ARCHAEOLOGICAL SERVICES WYAS

Land at Monks Cross
York

Geophysical Survey

Report no. 2566

January 2014

Client: Prospect Archaeology Ltd

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Land at Monks Cross
York

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering approximately 50 hectares was carried out on agricultural land at Monks Cross, York, to inform the determination of an outline planning application for the proposed development of the site. The anomalies identified generally correspond to features depicted on the first edition Ordnance Survey map (1854) and are consistent with a 19th and 20th century agricultural landscape. No anomalies of archaeological potential have been identified. Therefore, on the basis of the geophysical survey, the site is considered to be of low archaeological potential.

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Report Information

Client:	Prospect Archaeology Ltd
Address:	Prospect House, Garden Lane, Sherburn-in-Elmet, Leeds, North Yorkshire, LS25 6AT
Report Type:	Geophysical Survey
Location:	Monks Cross, York
County:	East Yorkshire
Grid Reference:	SE 6263 5593
Period(s) of activity:	Post-Medieval?
Report Number:	2566
Project Number:	4149
Site Code:	YMC13
OASIS ID:	archaeol11-169101
Planning Application No.:	
Museum Accession No.:	n/a
Date of fieldwork:	November - December 2013
Date of report:	January 2014
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Fieldwork:	Tom Fildes BA
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Research:	n/a

Authorisation for distribution: --

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1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Nansi Rosenberg of Prospect Archaeology Ltd (The Client), to undertake a geophysical (magnetometer) survey of land at Monks Cross, York, prior to the submission of a planning application for the proposed development of the site. The work was undertaken in accordance with a Project Design (Harrison, 2013) supplied to and approved by the client, 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 November 19th and December 4th 2013 in order to provide additional information on the archaeological potential of the site.

Site location, topography and land-use

The Proposed Development Area (PDA) is situated on the north-eastern periphery of York, immediately north of Monks Cross Shopping Centre, centred at SE 6263 5593. The PDA comprises an irregularly-shaped parcel of land over 34 fields which is bound to the south by Monks Cross Shopping Centre, by Monks Cross Link Road to the east, by the A1237 to the north-east and by residential properties to the west. North Lane runs through the north of the PDA (see Fig. 2). Topographically, the site is flat, being at between 16m and 18m above Ordnance Datum (aOD). Generally, the land was either under pasture or cereal crop at the time of survey although overgrown areas, horse paddocks, farm buildings and infrastructure and areas of flooding restricted survey within several areas (see plates). These areas are shown on Figure 2.

Soils and geology

The underlying bedrock comprises Sherwood Sandstone Group. The solid geology is overlain by clay and silt superficial deposits of the Alne Glaciolacustrine Formation and Sutton Sand Formation (British Geological Survey 2014).

The soils in this area are classified in the Wigton Moor and Foggathorpe 2 associations, characterised as slowly permeable, seasonally waterlogged clays and fine loams (Soil Survey of England and Wales 1983).

2 Archaeological Background

No detailed archaeological background is available at the time of writing, although it is understood that there is very limited known archaeology on the site or its immediate environs. Some of the fields within the PDA remain as shown on the first edition Ordinance Survey (1854) and are in strips indicating that they are part of a strip field system of possible medieval or post-medieval origin. Extant earthworks indicative of ridge and furrow cultivation survive within some of these fields.

Farmsteads at Stockton Moor West and New Earswick are close to the survey area and have been identified as Roman in date. These farmsteads may be associated, based on aerial photographs, with a temporary Roman encampment, approximately 1 kilometre to the south of the survey area.

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 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, an area of 50 hectares.

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 (1:5000) location plan displaying the processed magnetic data. Figure 3 shows the first edition Ordnance Survey map (1854) at the same scale and includes field names and plate location information. Figure 4 is an overall data interpretation plot, also at 1:5000. Detailed data plots (‘raw’ and processed) and full interpretative figures are presented at a scale of 1:1000 in Figures 5 to 25 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 2013) 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 5 to 25 inclusive)

Generally, a low level of background variation has been recorded across the PDA, as is often the case on sandstone geologies, particularly those overlain with sand and gravel-based superficial deposits. Nevertheless, numerous anomalies have been identified by the survey. These fall into a number of different types and categories according to their origin and these are discussed below and cross-referenced to specific examples and locations within the site.

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.

A high magnitude dipolar linear anomaly, **A**, skirting along the north-eastern edges of Fields 8 and 19 (see Figs 8, 9 and 10), is caused by a sub-surface service pipe. Another service pipe, **B**, has been identified within the east of Field 12, orientated north/south and aligned towards some stables within the north of the field (see Figs 11, 12 and 13). Towards the south of the PDA a high magnitude linear anomaly, **C**, can be seen traversing the north of Fields 33 and 34 and the western perimeters of Fields 32 and 26 (see Figs 17, 18 and 19 and Figs 23, 24 and 25). This anomaly is also thought to be due to a buried service pipe.

Areas of disturbance around the periphery of the PDA are due to ferrous material forming part of, or incorporated into, the adjacent field boundaries. Broader areas of magnetic disturbance are due to spreads of ferrous material within the topsoil and, within the south of Fields 15 and 25, the close proximity of farm buildings (e.g. see Plate 9).

Modern Anomalies

Several anomalies have been identified by the survey which correspond to features depicted on the first edition Ordnance Survey map of 1854 (see Fig. 3). The most obvious of these are the high magnitude linear anomalies, **D**, extending from the south of Field 33 in a north-easterly direction through Field 32 (see Figs 17 to 25 inclusive). These anomalies correspond to the course of a dismantled railway and are thought to be due to magnetic material within the railway foundations.

A number of rectangular features depicted on the historical mapping manifest in the data as broad high magnitude anomalies; **E**, **F**, **G** (see Figs 14, 15 and 16) and **H** (see Figs 23, 24 and 25). These are thought to indicate former sheds and/or stables as are depicted in the surrounding landscape on the first edition map. The anomalies are thought to be caused by the presence of buried magnetic demolition material. The high magnitude anomaly, **I**, within the east of Field 32 (see Figs 23, 24 and 25) appears to correspond to a former pond. In this instance, the anomaly is due to the magnetic material used to backfill the pond. Within the south of Fields 7 and 8 a fragmented linear anomaly, **J**, can be seen running parallel to North Lane (see Figs 8, 9 and 10). This anomaly, thought to indicate a boundary ditch, corresponds to the northern extent of a linear feature annotated on the first edition map as ‘The Poor’s Gardens’. Several discrete anomalies to the south of the ditch have been interpreted and are likely to be due to variations in the composition of the soils within the plough-damaged ‘garden’ or allotment remains.

Agricultural Anomalies

Historical mapping shows that the division and layout of fields within the PDA has remained largely unchanged since the publication of the first edition map in 1854. However, Fields 8, 19, 25, 30 and 32 – 34 have been increased in size by the removal of a number of field boundaries. Some of these former boundaries have not been detected by the magnetometer survey, and those that have are generally only visible as weak, low magnitude linear anomalies **K – R**. The anomalies are caused by magnetic backfill material in the ditch of the former boundary. The boundaries that do not manifest as magnetic anomalies may have been ploughed out or have been backfilled with material with similar magnetic characteristics to the surrounding soil.

Throughout the site a number of parallel linear trend anomalies have been identified. The slightly curving, trends are due to the medieval and post-medieval agricultural practice of ridge and furrow cultivation. The anomalies are due to the magnetic contrast between the now soil-filled furrows and the former ridges.

Parallel linear trend anomalies within Fields 10, 20, 30, 31, 33 and 34 are speckled in appearance - a characteristic typical of field drains.

Geological anomalies

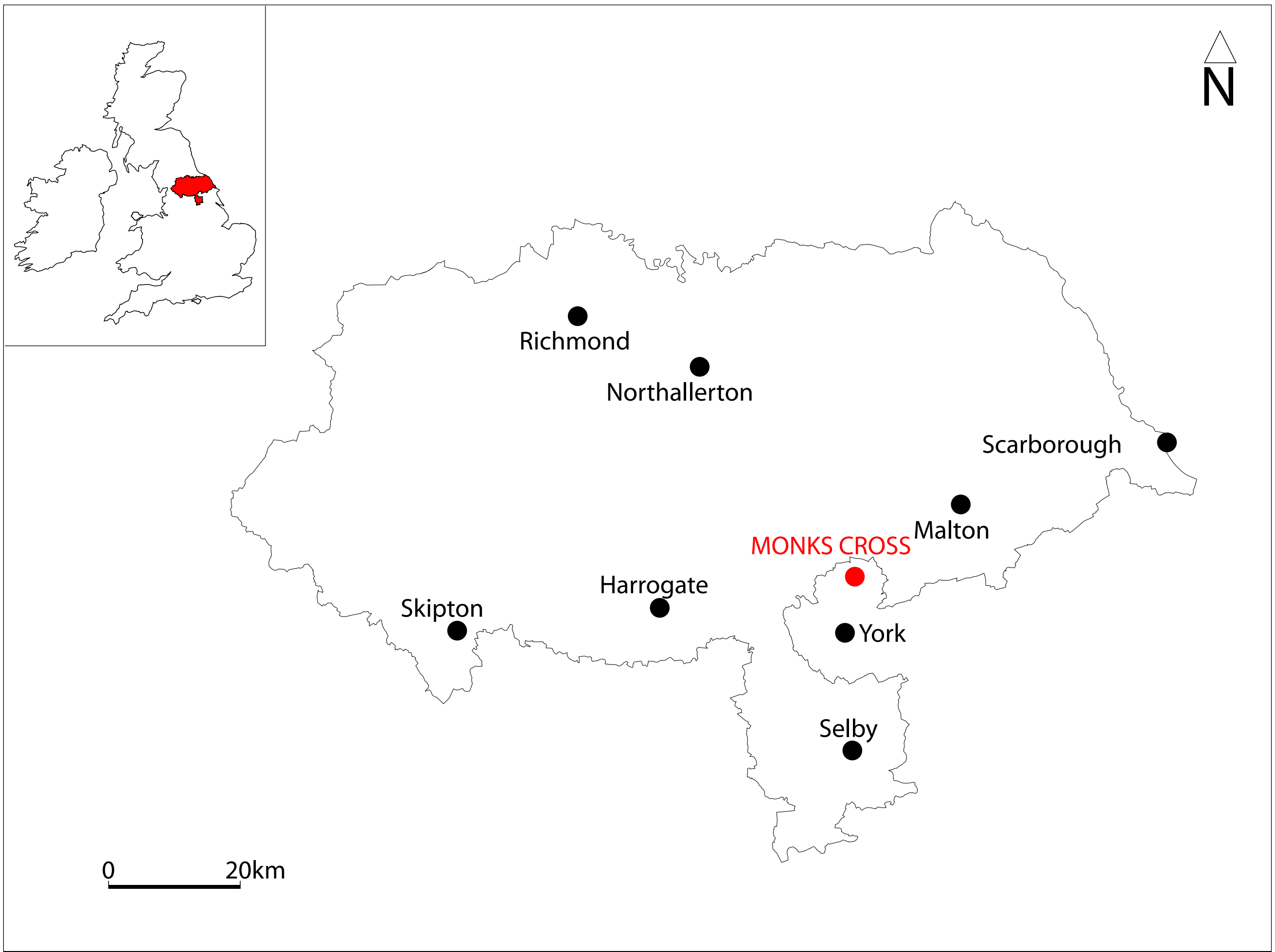
As discussed above, a low level of background variation has been recorded throughout the PDA. This is likely to result form the homogenous properties of the prevailing sandstone geology. Few anomalies have been interpreted as geological in origin. Those that have are thought to be due to variation in the upper soil horizons, possibly as a result of silting or seasonal waterlogging.

5 Conclusions

No anomalies of archaeological potential have been identified by the geophysical survey. The majority of the anomalies identified are consistent with the 19th century agricultural landscape as depicted on the first edition Ordnance Survey map, and therefore, a post-medieval origin is probable. Some of these anomalies may be of local historical interest but are not thought to be of any archaeological significance. Three buried service pipes have been mapped and the only other anomalies identified by the survey are the ubiquitous ferrous ‘spikes’ in the data and areas of magnetic disturbance caused by ferrous material within perimeter fences and adjacent buildings.

Therefore, on the basis of the geophysical survey, the archaeological potential of the site is considered to be low.

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



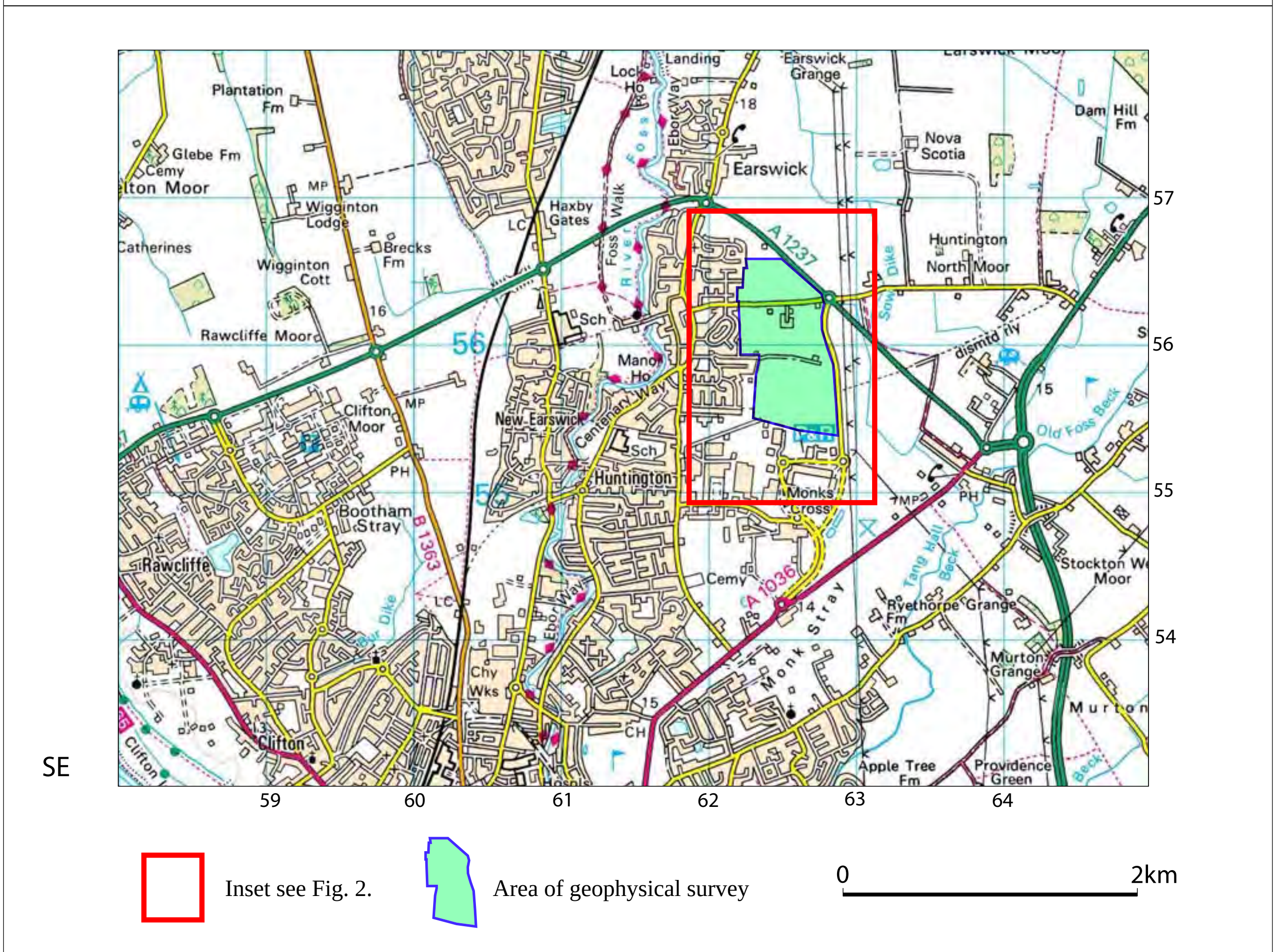


Fig. 1. Site location

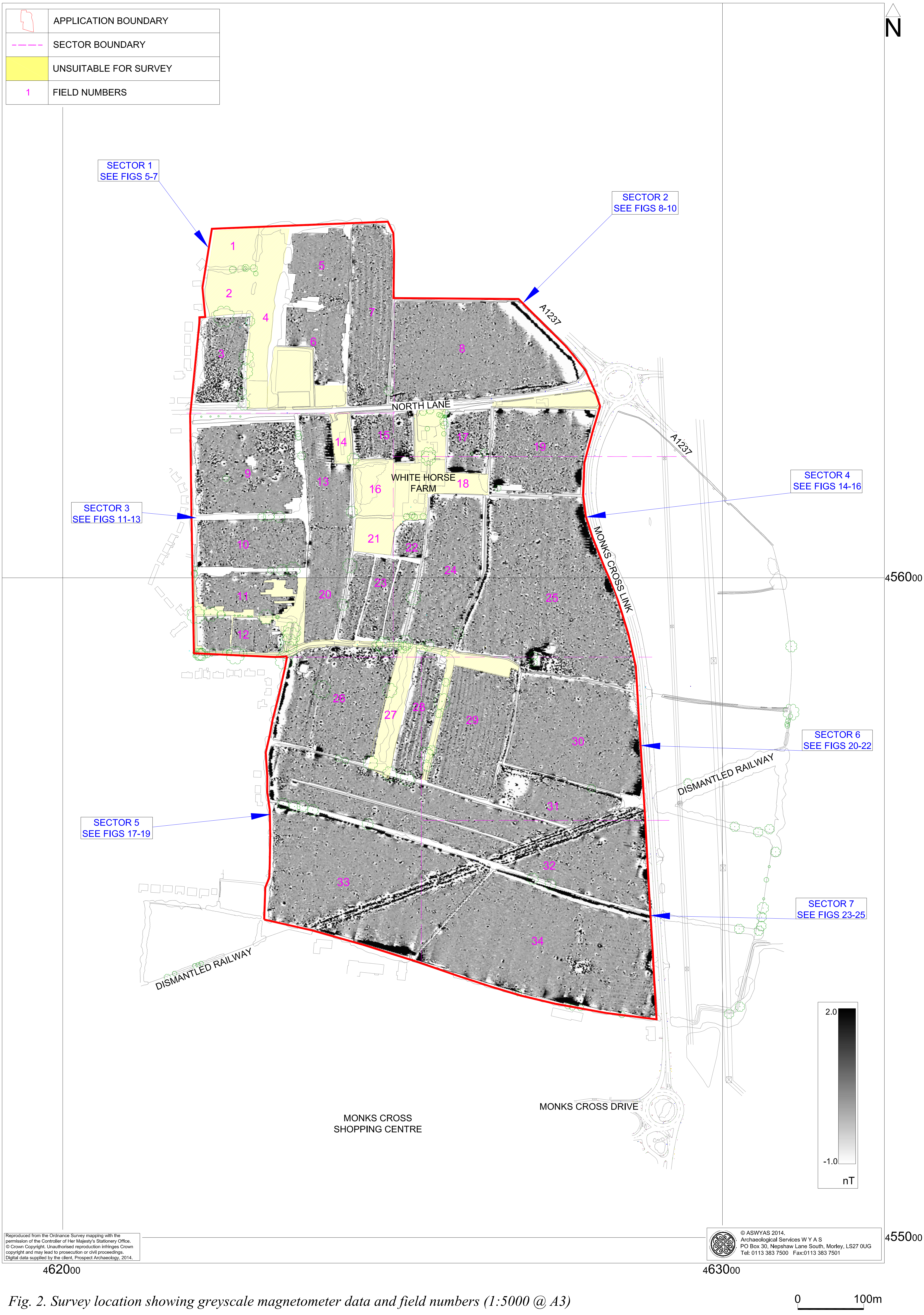


Fig. 2. Survey location showing greyscale magnetometer data and field numbers (1:5000 @ A3)

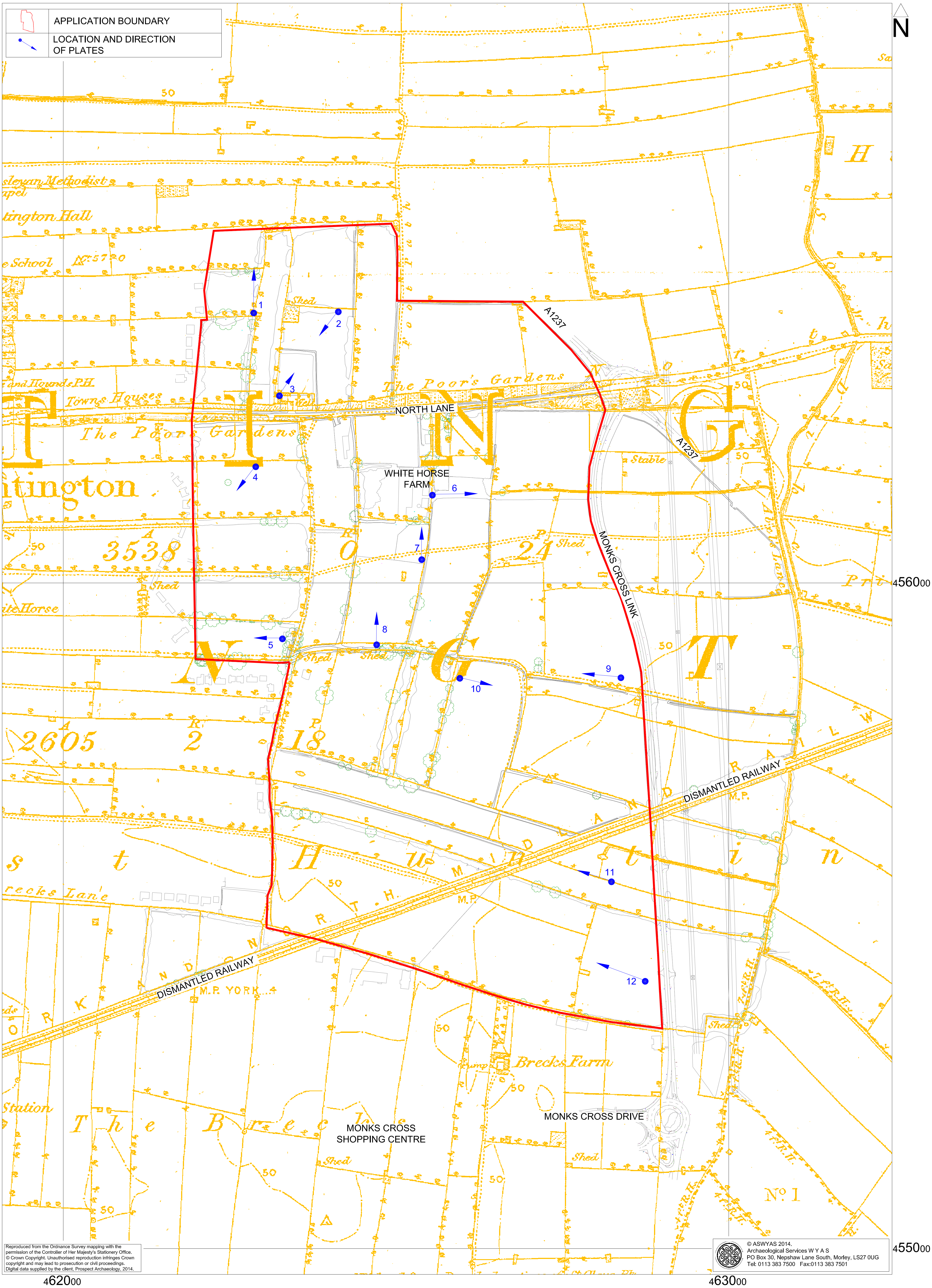


Fig. 3. Plan of the first edition Ordnance Survey mapping of 1854 showing plate locations (1:5000 @ A3)

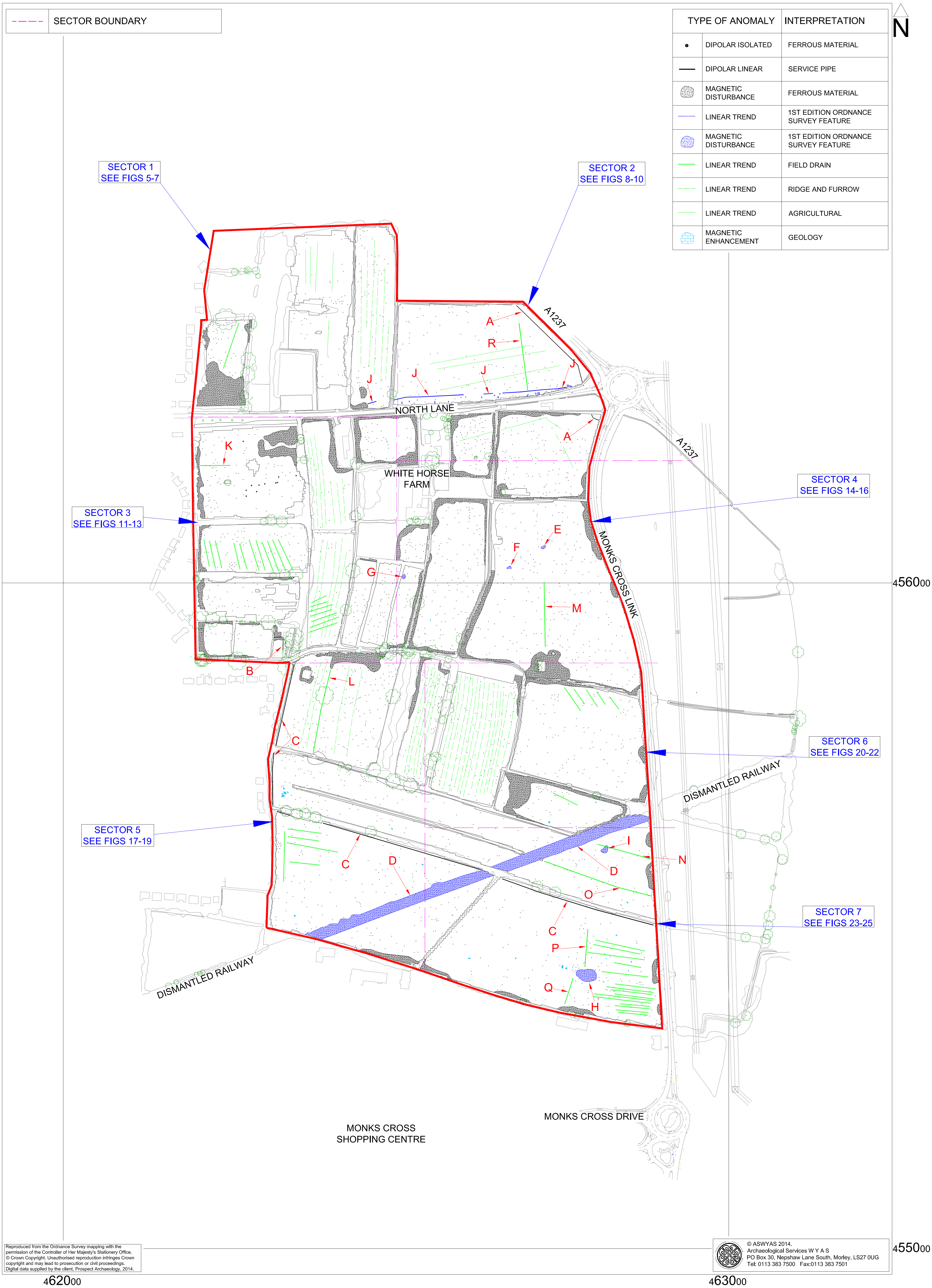


Fig. 4. Overall interpretation of magnetometer data (1:5000 @ A3)

0 100m

Fig. 5. Processed greyscale magnetometer data; Sector 1 (1:1250 @ A3)

0 20m

Fig. 6. XY trace plot of minimally processed magnetometer data; Sector 1 (1:1250 @ A3)

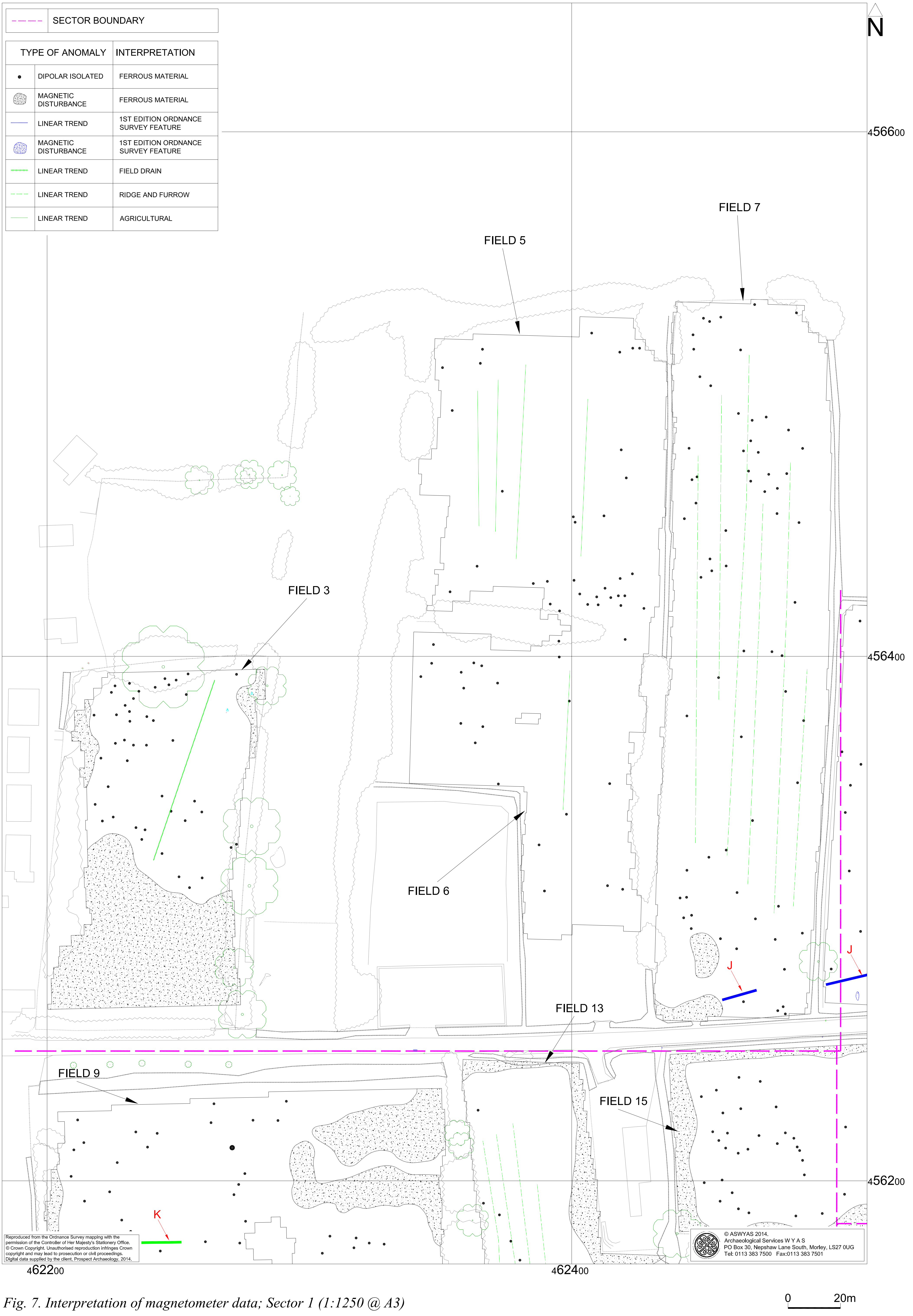


Fig. 7. Interpretation of magnetometer data; Sector 1 (1:1250 @ A3)

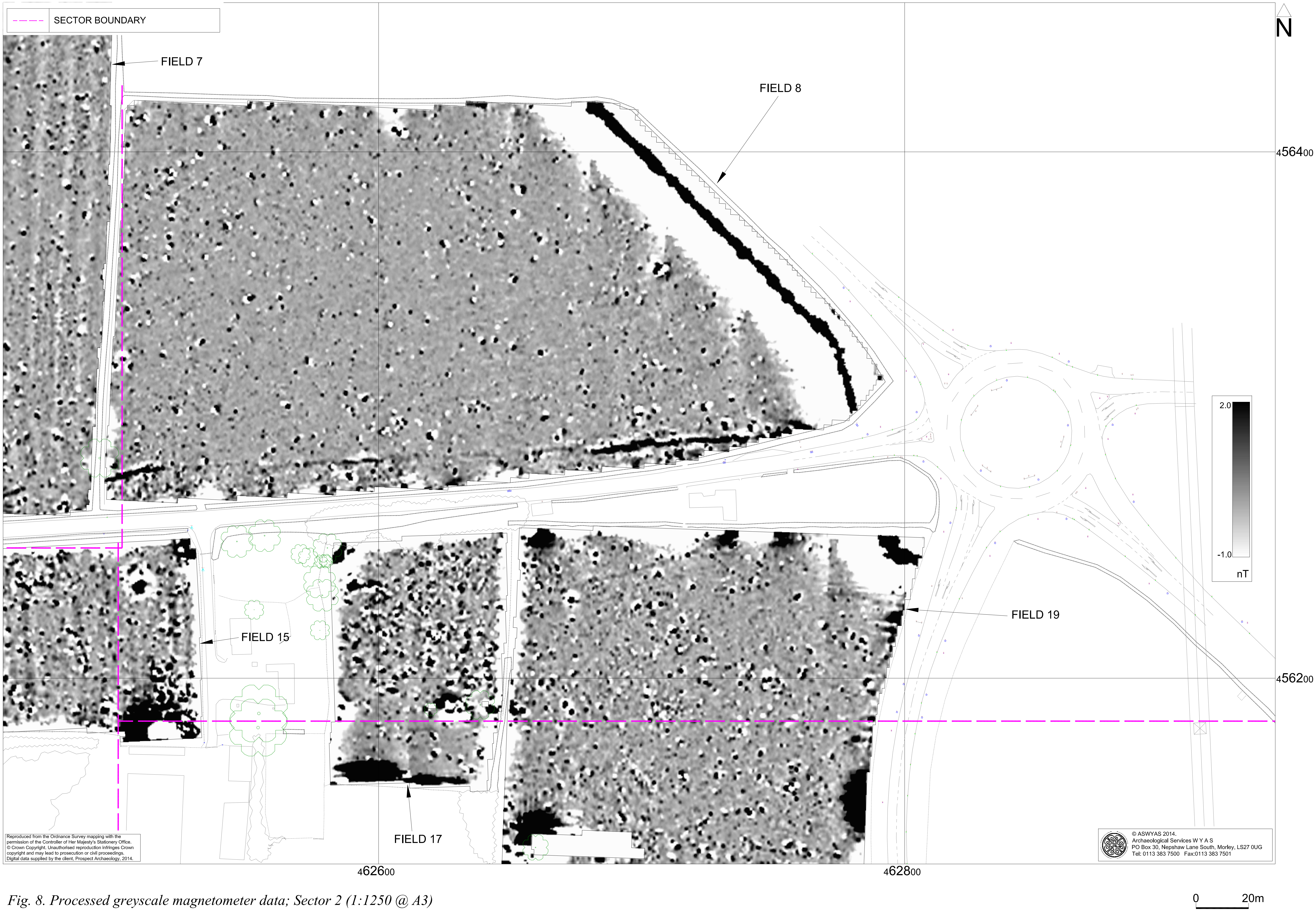


Fig. 8. Processed greyscale magnetometer data; Sector 2 (1:1250 @ A3)

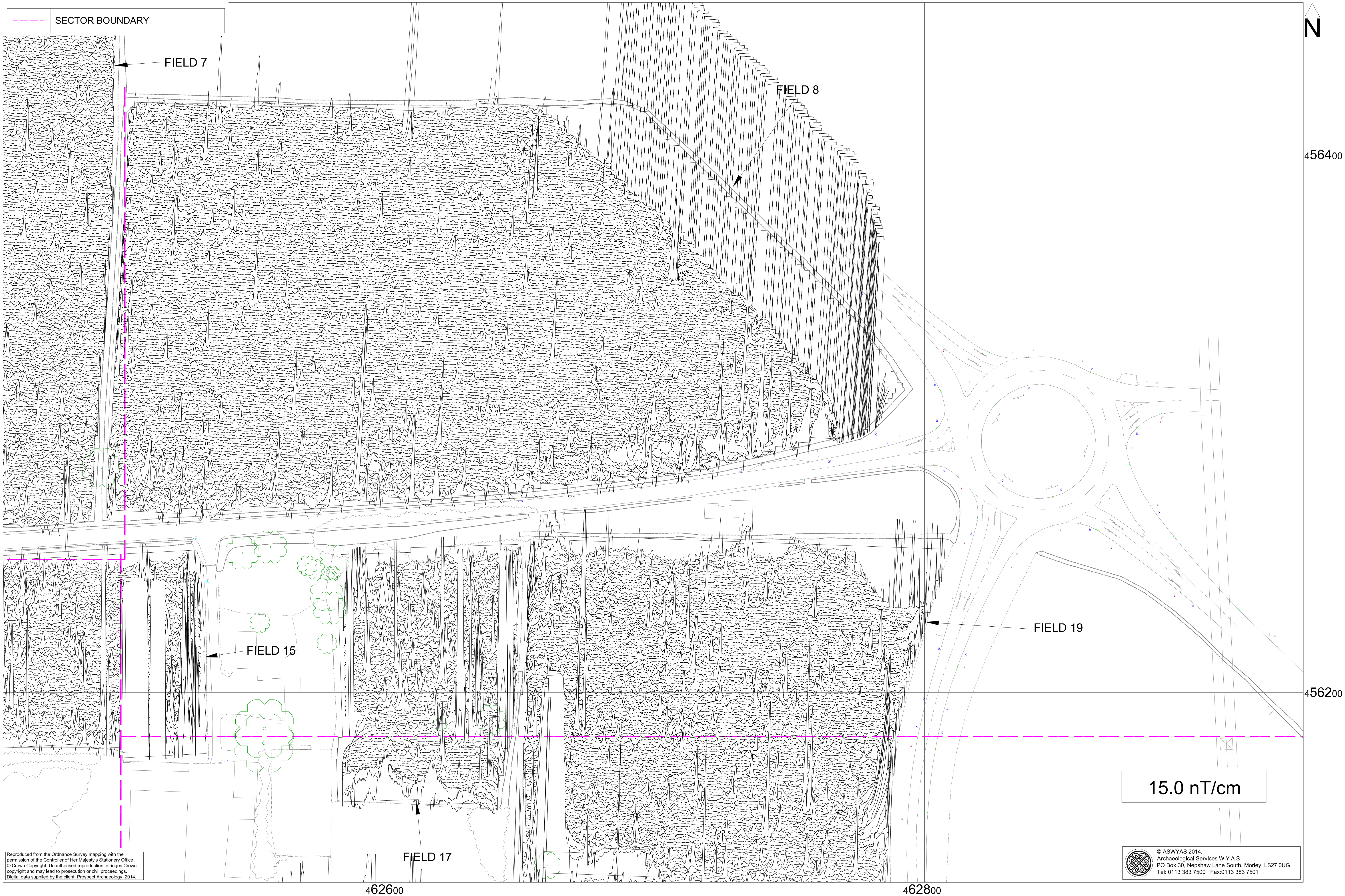


Fig. 9. XY trace plot of minimally processed magnetometer data; Sector 2 (1:1250 @ A3)

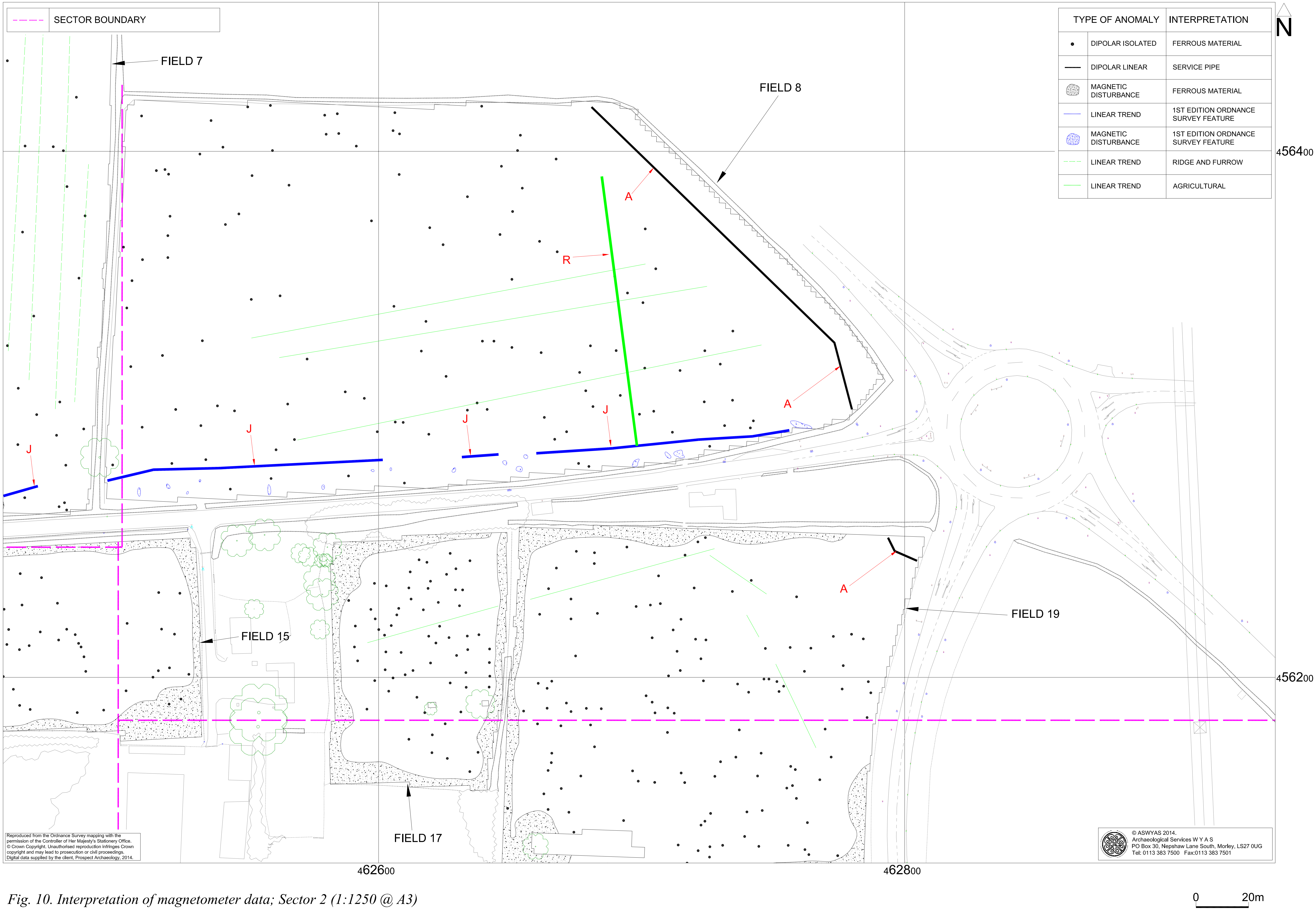


Fig. 10. Interpretation of magnetometer data; Sector 2 (1:1250 @ A3)

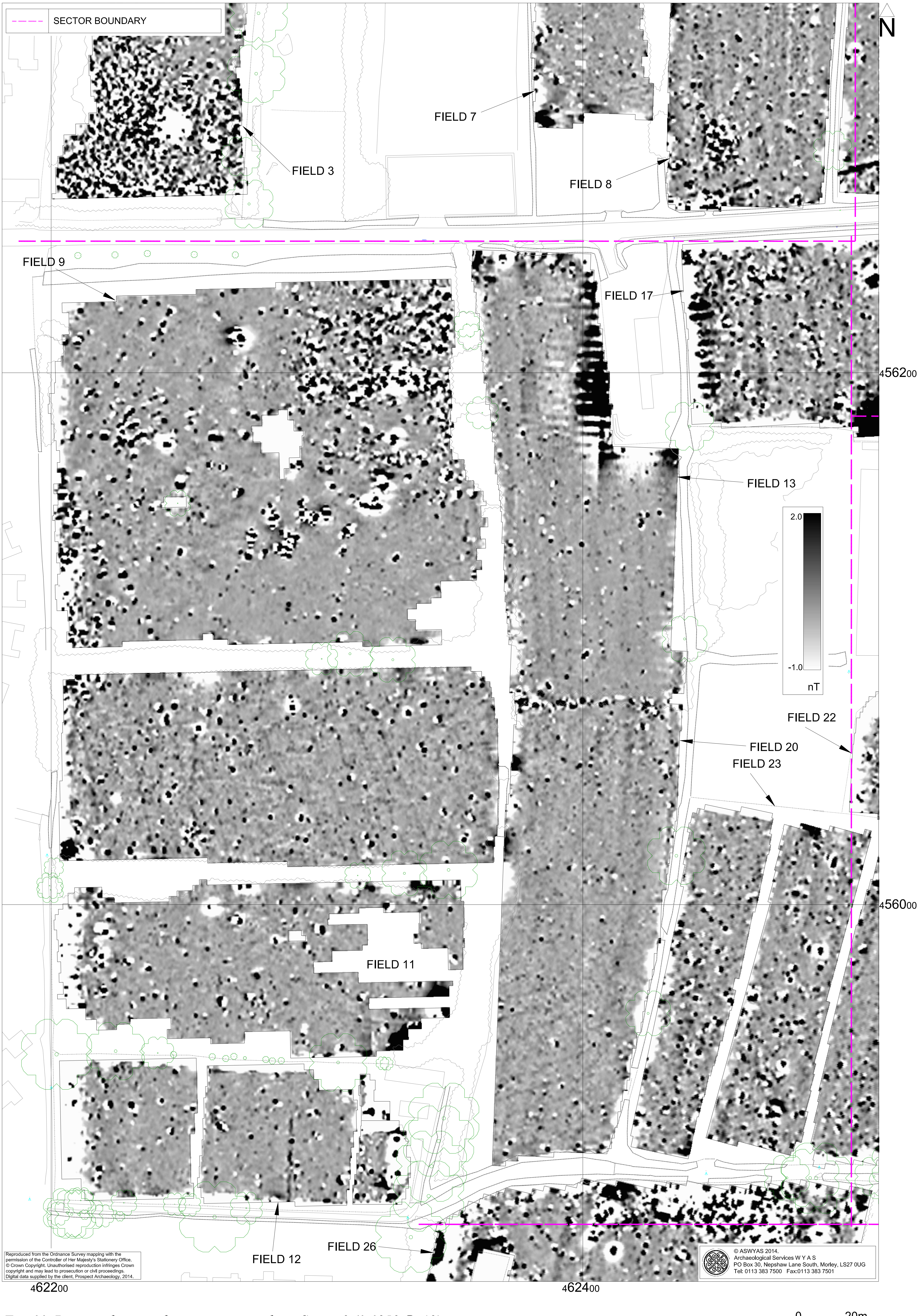


Fig. 11. Processed greyscale magnetometer data; Sector 3 (1:1250 @ A3)

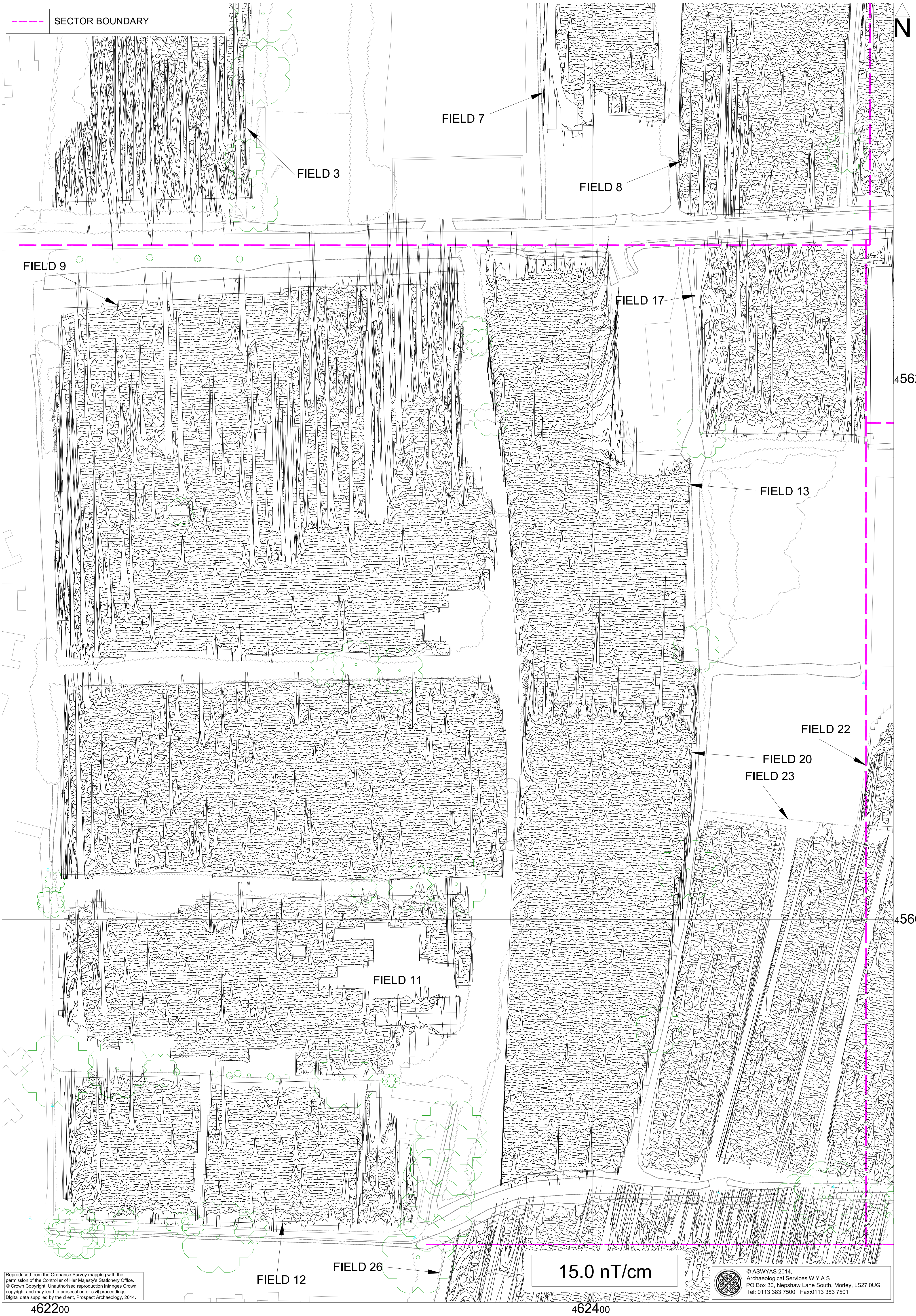


Fig. 12. XY trace plot of minimally processed magnetometer data; Sector 3 (1:1250 @ A3)

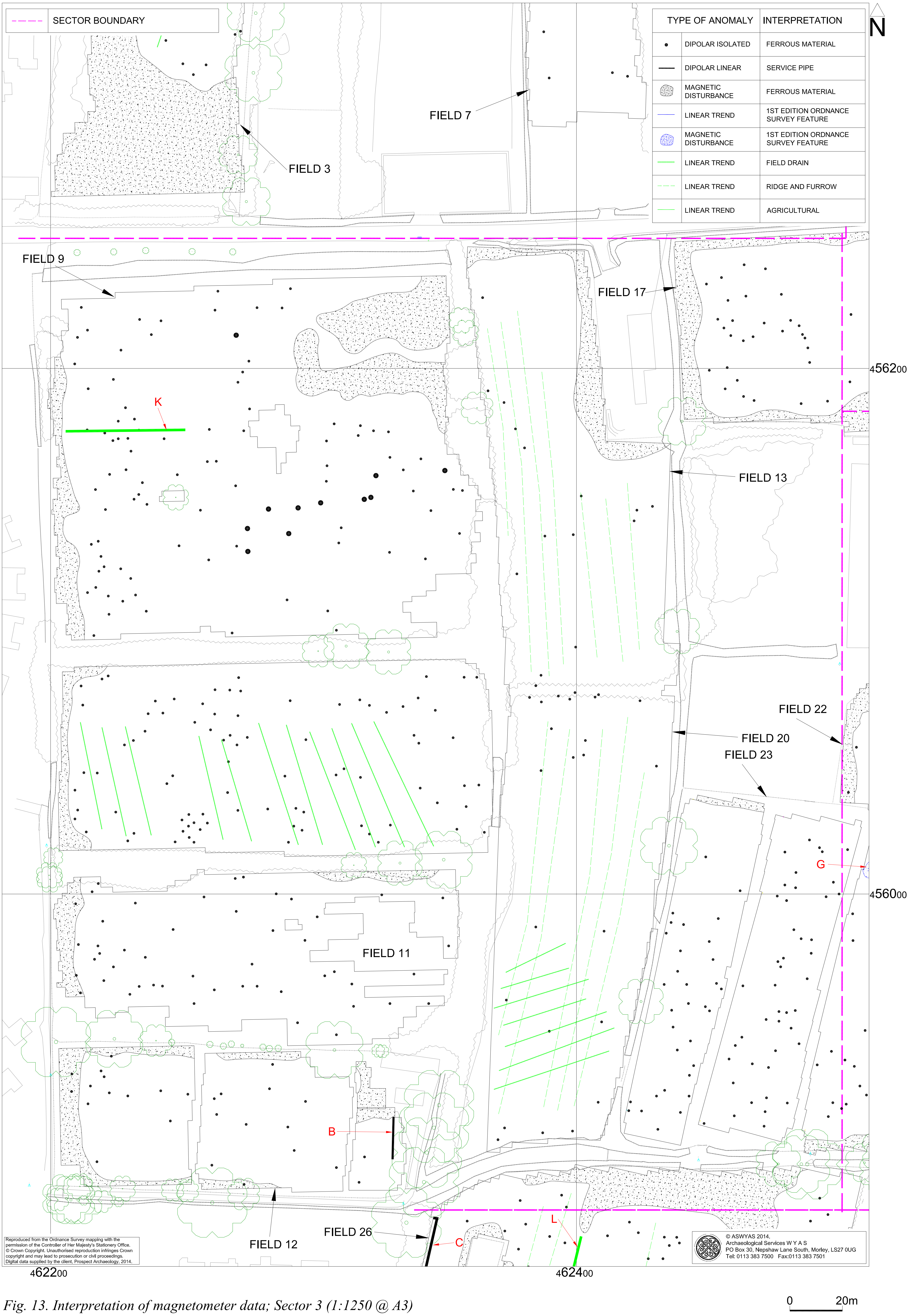


Fig. 13. Interpretation of magnetometer data; Sector 3 (1:1250 @ A3)

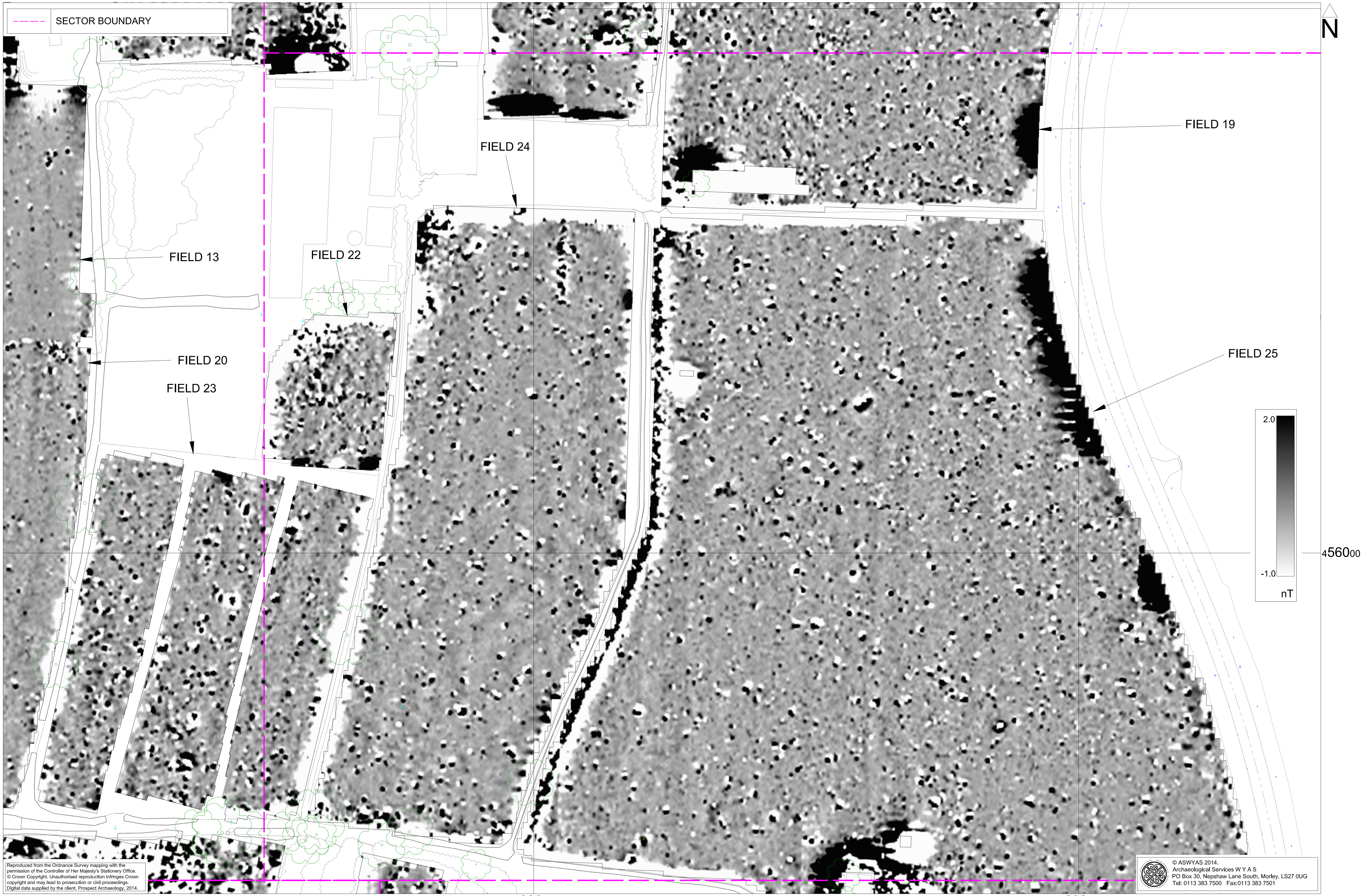


Fig. 14. Processed greyscale magnetometer data; Sector 4 (1:1250 @ A3)

0 20m

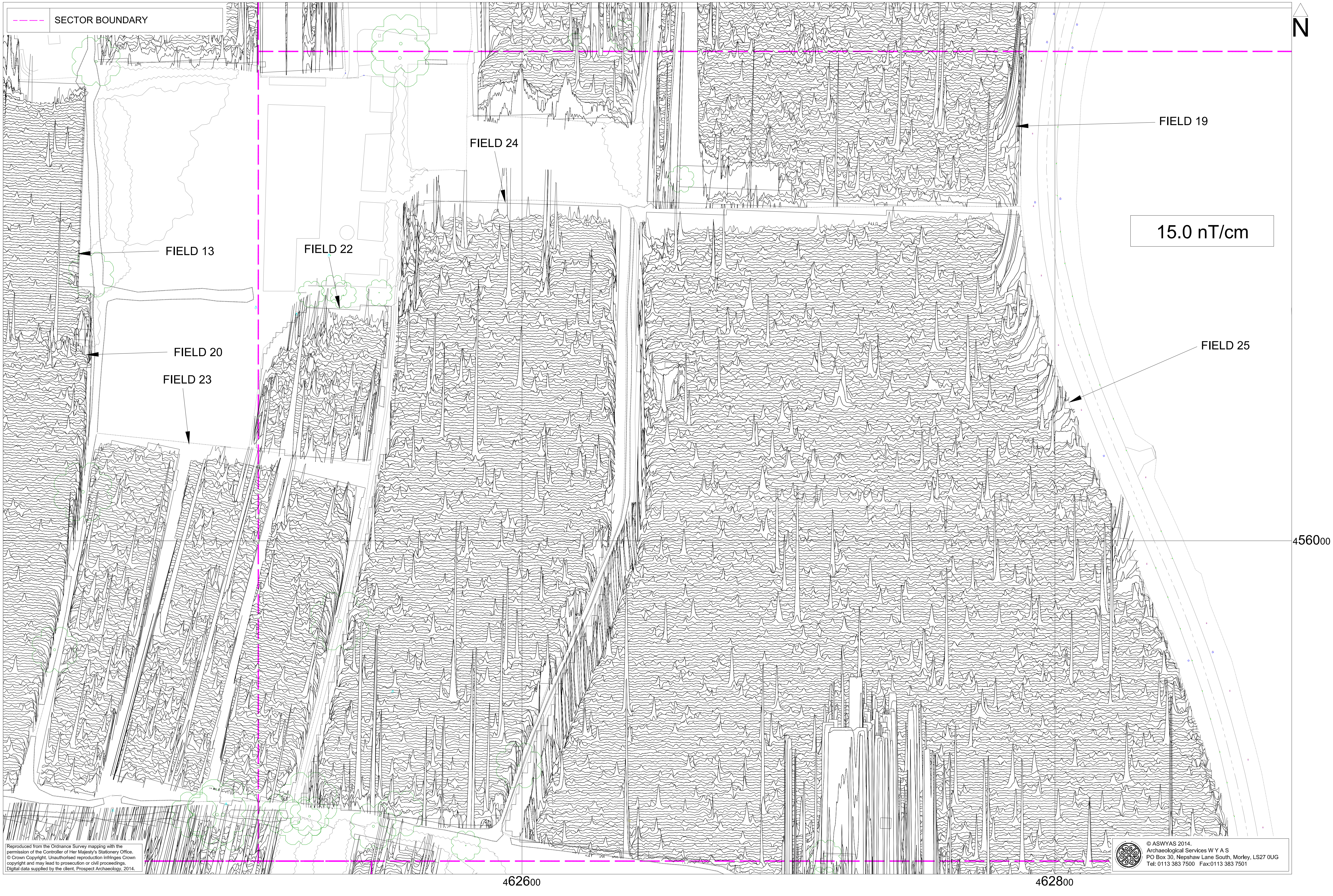


Fig. 15. XY trace plot of minimally processed magnetometer data; Sector 4 (1:1250 @ A3)

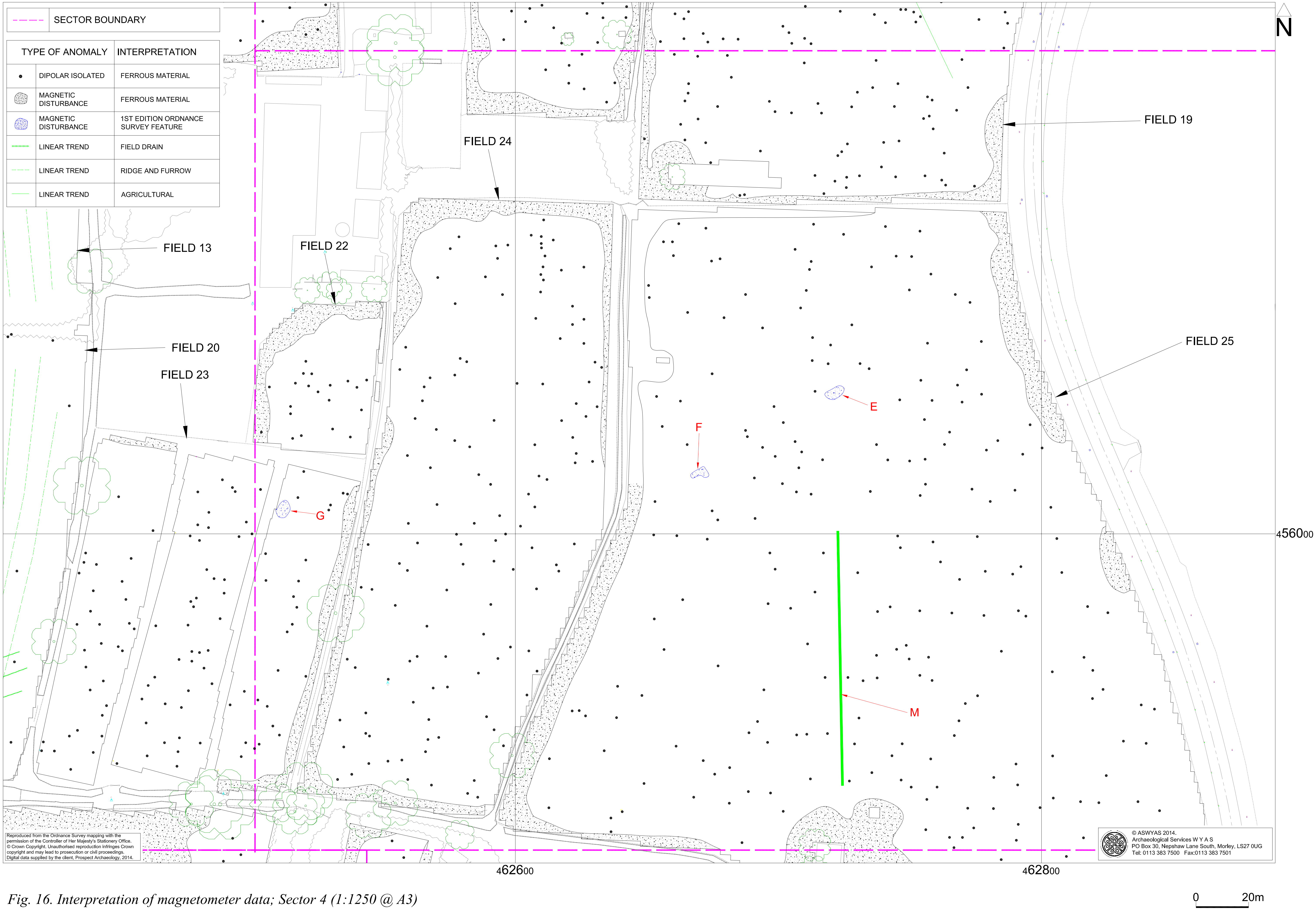


Fig. 16. Interpretation of magnetometer data; Sector 4 (1:1250 @ A3)

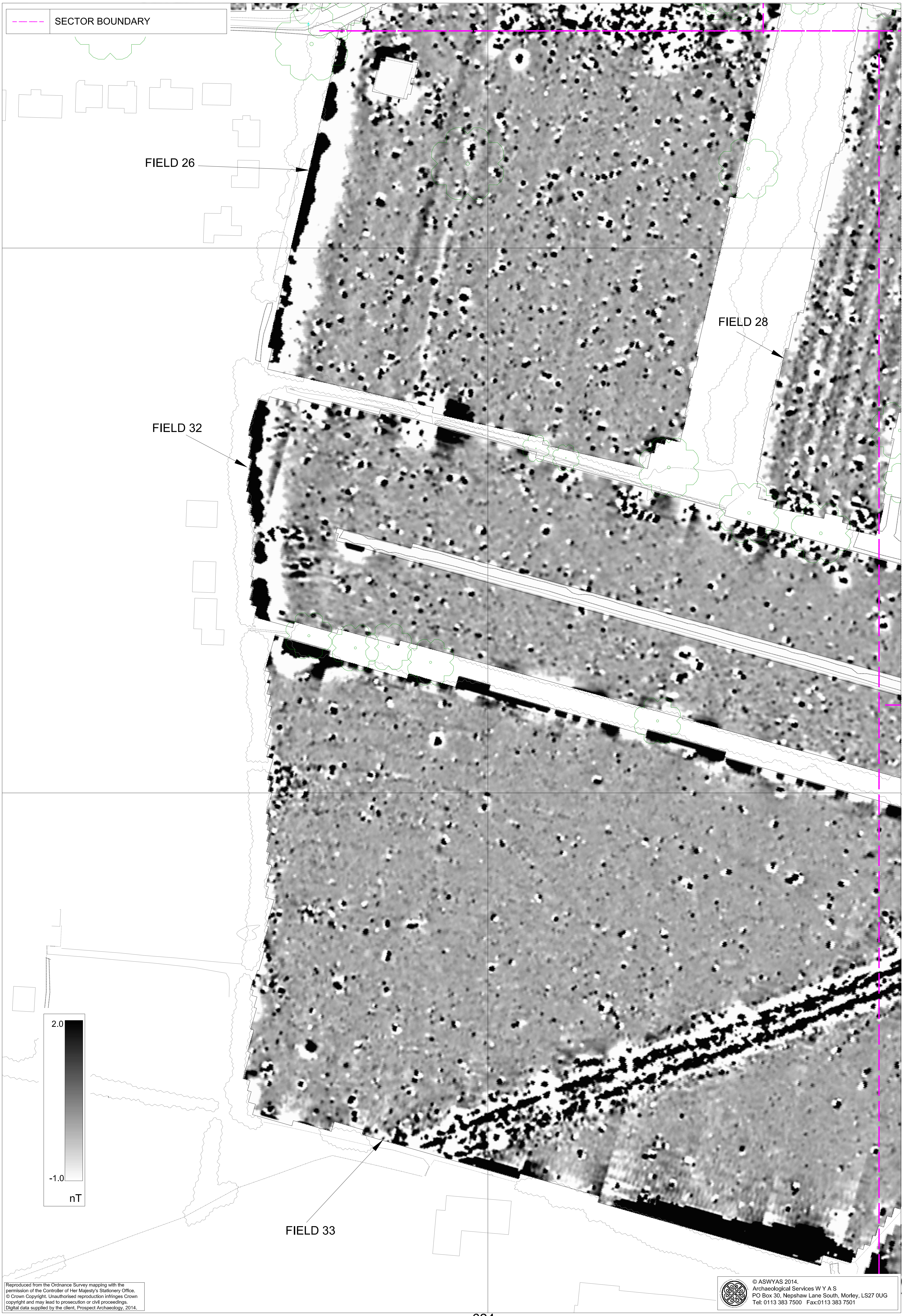


Fig. 17. Processed greyscale magnetometer data; Sector 5 (1:1250 @ A3)

0 20m

Fig. 18. XY trace plot of minimally processed magnetometer data; Sector 5 (1:1250 @ A3)

0 20m

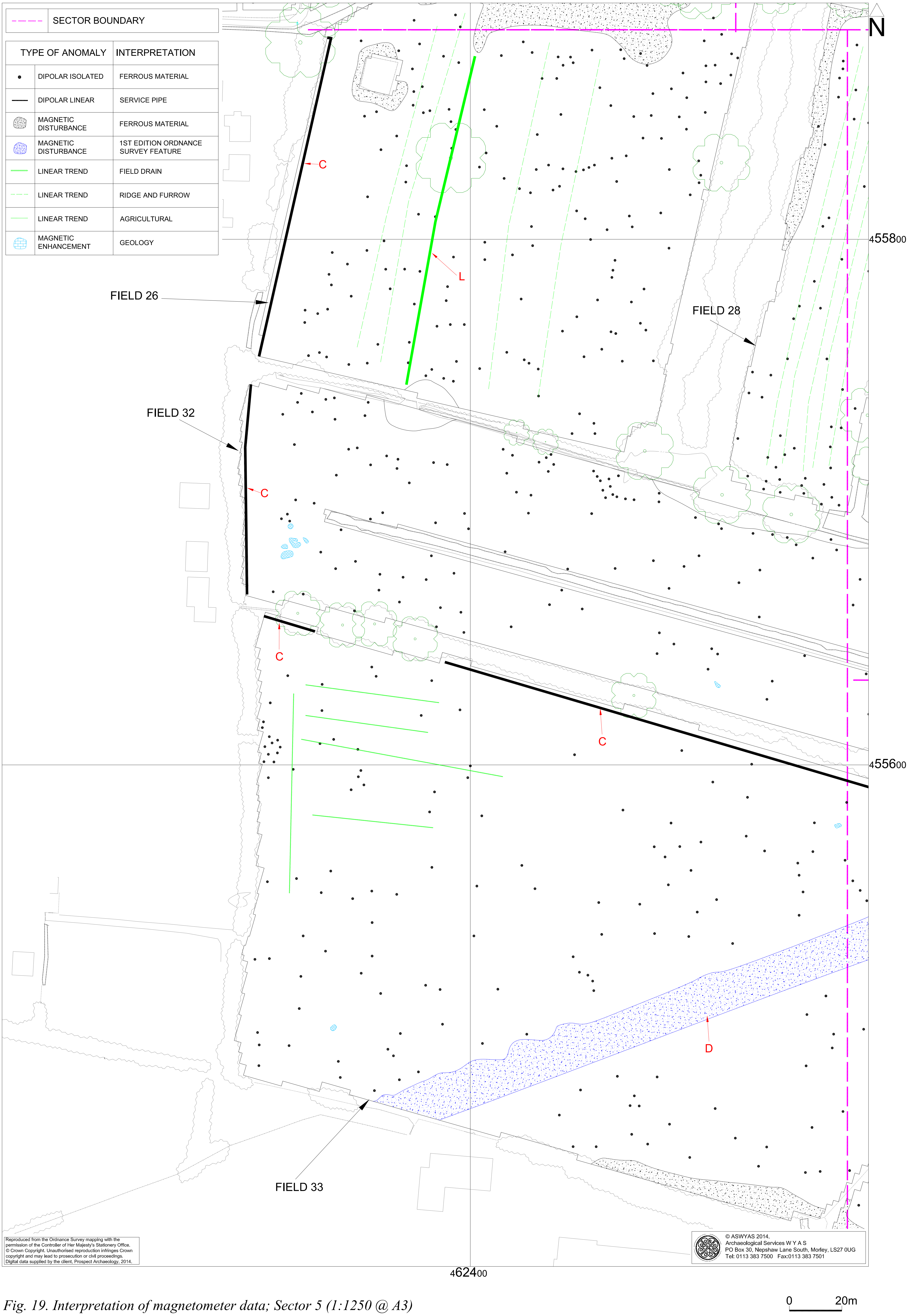


Fig. 19. Interpretation of magnetometer data; Sector 5 (1:1250 @ A3)

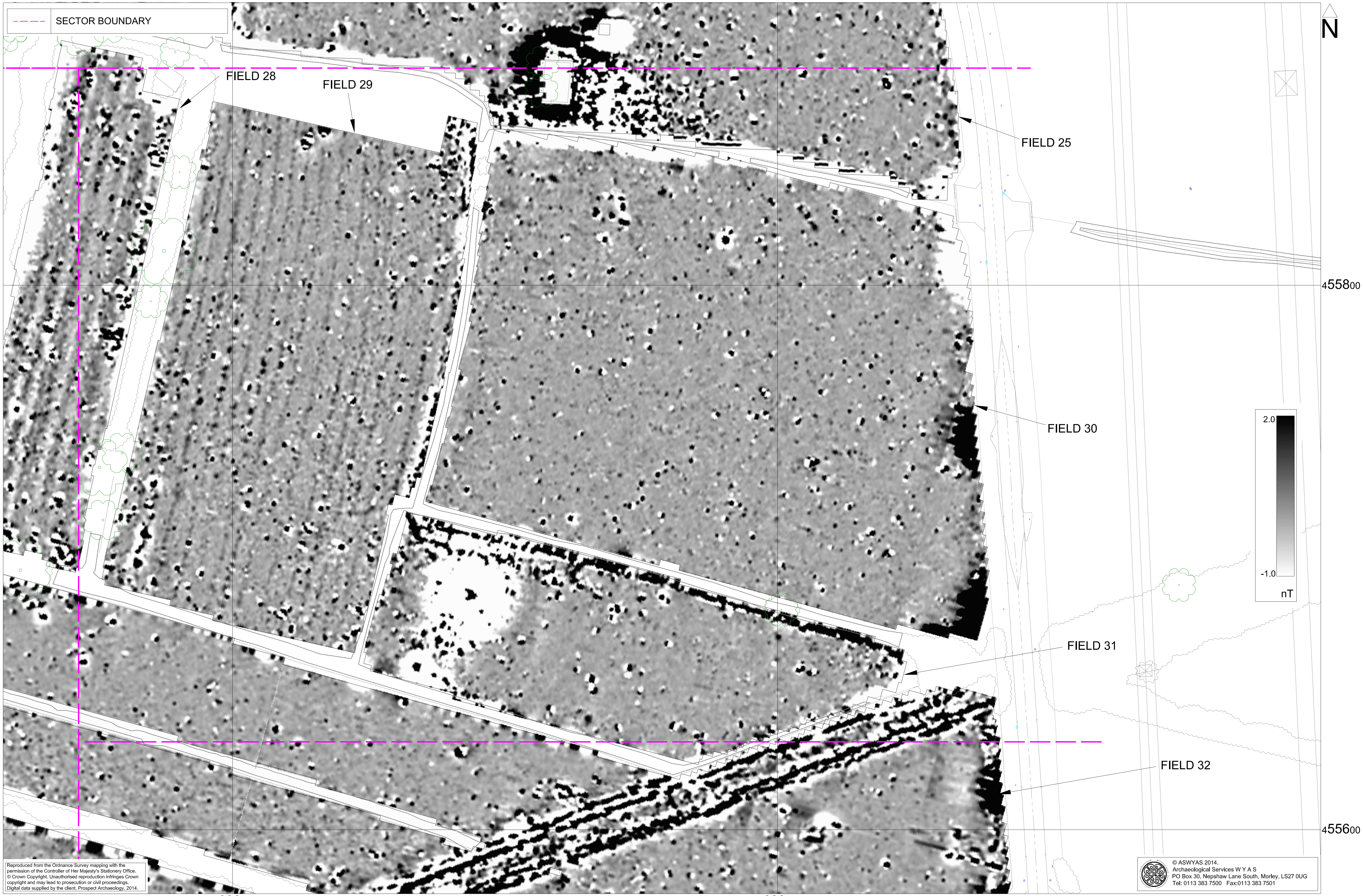


Fig. 20. Processed greyscale magnetometer data; Sector 6 (1:1250 @ A3)

0 20m

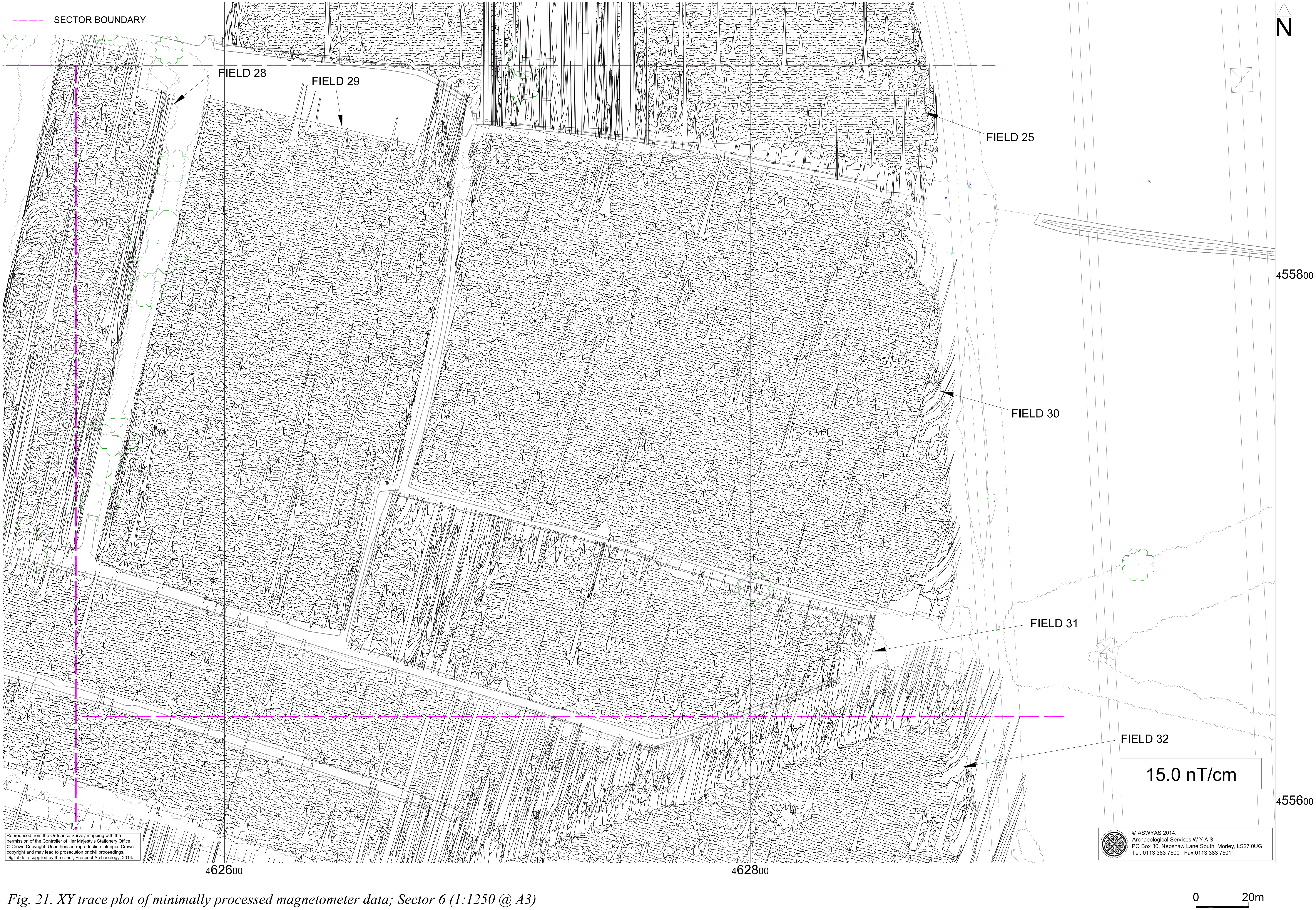


Fig. 21. XY trace plot of minimally processed magnetometer data; Sector 6 (1:1250 @ A3)

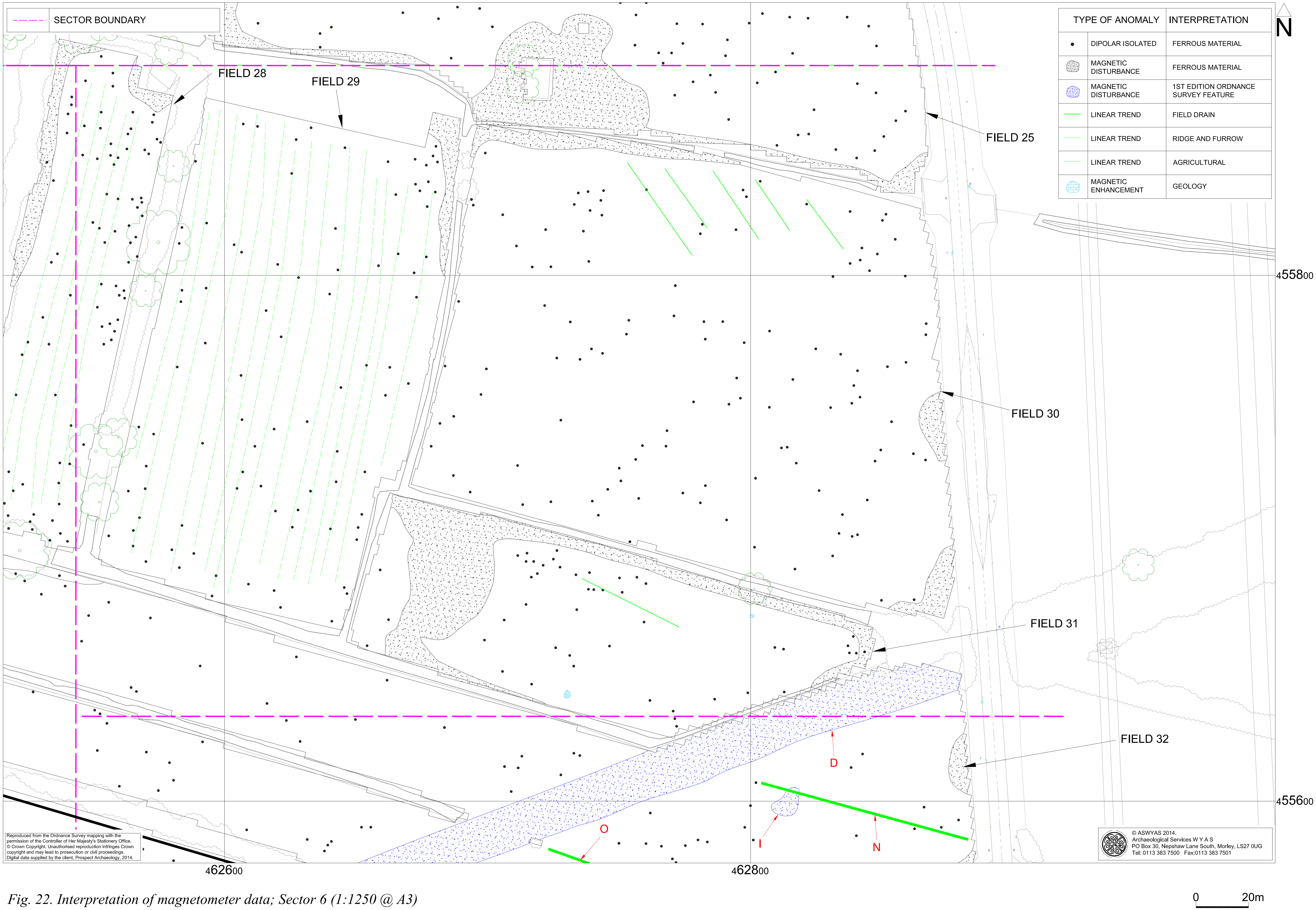


Fig. 22. Interpretation of magnetometer data; Sector 6 (1:1250 @ A3)

Fig. 23. Processed greyscale magnetometer data; Sector 6 (1:1250 @ A3)

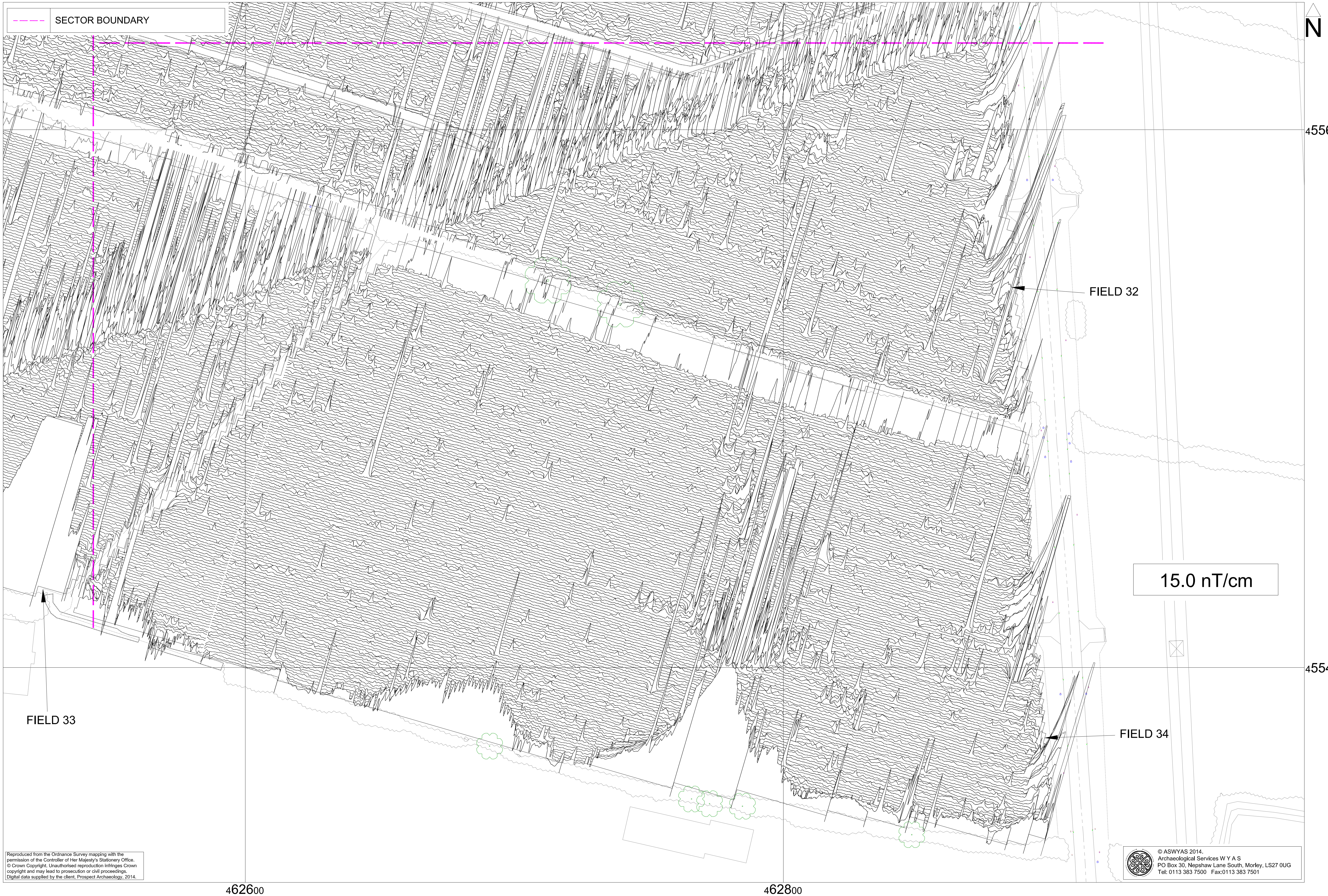


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Fig. 24. XY trace plot of minimally processed magnetometer data; Sector 7 (1:1250 @ A3)

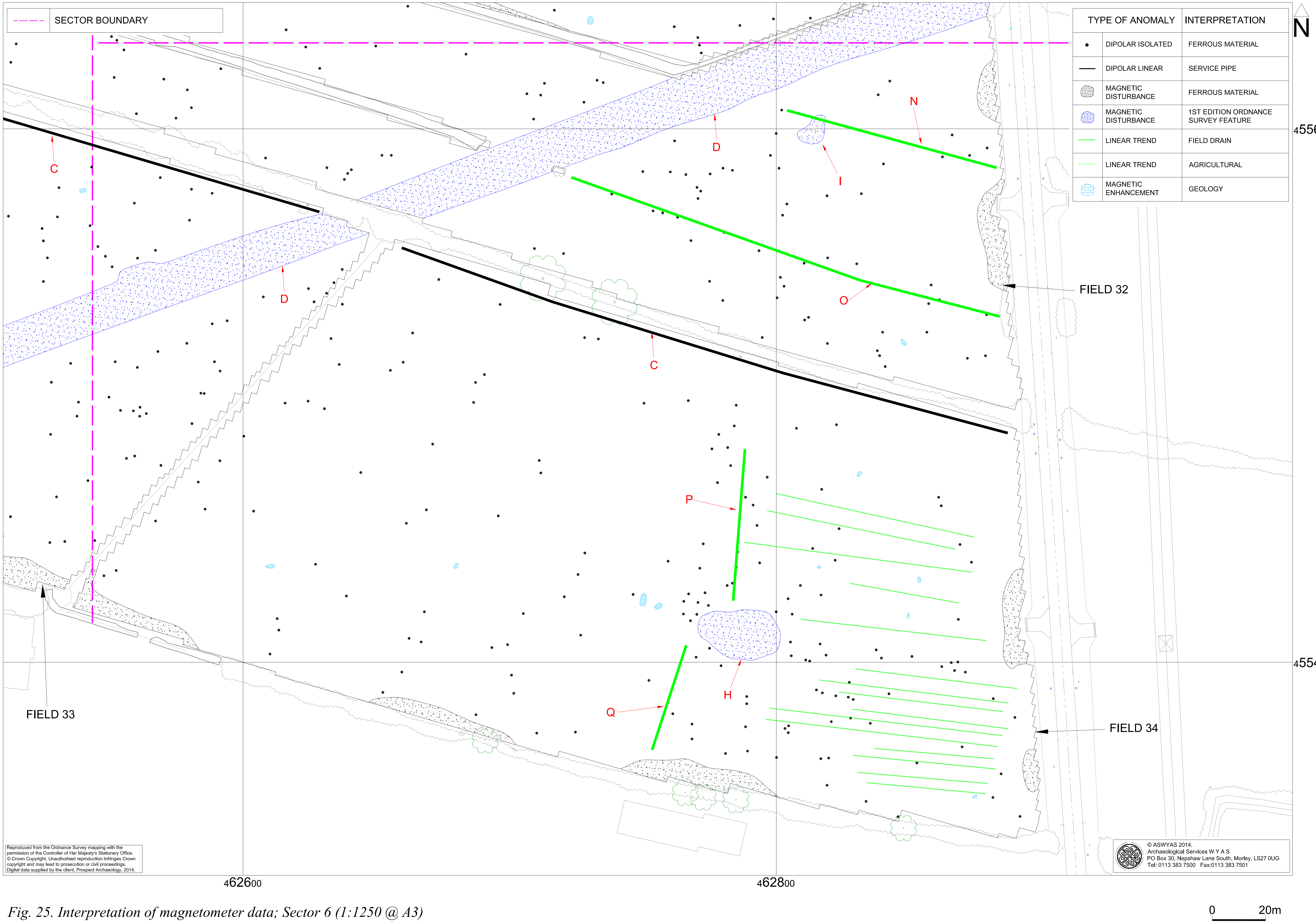

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Fig. 25. Interpretation of magnetometer data; Sector 6 (1:1250 @ A3)

Plate 1. General view of unsuitable area in Field 2, looking north

Plate 2. General view of Field 6, looking south-west

Plate 3. General view of unsuitable area in Field 6, looking north-east

Plate 4. General view of Field 4, looking south-west

Plate 5. General view of Field 12, looking west

Plate 6. General view of Field 18, looking east

Plate 7. General view of Field 22, looking north

Plate 8. General view of Field 23, looking north

Plate 9. General view of Field 23 showing barn, looking west

Plate 10. General view of Field 29 and unsuitable area, looking east

Plate 11. General view of Field 32, looking west

Plate 12. General view of Field 34, looking 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.

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).

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