ARCHAEOLOGICAL SERVICES WYAS

Woodlands Farm
Calcott
Kent

Geophysical Survey

Report no. 2516

September 2013

Client: Hyder Consulting (UK) Ltd

REGISTERED · IA · ORGANISATION

Woodlands Farm
Calcott
Kent

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 23 hectares, was carried out on agricultural land east of Woodlands Farm, Calcott, to inform the determination of an outline planning application for a proposed solar park. The survey has identified anomalies caused by geology, sub-surface pipes and a probable field drain. No anomalies of archaeological potential have been recorded and the survey has not identified a possible rectangular enclosure visible as a cropmark on satellite images of the site, nor an extensive system of field drains in the same part of the site, also clearly visible as cropmarks. This suggests that it may not be possible to detect soil-filled archaeological features, such as ditches pits and gullies (if present), on the prevailing soils and geology. However, even under unfavourable conditions it might be expected that major areas of settlement/occupational activity might be identifiable. On the basis of the survey it is considered unlikely that there are any major areas of archaeological activity on this site, but that there may be features, such as the previously identified enclosure, that are not detectable due to the prevailing soils and geology.

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Report Information

Client:	Hyder Consulting (UK) Ltd
Address:	The Mill, Brimscombe Port, Stroud, GL5 2QG
Report Type:	Geophysical Survey
Location:	Woodlands Farm, Calcott
County:	Kent
Grid Reference:	TR 180 632
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Report Number:	2516
Project Number:	4124
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Date of fieldwork:	September 2013
Date of report:	September 2013
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Research:	n/a

Authorisation for distribution: --

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1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Sarah Woodget of Hyder Consulting (UK) Ltd, to undertake a geophysical (magnetometer) survey of agricultural land to the east of Woodlands Farm, Calcott, Kent (see Fig. 1), prior to the submission of a planning application for a proposed solar power scheme. 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 September 9th and September 13th 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) comprises an irregular shaped parcel of land at Calcott, approximately 8km north-east of Canterbury and 10km south-east of Whitstable. It is centred at TR 180 632 and is situated to the north-east and south-east of Woodlands Farm (see Fig. 2) covering 23 hectares of arable farm land. Topographically the sites slopes gently to the north-east and is situated at approximately 40m above Ordnance Datum.

Soils and geology

The underlying bedrock comprises London Clay Formation – Clay and Silt Sedimentary Bedrock. An isolated area of superficial head deposits are recorded immediately east and south of Woodlands Farm (British Geological Survey 2013). These are made up of gravel, sand, silt and clay. The soils in this area are classified in the Windsor association, characterised as slowly permeable, seasonally waterlogged clays with brown sub-soils (Soil Survey of England and Wales 1983).

2 Archaeological Background

No archaeological background to the site was available at the time of writing. However, satellite imagery indicates the presence of a small rectangular enclosure towards the southern end of the site which may date from the Roman or early medieval period.

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 of the PDA was carried out, an area of 23 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 (1:4000) location plan displaying the processed magnetic data. Figure 3 is an overall data interpretation plot at the same scale. Detailed data plots ('raw' and processed) and full interpretative figures are presented at a scale of 1:1000 in Figures 4 to 18 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 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 (see Figs 4 to 18 inclusive)

The anomalies identified by the survey 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. It should be noted that no anomalies of archaeological potential have been identified by the survey.

Ferrous and Modern 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. The magnetic disturbance immediately east of the farm is undoubtedly due to the proximity of farm buildings. 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 linear dipolar anomaly, **A**, aligned east/west at the south-western corner of the site locates a sub-surface pipe. A much higher magnitude dipolar anomaly, **B**, aligned north/south towards the eastern end of the site locates a second pipe.

A large circular area of disturbance, **C**, 150m east of the farm, possibly locates a modern feature, such as a small clay extraction pit, which has been infilled over the years with farm rubbish.

Geological anomalies

Much of the western half of the site is dominated by numerous short linear and discrete anomalies characterised as localised areas of enhanced magnetic response. These anomalies appear in two major clusters aligned south-west/north-east and reducing in frequency and density, and disappearing almost completely, towards the north-eastern part of the site. These anomalies broadly correspond with a small area of superficial head deposits and also with noticeable clusters of flint nodules on the surface of the field. It is considered likely that these anomalies are caused by the variation within the head deposits, particularly the presence of magnetic gravels.

Agricultural Anomalies

There are very few anomalies recorded on this site that can be interpreted as of agricultural origin. One possible exception is a high magnitude L-shaped anomaly, **D**, to the west of the site that may be associated with, or form part of, a system of field drains that can be clearly distinguished on satellite images of the field immediately east of Woodlands Farm but which have not been identified by the magnetometer survey. Only one probable drain, **E**, aligned south-west/north-east in Field 2, has been located. Several vague linear ploughing trends have also been identified in Field 2.

5 Discussion

Neither the possible enclosure nor the extensive system of field drains, both visible on satellite images of the large field to the east of the farm, have been identified by the survey despite being identified as cropmarks. It is considered likely that this is predominantly due to the poor magnetic contrast between the clay soils and the London Clay bedrock but also partly to the variable magnetic background in this part of the site due to the presence of the superficial head deposits. The possible enclosure is also located close to the very strong magnetic anomaly, **A**, caused by a pipe, which may partly mask the response from the feature, if present. For these reasons it is considered possible that soil-filled archaeological features, such as ditches, gullies and large pits, may be difficult or impossible to identify under the prevailing geological and pedological conditions. However, even under the unfavourable geological conditions, it is probable that strongly magnetic features, such as hearths or kilns or other heat affected features indicative of settlement activity, would be identifiable.

6 Conclusions

The prevailing soils and geology on this site suggest that there is likely to be a very low magnetic contrast between any soil-filled archaeological features, if present, and the surrounding soils and superficial deposits. This probably explains why a possible cropmark enclosure (and an extensive system of field drains) have not been identified by the survey. In fact no anomalies of likely archaeological origin have been identified. It might be expected that more extensive archaeological (settlement) activity would probably be located by virtue of the likely presence of strongly magnetic, heat affected, features.

Therefore, on the basis of the geophysical survey, the potential for there still being currently unknown extensive (settlement) archaeological activity on this site is considered to be low. There remains, however, the possibility of soil-filled features, such as the possible enclosure, which may not be detectable due to the soils and geology.

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.

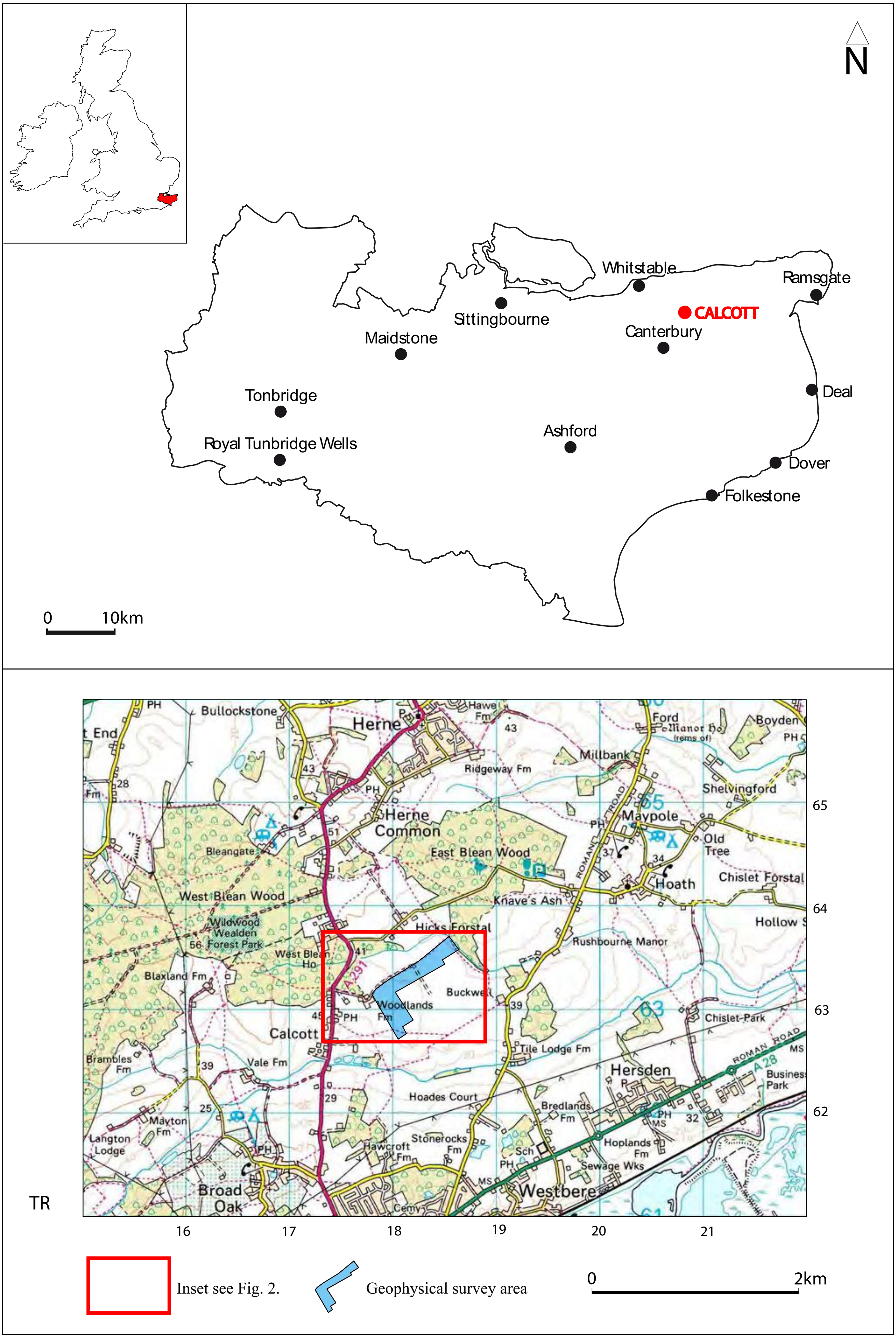

Fig. 1. Site location

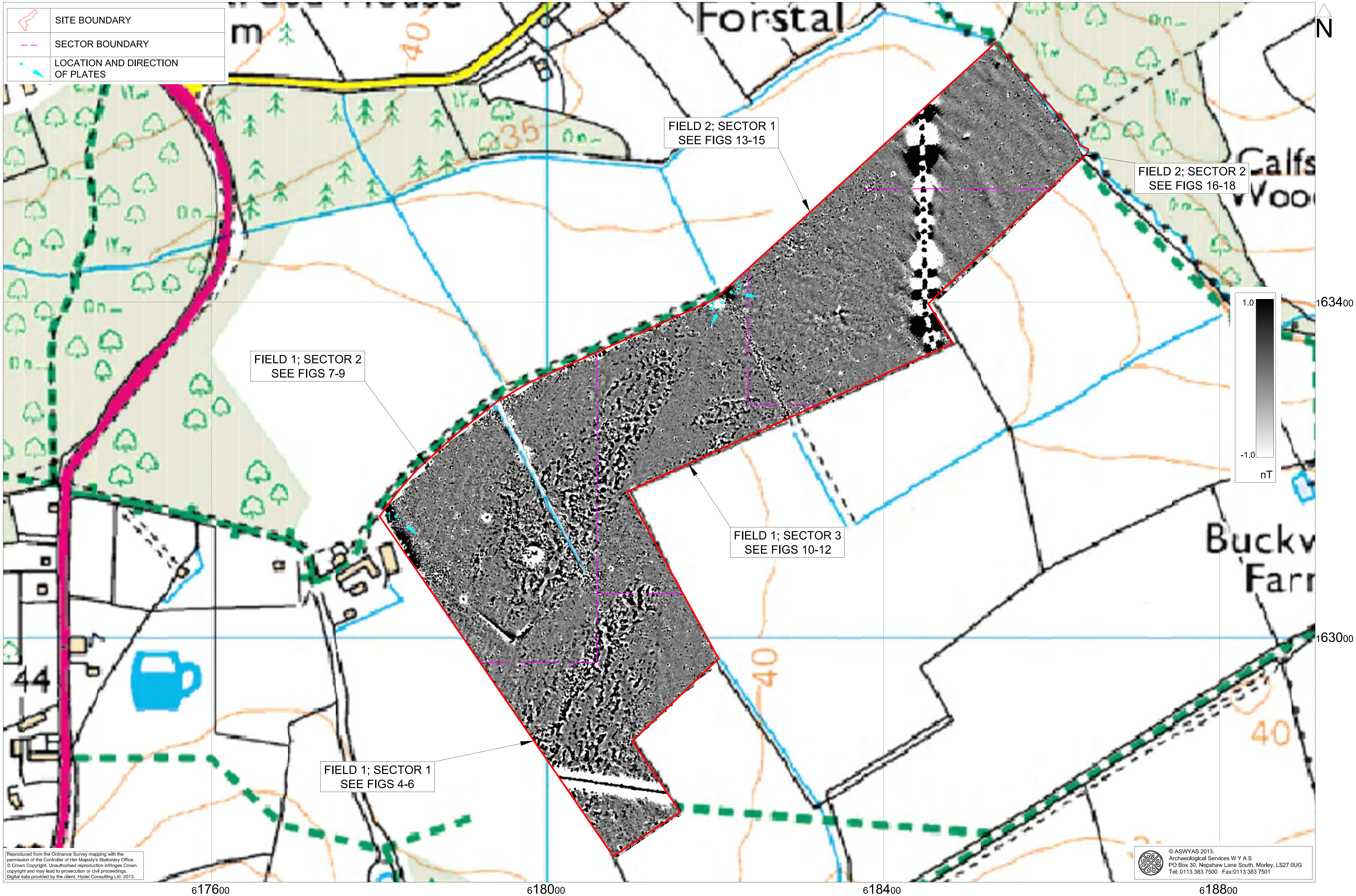

Fig. 2. Site location showing greyscale magnetometer data (1:4000 @ A3)

0 200m

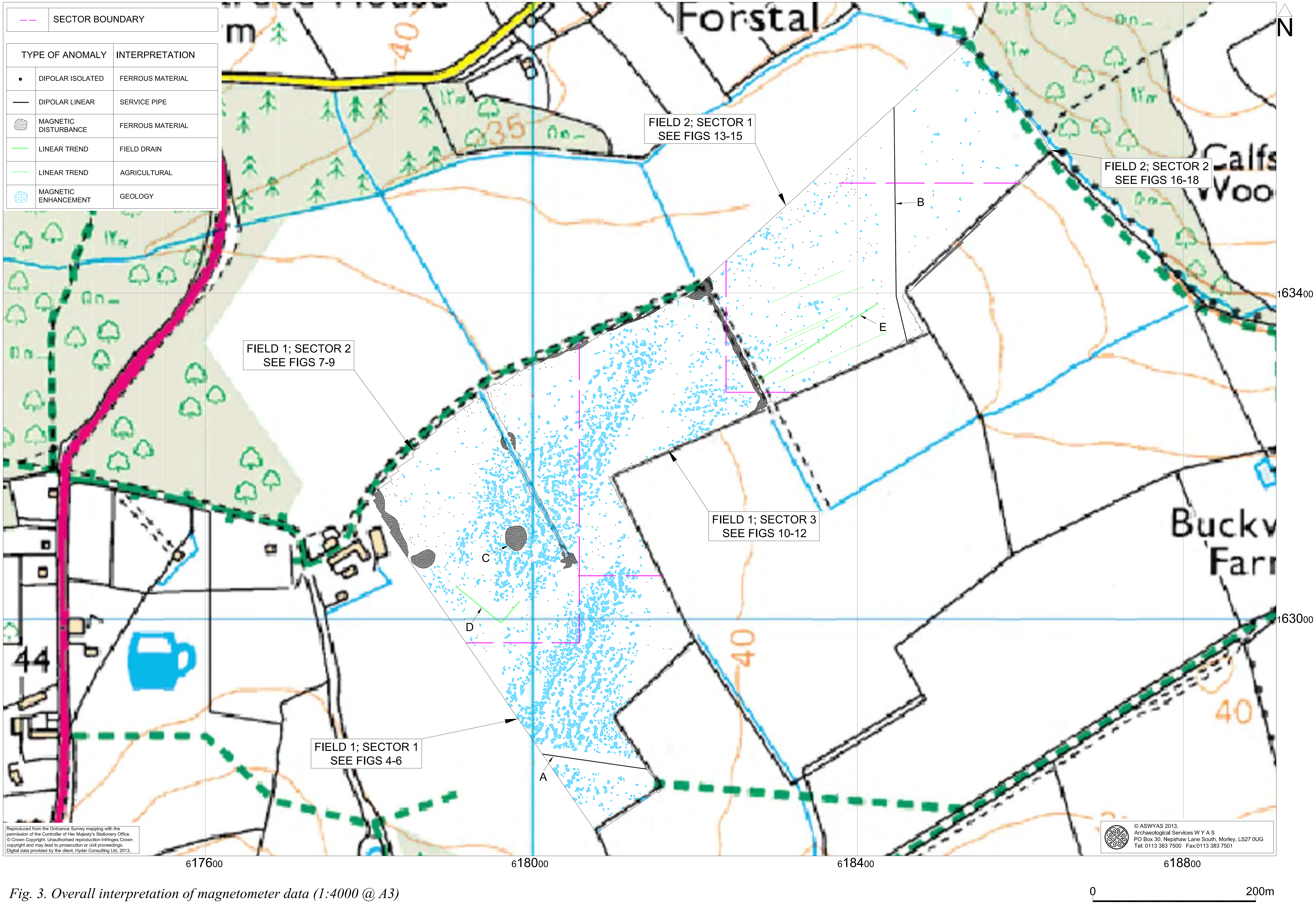

Fig. 3. Overall interpretation of magnetometer data (1:4000 @ A3)

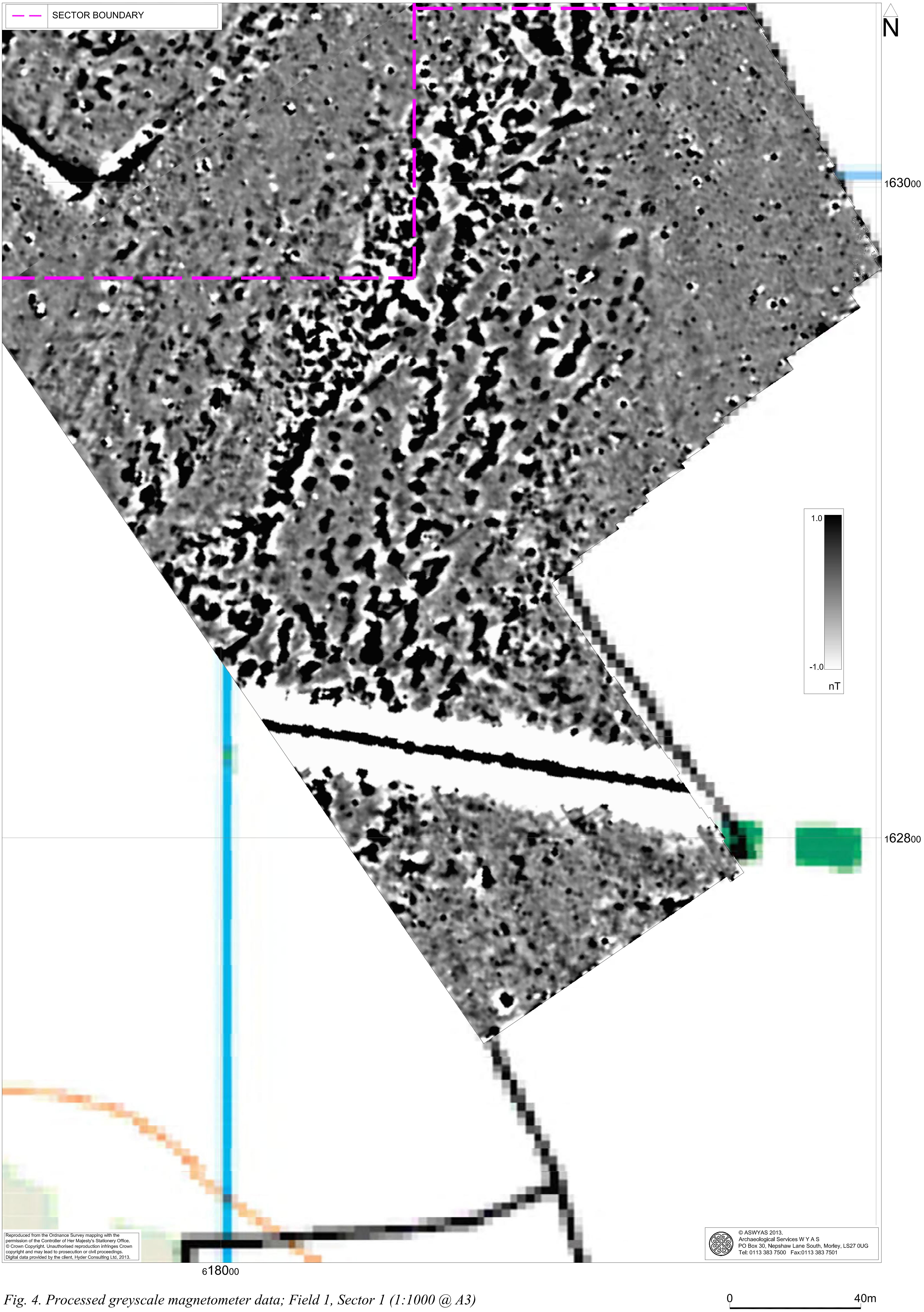

Fig. 4. Processed greyscale magnetometer data; Field 1, Sector 1 (1:1000 @ A3)

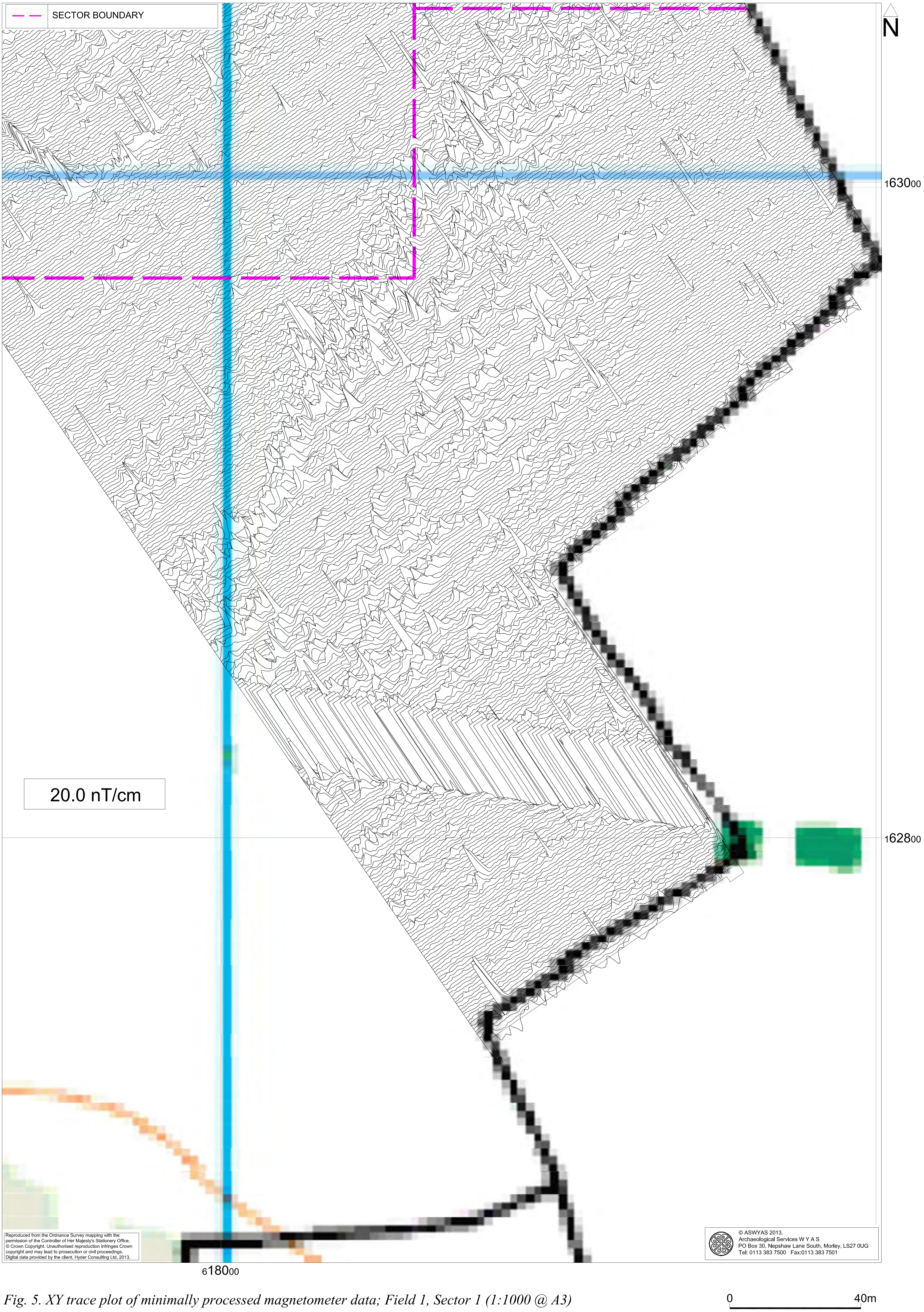

Fig. 5. XY trace plot of minimally processed magnetometer data; Field 1, Sector 1 (1:1000 @ A3)

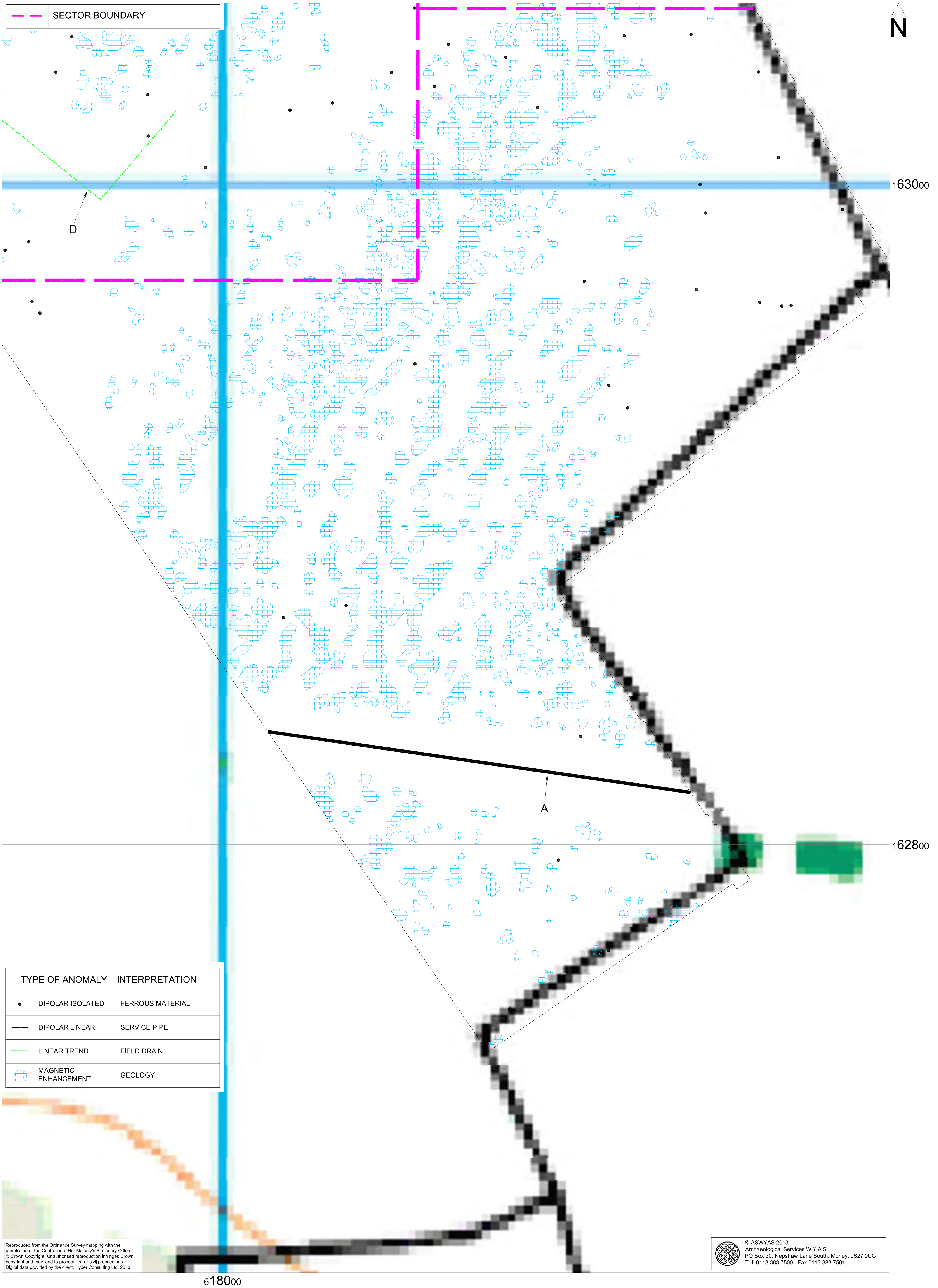

Fig. 6. Interpretation of magnetometer data; Field 1, Sector 1 (1:1000 @ A3)

0 40m

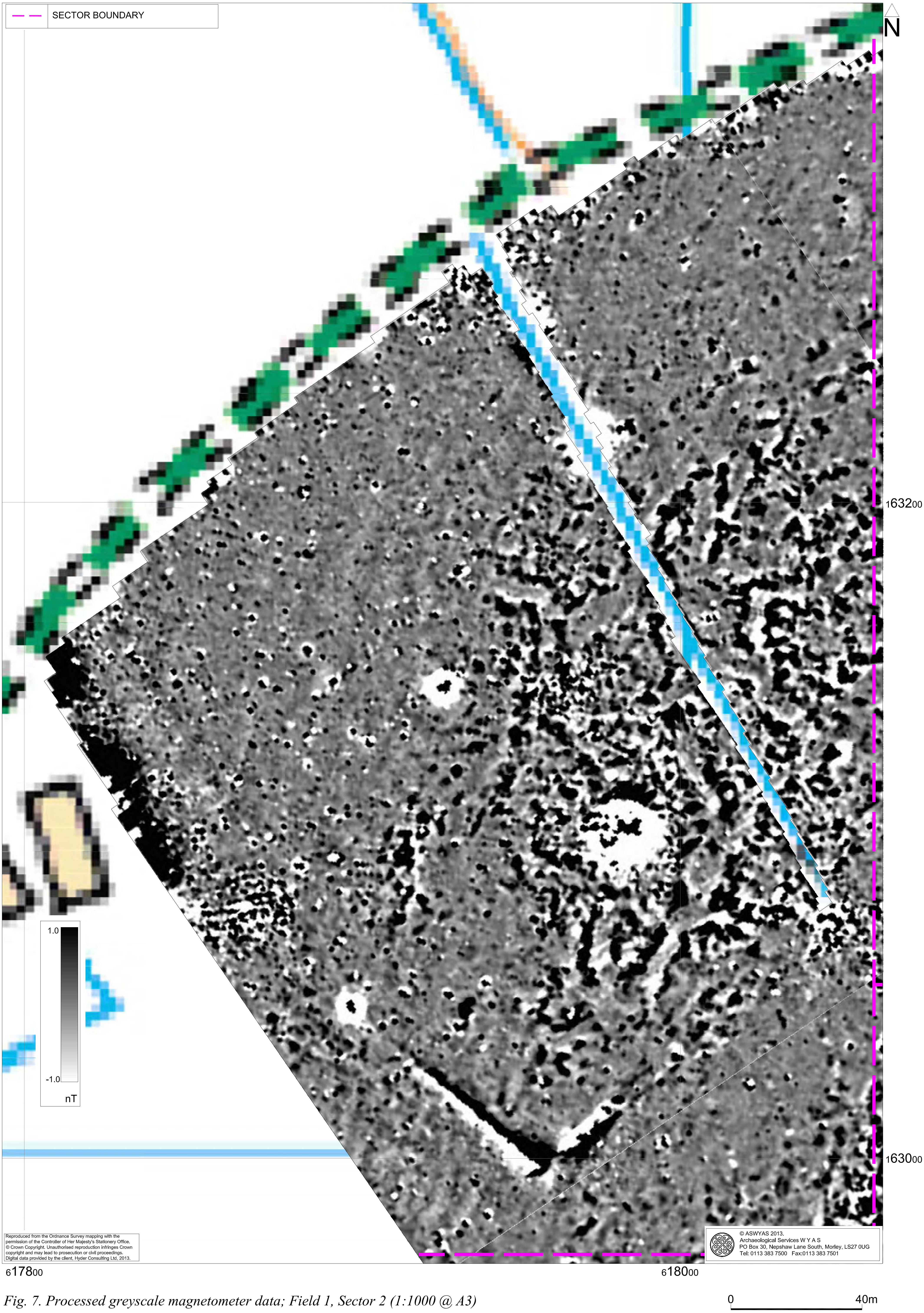

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Fig. 7. Processed greyscale magnetometer data; Field 1, Sector 2 (1:1000 @ A3)

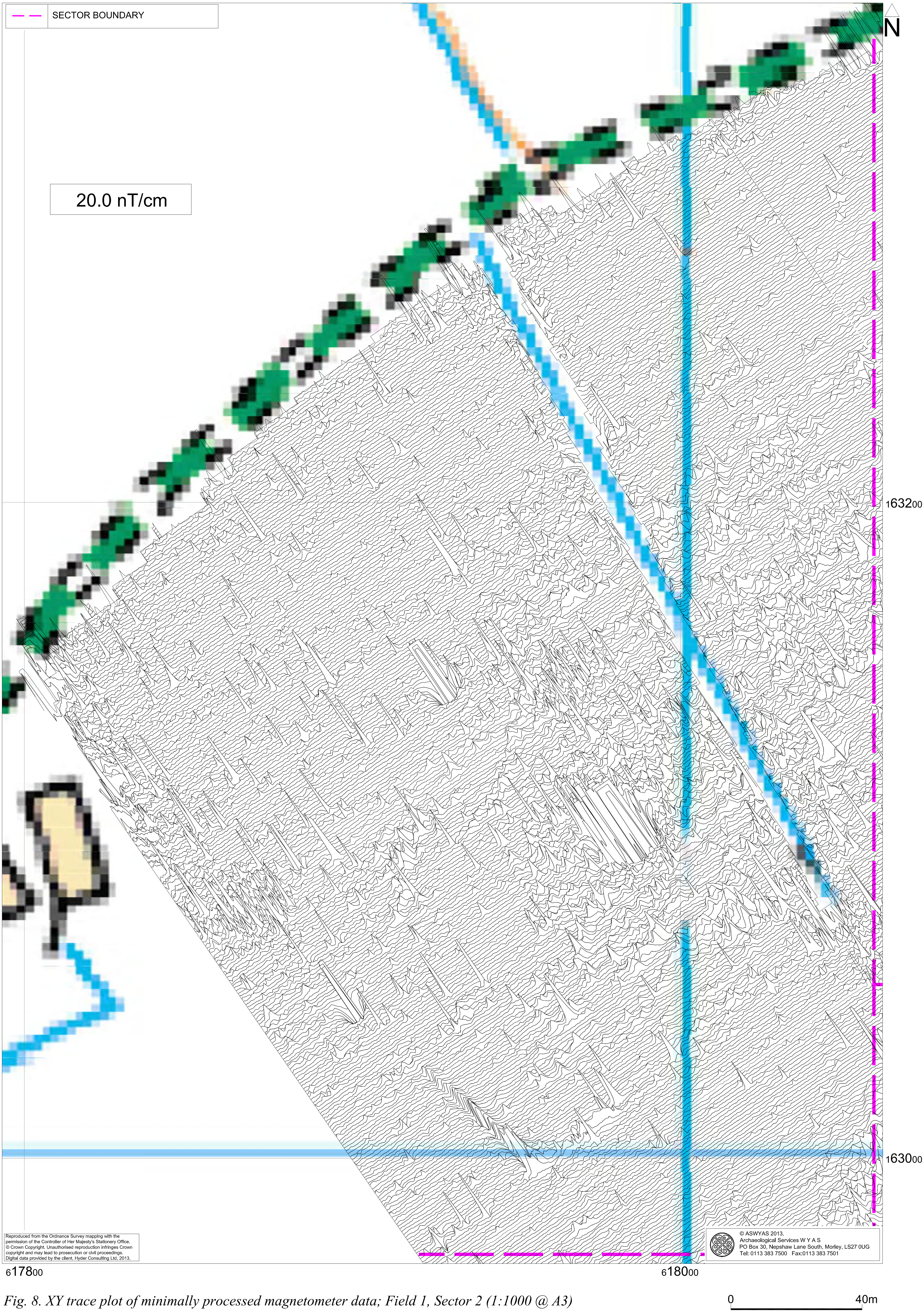

Fig. 8. XY trace plot of minimally processed magnetometer data; Field 1, Sector 2 (1:1000 @ A3)

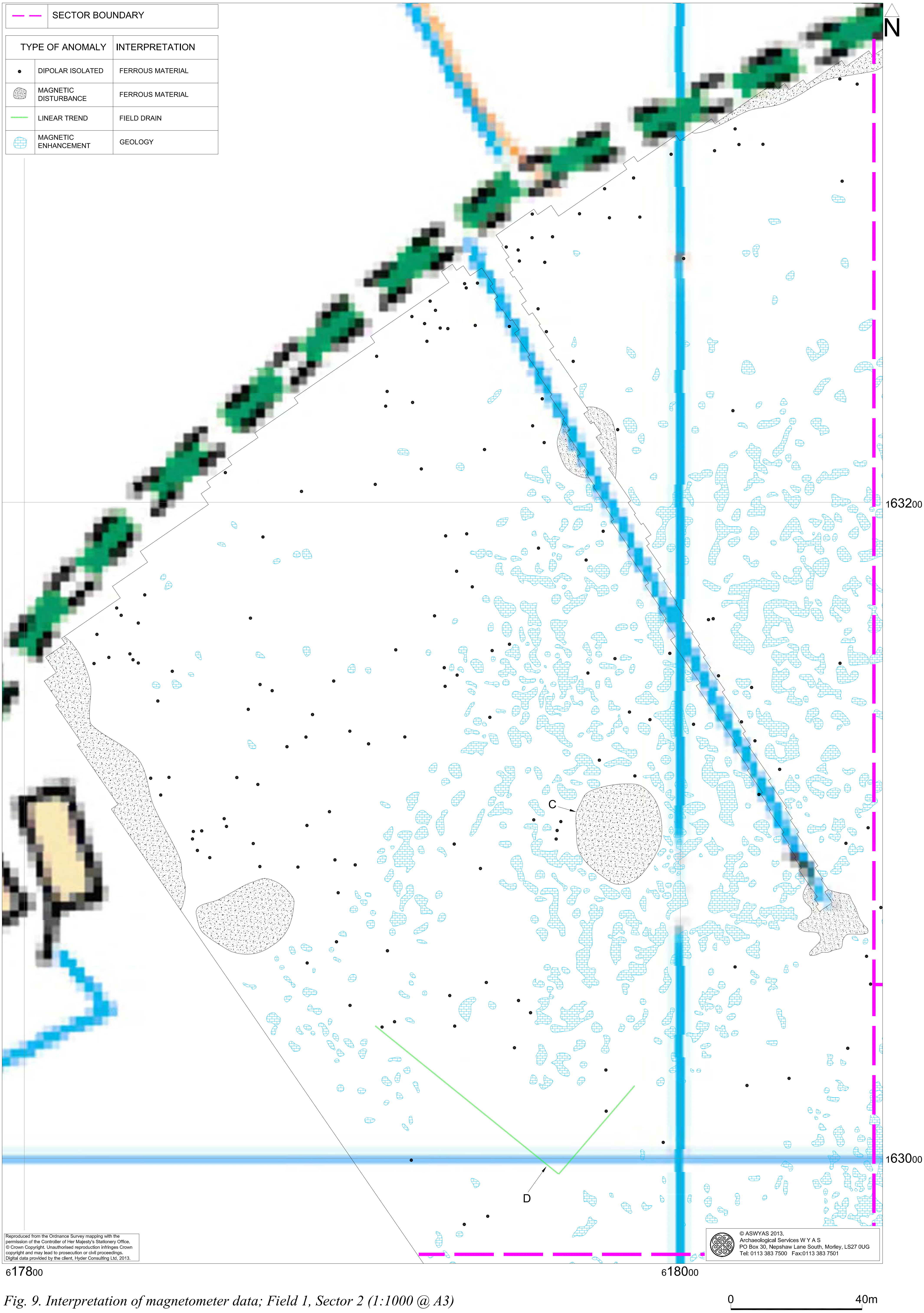

Fig. 9. Interpretation of magnetometer data; Field 1, Sector 2 (1:1000 @ A3)

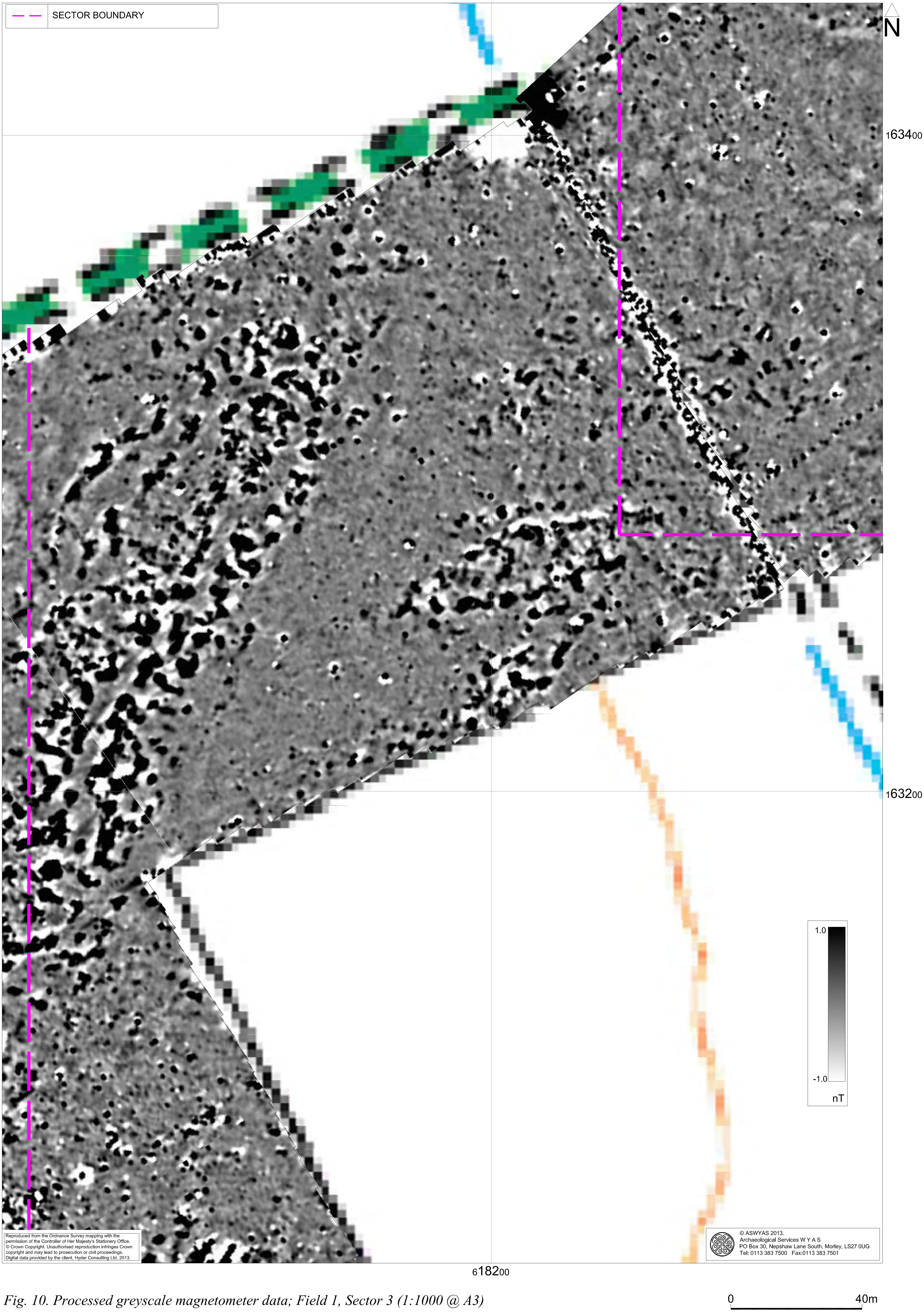

Fig. 10. Processed greyscale magnetometer data; Field 1, Sector 3 (1:1000 @ A3)

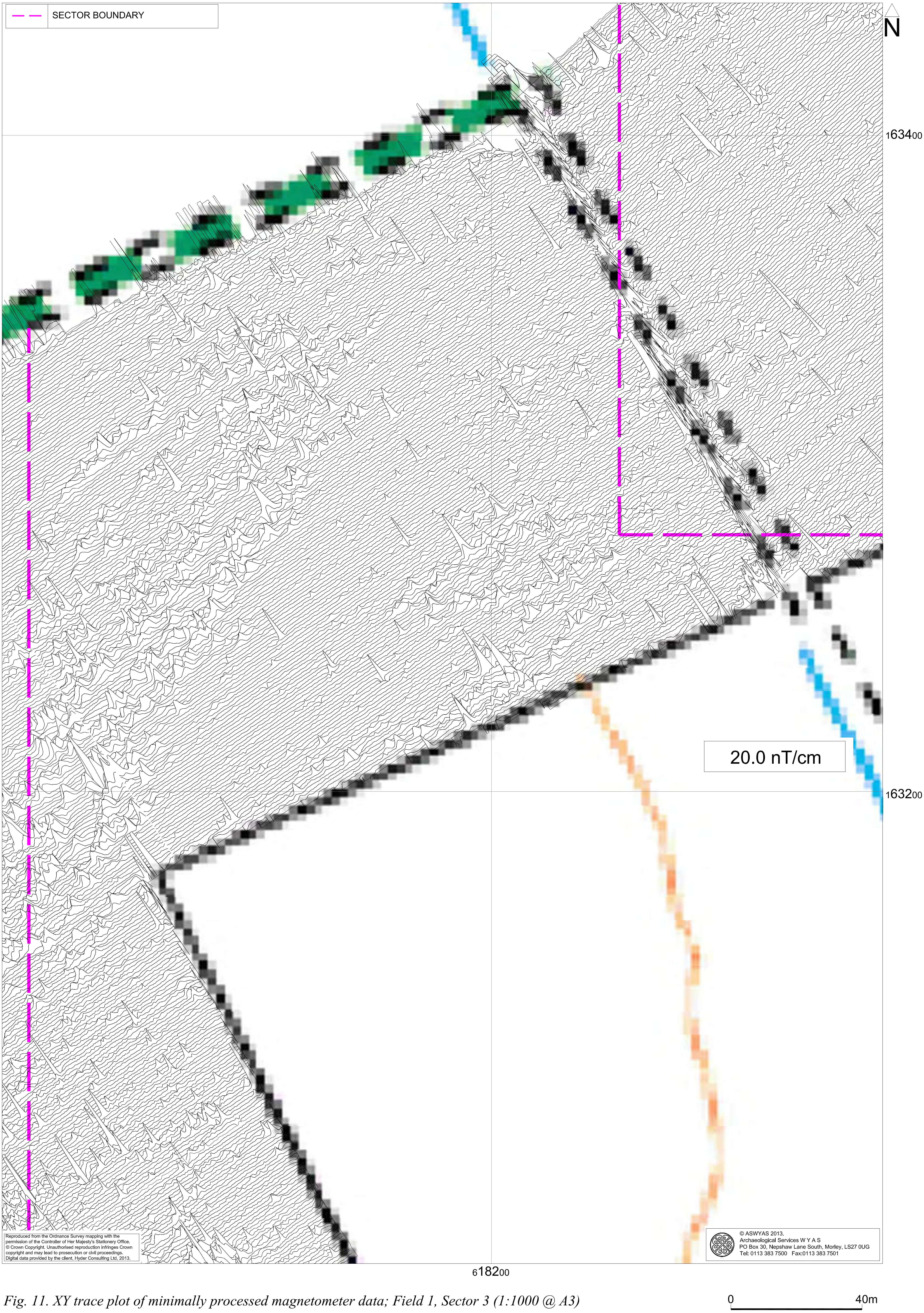

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Fig. 11. XY trace plot of minimally processed magnetometer data; Field 1, Sector 3 (1:1000 @ A3)

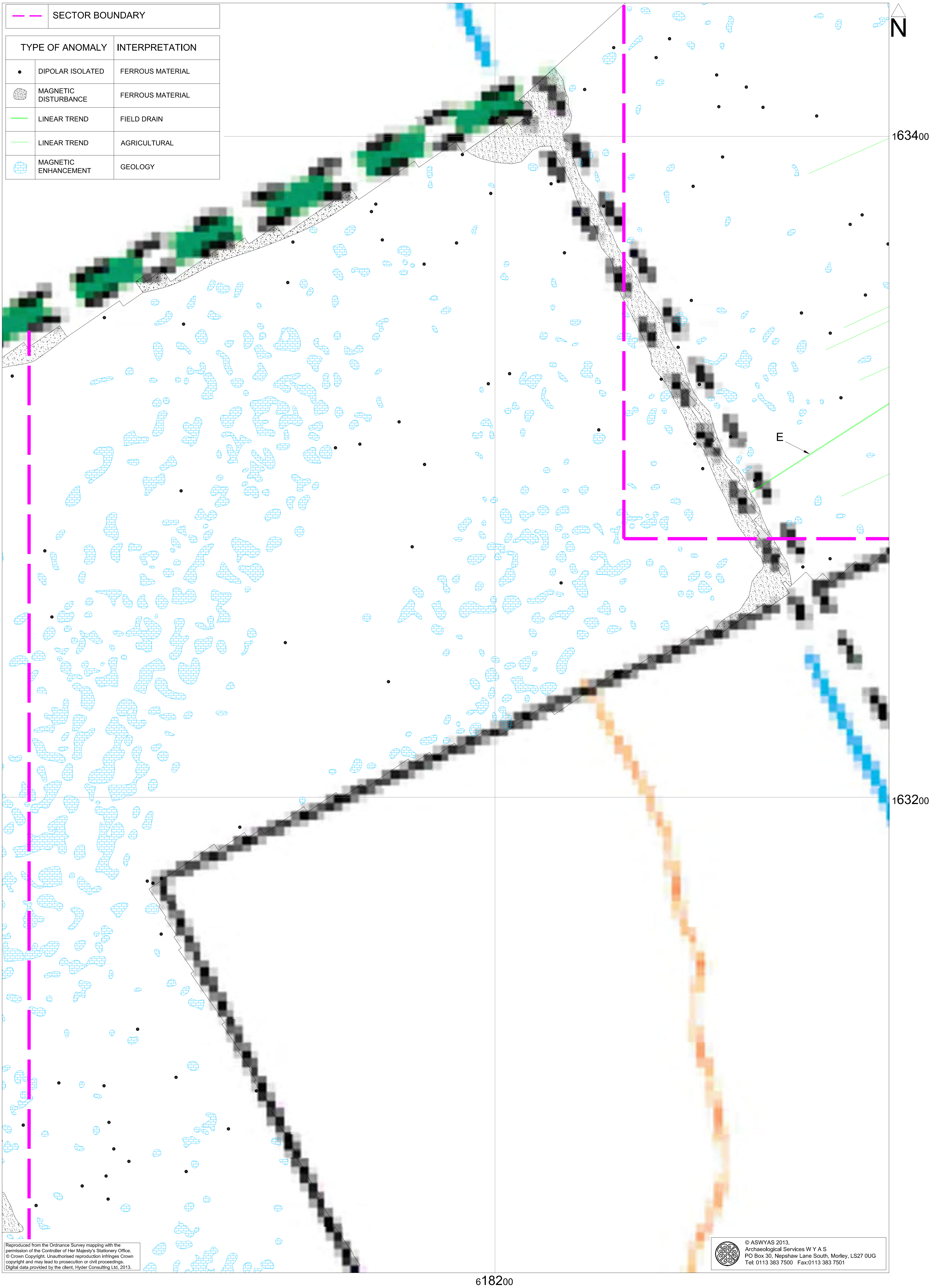

Fig. 12. Interpretation of magnetometer data; Field 1, Sector 3 (1:1000 @ A3)

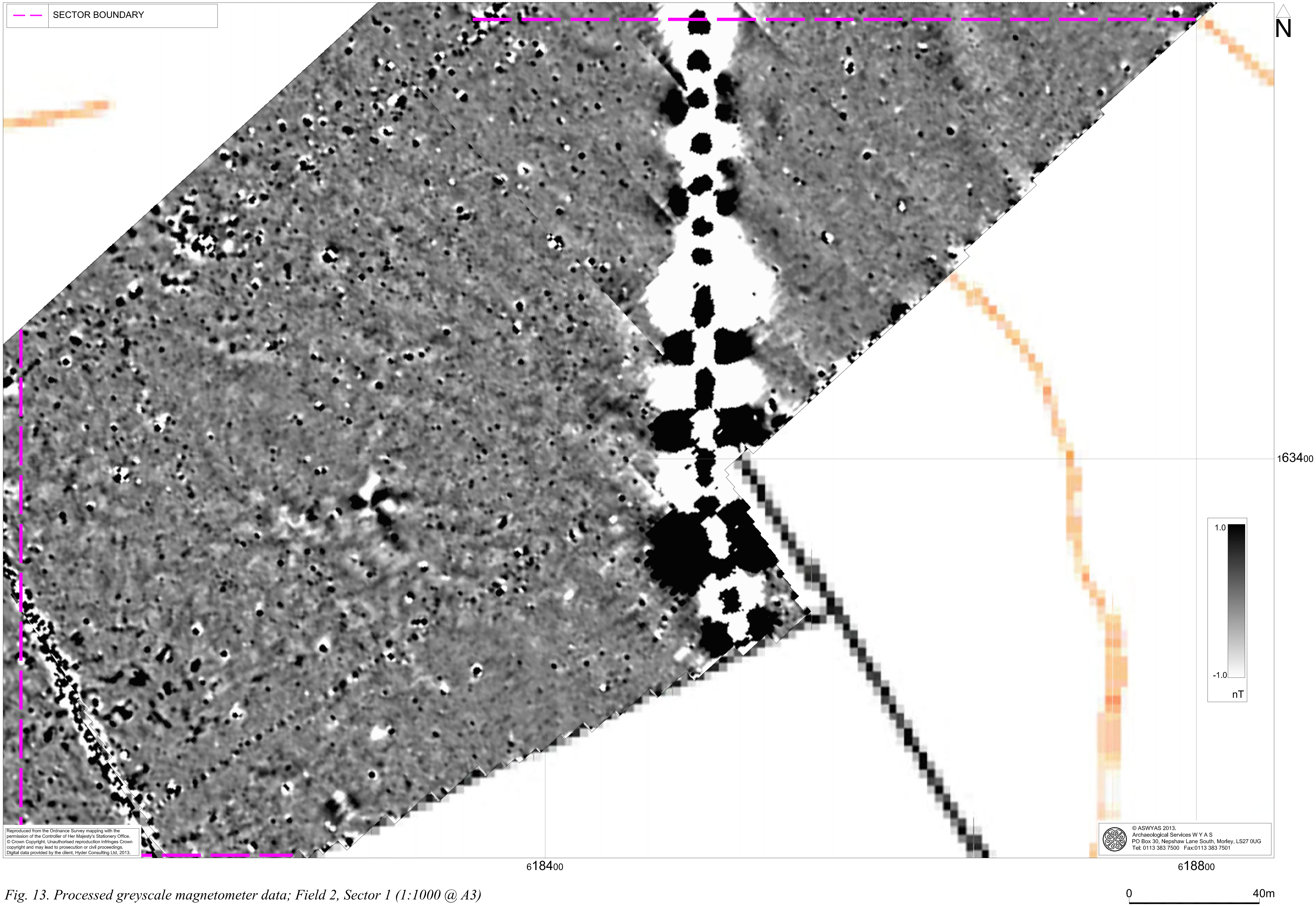

Fig. 13. Processed greyscale magnetometer data; Field 2, Sector 1 (1:1000 @ A3)

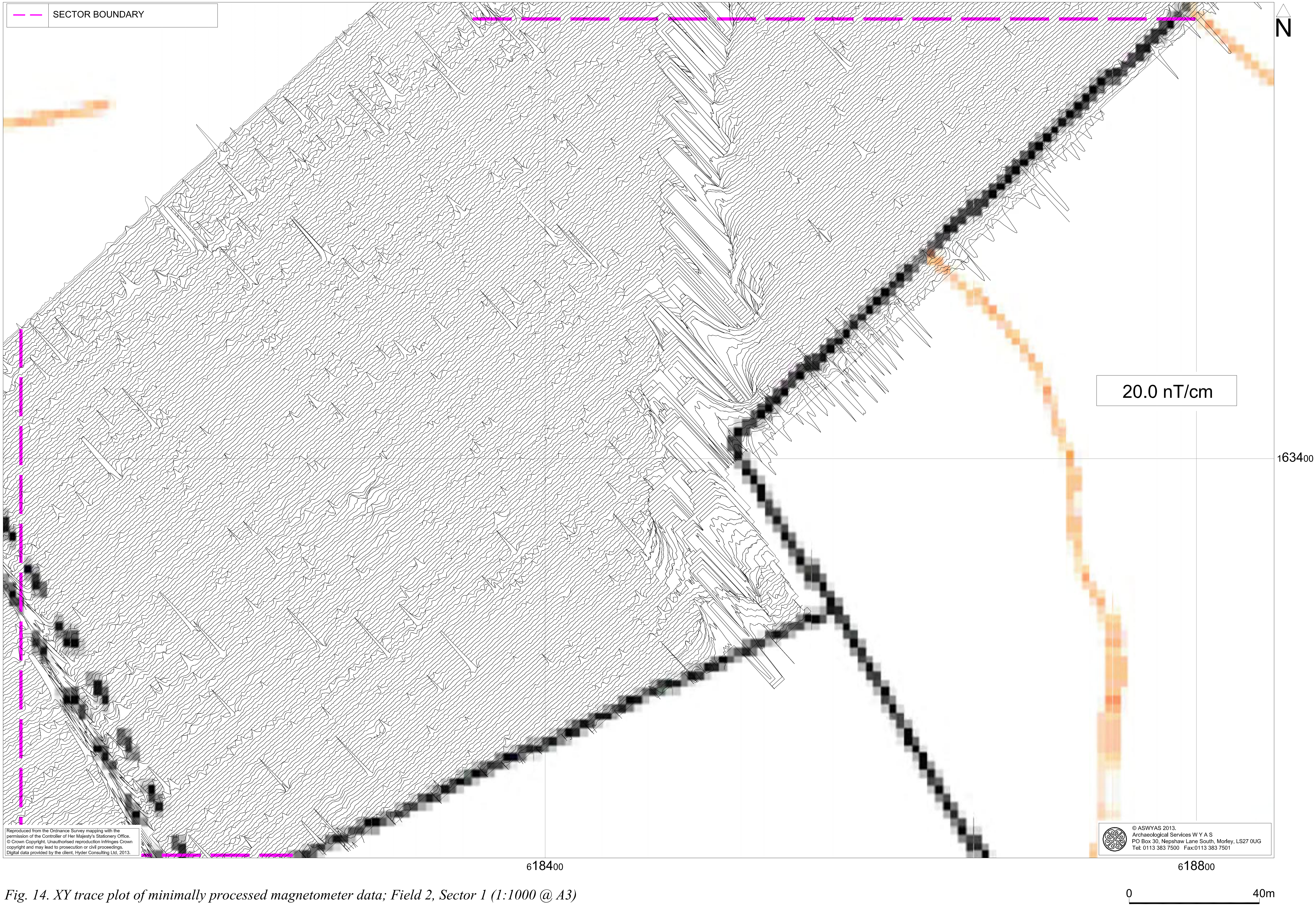

Fig. 14. XY trace plot of minimally processed magnetometer data; Field 2, Sector 1 (1:1000 @ A3)

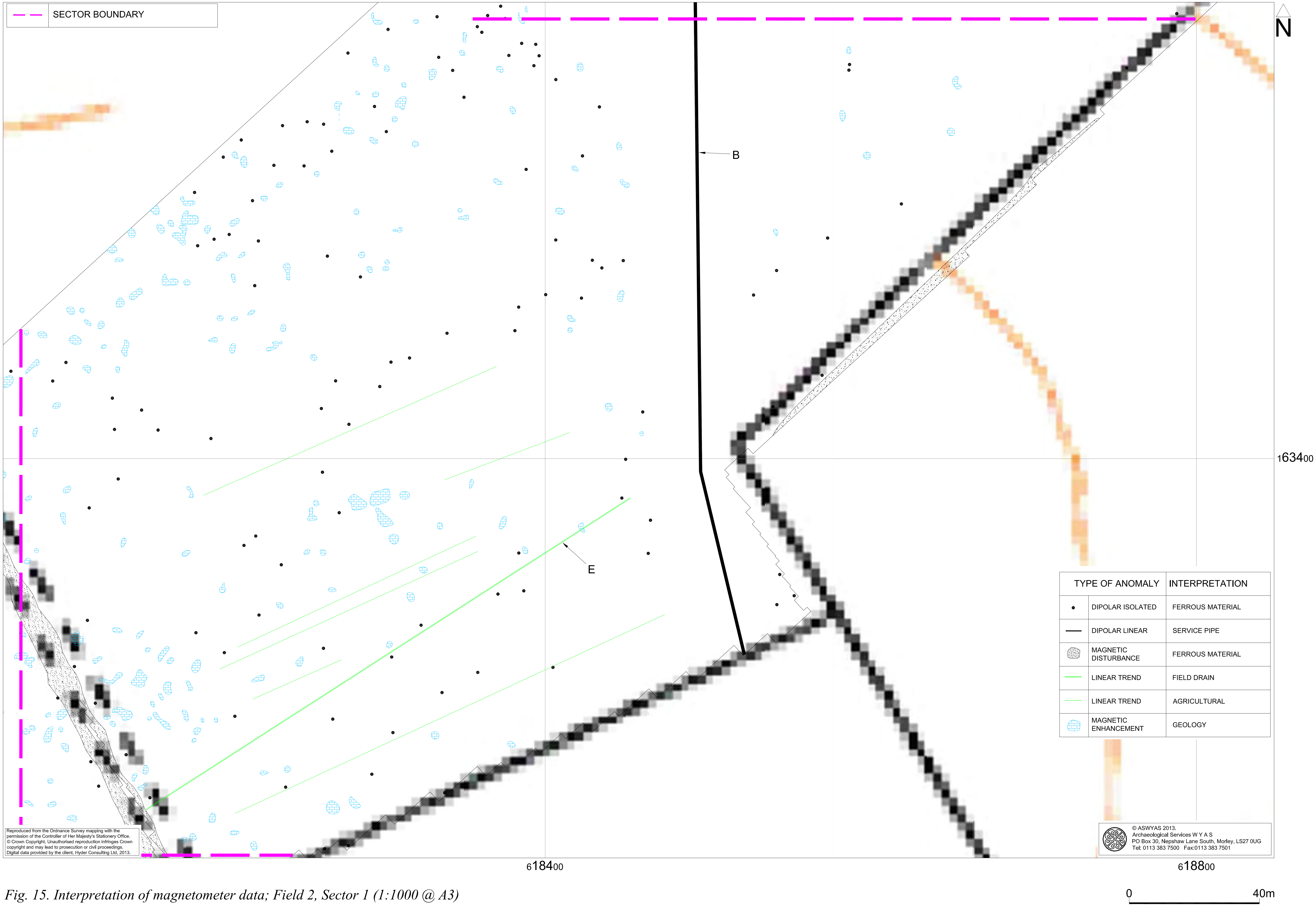

Fig. 15. Interpretation of magnetometer data; Field 2, Sector 1 (1:1000 @ A3)

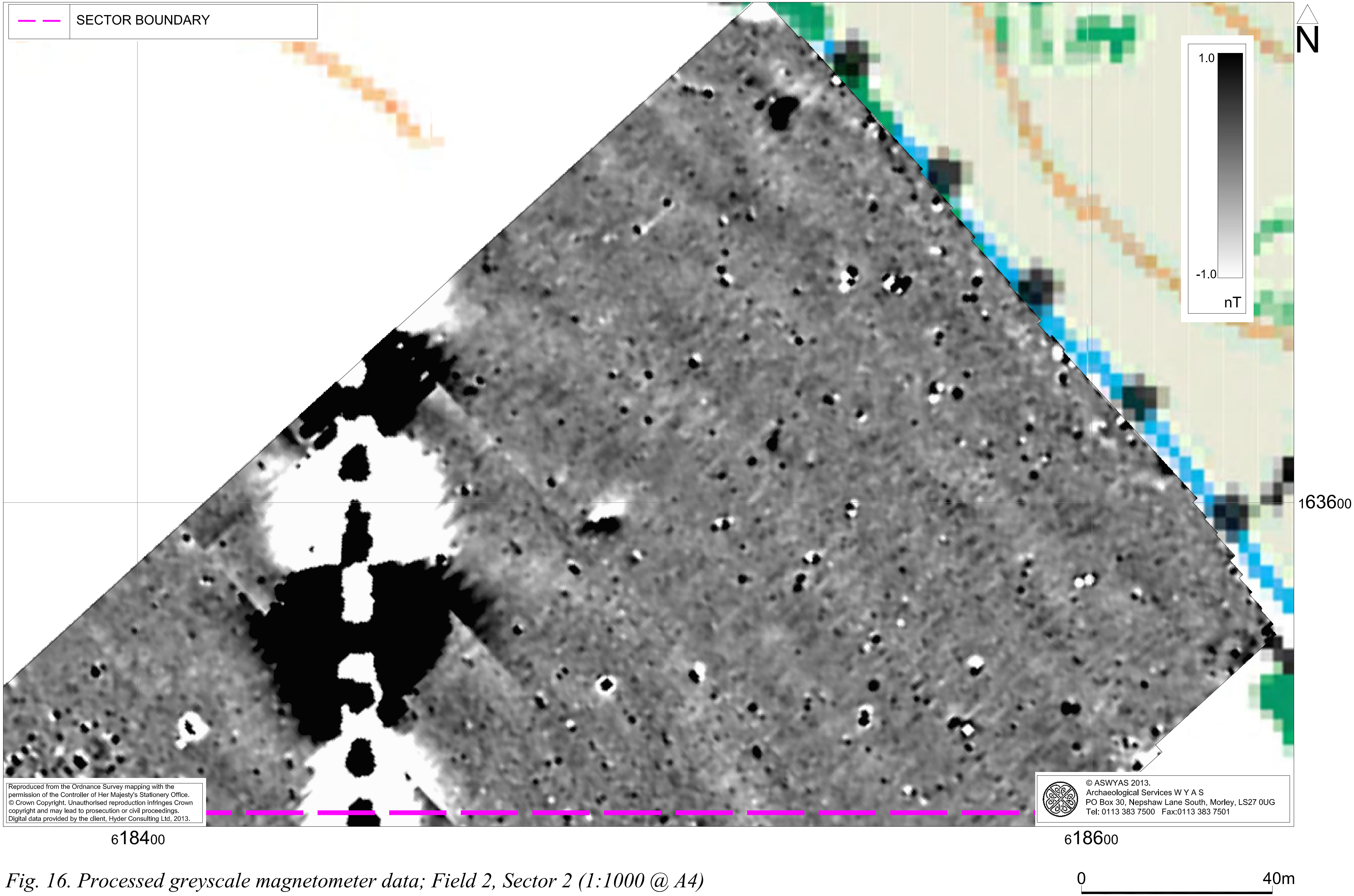

Fig. 16. Processed greyscale magnetometer data; Field 2, Sector 2 (1:1000 @ A4)

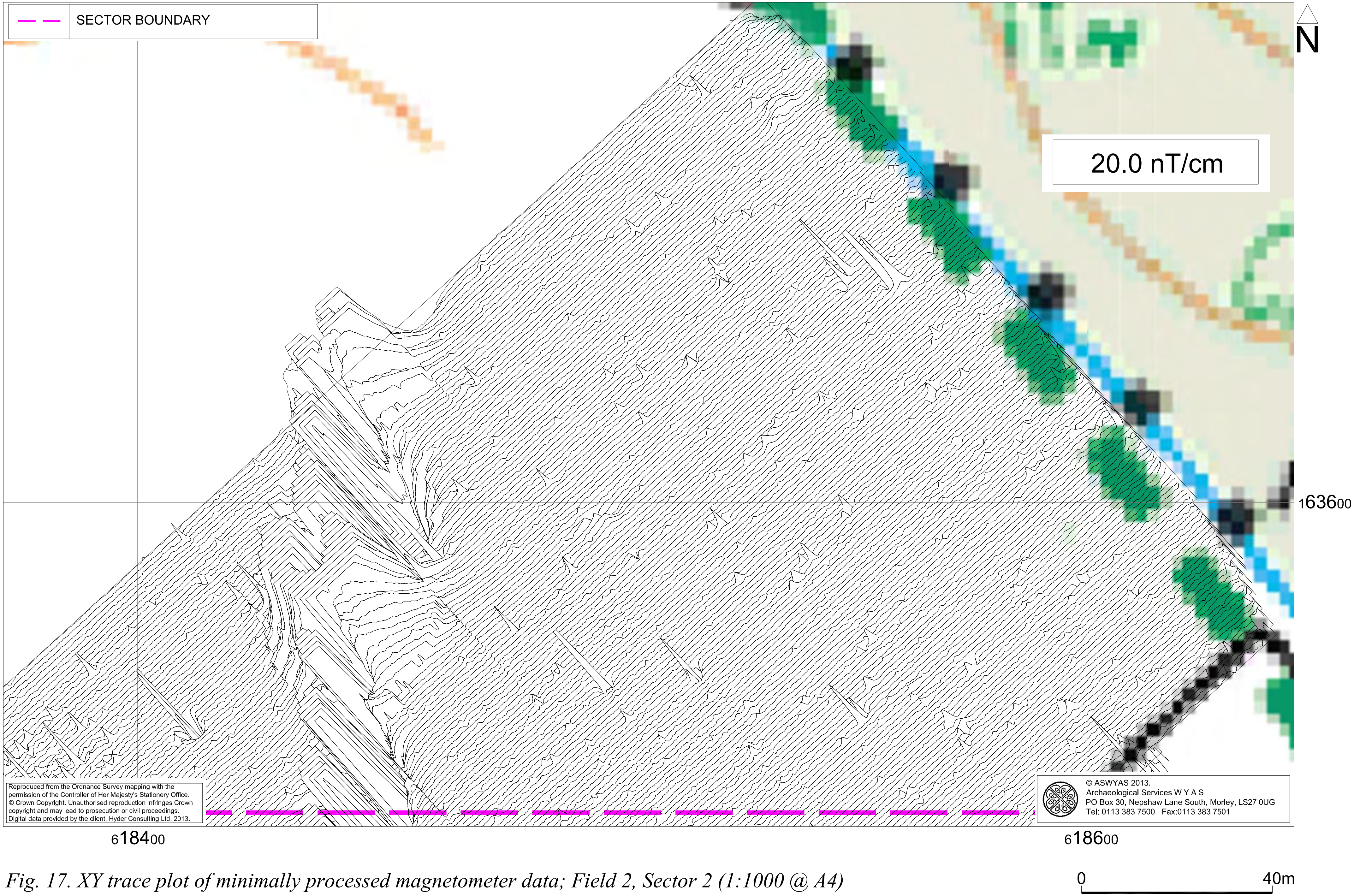

Fig. 17. XY trace plot of minimally processed magnetometer data; Field 2, Sector 2 (1:1000 @ A4)

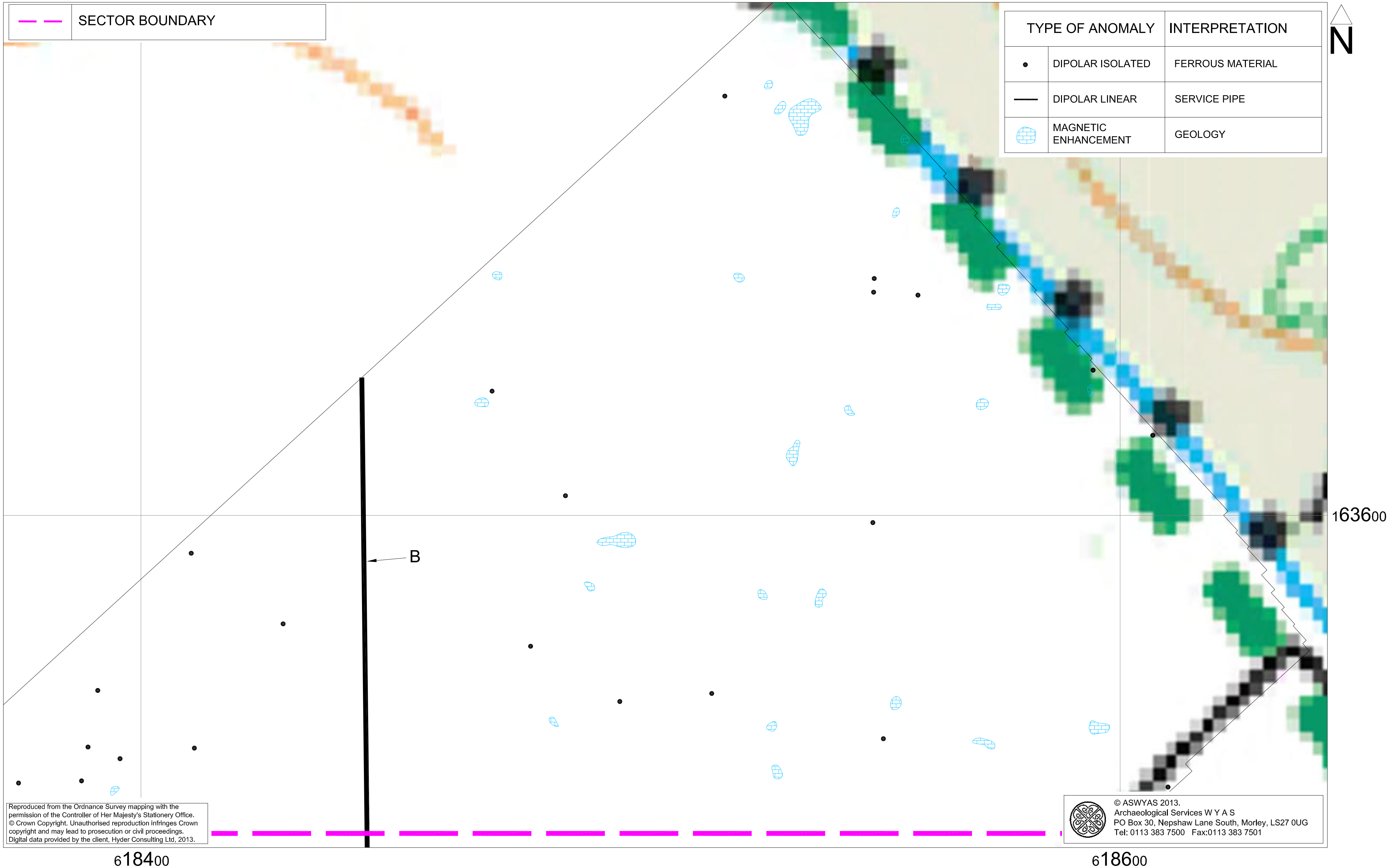

Fig. 18. Interpretation of magnetometer data; Field 2, Sector 2 (1:1000 @ A4)


Plate 1. General view of Field 1, looking south-east


Plate 2. General view of Field 1, looking south-west


Plate 3. General view of Field 2, looking south-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 Kent Historic Environment Record).

Bibliography

British Geological Survey, 2013. www.bgs.ac.uk/discoveringGeology/geology OfBritain/viewer.html . (Viewed September 16th 2013)

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

Harrison, D. 2013. *Land at Woodlands Farm, Kent; Geophysical Survey Project Design* Unpublished ASWYAS Document

Institute for Archaeologists, 2010. *Standard and Guidance for archaeological geophysical survey.* IfA

Soil Survey of England and Wales, 1983. *Soil Survey of England and Wales: Soils of Midland and Western England*, Sheet 3