Archaeological Services WYAS

Knaresborough Overhead Line
Bramham Moor
West and North Yorkshire

Geophysical Survey

Report no. 2435

January 2013

Client: Parsons Brinckerhoff

Knaresborough Overhead Line
Bramham Moor
West and North Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 9.5 hectares, was carried out along the proposed route for a scheme of pylon replacement across Bramham Moor. The survey has identified numerous anomalies which are caused by sub-surface archaeological features and which have been previously identified as cropmarks. In addition many other anomalies of obvious archaeological potential, not previously identified as cropmarks, have also been identified confirming the high archaeological potential of this area. These anomalies are indicative of infilled ditches forming fields and enclosures of likely late Iron Age/Romano-British date and are identified along all sections of the proposed route. In addition anomalies defining the line of a Roman road have also been identified. Overall the potential for encountering archaeological remains in any section of the scheme is considered to be high.

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Report Information

Client:	Parsons Brinckerhoff Ltd
Address:	Amber Court, William Armstrong Drive, Newcastle-upon-Tyne, NE4 7YQ
Report Type:	Geophysical Survey
Location:	Bramham Moor
County:	West and North Yorkshire
Grid Reference:	SE 4350 4230 (west) to SE 4600 4180 (east)
Period(s) of activity: represented	Prehistoric/Roman/Romano-British
Report Number:	2435
Project Number:	4008
Site Code:	KOL12
OASIS ID	archaeol11-143634
Planning Application No.:	n/a
Museum Accession No.:	n/a
Date of fieldwork:	December 2012
Date of report:	January 2013
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Authorisation for distribution: --

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1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Simon McCudden of Parsons Brinckerhoff, on behalf of their clients Northern Powergrid (Yorkshire) plc, to undertake a programme of geophysical survey along three routes along which it is proposed to upgrade electricity pylons (see Fig. 1). The work was carried out after consent for the scheme had been granted but in advance of any groundworks. The scheme of work was undertaken in accordance with guidance contained with the National Planning Policy Framework (2012) and to a Project Design (Archaeological Services WYAS 2012 – see Appendix 1). The survey was carried out between December 3rd and December 6th 2012.

Site location, land-use and topography

The survey area comprised three discrete sections (see Fig. 2). Section 1 is located 0.5km west of Bramham Moor sub-station and is centred at SE 437 422 whilst Section 2 is located 0.5km east of the sub-station, centred at SE 449 419. Both these areas lie in West Yorkshire. Section 3 is 0.25km east of Section 2 and is situated in North Yorkshire, centred at SE 457 418.

All of the survey routes traverse across agricultural land, predominantly arable fields that had recently been ploughed and re-seeded.

Geology and soils

The underlying bedrock comprises Dolostone of the Cadeby Formation (British Geological Survey 2013). There are no superficial deposits. The soils along all sections of the survey corridor comprise shallow, locally brashy, well-drained calcareous fine loams over limestone (Soil Survey of England and Wales 1983).

2 Archaeological and Historical Background

An Environmental Statement produced on behalf of National Grid in 2006 identified that the landscape around Bramham Moor Sub-station has a high archaeological potential. This potential was primarily based on analysis of air photographs which reveal extensive cropmarks in the Bramham Moor area. These cropmarks are interpreted as features of probable late Iron Age or Roman date indicative of the buried remains of field systems, enclosures and settlements. A Roman road is also thought to cross this landscape.

A geophysical survey recently carried out by ASWYAS (Webb 2012), also across the Bramham Moor landscape, confirmed and enhanced the cropmark evidence locating many of the cropmark features as well as other sub-surface features not previously identified as cropmarks. The line of the Roman road was also confirmed.

3 Aims, Methodology and Presentation

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact of the proposed development on any potential archaeological remains and for mitigation proposals, if appropriate, to be recommended. To achieve this aim a magnetometer survey covering the three sections of the cable corridor was carried out. In total an area of 9.5 hectares was surveyed.

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

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 2.

Reporting

A general site location plan, incorporating the Ordnance Survey map, is shown in Figure 1. Figure 2 shows the sections of the survey corridor with the magnetometer data and the boundaries from the first edition Ordnance Survey overlaid at a scale of 1:7500. Figure 3, also at 1:7500, shows the data with the cropmark data overlaid. Greyscale plots of the data in each of the three sections together with the interpretations are presented at a scale of 1:2500 in Figures 4 to 9 inclusive with large scale (1:1000) plots and interpretations by sector presented in Figures 10 to 30 inclusive.

Further technical information on the equipment used, data processing and survey methodologies are given in Appendix 2 and Appendix 3. Appendix 4 describes the composition and location of the site archive.

Archaeological Services WYAS is registered with the Online Access to the Index of archaeological investigations project (OASIS). The OASIS ID for this project is archaeol11-143634.

The geophysical survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the Institute for Archaeologists (IfA 2010). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The figures in this report have been produced following analysis of the data in 'raw' and processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.

4 Results and Discussion (see Figs 3 to 30 inclusive)

Ferrous Anomalies - Modern

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. Ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. Throughout the corridor iron 'spike' anomalies are common and there is no obvious pattern or clustering to their distribution to suggest anything other than a random background scatter of ferrous debris in the plough-soil.

Agricultural Anomalies – Post-medieval

Parallel linear trend anomalies have been identified in most sectors of the surveyed area. The relatively narrow corridor width makes it difficult to establish a specific cause for any of these anomalies but all are likely to relate to agricultural activity, specifically ploughing (recent and post-medieval ridge and furrow ploughing), land drains or former boundaries.

Section 1 (see Figs 4 and 5 and 10 to 18 inclusive)

The effects of the existing electricity infrastructure can be clearly seen in the data, particularly in Sector 1 where the effects of the proximity of two pylons has resulted in massive magnetic disturbance which manifests as the observed 'halo' effect around the two structures. The other areas of magnetic disturbance in Sector 1 are also due to above and below ground structures associated with electricity supply. The same 'halo' effect can also be seen to the south-east in Sector 2, again due to the proximity of a pylon, just to the north of the survey area. These very strong readings mean that the much weaker responses of any sub-surface archaeological features, if present, in the immediate vicinity of these highly magnetic steel structures are likely to be 'masked'. Several discrete anomalies have been interpreted as possibly archaeological but given the amount of magnetic disturbance this interpretation should be treated with a degree of caution.

Beyond the zone affected by the pylons anomalies of obvious archaeological origin can be clearly discerned. In the southern arm of Sector 1 anomalies, indicative of infilled ditches, forming three conjoining enclosures (two complete and one partial), **A**, **B** and **C**, are present. These enclosures have not previously been identified as cropmarks although a single linear cropmark does correlate with the ditch forming the northern side of enclosure **B** (see Fig. 5). Discrete anomalies within the enclosures are also likely to have an archaeological origin.

To the south and east of the pylons short linear, ditch-type, anomalies, **D** and **E**, are also identified. These two anomalies correlate with cropmark features, forming part of a field system to the east of the three enclosures described above.

A linear trend anomaly at right angles to anomaly **E** locates a recently removed field boundary. Regularly spaced linear trend anomalies are also indicative of agricultural activity being due to recent ploughing.

In Sector 2 linear anomalies defining four more enclosures/fields, **F**, **G**, **H** and **I**, have been identified. Here too the magnetic data significantly enhances the archaeological knowledge as the cropmark evidence is fairly fragmentary in this part of the landscape (see Fig. 5).

Sector 3 comprises a very small area split into three small parcels by intersecting boundaries. A single linear anomaly, **J**, has been tentatively interpreted as archaeological but it does not correspond with any cropmark and an agricultural origin (ploughing) is equally plausible.

Section 2 (see Figs 6 and 7 and 19 to 24 inclusive)

Within Section 2 the response of an electricity pylon has been identified in Sector 4. This is located within an existing field boundary. A service pipe has also been identified within Sector 4 running in a north-south direction.

In the eastern part of Sector 5 numerous discrete anomalies (areas of localised magnetic enhancement) have been recorded in the survey. On the prevailing bedrock geology these anomalies may be due to natural features, such as solution hollows, eroded into the bedrock which have become filled with topsoil. These anomalies might also be caused by infilled archaeological features, such as pits or post-holes, but on balance a geological origin is preferred.

To the immediate north of the field boundary in Sector 4, parallel linear anomalies, **K** and **L**, which are indicative of roadside ditches, are thought to locate the Roman road. Two clusters of discrete anomalies, **M** and **N**, to the north and south of the road respectively, are thought to be caused by infilled extraction pits from which limestone would have been quarried for use in the construction of the road.

Four linear ditch type anomalies, **O**, **P**, **Q** and **S**, have been recorded. Anomalies **O** and **P** possibly form part of a field system that is on a different alignment to the Roman road, perhaps indicating an earlier or later origin. These anomalies do not correspond with the cropmarks. An enclosure, **R**, is located at the junction of anomalies **Q** and **S** and contains a number of anomalies that may represent internal features. These anomalies do correspond with cropmarks.

Section 3 (see Figs 8 and 9 and 25 to 30 inclusive)

A large dipolar linear and associated magnetic disturbance has been identified in the west of Sector 6, represents the route of a gas pipeline. As with the pylon structures in Section 1 (see above), these very strong readings mean that the much weaker responses of any sub-surface archaeological features, if present, in the immediate vicinity of the service pipe are likely to be ‘masked.

In Sector 6 and Sector 7 four linear ditch type anomalies, **T**, **U**, **V** and **W** have been identified. Of these anomalies only **T** is not recorded as a cropmark. In close proximity to these ditches a number of discrete anomalies (areas of localised magnetic enhancement) have been identified. As in Section 2 (see above) these anomalies may be due to natural features, or caused by infilled archaeological features such as pits or post-holes.

A former field boundary is evident in Sector 7, identifiable as a negative/positive linear anomaly.

5 Conclusions

The geophysical survey has identified anomalies of probable archaeological origin along all sections of the route of the overhead line and in the majority of the seven sectors confirming and enhancing the cropmark data. A series of anomalies forming enclosures have been identified within Sector 1, 2 and Sector 5. In Section 4 anomalies confirming the line of a Roman road have been identified with discrete anomalies interpreted as roadside quarry pits also located. Ditches probably indicating a field system have been recorded in Sector 1 and Sectors 4 to 7 inclusive. Overall on the basis of the geophysical survey the archaeological potential is considered to be high.

Disclaimer

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.

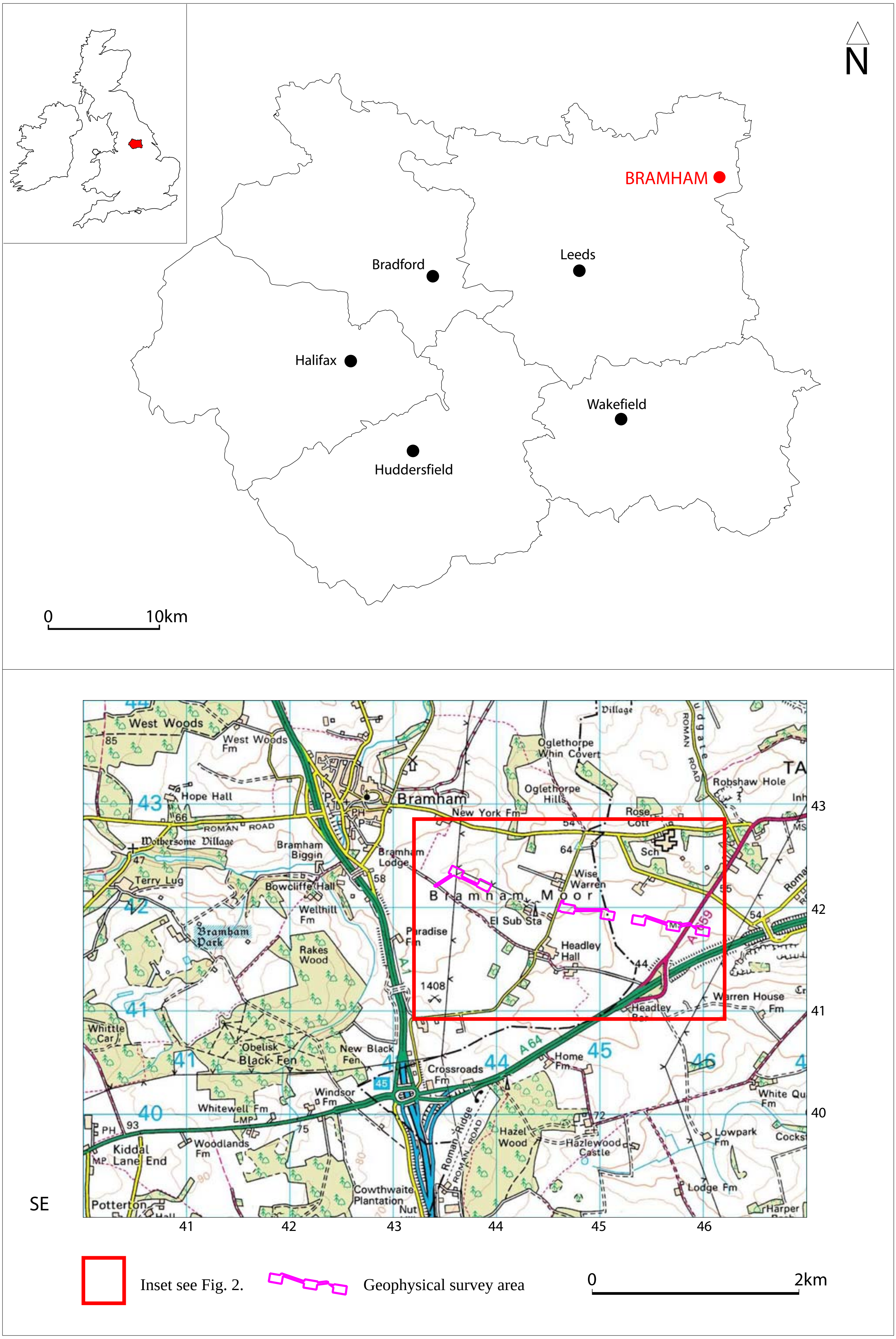

Fig. 1. Site location

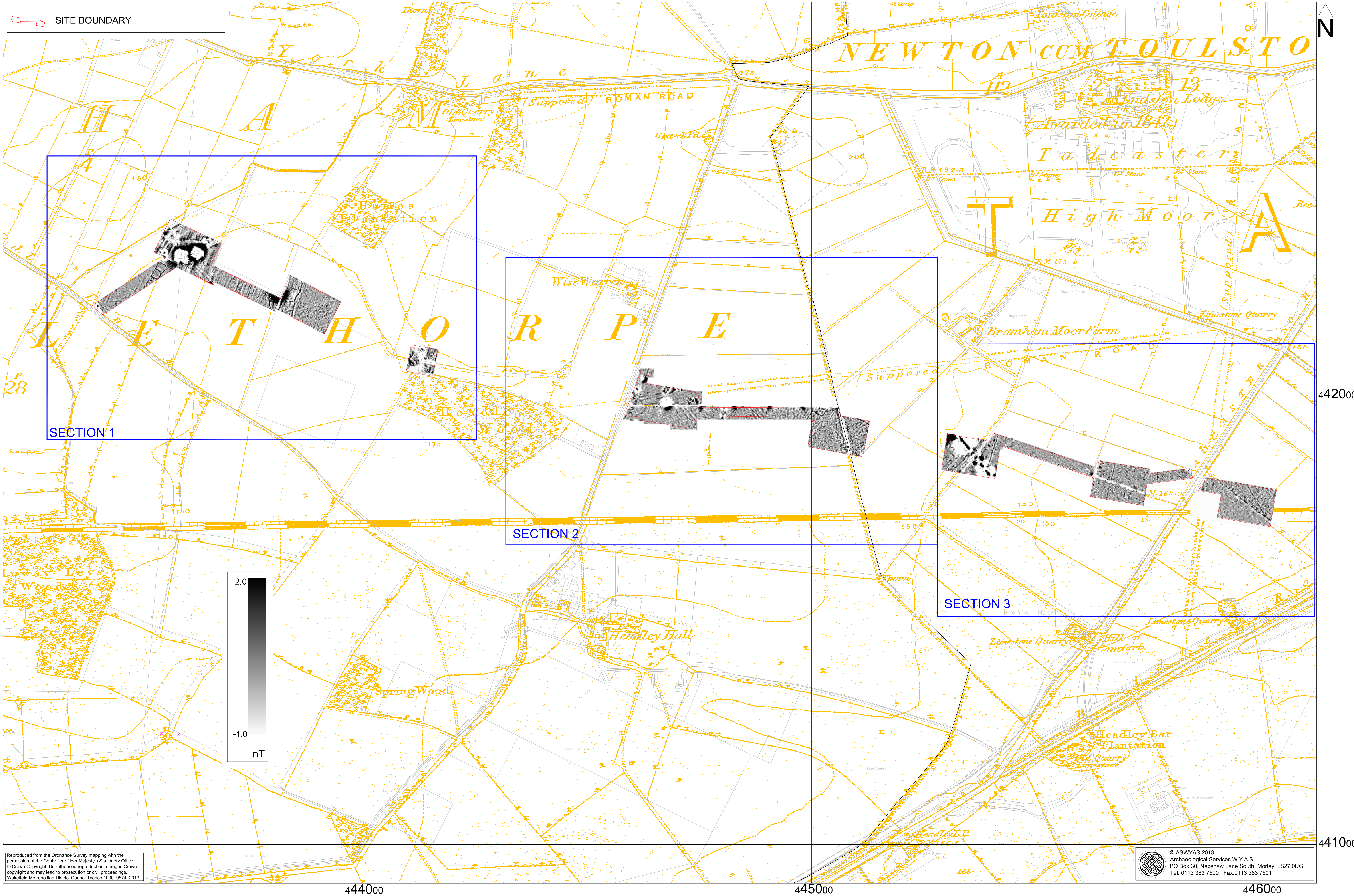

Fig. 2. Site location showing first edition Ordnance Survey mapping and greyscale magnetometer data (1:7500 @ A3)

0 150m

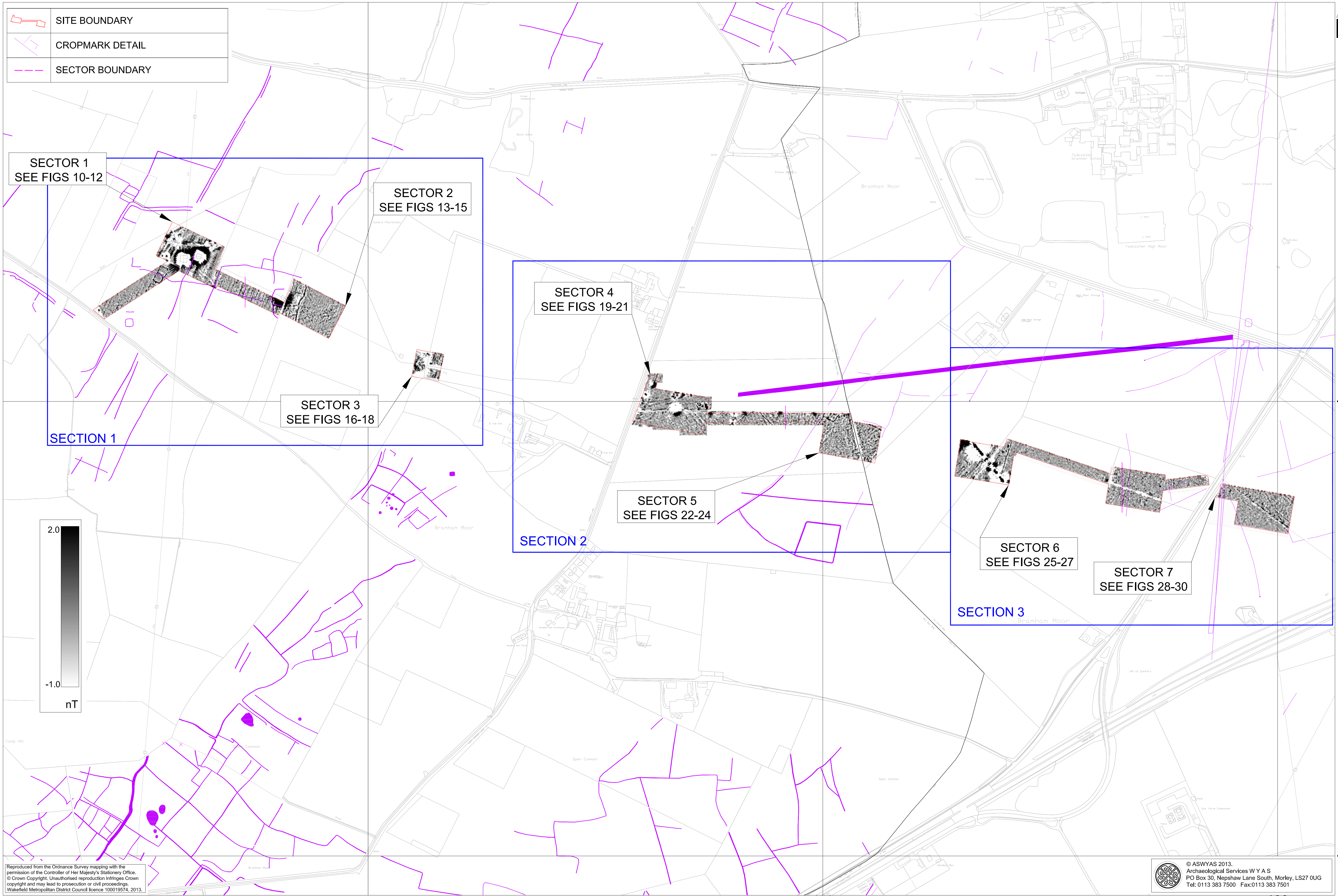

Fig. 3. Site location showing survey data and cropmarks (1:7500 @ A3)

Fig. 4. Processed greyscale magnetometer data; Section 1 (1:2500 @ A3)

0 100m

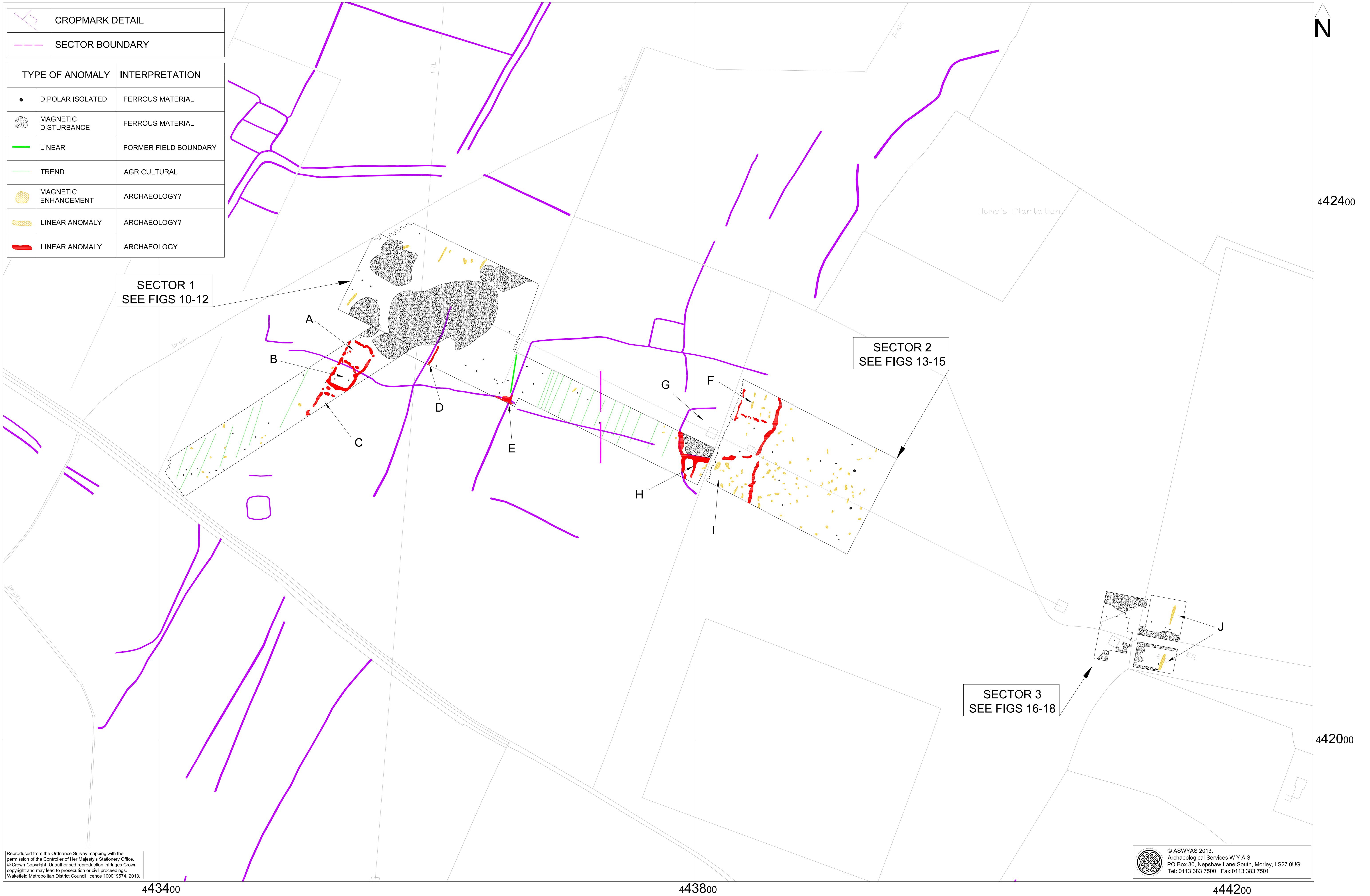

Fig. 5. Interpretation of magnetometer data; Section 1 (1:2500 @ A3)

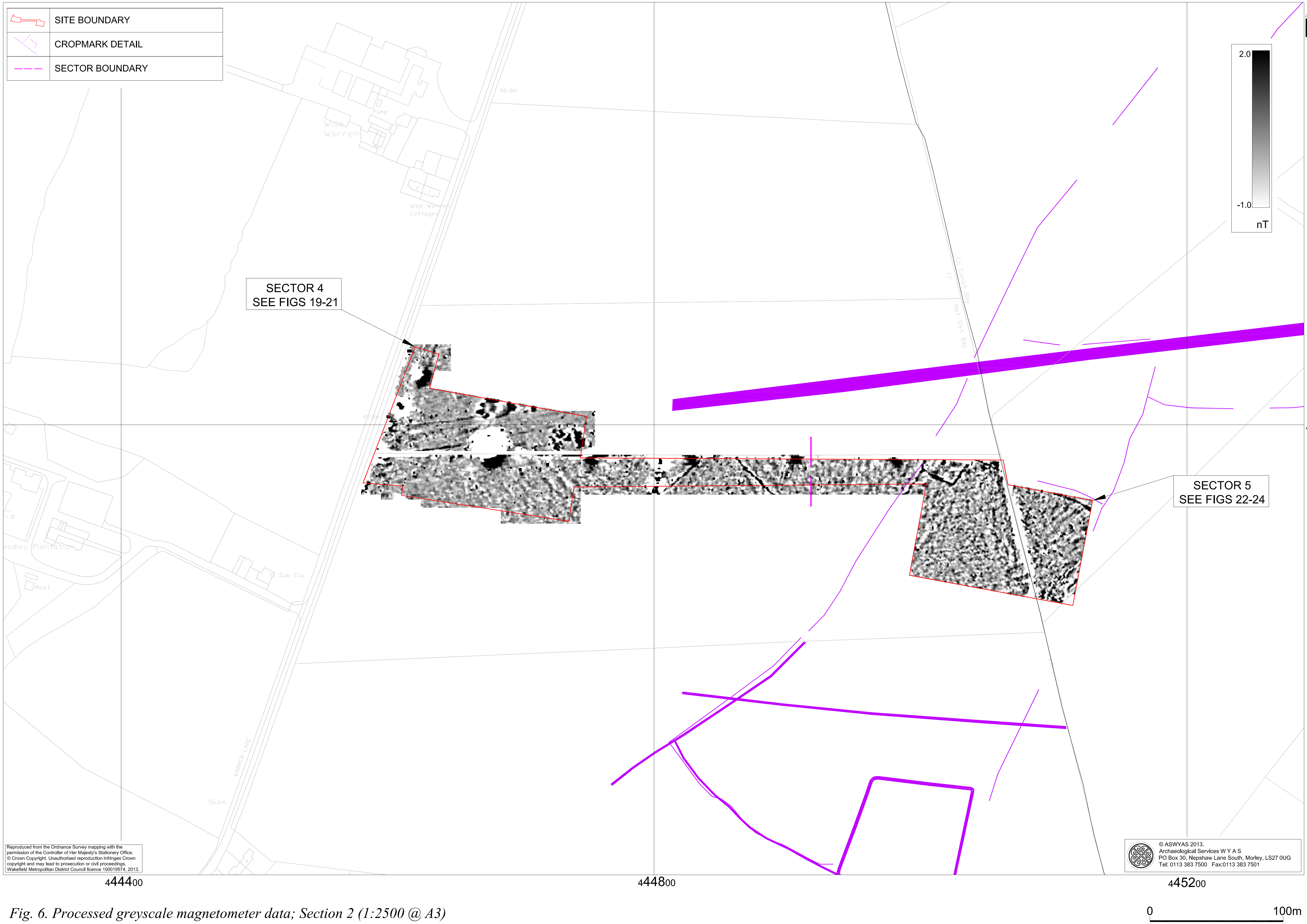

Fig. 6. Processed greyscale magnetometer data; Section 2 (1:2500 @ A3)

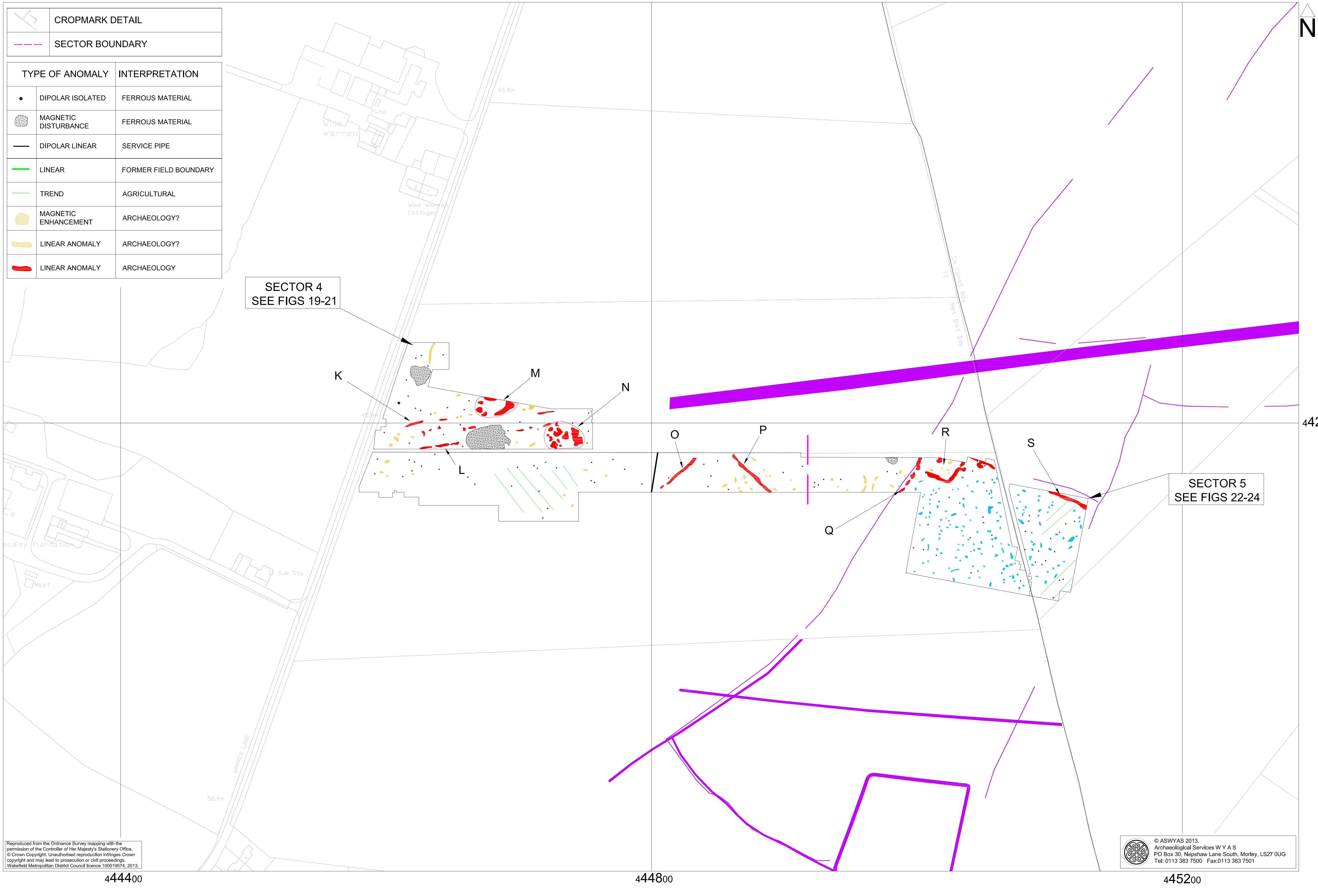

Fig. 7. Interpretation of magnetometer data; Section 2 (1:2500 @ A3)

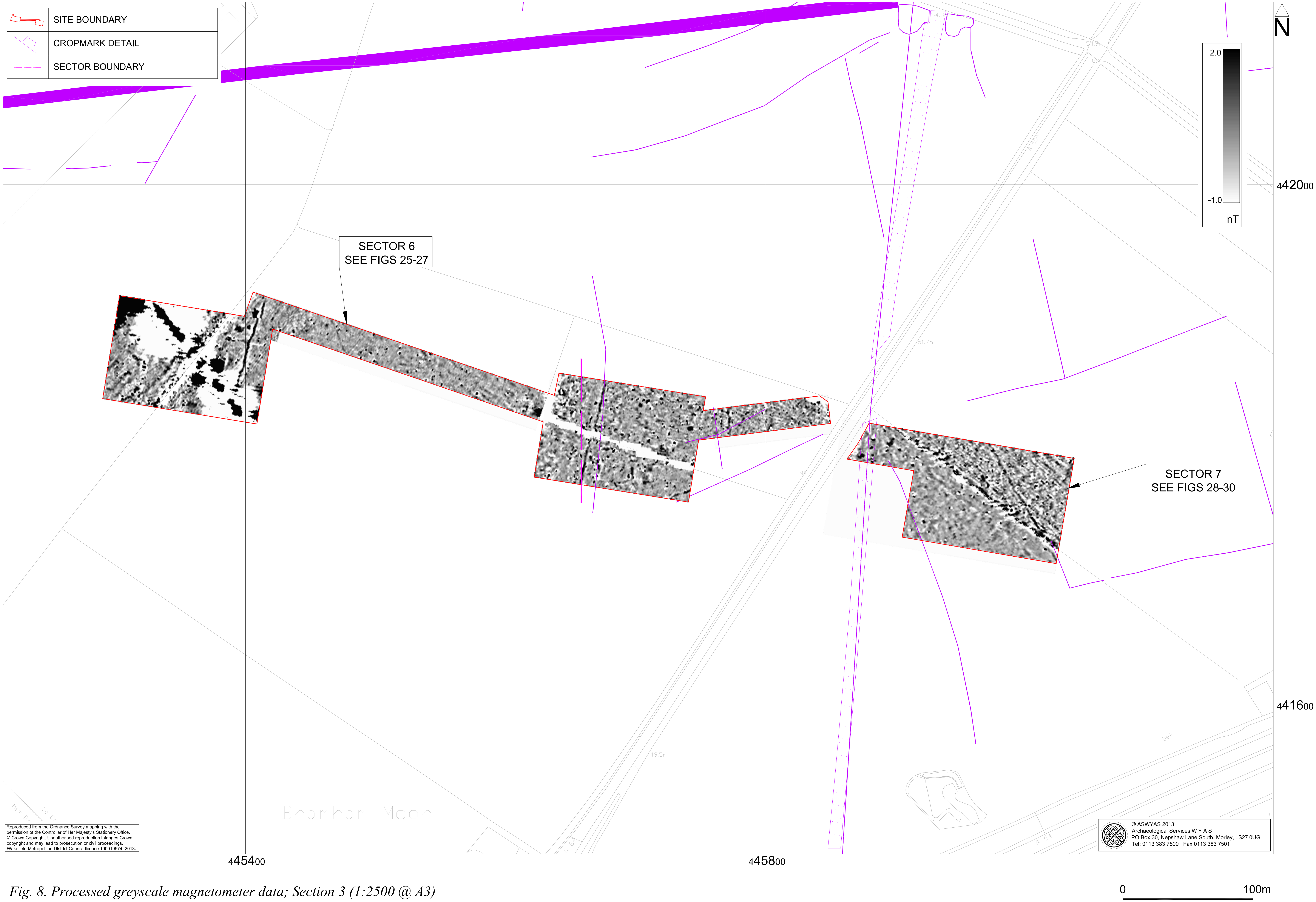

Fig. 8. Processed greyscale magnetometer data; Section 3 (1:2500 @ A3)

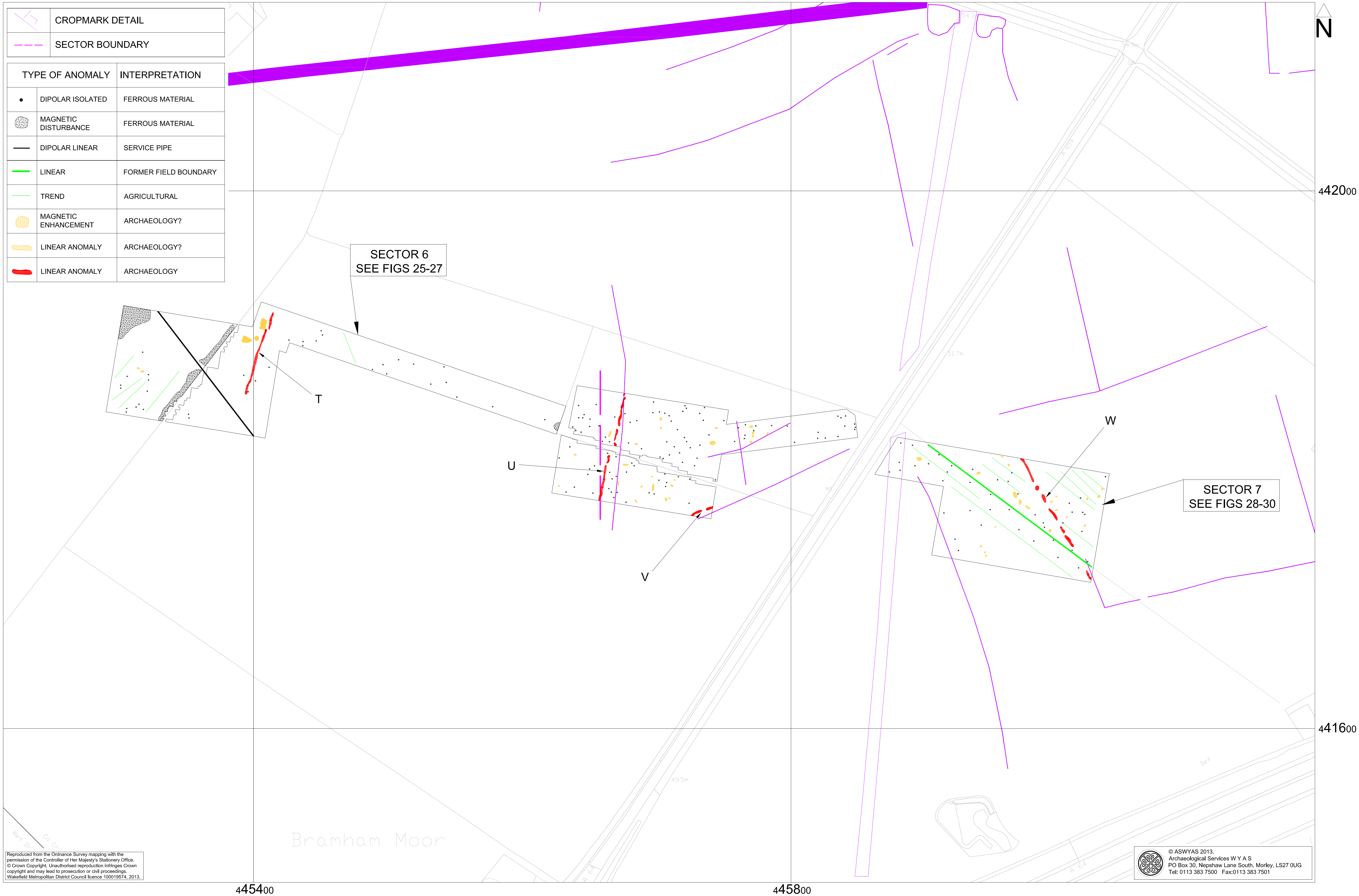

Fig. 9. Interpretation of magnetometer data; Section 3 (1:2500 @ A3)

0 100m

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

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

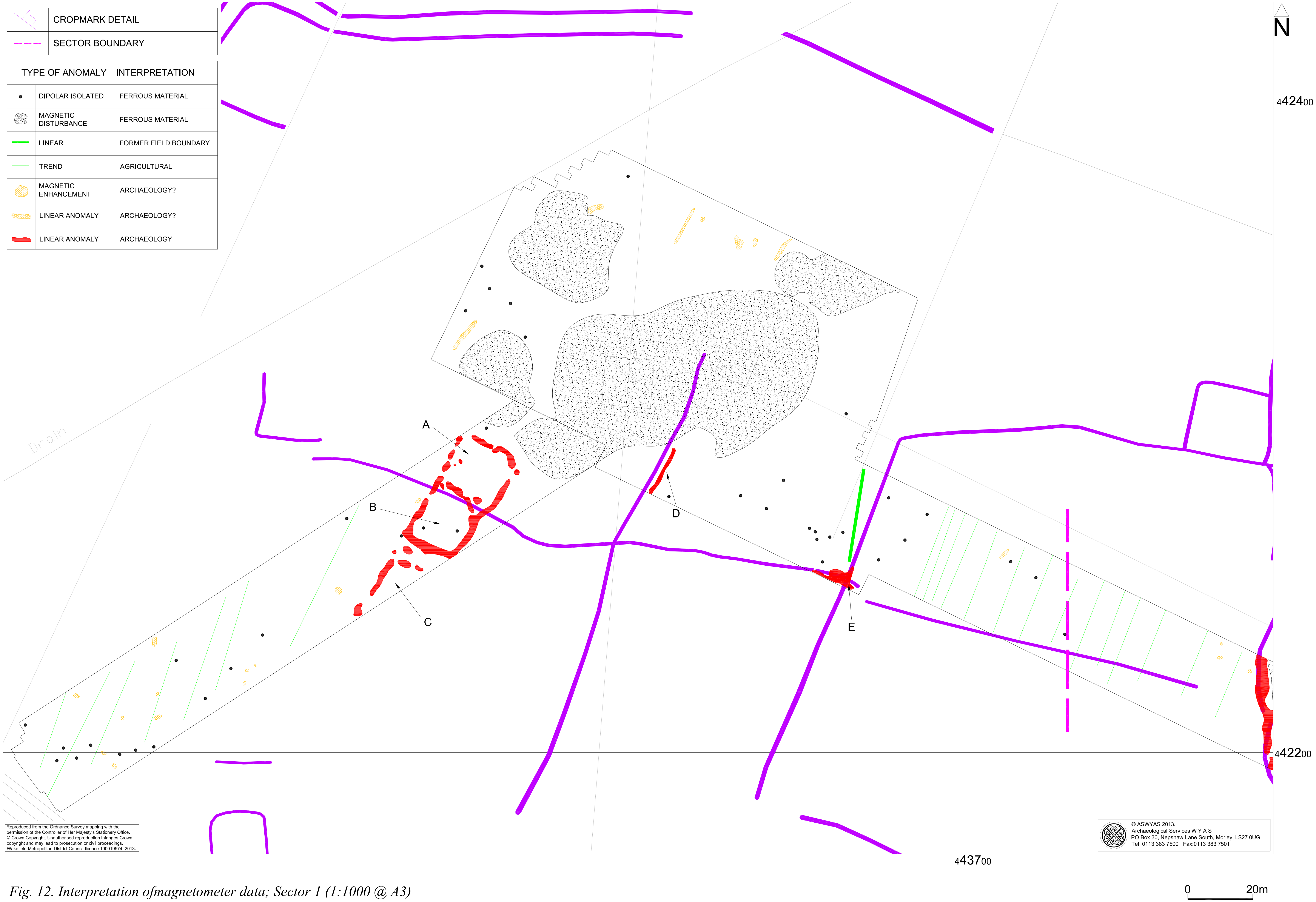

Fig. 12. Interpretation ofmagnetometer data; Sector 1 (1:1000 @ A3)

Fig. 13. Processed greyscale magnetometer data; Sector 2 (1:1000 @ A4)

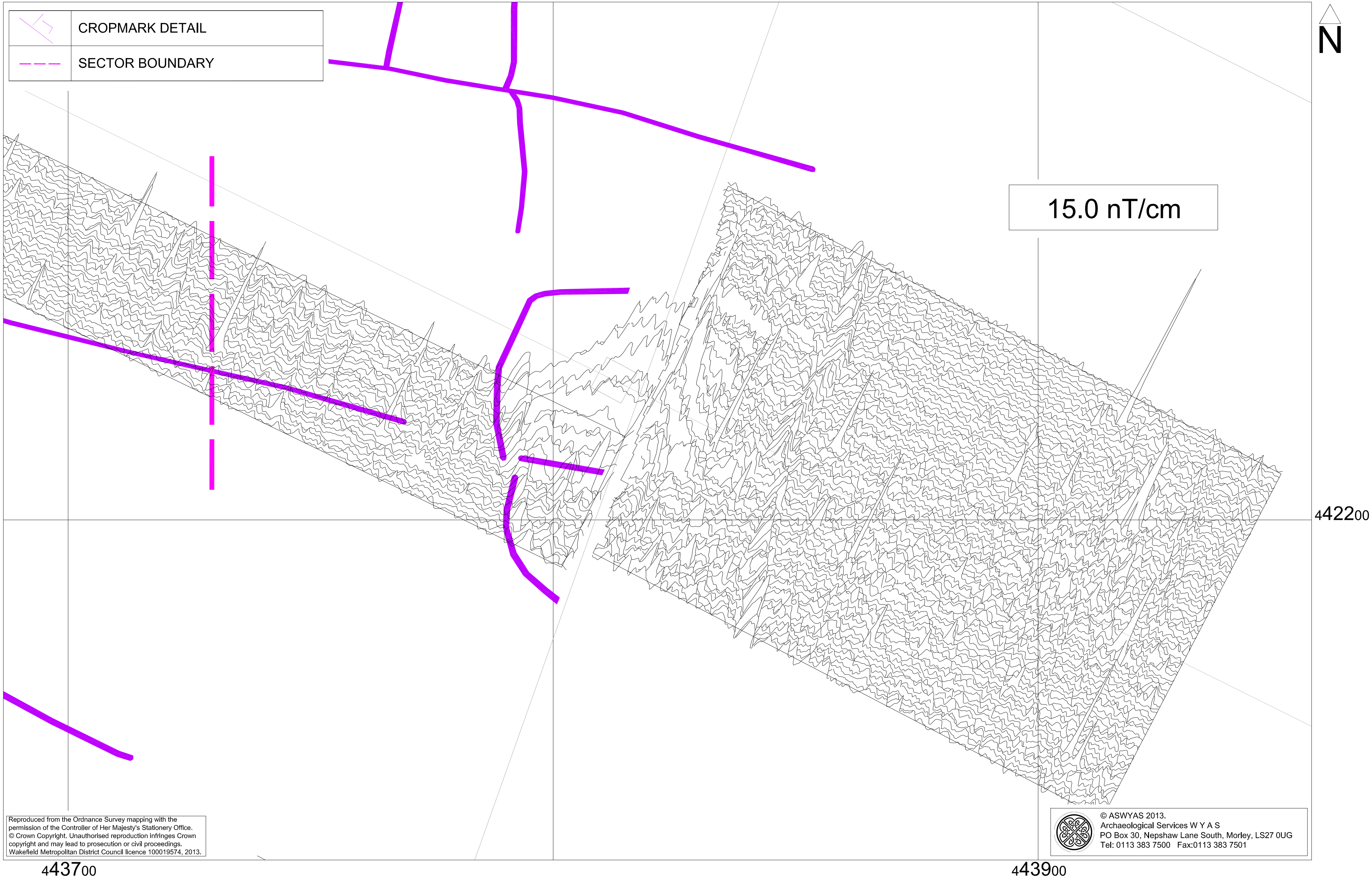

Fig. 14. XY trace plot of minimally processed magnetometer data; Sector 2 (1:1000 @ A4)

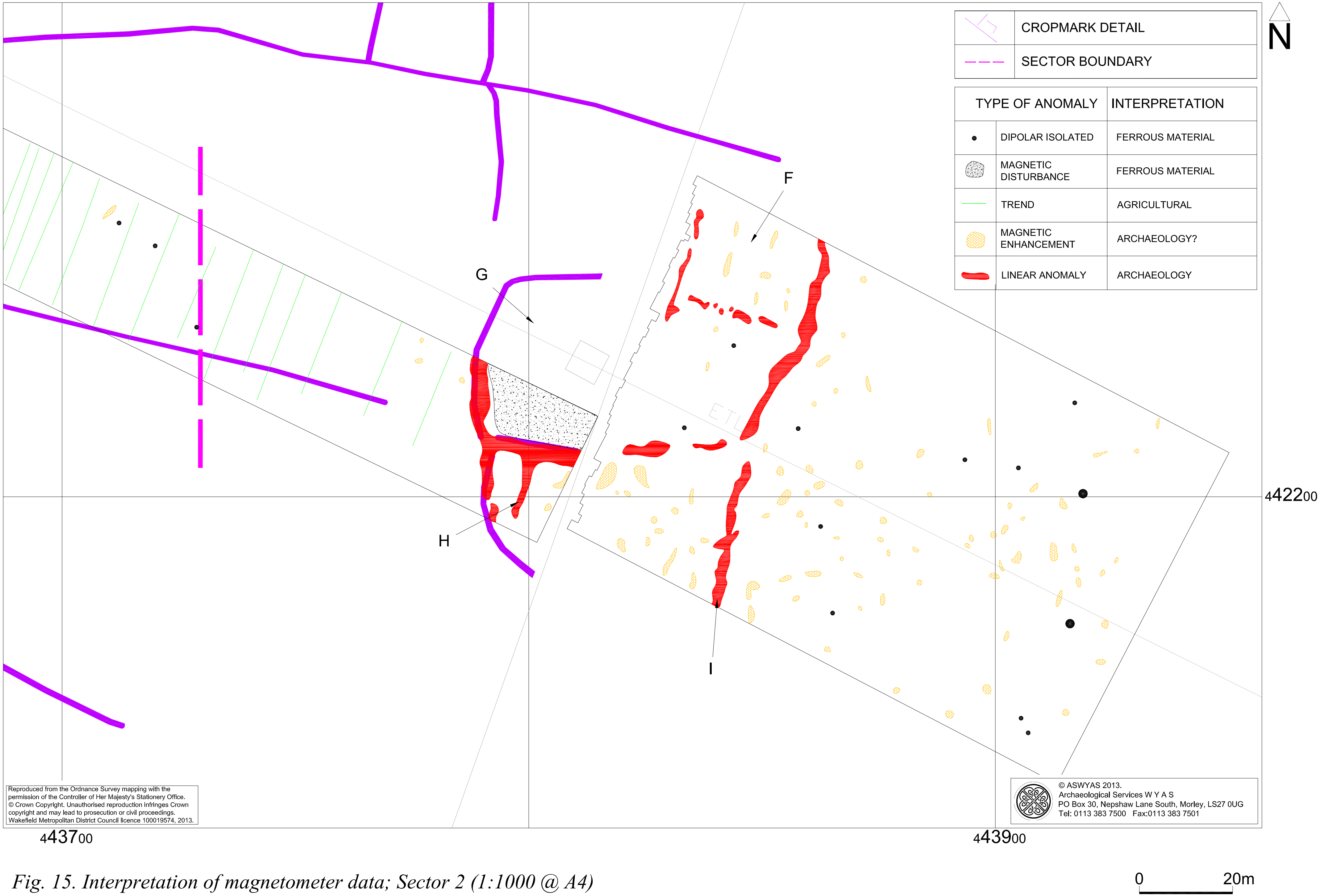

Fig. 15. Interpretation of magnetometer data; Sector 2 (1:1000 @ A4)

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Fig. 16. Processed greyscale magnetometer data; Sector 3 (1:1000 @ A4)

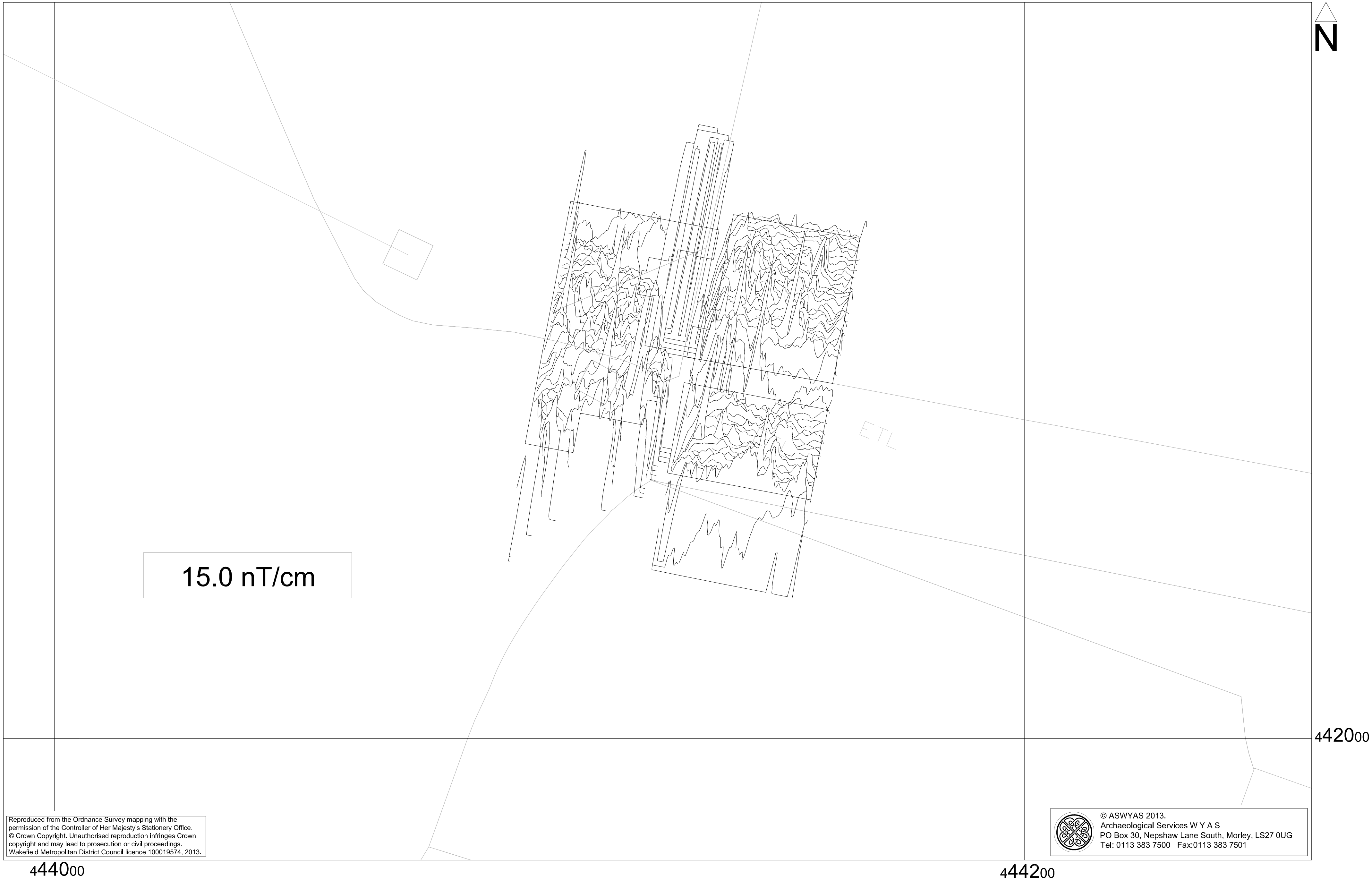

Fig. 17. XY trace plot of minimally processed magnetometer data; Sector 3 (1:1000 @ A4)

0 20m

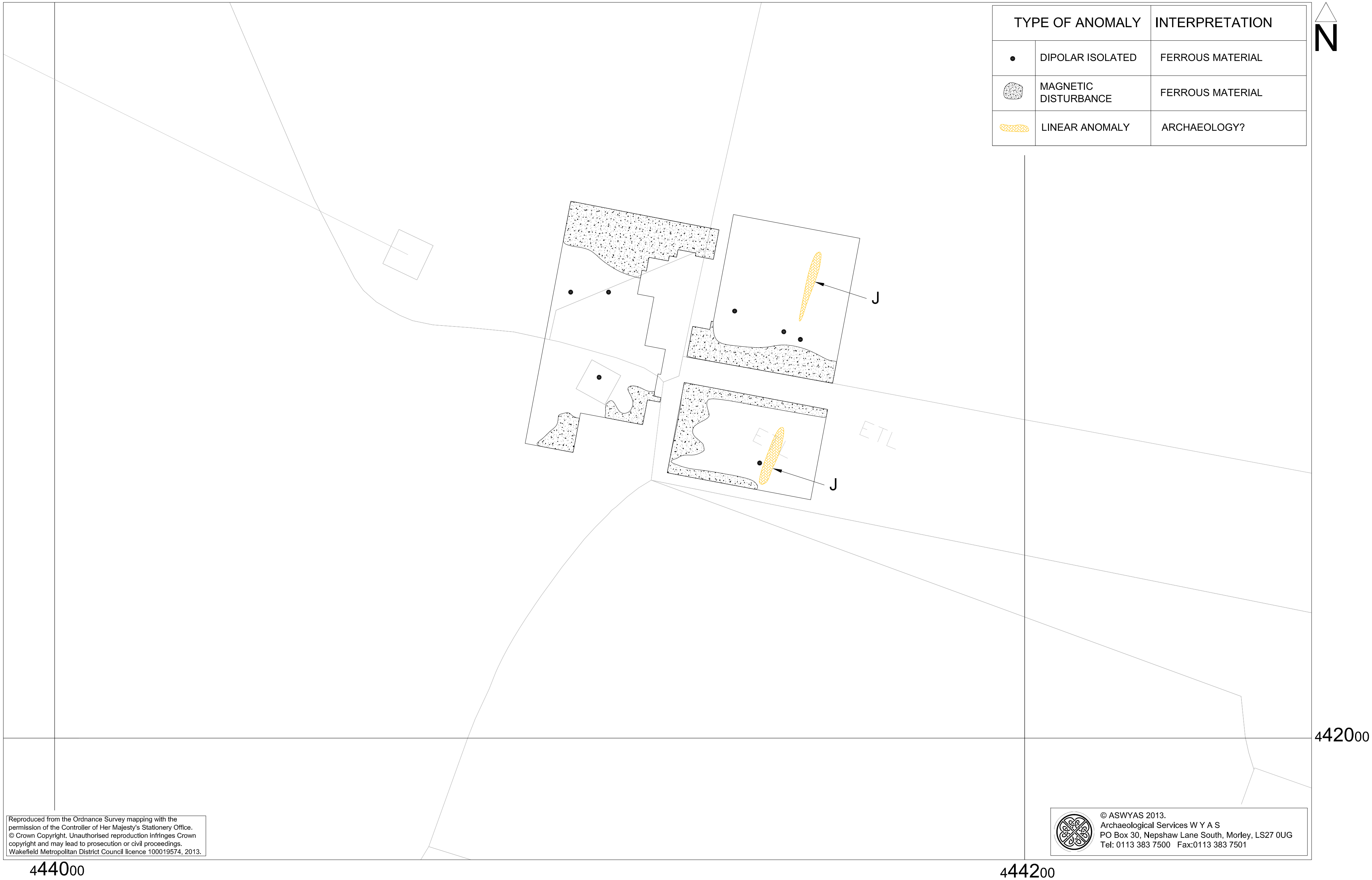

Fig. 18. Interpretation of magnetometer data; Sector 3 (1:1000 @ A4)

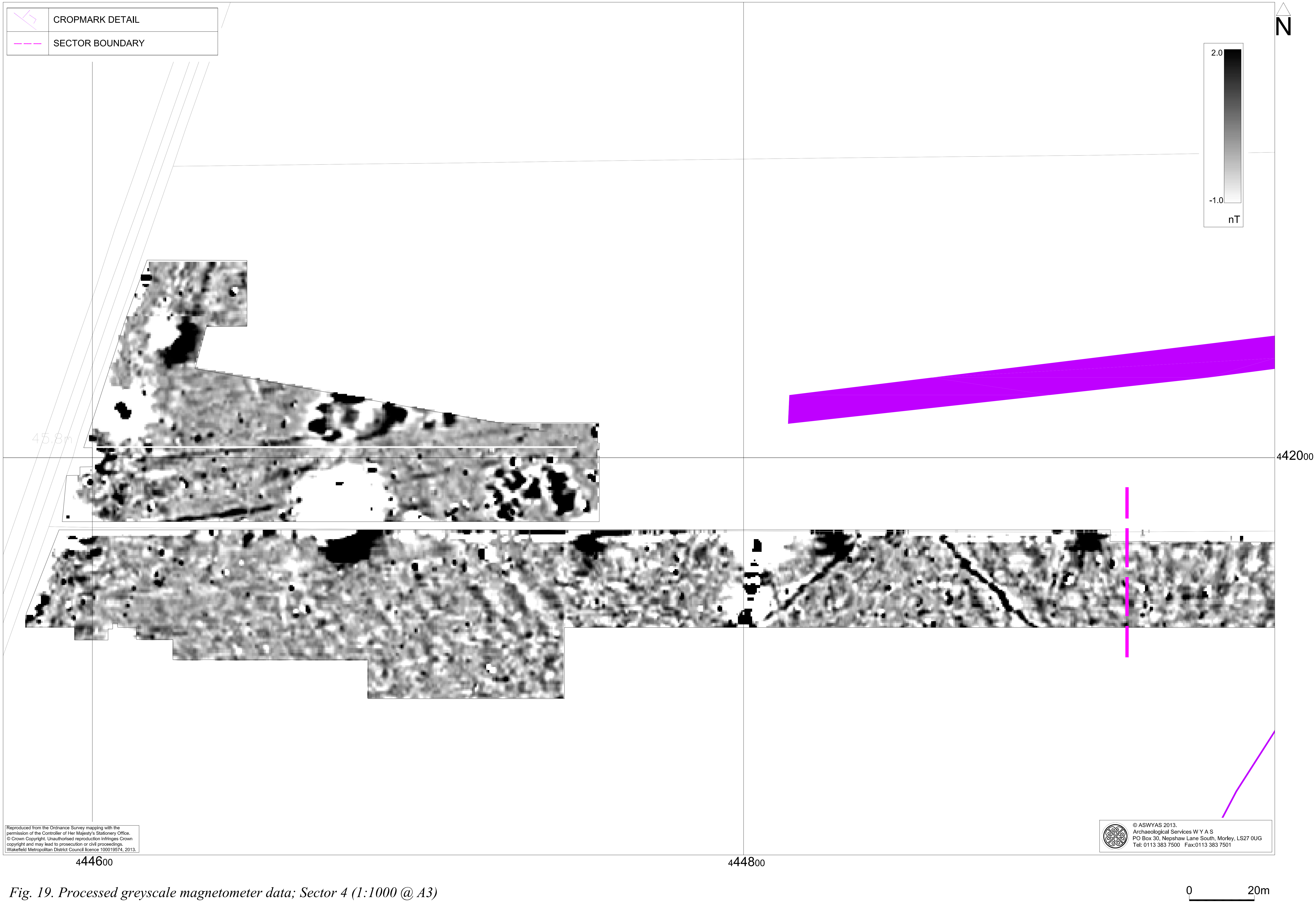

Fig. 19. Processed greyscale magnetometer data; Sector 4 (1:1000 @ A3)

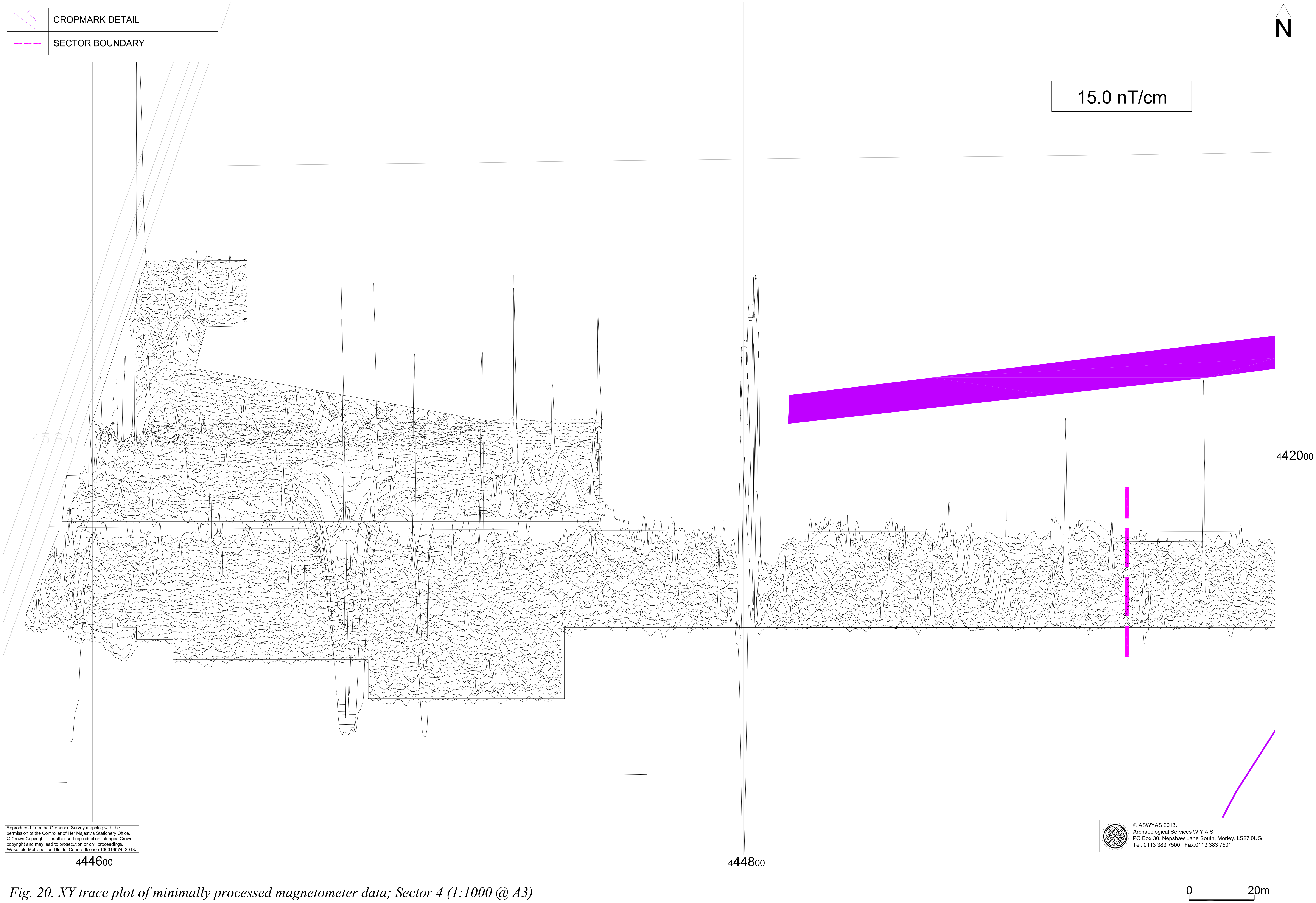

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Fig. 20. XY trace plot of minimally processed magnetometer data; Sector 4 (1:1000 @ A3)

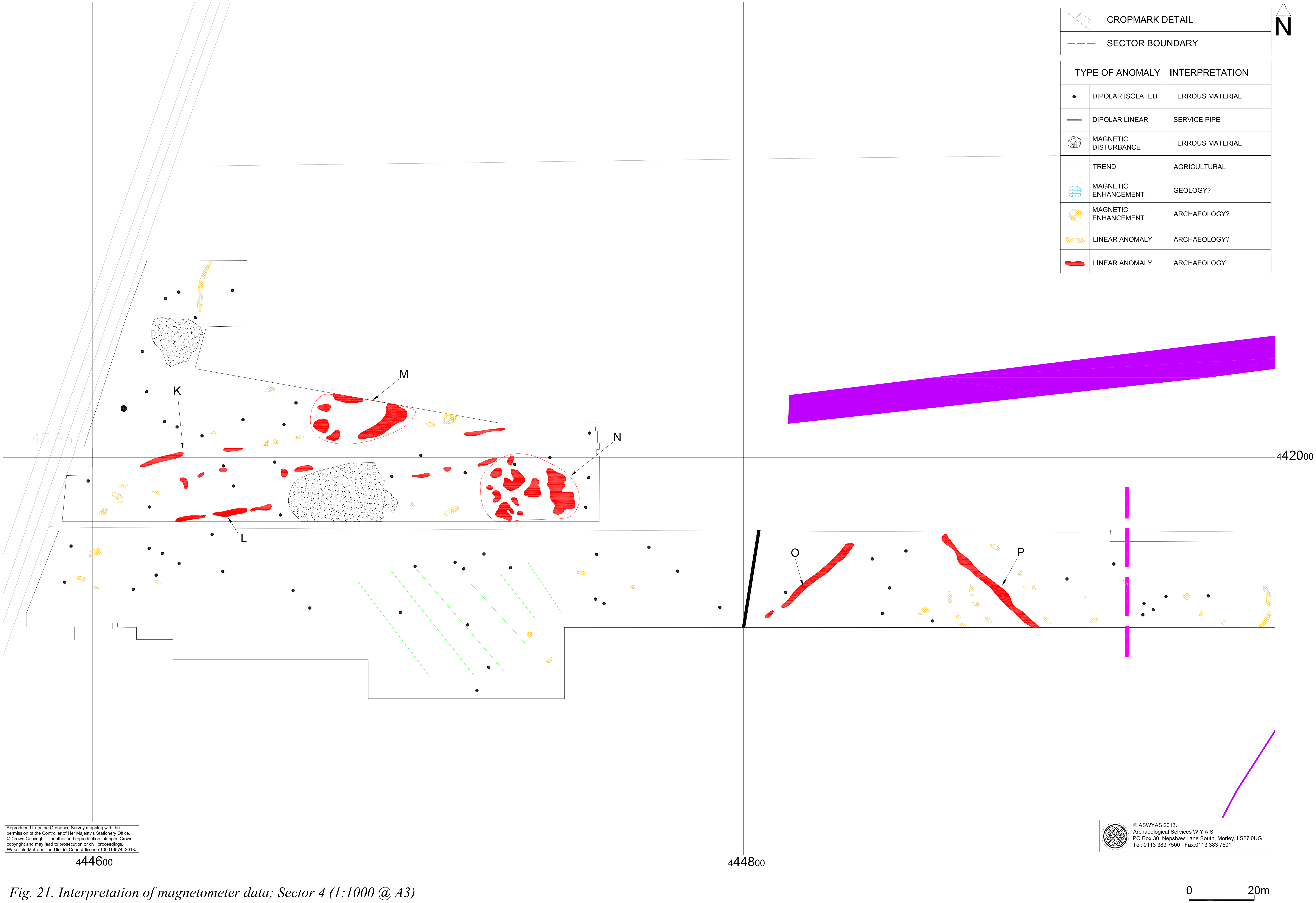

Fig. 21. Interpretation of magnetometer data; Sector 4 (1:1000 @ A3)

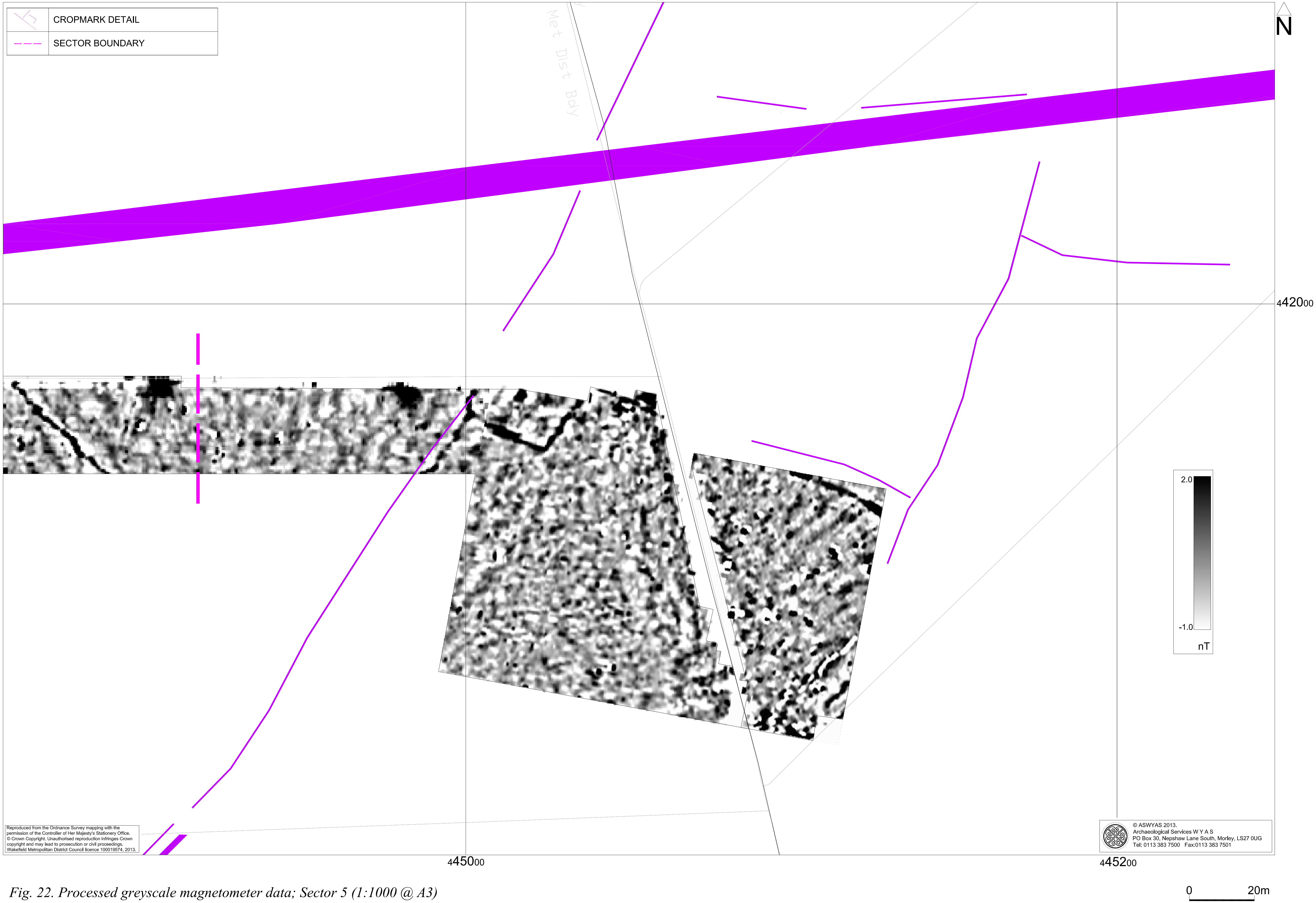

Fig. 22. Processed greyscale magnetometer data; Sector 5 (1:1000 @ A3)

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Fig. 23. XY trace plot of minimally processed magnetometer data; Sector 5 (1:1000 @ A3)

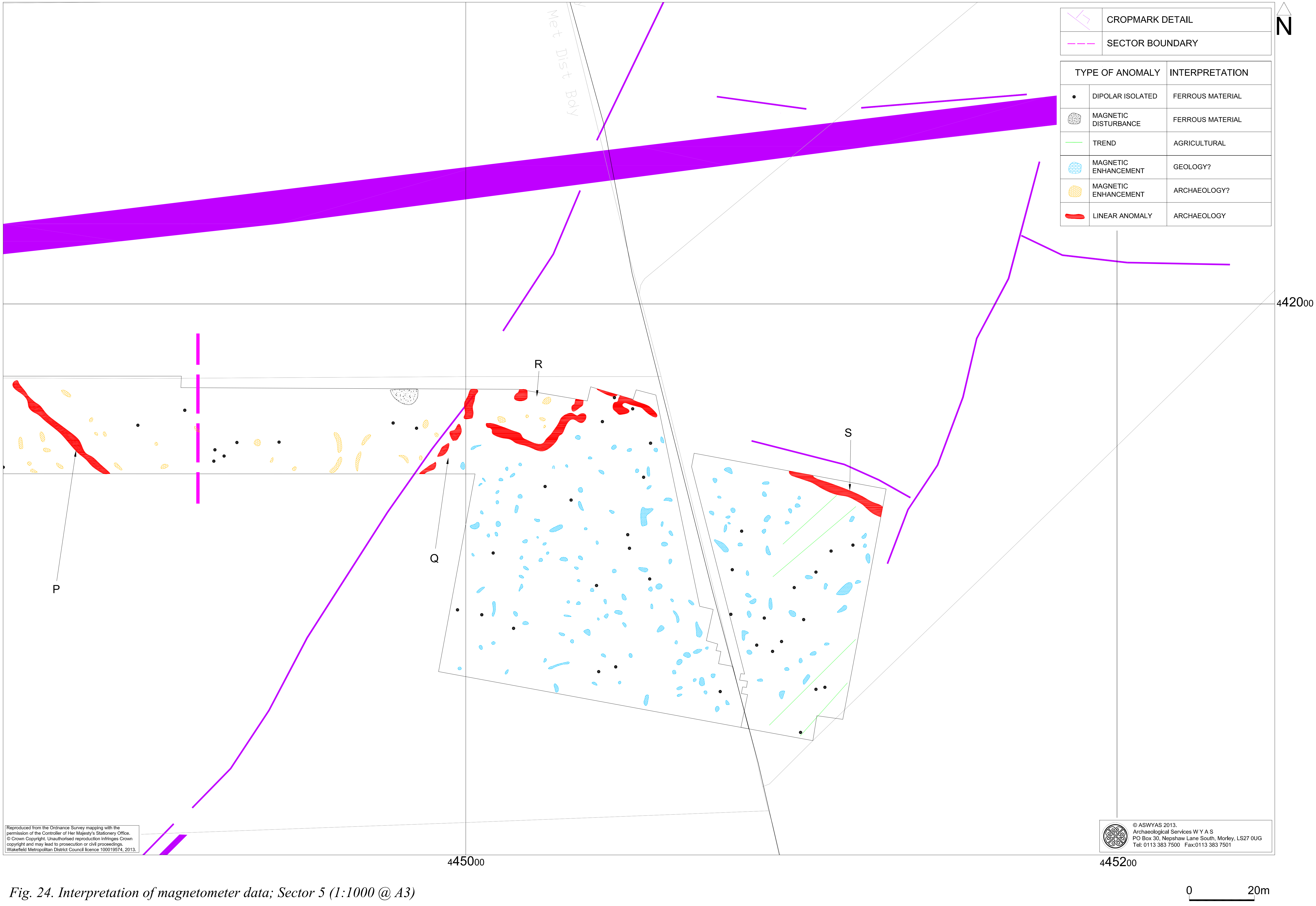

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Fig. 24. Interpretation of magnetometer data; Sector 5 (1:1000 @ A3)

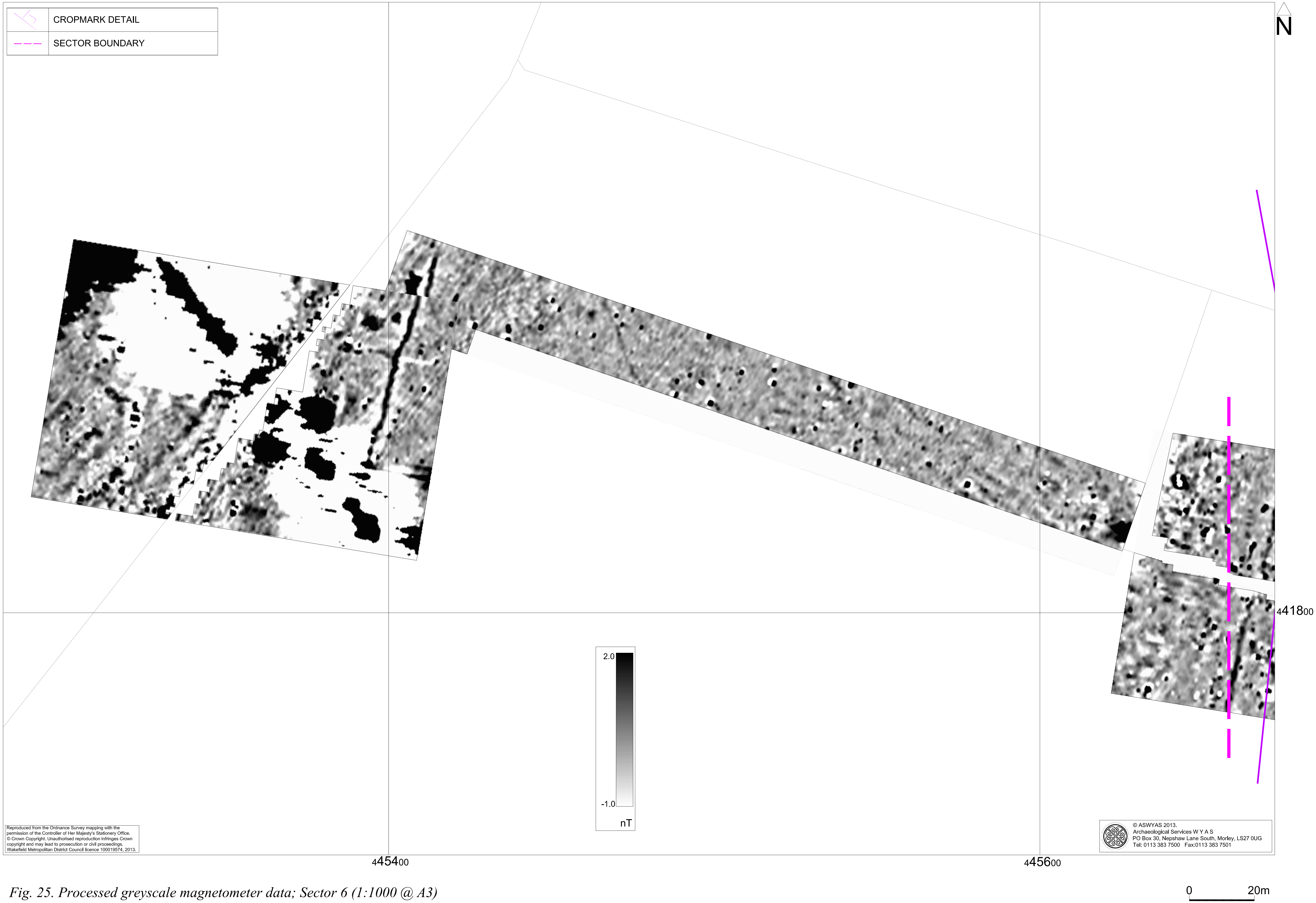

Fig. 25. Processed greyscale magnetometer data; Sector 6 (1:1000 @ A3)

Fig. 26. XY trace plot of minimally processed magnetometer data; Sector 6 (1:1000 @ A3)

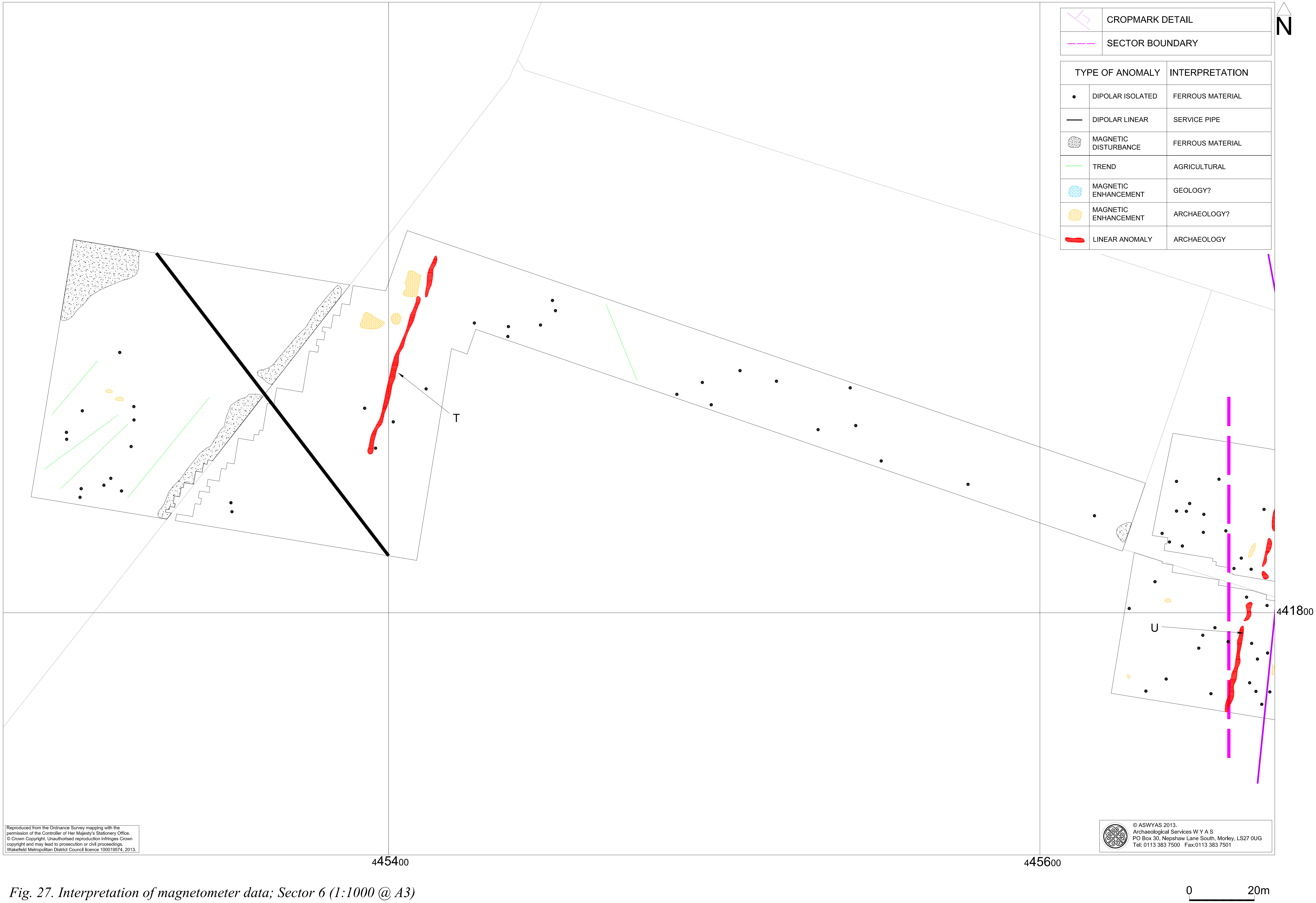

Fig. 27. Interpretation of magnetometer data; Sector 6 (1:1000 @ A3)

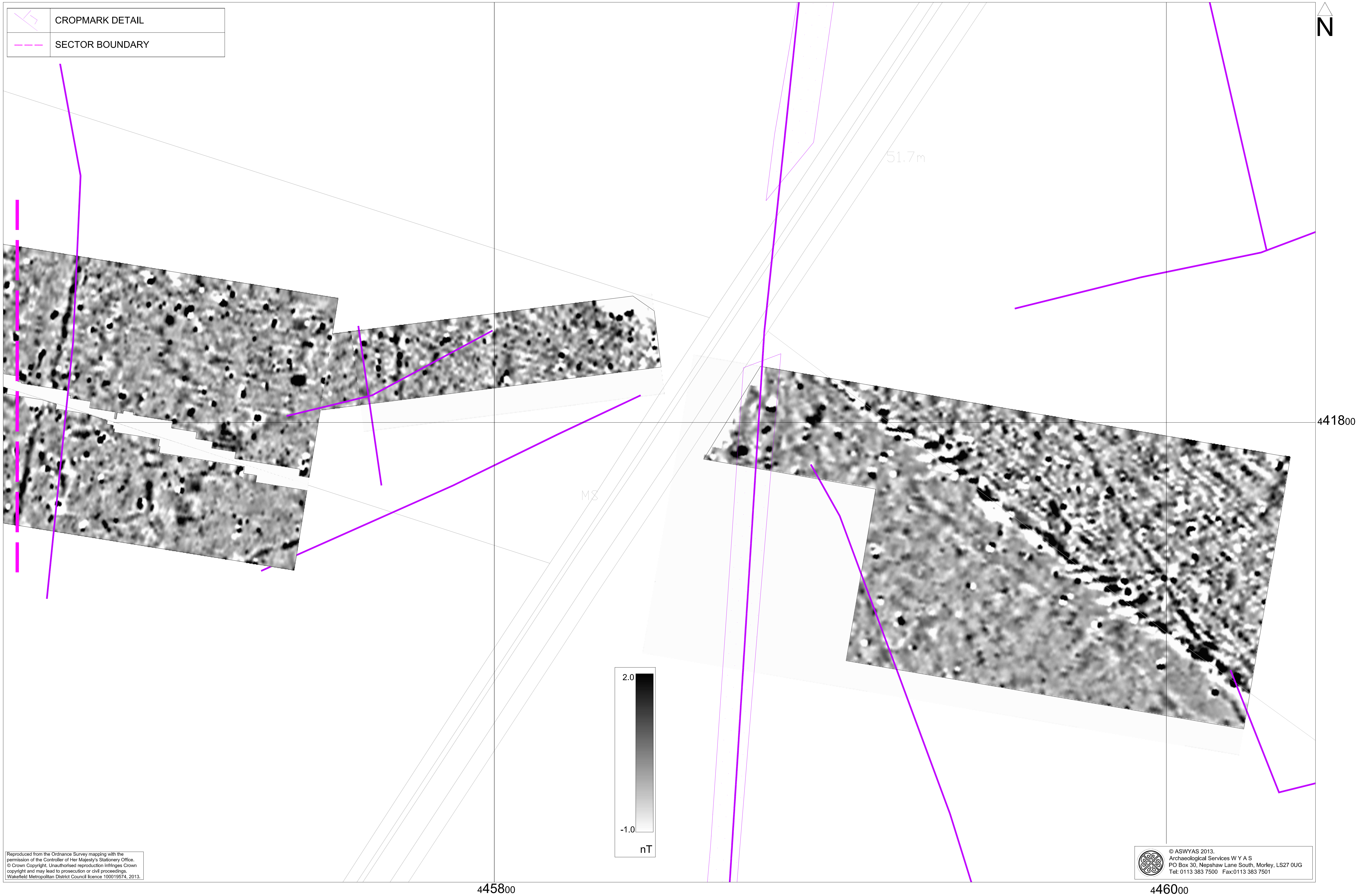

Fig. 28. Processed greyscale magnetometer data; Sector 7 (1:1000 @ A3)

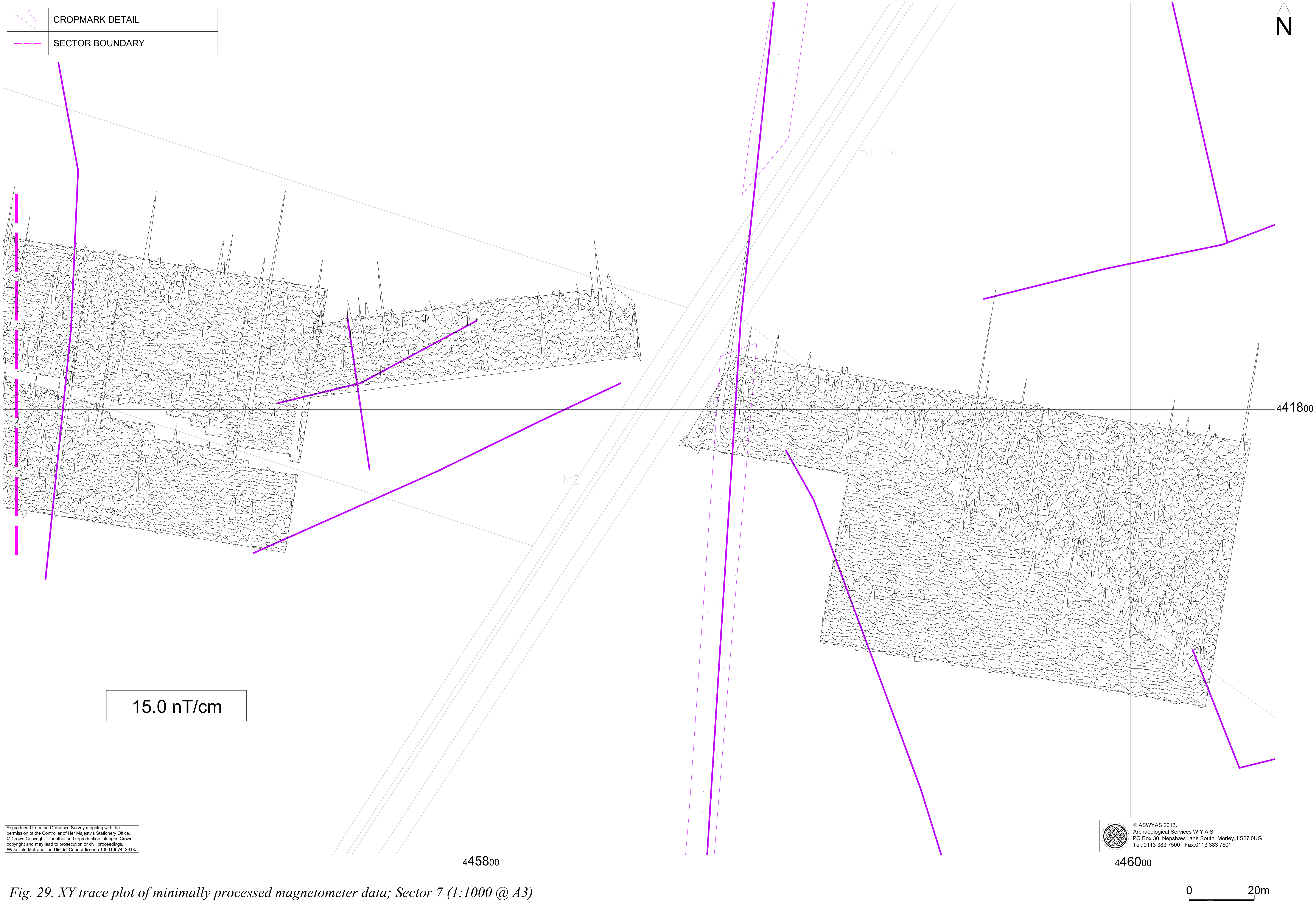

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Fig. 29. XY trace plot of minimally processed magnetometer data; Sector 7 (1:1000 @ A3)

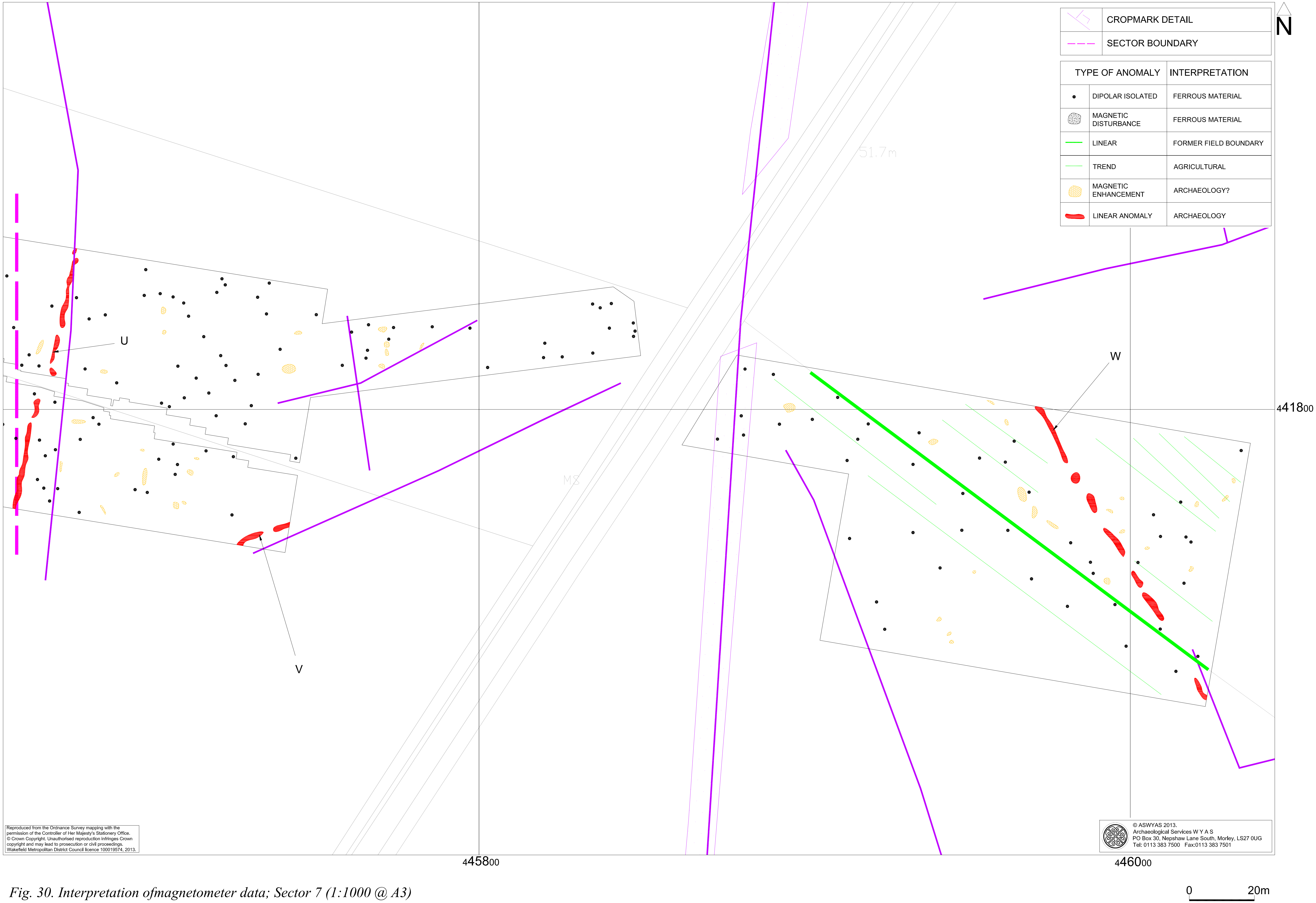

Fig. 30. Interpretation ofmagnetometer data; Sector 7 (1:1000 @ A3)

Appendix 1: Written Scheme of Investigation

Knaresborough Overhead Line

Bramham Moor

West Yorkshire and North Yorkshire

Geophysical Survey Project Design

Prepared by: Sam Harrison
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Leeds
West Yorkshire
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November 2012

Project Design for Geophysical Survey of Knaresborough Overhead Line

1. Introduction

1.1 This Project Design has been prepared by Archaeological Services WYAS (ASWYAS) for Simon McCudden of Parsons Brinkerhoff in advance of a geophysical (magnetometer) survey of the proposed connection route between the XC Monk Fryston-Poppleton Circuit and the PHG Ferrybridge-Knaresborough Circuit on Bramham Moor, West Yorkshire and North Yorkshire.

1.2 The scheme of work will be undertaken in accordance with the requirements of the National Planning Policy Framework (2012).

1.3 This document details a proposed programme of non-intrusive geophysical (magnetometer) survey.

1.4 The Project Design was produced to the standards laid down in English Heritage's guideline publication *Geophysical Survey in Archaeological Field Evaluation* (2008) and the Institute for Archaeologists (IfA) *Standard and Guidance for Archaeological Geophysical Survey (IfA 2010).*

2. Site location and Description

2.1 The proposed connection route is located to the east of Bramham, West Yorkshire and west of Tadcaster, North Yorkshire. The survey area comprises of four blocks totalling approximately 9.5 hectares between SE 43396 42208 and SE 46041 41743 (see Fig. 1).

3. Geology and Soils

3.1 The underlying bedrock comprises Cadeby Formation (formally magnesian limestone (BGS 2012). The soils in this area are classified in the Aberford association, characterised as shallow, locally brashy, well-drained calcareous fine loams over limestone (Soil Survey of England and Wales 1983).

4. Archaeological Background

4.1 The landscape is known to have a high archaeological potential with records inclusing the buried remains of field systems, enclosures and settlements of probable late Iron Age or Roman date. This assessment was based primarily on the extensive cropmarks evidence in the Bramham Moor area. In addition the route is considered likely to cross the Roman Ridge.

5. Aims and Objectives

5.1 The aims and objectives of the programme of geophysical survey is to gather sufficient information to establish the presence/absence, character, extent, of any archaeological remains within the specific areas to be impacted by the proposed connection route, and to inform further strategies should they be necessary.

The aims of the survey are to:

- 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;
- to produce a comprehensive site archive and report.

6. Fieldwork Methodology

6.1 A geophysical (magnetometer) survey will be carried out across the footprint of the proposed connection route. The total area for survey will be approximately 9.5 hectares.

6.2 The geophysical survey site grid will be established using a Trimble 5800 VRS dGPS system or 5600 Total Station. The site grid will be tied into the Ordnance Survey National Grid and semi-permanent survey markers will be left on site, so that the grid can be accurately re-located during any later stages of archaeological investigation.

6.3 The survey will be undertaken using Bartington Grad601 instruments to take readings at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m grid squares, allowing 3600 readings to be recorded in each grid square. These readings will be stored in the memory of the instrument and later downloaded for processing and interpretation. Geoplot 3 (Geoscan Research) software will be used to process and present the data.

6.4 The geophysical survey will comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the Institute for Archaeologists (IfA 2010). All figures will be reproduced from Ordnance Survey mapping with the permission of the controller of Her Majesty’s Stationery Office (© Crown copyright).

6.5 On completion of the geophysical survey, a report will be produced containing all relevant information including:

i) Site code/project number; dates for fieldwork visits; grid references; location plan, and a plan showing the limits of the detailed study area.

ii) A non-technical summary of the reason, aims and main results of the assessment.

iii) An introduction to outline the circumstances leading to the commission of the report and any restrictions encountered.

iv) The aims and objectives of the study

v) The methodology used.

vi) A summary and synthesis of the archaeological results in relation to the methods used. This shall be supported by a survey location plan (minimum scale 1:2500), a plot of raw data (preferred minimum scale 1:1000, grey-scale format, and/or X-Y trace format as appropriate to the technique(s) used), a plot of enhanced data and one, or more, interpretative plots. Each plan/plot will have a bar scale and accurately oriented north sign.

vii) An assessment of the importance of sites and features within the study area against a background of national, regional or local importance.

viii) Recommendations regarding the future treatment of the remains and/or any further archaeological work necessary on site in advance of, or during, development.

ix) References to all primary and secondary sources consulted.

6.6 A project archive will be prepared in accordance with recent good practice guidelines and submitted to the client in acceptable formats. The geophysical archive will comprise:

- an archive CD containing compressed (WinZip 8) files of the raw data, report text (Word 2000), and graphics files (Adobe Illustrator and AutoCAD 2007) files;
- a full copy of the report.

6.7 Following completion and submission of the report to the client, and deposition of the archive, copies of the report will by sent to the relevant Historic Environment Record, local authority Planning Officer and/or Conservation Officer. In addition, ASWYAS will make their work accessible to the wider research community by submitting digital data and copies of the report on line to OASIS.

7 Copyright, Confidentiality and Publicity

7.1 The copyright of any written, graphic or photographic record and reports produced as part of this project shall belong to the client, unless otherwise agreed, with ASWYAS being acknowledged as the originating body.

7.2 The circumstances under which the report or records can be used by other parties will be identified at the commencement of the project, as will the proposals for the distribution of the report. ASWYAS will respect any requirements regarding confidentiality, but will endeavour to emphasise the company's professional obligation to make the results of archaeological work known to the wider archaeological community within a reasonable time.

8. Health and Safety

8.1 All work will conform to the ASWYAS Health and Safety Policy (a copy of which can be supplied if requested), which makes particular reference to the FAME (Federation of Archaeological Managers and Employers) Health and Safety Manual and will be carried out according to the relevant Health and Safety Legislation. This includes, in particular, the following regulations:

- Health and Safety at Work 1974
- Construction (Design and Management) Regulations 2007
- The Management of Health and Safety at Work Regulations 1999
- Personal Protective Equipment at Work Regulations 1992
- Provision and Use of Work Equipment Regulations 1998
- Manual Handling Operations Regulations 1992
- Workplace (Health, Safety and Welfare) Regulations 1992

8.2 In addition each project undergoes a 'Risk Assessment' which sets project specific Health and Safety requirements to which all members of staff are made aware of prior to on–site work commencing.

8.3 Health and Safety will take priority over archaeological matters. Necessary precautions will be taken with regard to protecting ASWYAS staff and the public.

9. Insurance

9.1 ASWYAS is covered by the insurance and indemnities of the City of Wakefield Metropolitan District Council. Insurance has been effected with: Zurich Municipal, PO Box 568, 1st Floor, 1 East Parade, Leeds, LS1 2UA (policy number QLA-03R896 0013). Any further enquiries should be directed to: City of Wakefield Metropolitan District Council, Corporate Services, Financial Services (Insurance, Room 403), County Hall, Bond Street, Wakefield WF1 2QW.

10. Quality

10.1 ASWYAS is an accredited ISO 9001:2008 organisation and a Registered Archaeological Organisation with the Institute for Archaeologists, operating to nationally agreed guidelines, processes and procedures. These are set within a framework that endeavours to carry out the required work and submit the final report in a manner that meets with our client's specific needs, providing quality assurance throughout the project and for the end product. These guidelines, processes and procedures are contained within a Quality Manual and all staff work in accordance with this manual.

11. Monitoring

11.1 A standard working day will involve driving to site, condition surveys of the survey area, survey area setting out and detailed earth resistance and/or magnetic survey recording. Constant updating of the survey work will be relayed back to the office by telephone.

Contacts

Senior Managing Archaeologist: Alistair Webb	0113 393 9753
Project Manager: Sam Harrison	0113 393 9745
Health and Safety Coordinator: Alistair Webb	0113 393 9753
Survey team:	07796 9964(44)/(46)

12. Staffing

Archaeological Services WYAS currently employs seven dedicated geophysicists together with a further two staff with extensive field experience. Summary Curriculum Vitae for all the staff to be employed on the proposed project are detailed below together with their proposed role in the scheme.

Senior Project Management:	Alistair Webb BA MIfA
Senior Geophysicist / Project Manager:	Sam Harrison BSc MSc AIfA
Archaeological Geophysicist	David Harrison BA MSc MIfA
Archaeological Geophysicist	Chris Sykes BA MSc
Archaeological Geophysicist	James Lawton BSc MSc PIfA
Assistant Geophysicist	Orlando Prestidge BA MA PIfA
Assistant Geophysicist	Louise Felding BA Mag.Art
Assistant Geophysicist	David Williams BA PIfA
Assistant Geophysicist	Marina Rose BSc

Name:- Alistair Webb BA MIfA

Current Position:- Senior Managing Archaeologist

Proposed Role:- Senior Archaeological Geophysicist

Alistair is the Senior Manager responsible for overall management of the geophysical survey teams, as well as other developer funded archaeological field projects. He has more than twenty years archaeological experience being involved in geophysical surveys almost exclusively for fifteen years. During this time he has written well in excess of three hundred geophysical survey reports for clients including English Heritage and Historic Scotland, as well as for commercial companies such as Barratts, Bryant Homes, Ben Bailey and RJB Mining and for archaeological consultants and contractors including Albion Archaeology, AC Archaeology, Headland Archaeology, Ed Dennison Archaeological Services and Northern Archaeological Associates.

Alistair gained his BA in Environmental Studies in 1984 and in 1995 successfully completed modules on Magnetic and Electromagnetic Methods of Survey, part of the MSc in Archaeological Prospection run by Bradford University. Alistair is a member of the Institute for Archaeologists at Member level (MIfA)

Name:- Sam Harrison BSc MSc AIfA

Current Position:- Senior Archaeological Geophysicist

Proposed Role:- Project Manager

Sam graduated in 2002 from Bradford University with an Honours degree in Archaeological Sciences having a particular interest in Archaeological Geophysics. He subsequently refined this interest gaining an MSc in Archaeological Prospection, also at Bradford, in 2005.

Prior to joining Archaeological Services on a full time basis in April 2004 Sam worked for Stratascan Ltd. He has substantial experience in shallow sub-surface archaeological prospection techniques including magnetometry, earth resistance, ground penetrating radar and electro-magnetic methods. Sam is also experienced in software programs including Geoplot 3, AutoCad Map, Illustrator, MapInfo and ArcGIS.

Since joining ASWYAS Sam has managed over a 100 geophysical projects from small scale Heritage Lottery funded schemes to large-scale infrastructure projects.

Sam is a member of the Institute for Archaeologists at Associate level (AIfA) Sam is also CSCS certified and Emergency First Aid at Work trained.

Name:- David Harrison BA MSc MIfA

Current Position:- Project Officer (Geophysics)

Proposed Role:- Senior Geophysical Supervisor

David has recently joined ASWYAS in August 2010 as a Geophysicist following five years experience undertaking and managing (since May 2006) the geophysical survey team at Margaret Gowen and Co Ltd, a large multidisciplinary commercial archaeological consultancy based in Dublin. Whilst at Margaret Gowen David undertook over 100 surveys across Ireland ranging from small independent developments to pipelines, regional and national infrastructure projects. In his former post he had responsibility for tendering, data collection and processing, client liaison and final report preparation. In addition David has more than three years commercial archaeological excavation experience half of which was at a Supervisory level.

David has a BA (Hons) in Archaeology awarded in by 1999 by King Alfred’s College, Winchester and an MSc in Archaeology awarded by the University of

Liverpool in 2002. David is also CSCS certified and Emergency First Aid at Work trained. He has recently attained MIfA status within the Institute for Archaeologists.

Name:- Chris Sykes BA MSc

Current Position:- Archaeological Geophysicist

Proposed Role:- Geophysical Surveyor/Supervisor

Having graduated from the University of Sheffield with his degree in Archaeology in 2008, Christopher has been engaged in a number of community involvement projects in and around South Yorkshire as an excavation supervisor. It was an interest in geophysical survey which prompted him to undertake the Masters programme in Archaeological Prospection at Bradford University in September 2009.

Since completing his Masters studies, Christopher immediately began working as a geophysicist in Ireland with Headland Archaeology on the major N20 project. Building on this experience he undertook geophysics in Crete, before becoming the geophysicist for Wessex Archaeology at their Sheffield office. Here he supervised staff in the undertaking of geophysical projects and also assisted in excavations, before joining ASWYAS in 2011.

Starting in 2005, Christopher has been involved in a number of community focused archaeological pursuits which has included working with children and adults with special requirements. Chris is CSCS certified.

Name:- James Lawton BSc MSc PIfA

Current Position:- Archaeological Geophysicist

Proposed Role:- Geophysical Surveyor/Supervisor

James graduated from the University of Bradford in 2007 where he had studied for 5 years which included a 4 year BSc Undergraduate course in Geoarchaeology followed by a 1 year MSc in Archaeological Prospection.

As part his undergraduate, James completed a 1 year diploma in archaeology where he undertook geophysical surveying with GSB Prospection Ltd. During the course of this placement James gained experience surveying throughout the British Isles and Ireland as well as the Isle of Man.

After graduating James took a job with AECOM Ltd as a graduate archaeologist working as a consultant, where he spent four and half years gaining experience and knowledge within archaeology sector, working on large scale developments. This involved consultations between the client and developer and writing detailed reports as part of the planning requirements. These involved Desk-based Assessments and Environmental Impact Assessments.

As part of his work James continued to be involved with geophysics writing tenders for geophysical subcontractors planning specifications and undertaking voluntary geophysical surveys in his spare time as part of his own archaeological research. James joined ASWYAS in late September 2012. James is CSCS certified and Emergency First Aid at Work trained.

Name:- Orlando Presidge BA MA PIfA

Current Position:- Assistant Geophysicist

Proposed Role:- Geophysical Surveyor

Orlando joined ASWYAS in September 2012 after having completed over 12 months commercial experience throughout the UK in both geophysics and excavation. Having previously worked for 6 months as a Geophysical Survey Technician for Stratascan and an Archaeologist for Trent and Peak Archaeology, Orlando has also helped to supervise excavations as part of the Stonehenge Riverside Project (SRP) and has also been fortunate enough to both work and be part of excavations at the Flag Fen Bronze Age Centre.

Orlando had his first experience of geophysical survey while at the SRP in 2007, and has since carried out extensive surveys with other community archaeology projects including the Sedgeford Historical and Archaeological Research Project (SHARP).

Orlando graduated from the University of Sheffield with a BA (Hons) in Archaeology, and also gained a Distinction grading in his MA studies in 20th Century Conflict Archaeology at the University of Bristol. While studying, he also completed work-experience and research placements at a number of museums and research institutes across the UK and France. These include the Caverne du Dragon Great War museum in the Aisne region of Northern France, and the Cambridgeshire County Museums Service amongst others. Following the research carried out during these placements, Orlando has had a number of his academic articles included in the reference collection of leading Great War Museums on the continent.

Orlando is a member of the Institute for Archaeologists at Practitioner level, and is also fully CSCS accredited.

Name:- Louise Felding BA Mag.Art

Current Position:- Assistant Geophysicist

Proposed Role:- Geophysical Surveyor

Louise Felding is a Danish archaeologist with 10 years working experience within the cultural heritage sector. After obtaining her bachelor degree in 2002 from Copenhagen University, Louise gained substantial archaeological fieldwork experience from numerous projects across Denmark, Europe and the UK. Work responsibilities have involved the daily supervision and management of excavations, including managing staff as well as client consultation and liaison. Louise then obtained a postgraduate research degree Mag.Art 'magisterkonferens' from Copenhagen University on Danish rock carvings and Bronze Age landscapes in 2009. Louise has experience of magnetometer surveys during her time at Glasgow University.

Louise joined ASWYAS as assistant archaeologist (geophysicist) in September 2012 and has already worked on a number of differing projects across the UK that includes pipelines, road corridors and sample surveys of large areas. Louise is CSCS certified.

Name:- David Williams BA PIfA

Current Position:- Archaeologist

Proposed Role:- Geophysical Surveyor

David graduated from the University of York in 2005 with a BA in Archaeology having worked with Cambria Archaeology on the Iron Age defended enclosure project and the training excavation at Castell Henllys, before joining Archaeological Services WYAS in September 2005.

David has worked on a range of projects, including, as a site assistant, the excavation and evaluation of later prehistoric and Romano-British rural settlement sites at Newbridge Quarry, Pickering, the A165 Reighton Bypass and at Pastures Road, Mexborough as a Site Assistant. Since 2007 he has worked in a supervisory capacity, overseeing the open area excavation of extensive rural sites at Darrington Quarry and Newbridge Quarry, Pickering. David has also supervised a site in the centre of Otley which produced limited evidence for Romano-British occupation and post medieval tanning pits. Since 2009 David has assisted the geophysical survey team working throughout the UK on a large number of surveys that have included pipeline schemes, road corridors and 100% large scale surveys. He has recently undertaken geophysical survey community open days on Castle Hill, Almondbury where he discussed and taught the techniques of magnetometry and earth resistance survey with members of the public.

David has attained Practitioner status PIfA with the Institute for Archaeologists and is CSCS certified and Emergency First Aid at Work trained.

Name:- Marina Rose

Current Position:- Archaeologist

Proposed Role:- Geophysical Surveyor

Since graduating with a BSc in Archaeology from the University of Bournemouth in 1997 Marina has worked continuously in archaeology, principally excavation and field survey, on a wide range of rural and urban sites of all periods in, first working for Worcestershire Archaeology Unit. Marina has a long-term involvement with the Wood Hall moated manor project and supervised a project on the River Aire excavating and recording 18th century river craft and associated industrial remains and a large multi-period settlement site at Easington, East Yorkshire. Marina has worked for Archaeological Services WYAS since 1999 and has supervised excavations on numerous sites of all types, including a number of road schemes and other linear projects. Since 2009 Marina has assisted the geophysical survey team working throughout the UK on a large number of surveys that have included pipeline schemes, road corridors and 100% large scale surveys.

Marina is also CSCS certified and Emergency First Aid at Work trained.

12.2 Archaeological Services WYAS project personnel may be subject to change.

13. References

BGS, 2012. http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html (Viewed 29th November 2012)

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

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

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

Appendix 2: 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 3: 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 4: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the relevant Historic Environment Record).

Bibliography

British Geological Survey. http://maps.bgs.ac.uk/geologyviewer/ (Viewed January 22nd 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

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