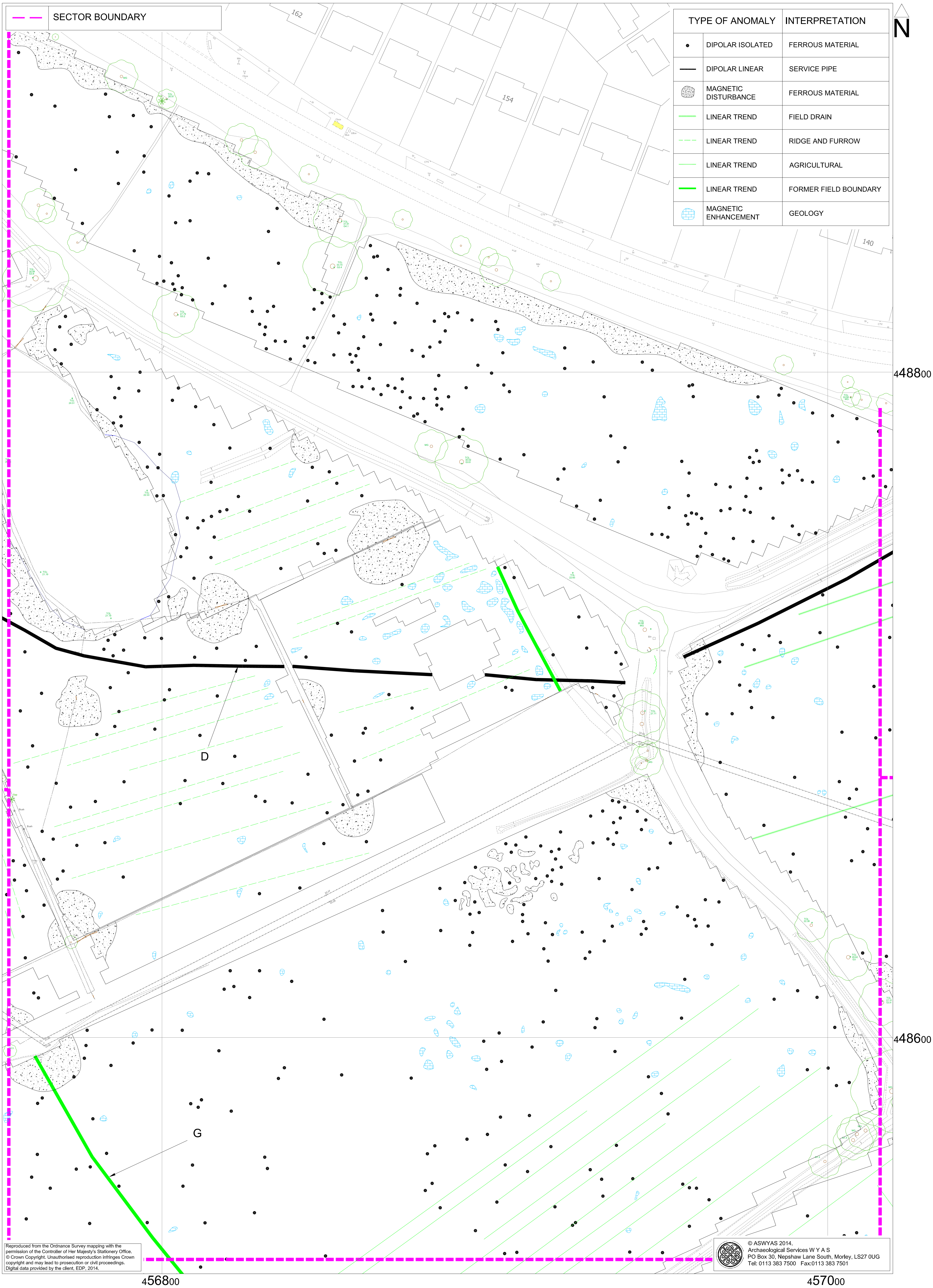


Fig. 23. Interpretation of magnetometer data; Sector 6 (1:1000 @ A3)

0 40m

Fig. 24. Processed greyscale magnetometer data; Sector 7 (1:1000 @ A3)

Fig. 25. XY trace plot of minimally processed magnetometer data; Sector 7 (1:1000 @ A3)

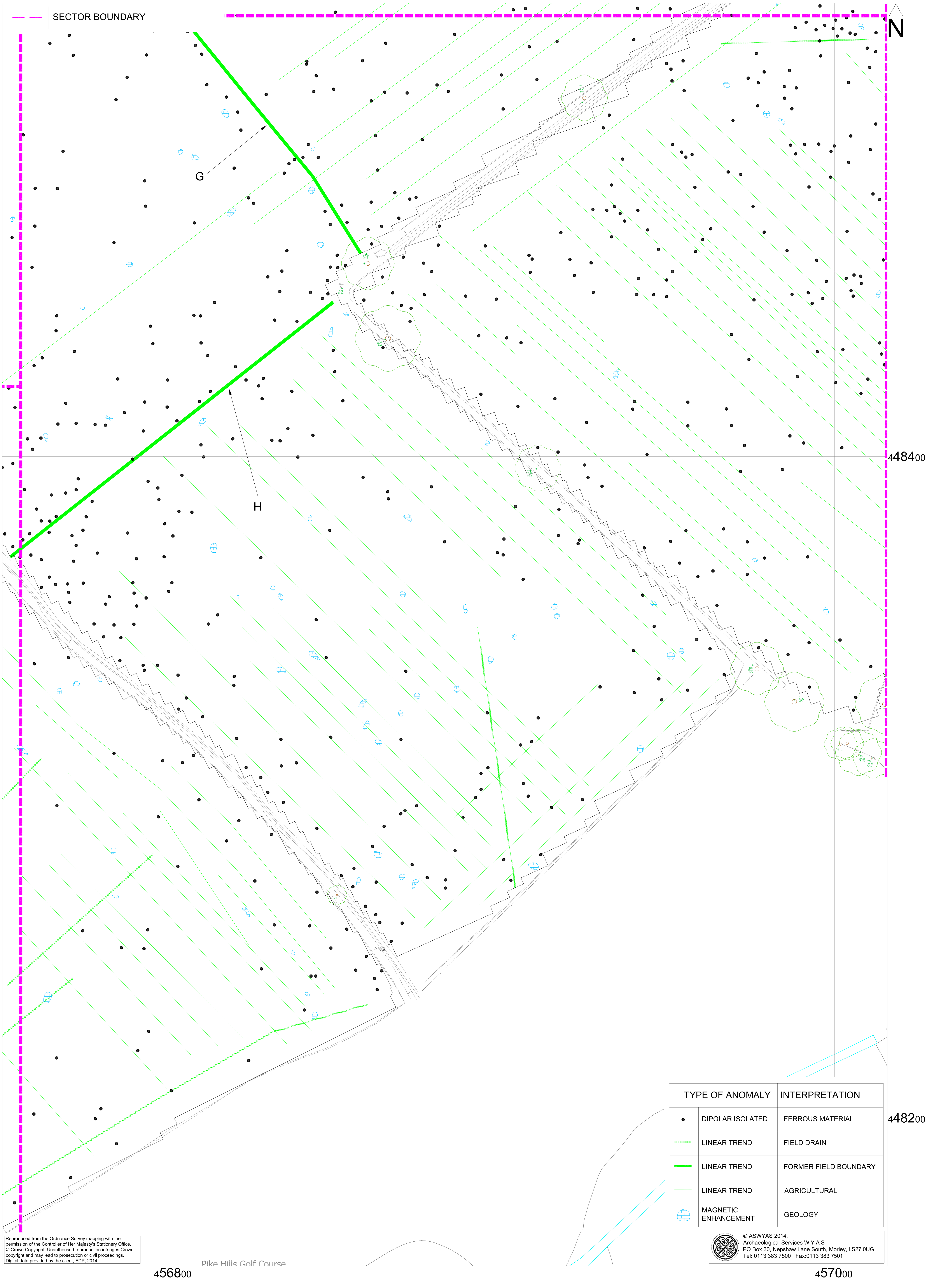


Fig. 26. Interpretation of magnetometer data; Sector 7 (1:1000 @ A3)

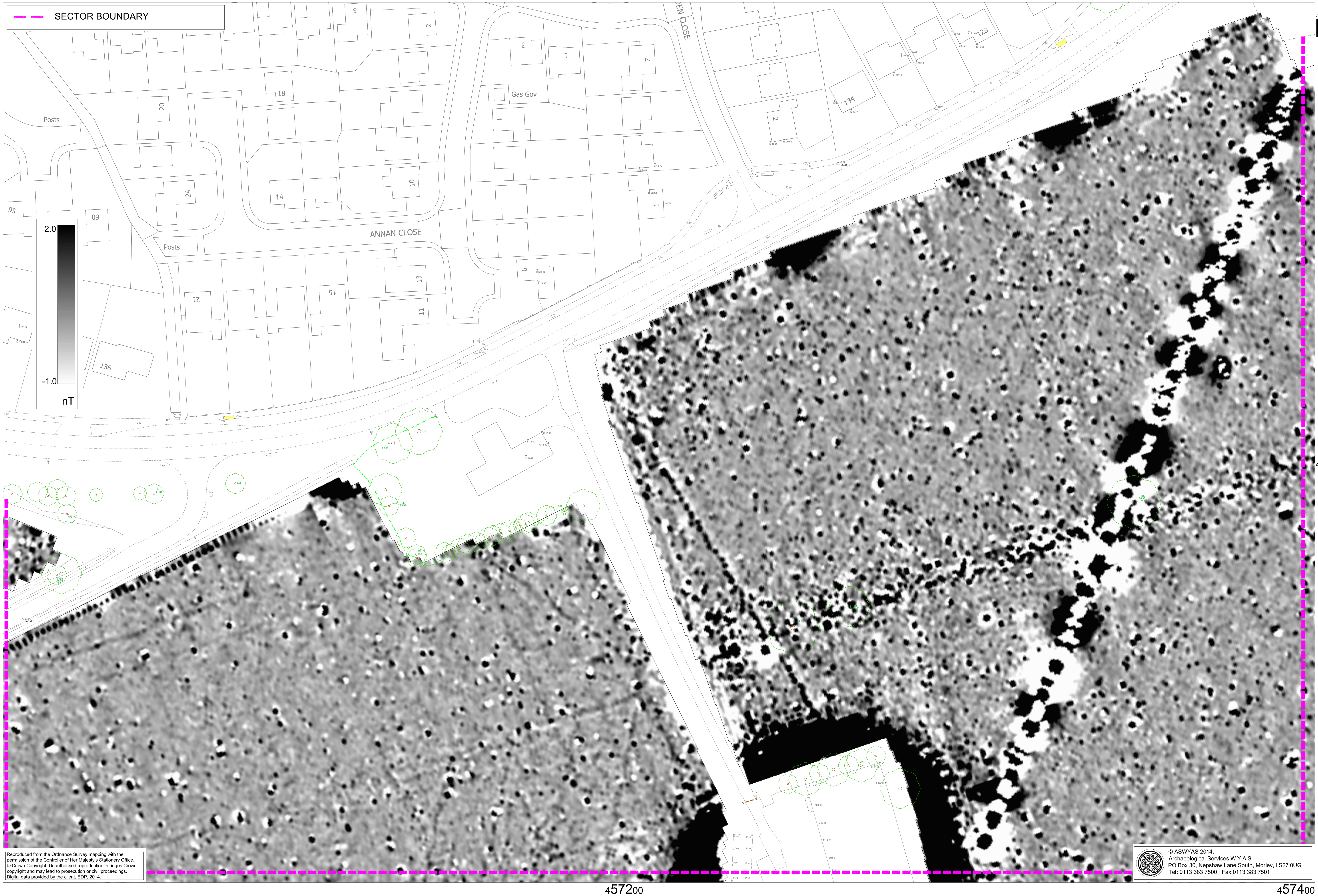


Fig. 27. Processed greyscale magnetometer data; Sector 8 (1:1000 @ A3)

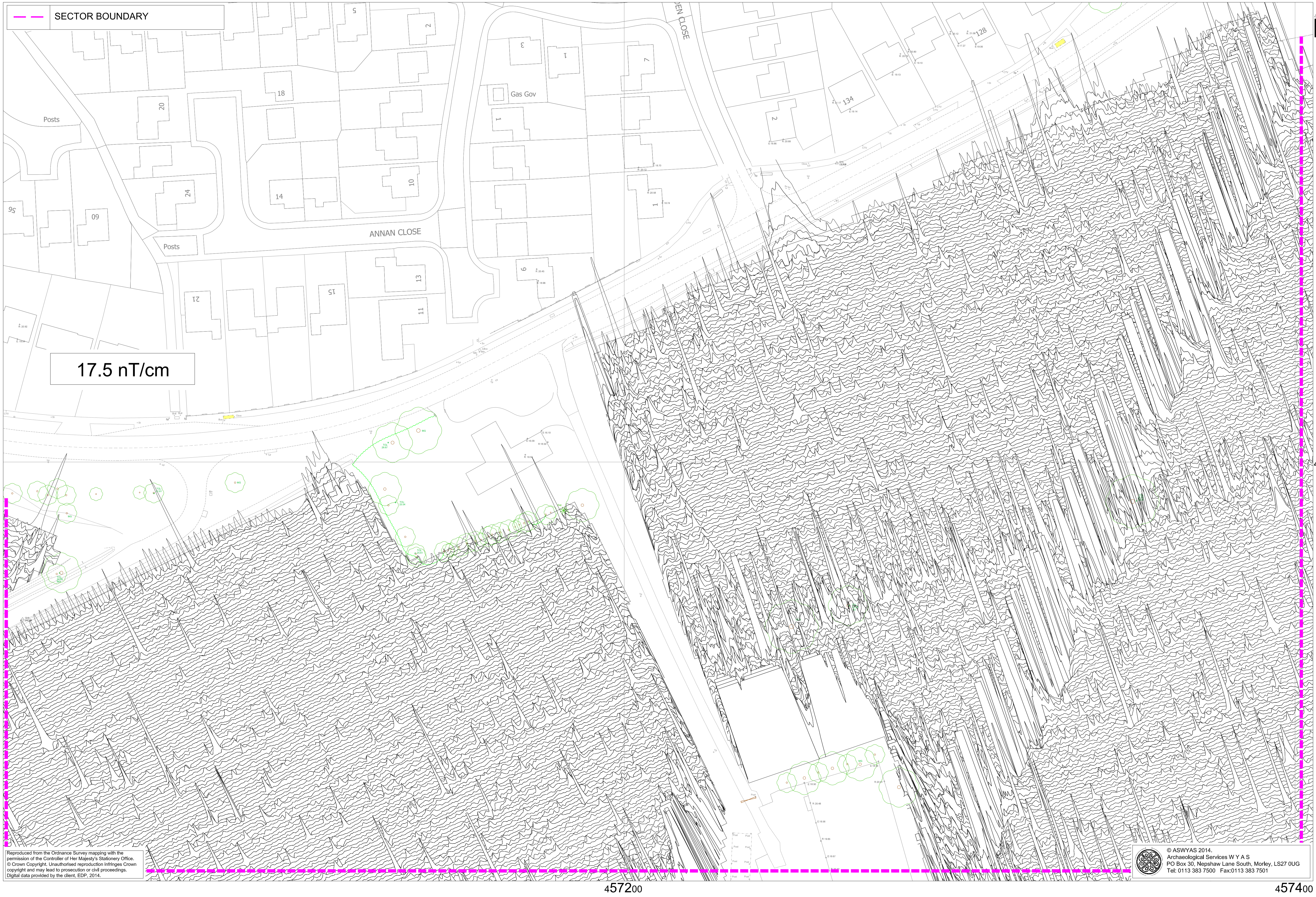


Fig. 28. XY trace plot of minimally processed magnetometer data; Sector 8 (1:1000 @ A3)

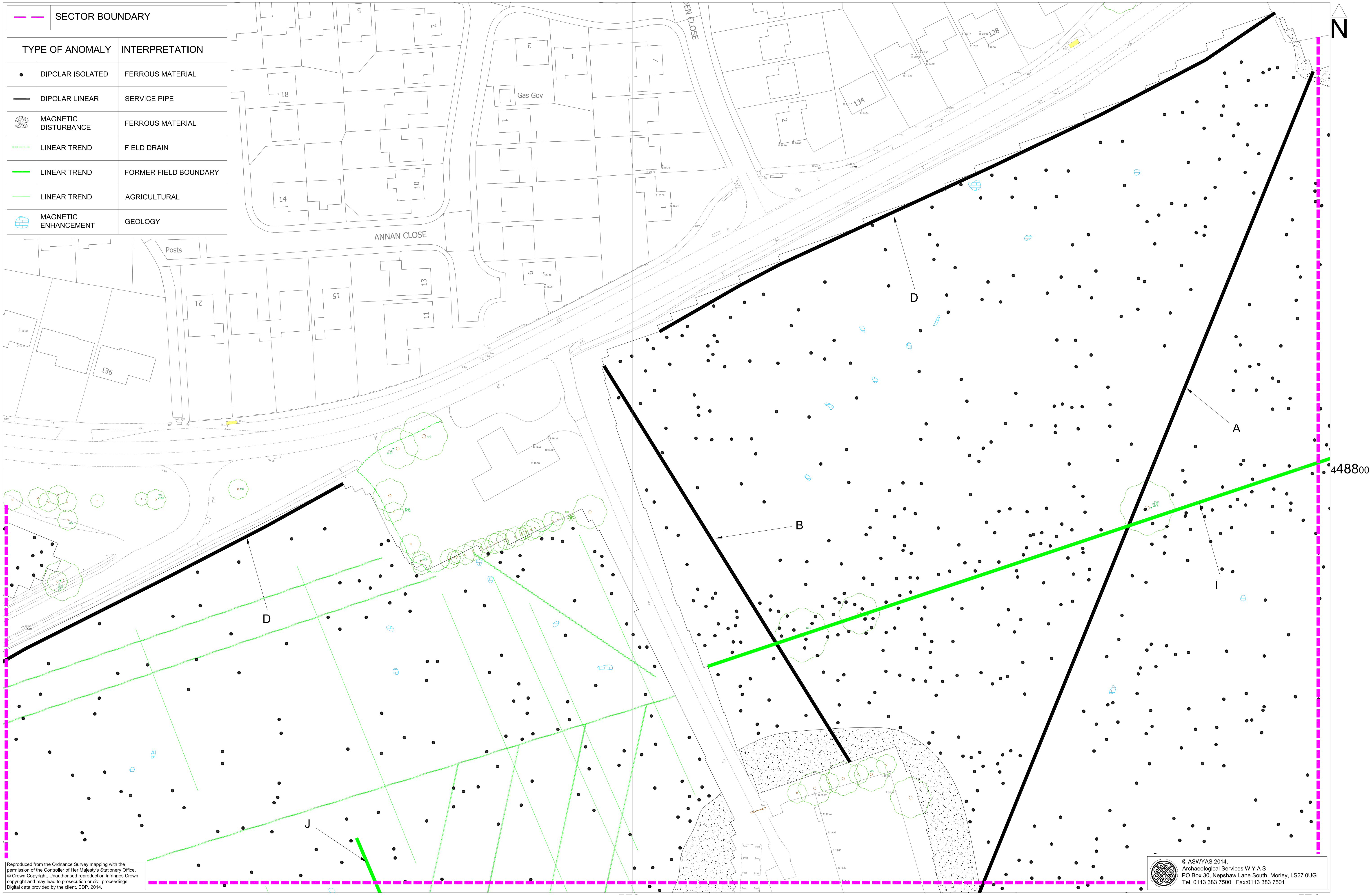


Fig. 29. Interpretation of magnetometer data; Sector 8 (1:1000 @ A3)

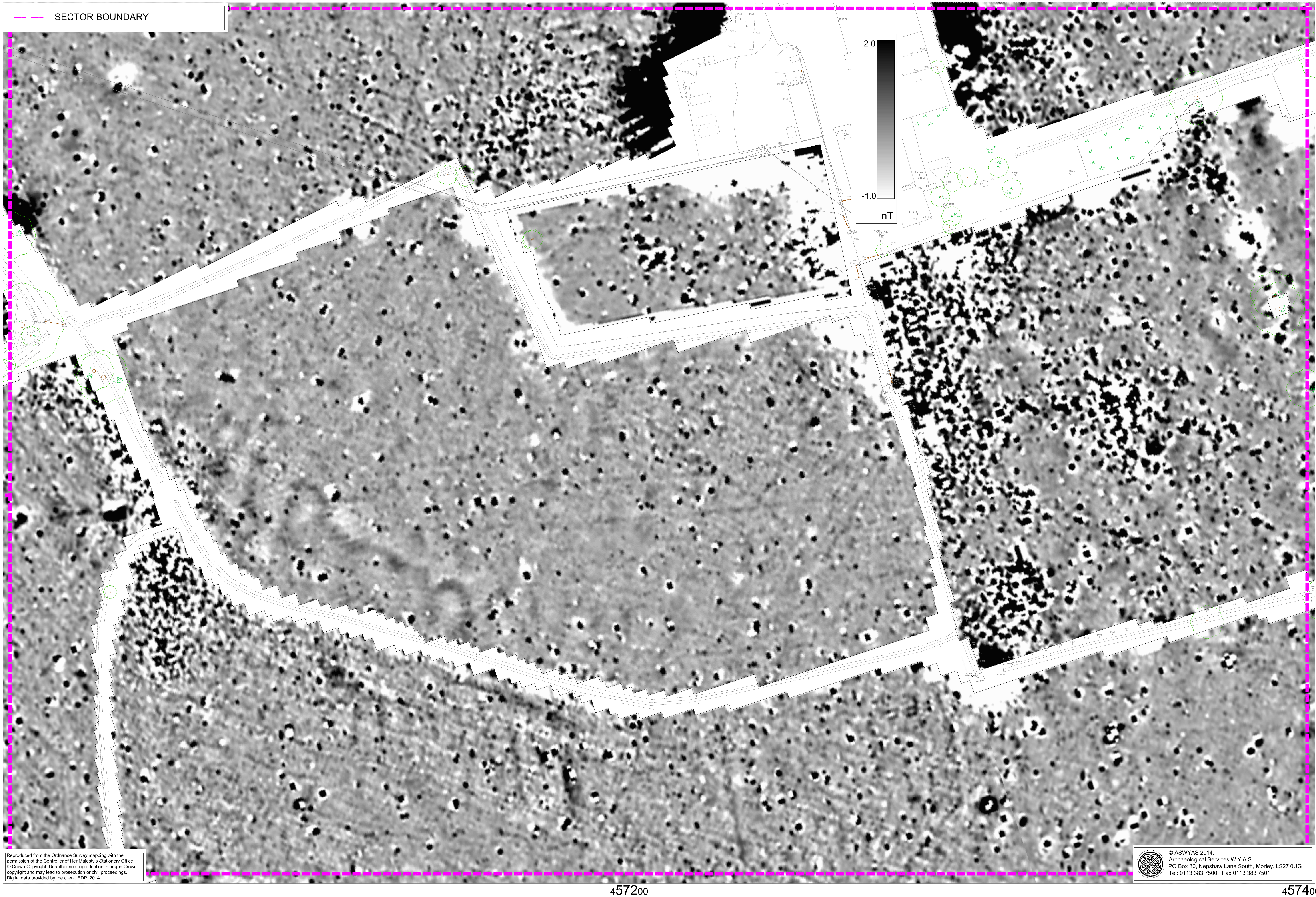


Fig. 30. Processed greyscale magnetometer data; Sector 9 (1:1000 @ A3)

© ASWYAS 2014.
Archaeological Services W Y A S
PO Box 30, Nepshaw Lane South, Morley, LS27 0UG
Tel: 0113 383 7500 Fax:0113 383 7501

Fig. 31. XY trace plot of minimally processed magnetometer data; Sector 9 (1:1000 @ A3)

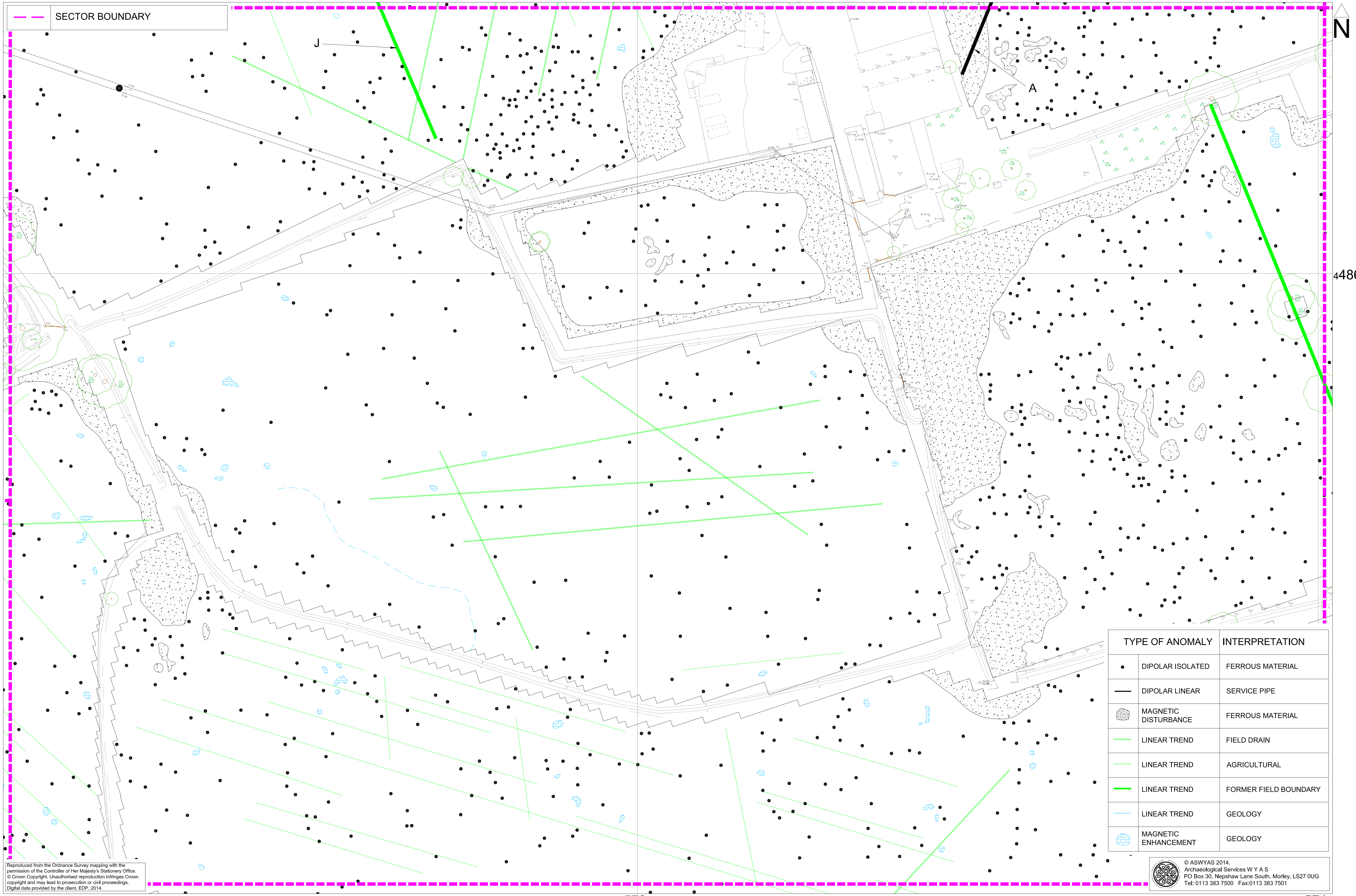


Fig. 32. Interpretation of magnetometer data; Sector 9 (1:1000 @ A3)

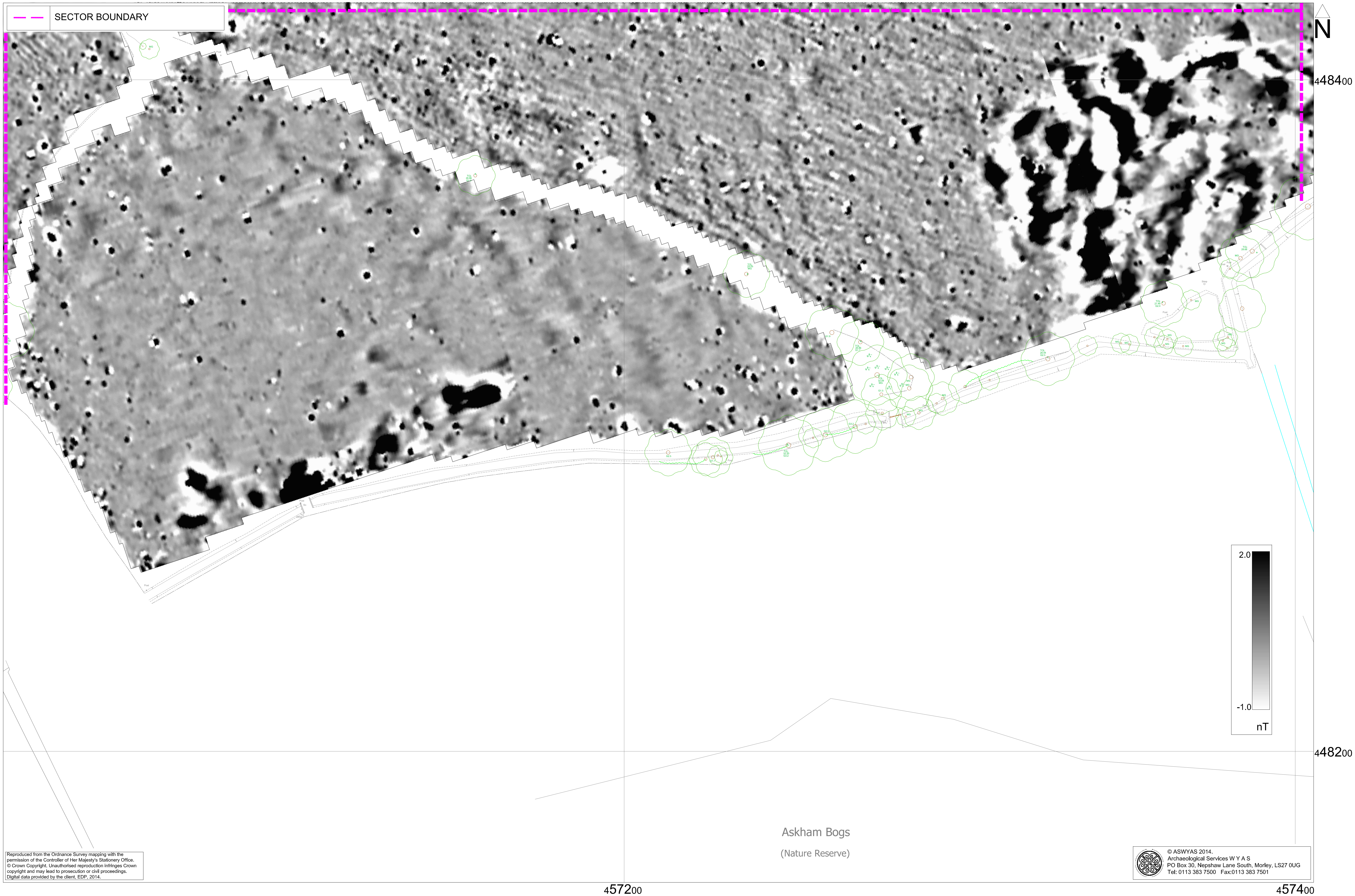


Fig. 33. Processed greyscale magnetometer data; Sector 10 (1:1000 @ A3)

© ASWYAS 2014.
Archaeological Services W Y A S
PO Box 30, Nepshaw Lane South, Morley, LS27 0UG
Tel: 0113 383 7500 Fax:0113 383 7501

Fig. 34. XY trace plot of minimally processed magnetometer data; Sector 10 (1:1000 @ A3)

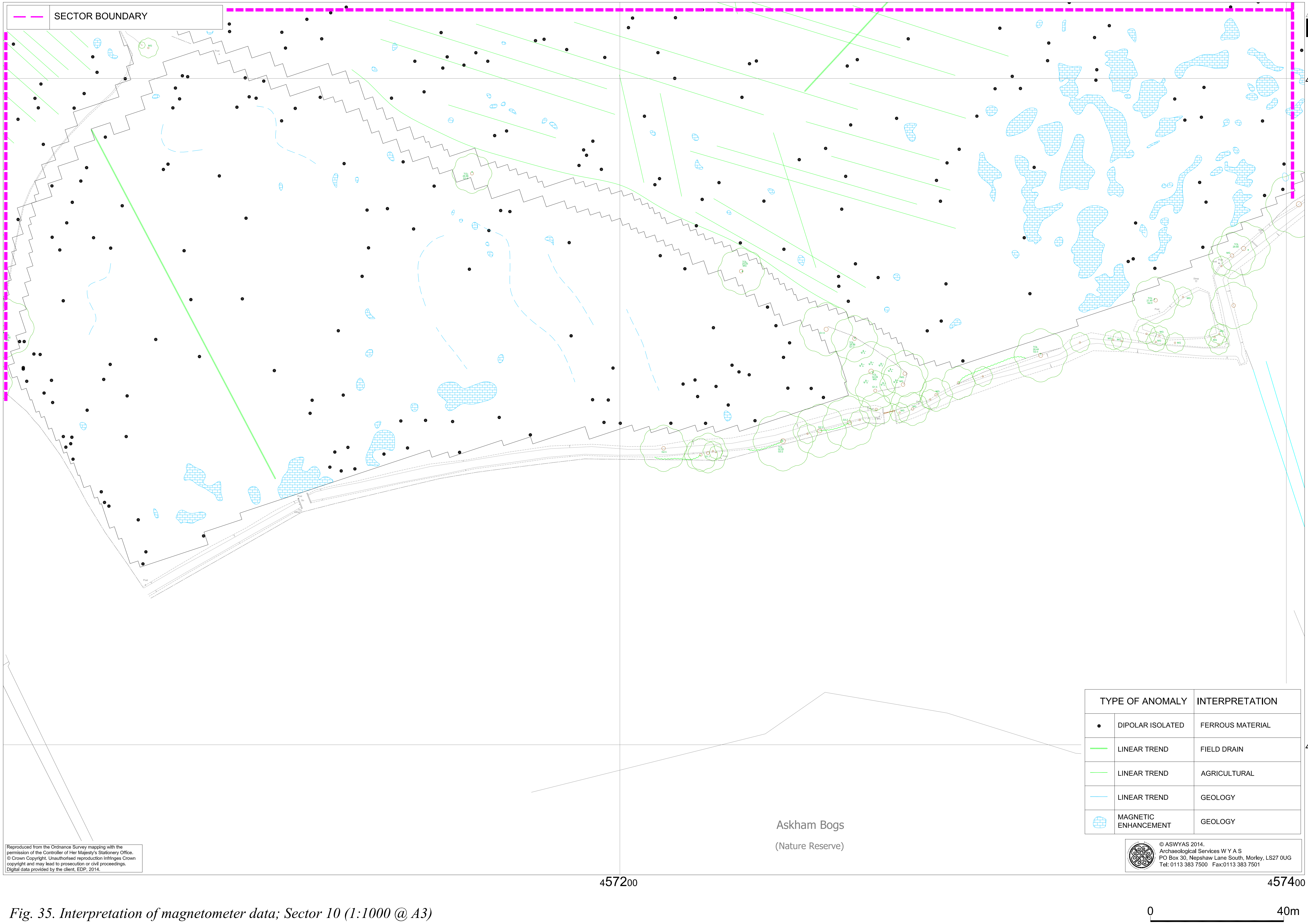


Fig. 35. Interpretation of magnetometer data; Sector 10 (1:1000 @ A3)

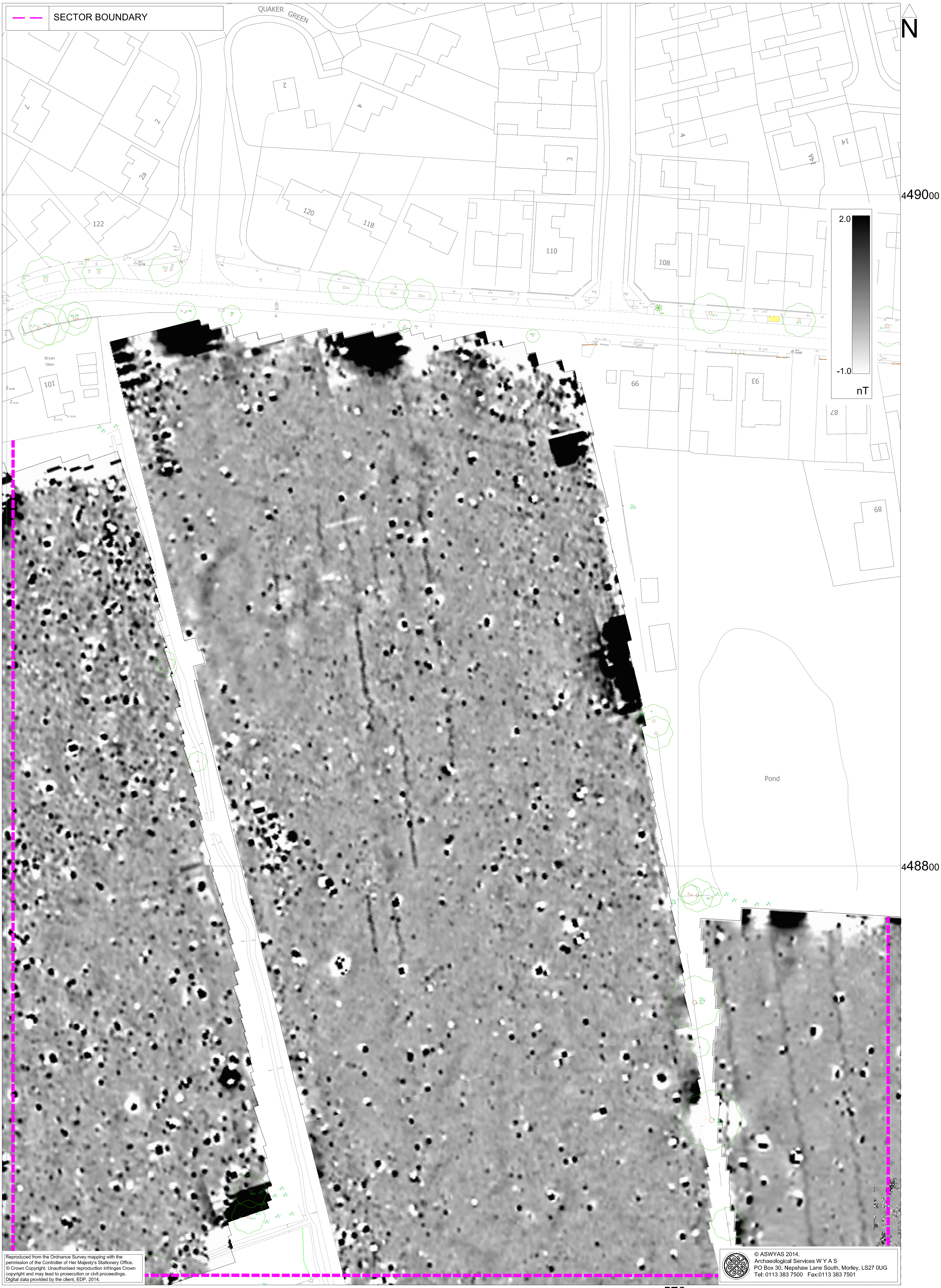


Fig. 36. Processed greyscale magnetometer data; Sector 11 (1:1000 @ A3)

0 40m

Fig. 37. XY trace plot of minimally processed magnetometer data; Sector 11 (1:1000 @ A3)

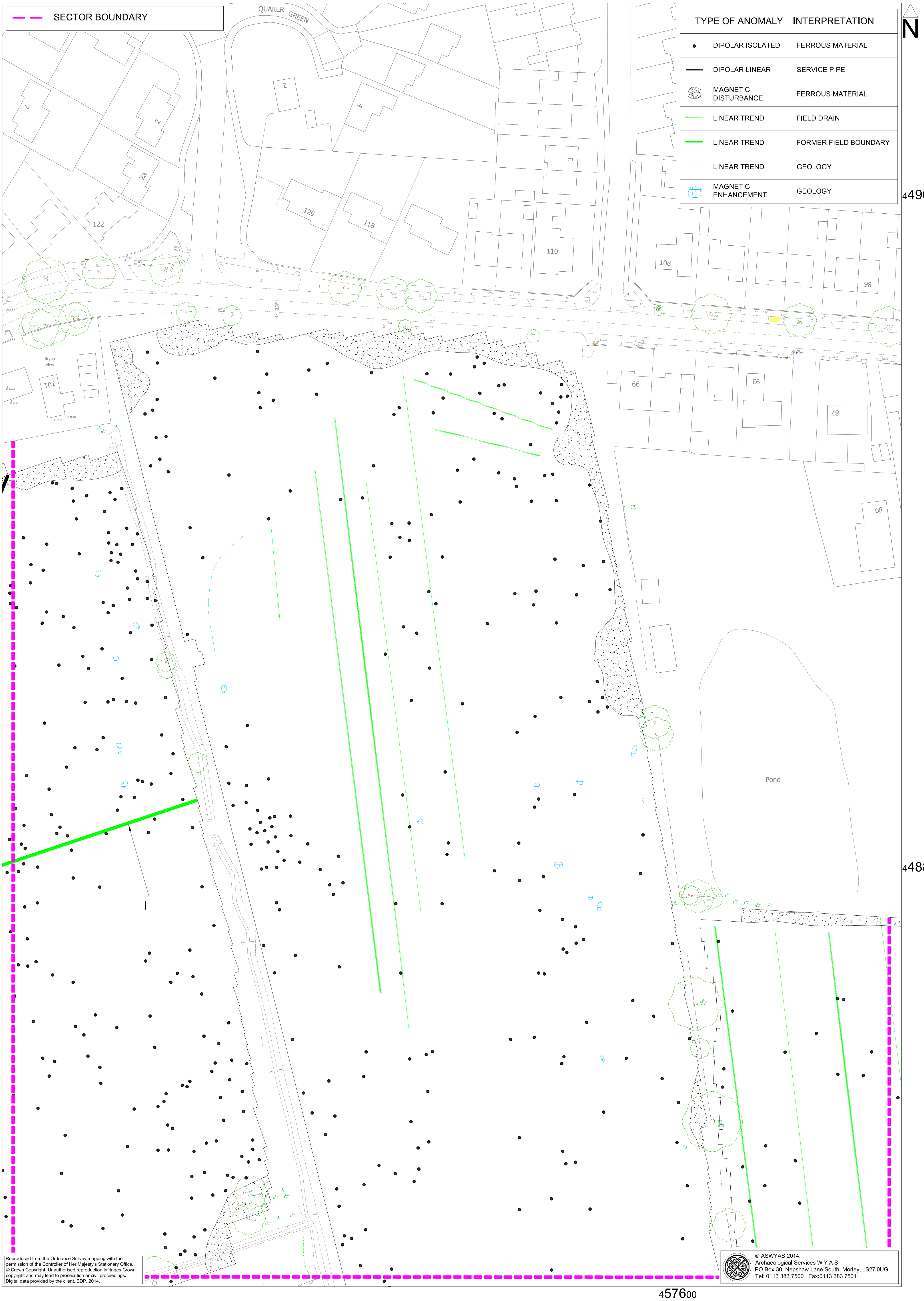
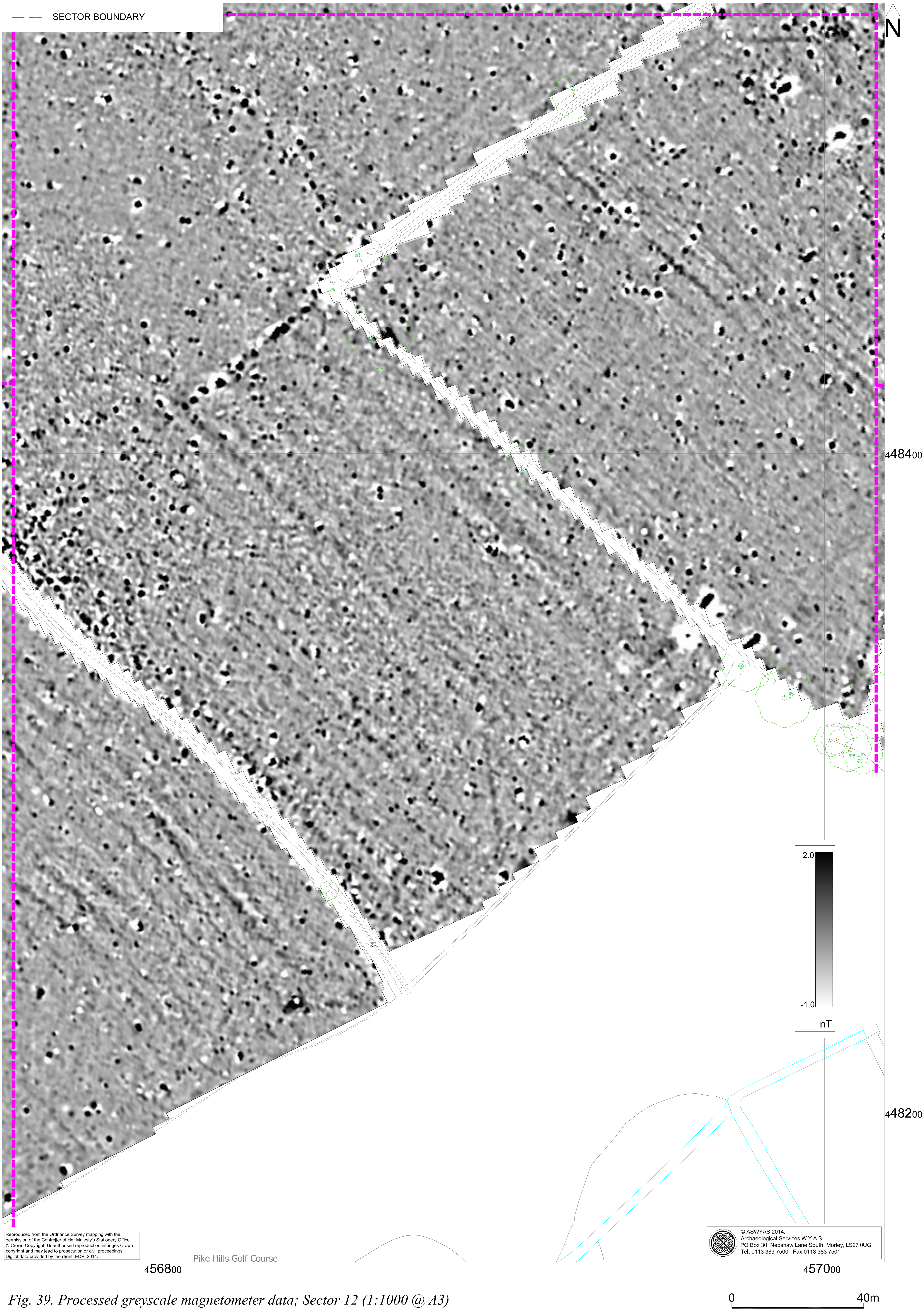


Fig. 38. Interpretation of magnetometer data; Sector 11 (1:1000 @ A3)



© ASWYAS 2014.
Archaeological Services W Y A S
PO Box 30, Nepshaw Lane South, Morley, LS27 0UG
Tel: 0113 383 7500 Fax:0113 383 7501

Fig. 39. Processed greyscale magnetometer data; Sector 12 (1:1000 @ A3)

Fig. 40. XY trace plot of minimally processed magnetometer data; Sector 12 (1:1000 @ A3)

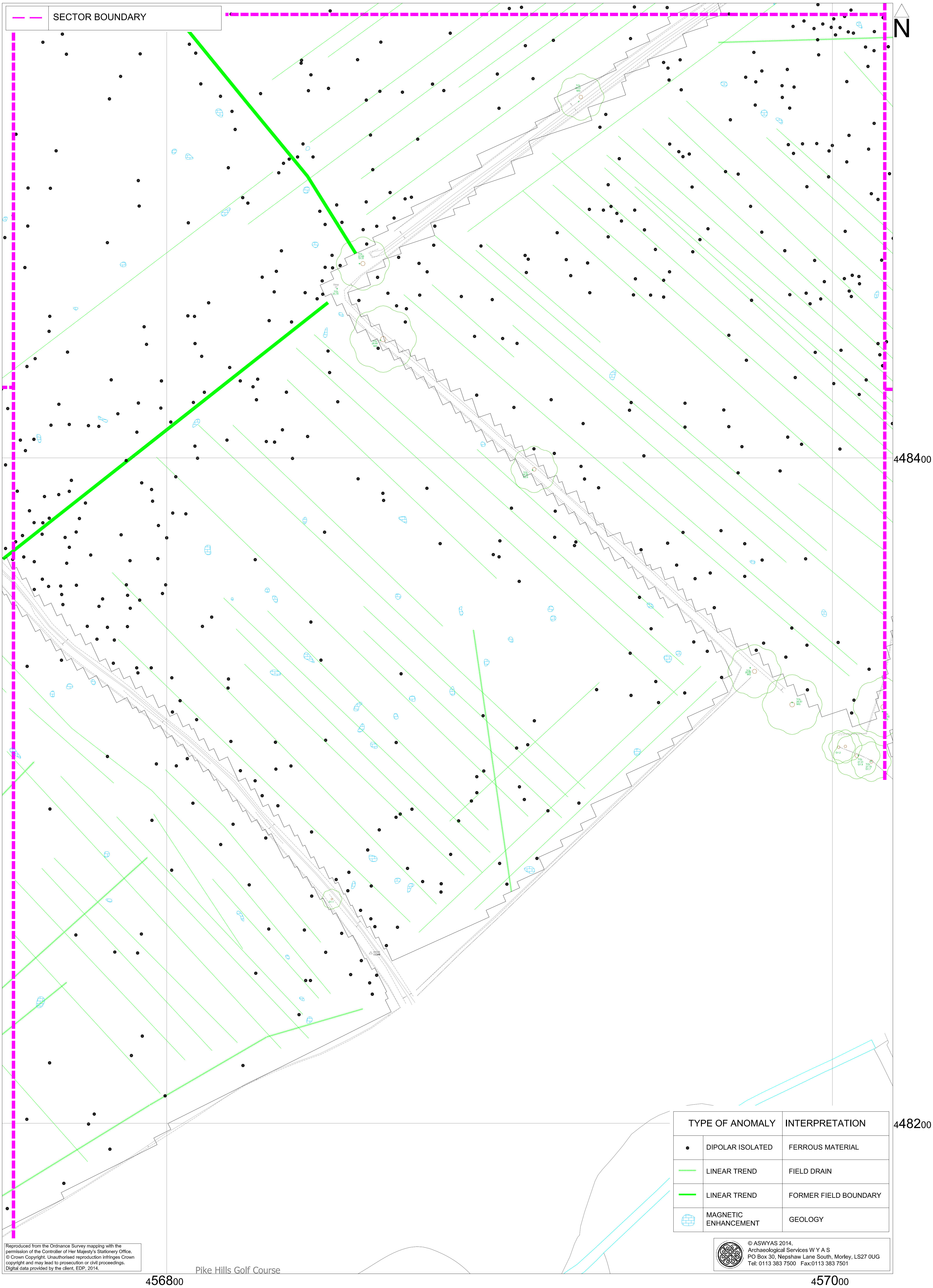


Fig. 41. Interpretation of magnetometer data; Sector 12 (1:1000 @ A3)

0 40m

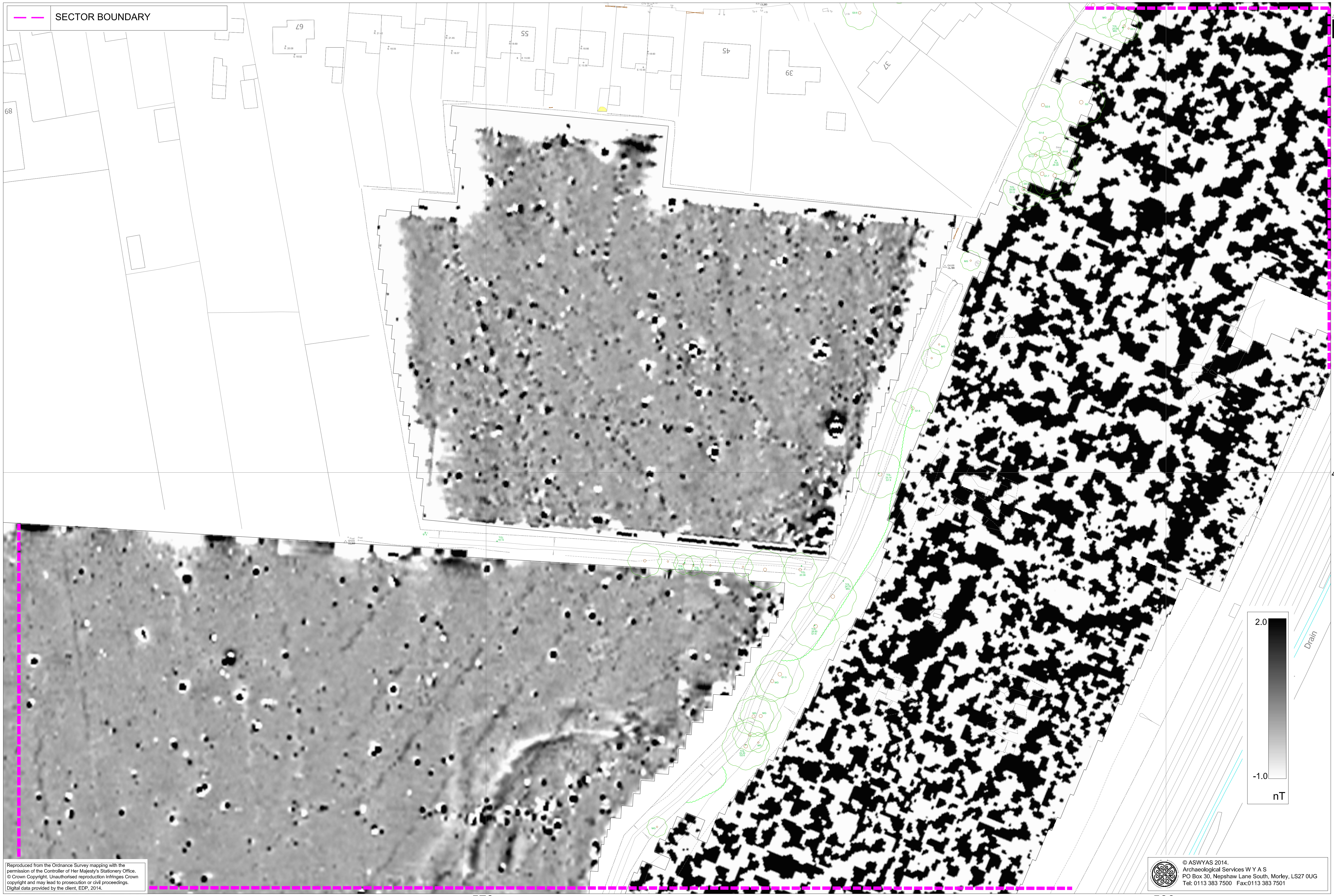


Fig. 42. Processed greyscale magnetometer data; Sector 13 (1:1000 @ A3)

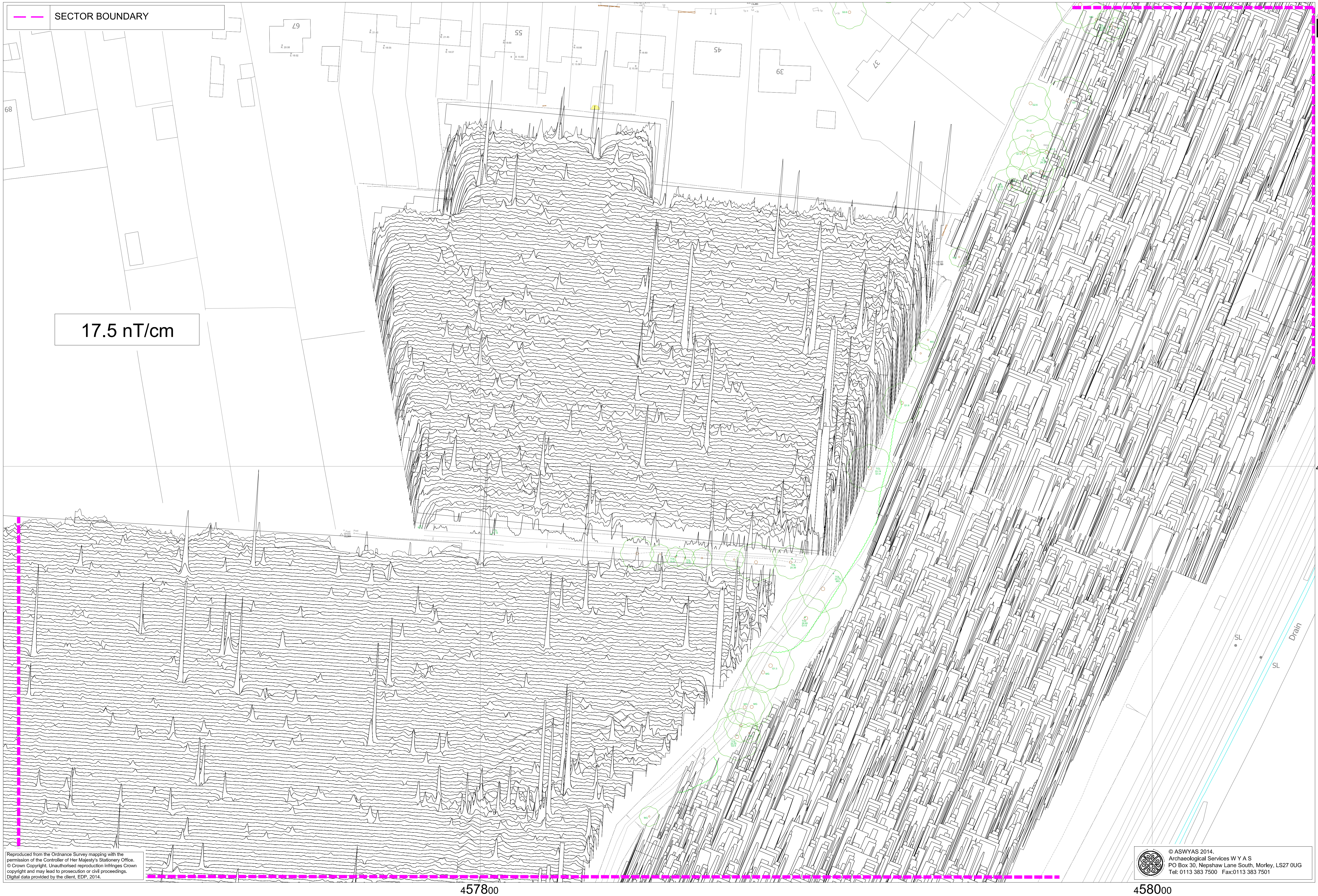


Fig. 43. XY trace plot of minimally processed magnetometer data; Sector 13 (1:1000 @ A3)

Fig. 44. Interpretation of magnetometer data; Sector 13 (1:1000 @ A3)

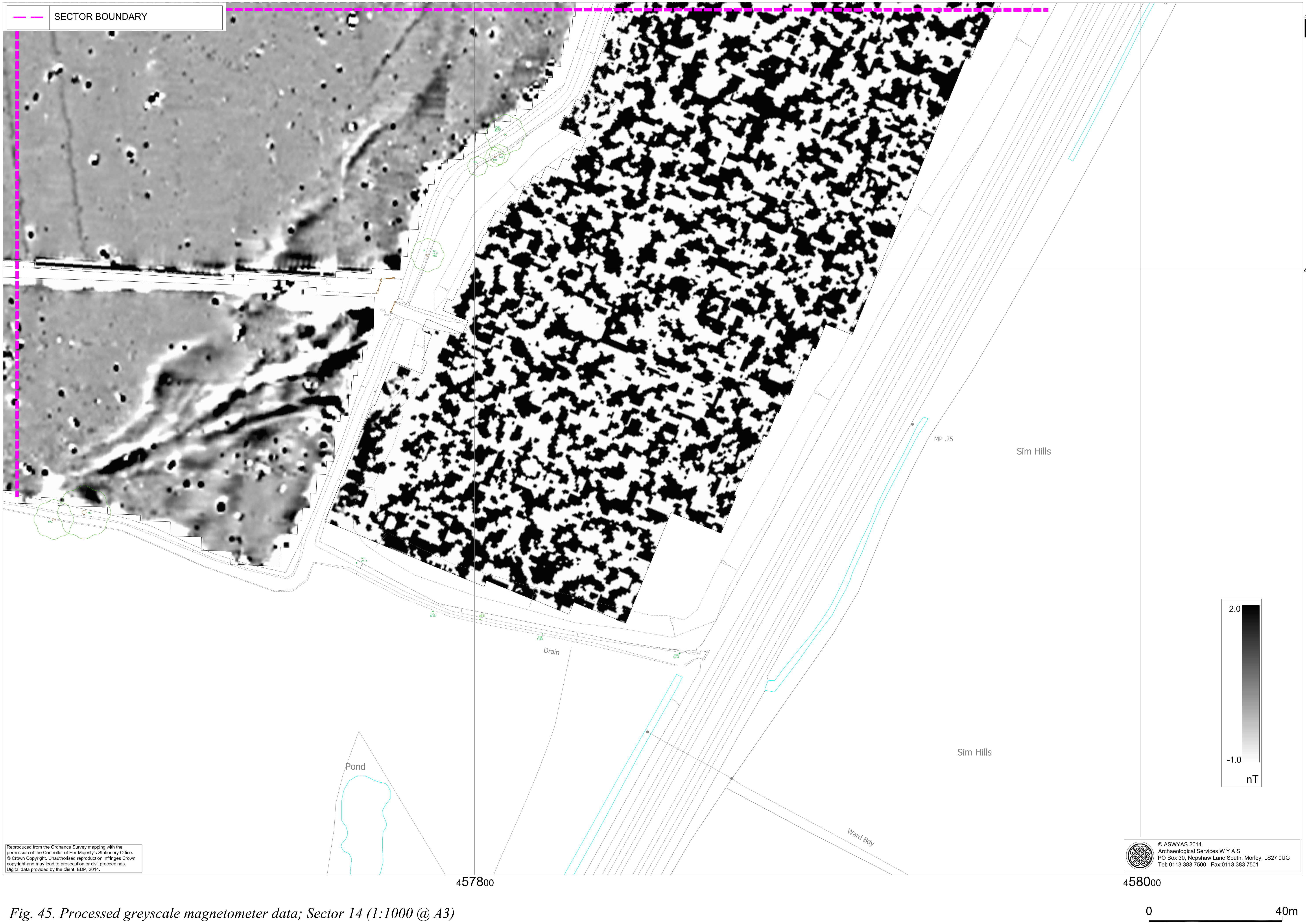


Fig. 45. Processed greyscale magnetometer data; Sector 14 (1:1000 @ A3)

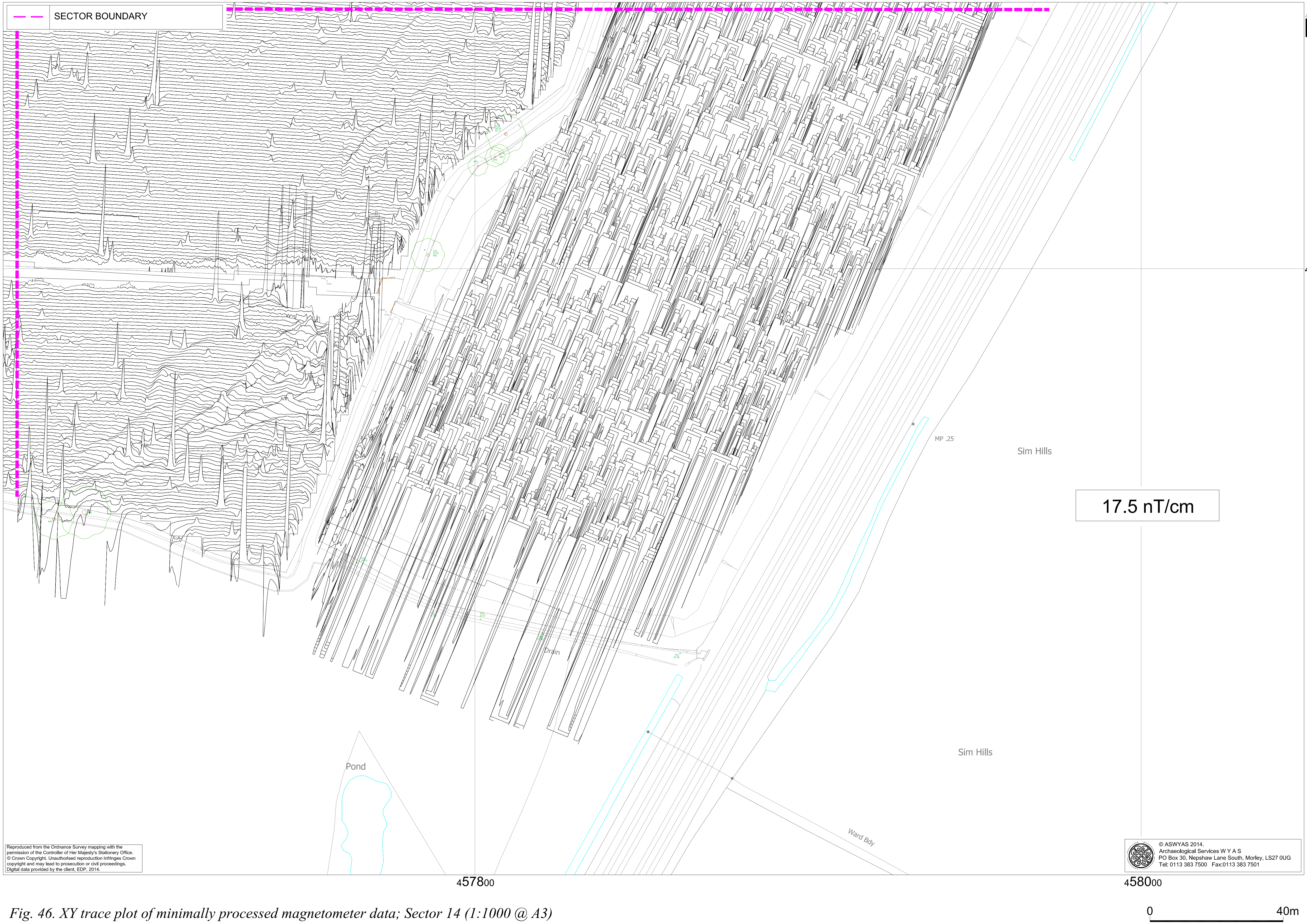
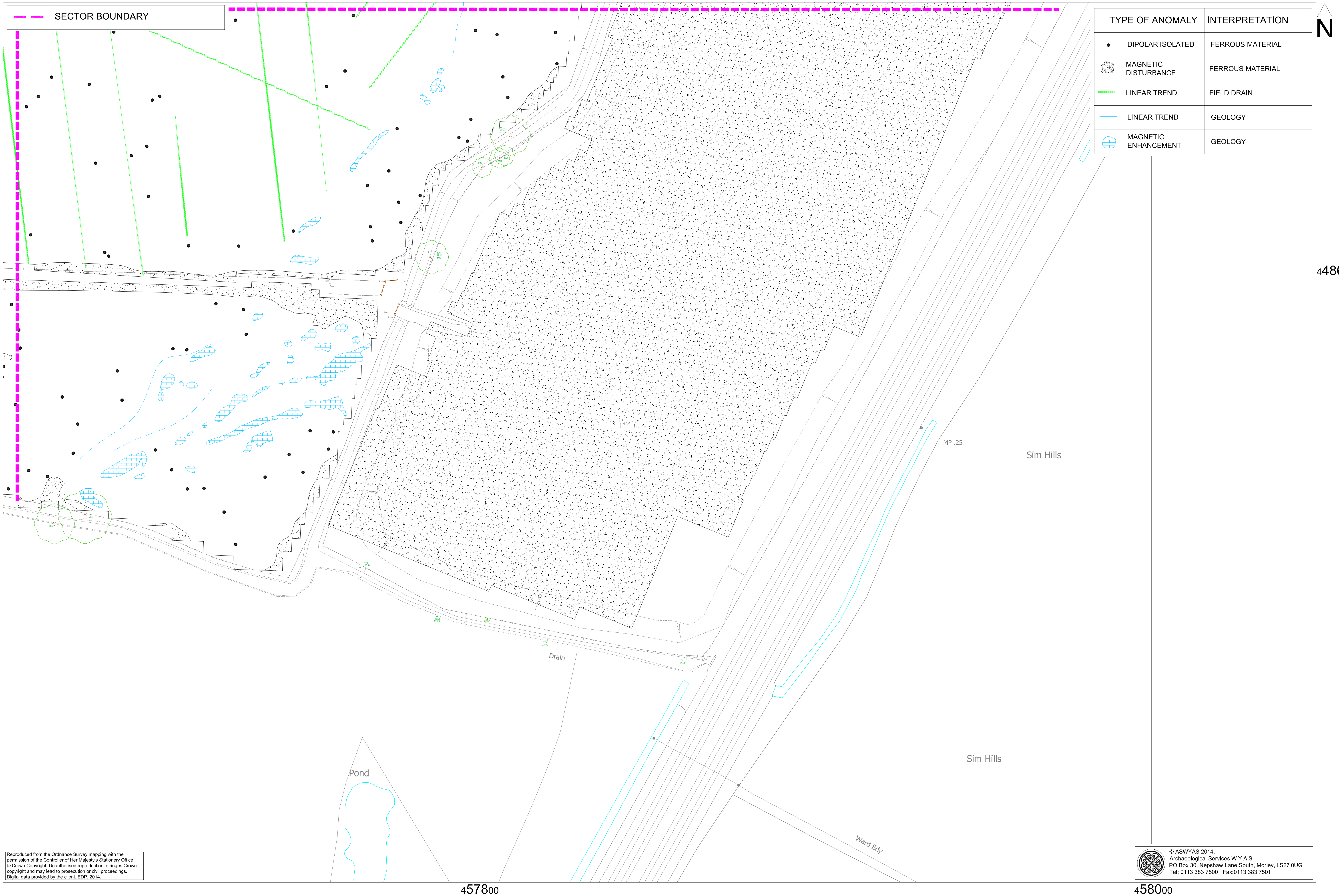


Fig. 46. XY trace plot of minimally processed magnetometer data; Sector 14 (1:1000 @ A3)



Archaeological Services W Y A S
PO Box 30, Nepshaw Lane South, Morley, LS27 0UG
Tel: 0113 383 7500 Fax:0113 383 7501

Fig. 47. Interpretation of magnetometer data; Sector 14 (1:1000 @ A3)

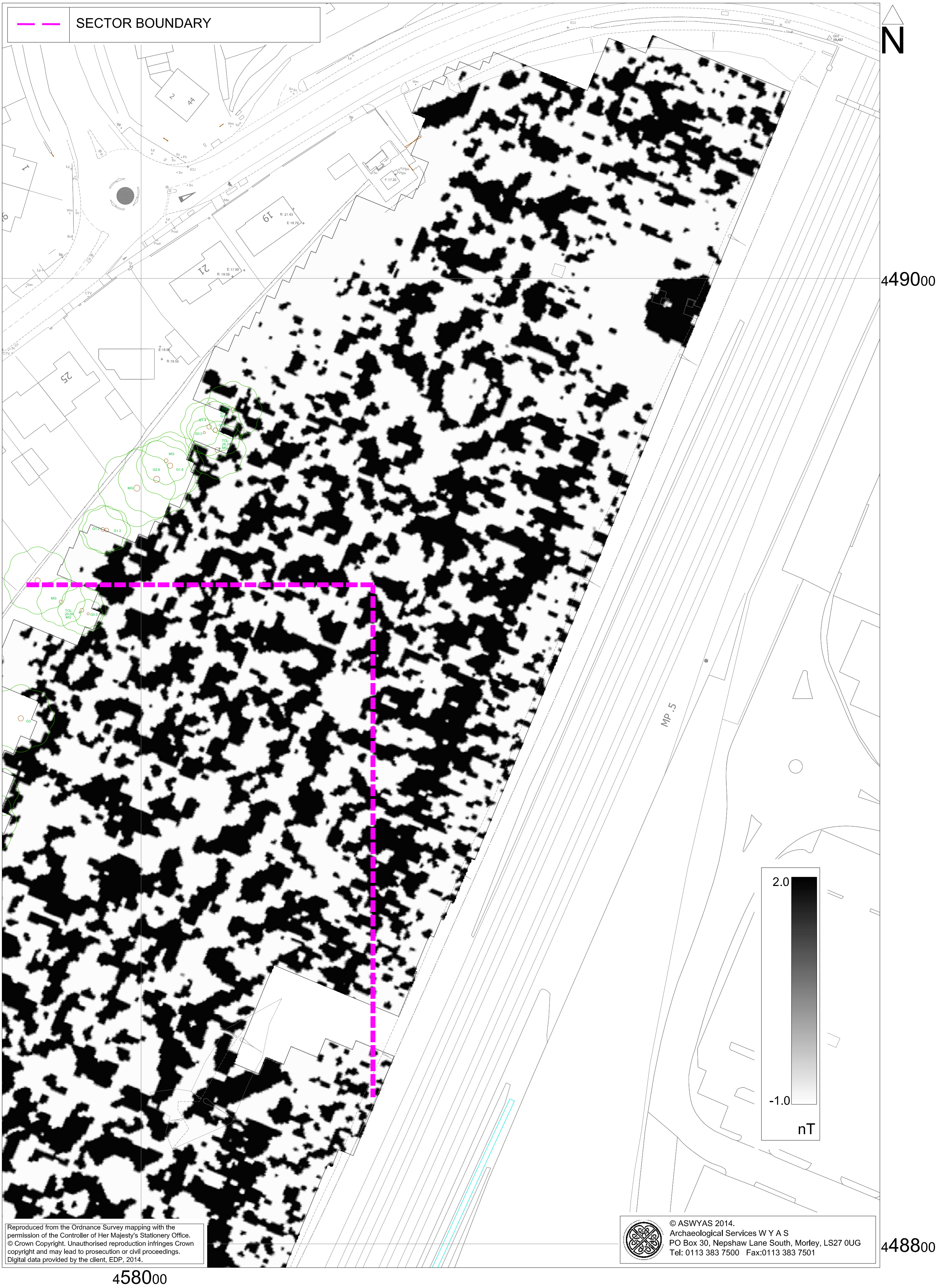


Fig. 48. Processed greyscale magnetometer data; Sector 15 (1:1000 @ A4)

0 40m

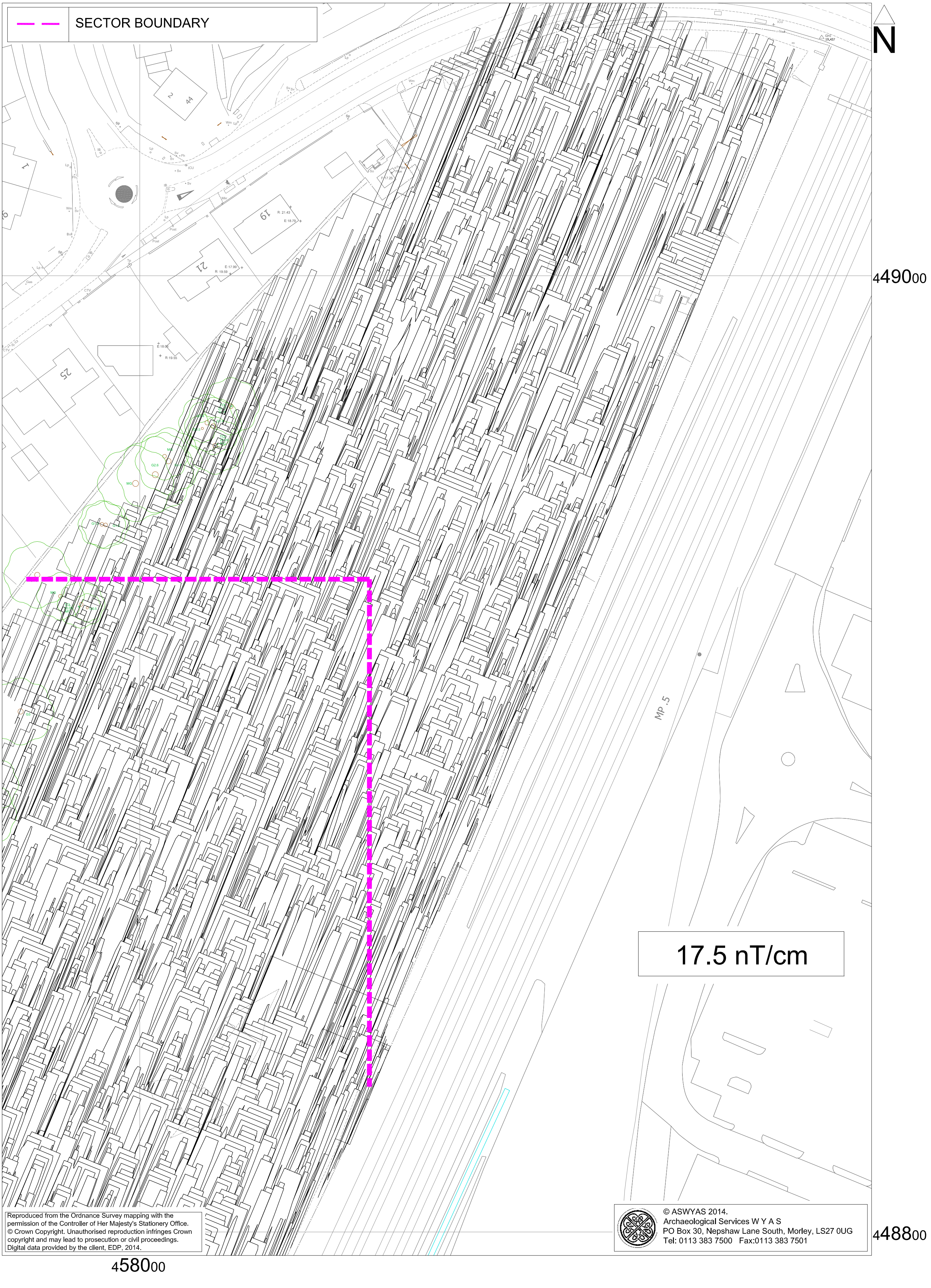


Fig. 49. XY trace plot of minimally processed magnetometer data; Sector 15 (1:1000 @ A4)

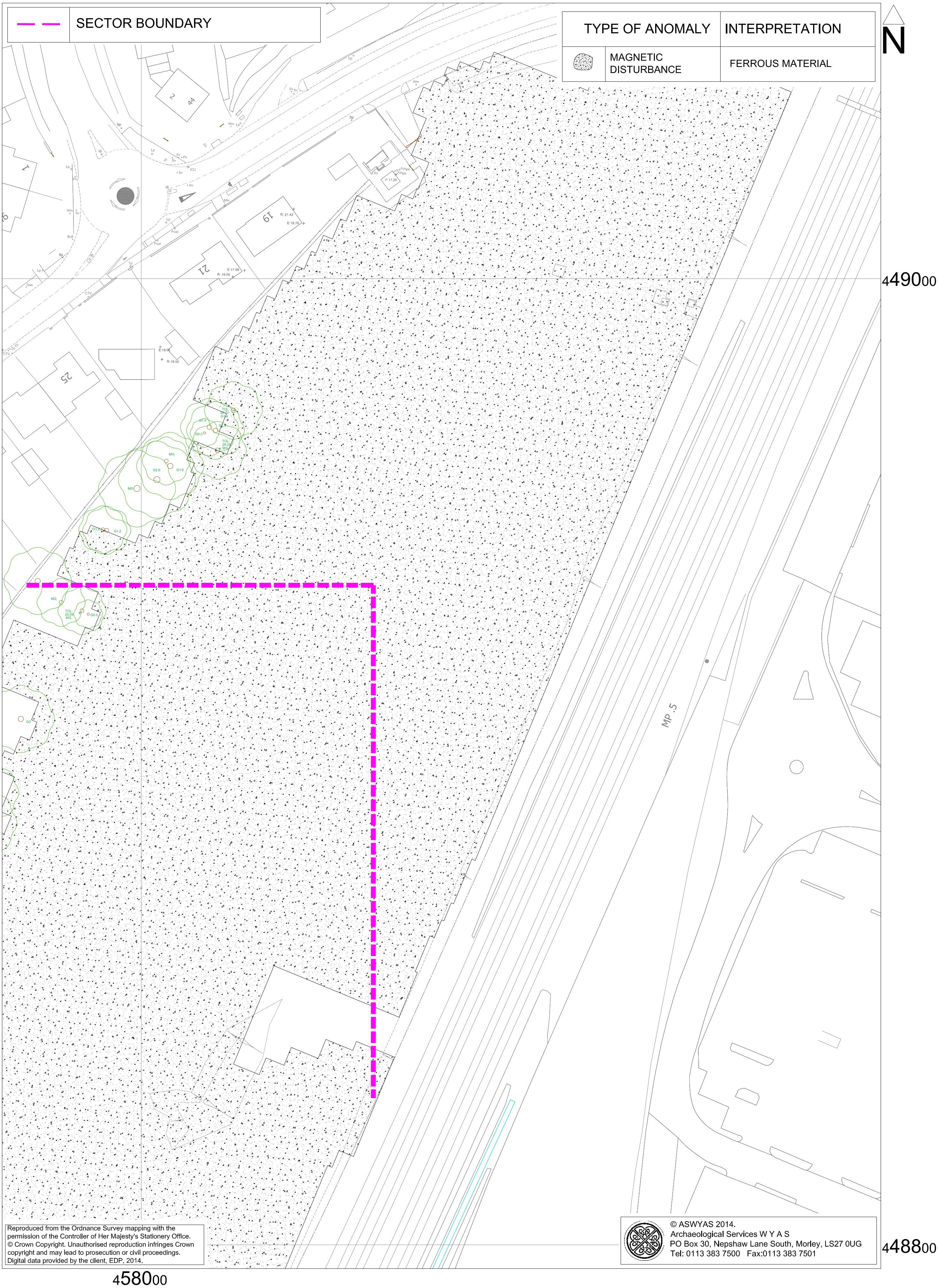


Fig. 50. Interpretation of magnetometer data; Sector 15 (1:1000 @ A4)

0 40m

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.

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 City of York Historic Environment Record).

Bibliography

British Geological Survey, 2014. www.bgs.ac.uk/discoveringGeology/geology OfBritain/viewer.html. (Viewed September 30th 2014)

Crutchley, A. 2014. *Moor Lane, York: Historic Environment and Landscape Assessment*. Unpublished EDP Client Report EDP2165_04c

David, A., N. Linford, P. Linford and L. Martin. 2008. *Geophysical Survey in Archaeological Field Evaluation: Research and Professional Services Guidelines (2nd edition)* English Heritage

Institute for Archaeologists, 2013. *Standard and Guidance for archaeological geophysical survey.* IfA

Soil Survey of England and Wales, 1983. *Soil Survey of England and Wales: Soils of Northern England*, Sheet 1

Webb, A. 2014. *Moor Lane, York: Geophysical Survey Project Design*. Unpublished Archaeological Services WYAS document