Archaeological Services WYAS

Loversall Carr
Near Doncaster
South Yorkshire

Geophysical Survey

Report no. 2746

April 2015

Client: Yorkshire Wildlife Trust

Registered CIfA Organisation

Loversall Carr
Near Doncaster
South Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey covering approximately 24 hectares was carried out at Loversall Carr, near Doncaster, where it is proposed to create seasonally wet features (‘wader scrapes’) adjacent to Potteric Carr Nature Reserve. The survey has identified two linear anomalies which are considered likely to be ditches forming part of the pattern of late prehistoric land division in the wider landscape as indicated by cropmarks. However, no anomalies indicative of settlement activity have been recorded and it would seem as if the proposed locations of the ‘wader scrapes’ successfully avoid areas of higher archaeological potential as indicated by the cropmarks. Elsewhere anomalies indicative of field drains, 19th century boundaries, geological variation and modern activity have been recorded. On the basis of the survey, the archaeological potential of the site is considered to be low but with moderate potential around the identified ditch features.

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Report Information

Client:	Yorkshire Wildlife Trust
Address:	1, St George's Place, York, YO24 1GN
Report Type:	Geophysical Survey
Location:	Loversall Carr, near Doncaster
County:	South Yorkshire
Grid Reference:	SE 5800 6810
Period(s) of activity:	prehistoric?
Report Number:	2746
Project Number:	4371
Site Code:	LVC15
OASIS ID:	archaeol11- 208212
Planning Application No.:	
Museum Accession No.:	n/a
Date of fieldwork:	February 2015
Date of report:	April 2015
Project Management:	Sam Harrison BSc MSc MCIfA
Fieldwork:	Ross Bishop Mark Evans Becky Goulding David Harrison BA MSc MCIfA Chris Sykes
Report:	Alistair Webb BA MCIfA
Illustrations:	David Harrison
Photography:	Alex Schmidt
Research:	n/a

Authorisation for distribution: --

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

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Contents

List of Figures

List of Plates

1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Jim Horsfall of Yorkshire Wildlife Trust (The Client), to undertake a geophysical (magnetometer) survey of land at Carr Lodge and Loversall Carr, on the southern outskirts of Doncaster (see Fig. 1). The work was undertaken in order to aid future groundworks on site which will involve the creation of seasonal wet features ('wader scrapes'). The work was undertaken in accordance with policy contained within the National Planning Policy Framework (DCLG 2012), in line with current best practice (CIfA 2014; David *et al.* 2008) to a Project Brief produced by Natural England following consultation with the South Yorkshire Archaeology Service and a Project Design (Harrison 2015) approved by the Client. The survey was carried out between February 26th and March 3rd 2015 to provide additional information on the archaeological resource of the site.

Site location, topography and land-use

The survey area comprised three, irregularly shaped, discrete parcels of land covering approximately 23.5 hectares, located either side of White Rose Way (see Fig. 2). Area A, to the west of White Rose Way, is centred at SE 584 998 and covers 15.5 hectares. Area B (SE 591 002) and Area C (SE 593 000) are adjoining and lie to the east of White Rose Way and cover a combined area of 7.7 hectares. All three areas are flat and low lying (less than 10m above Ordnance Datum) with a slight slope down to the east. All areas were under permanent pasture at the time of survey and were waterlogged in places, particularly in Area A (see plates 1 – 3), where several parts were unsuitable for survey for this reason. A tree screen along the southern edge of Area B (see Plate 6) prevented survey at this location.

Soils and geology

The underlying bedrock geology comprises dolomitic limestone of the Brotherton Formation in Area A with sandstone of the Nottingham Castle Sandstone Formation beneath Area B and Area C. Superficial alluvial deposits cover the bedrock across all three areas (British Geological Survey 2015). The soils are classified in the Foggathorpe 2 association, characterised as slowly permeable, seasonally waterlogged stoneless clays and fine loams (Soil Survey of England and Wales 1983).

2 Archaeological Background

The survey areas are located in a landscape of high archaeological potential evidenced by the number of cropmarks in the immediate vicinity indicative of Iron Age and Romano-British enclosures, ring ditches and trackways (see Fig. 2). These features have been assessed as of regional significance, and have been interpreted as possibly being a fortified settlement or 'marsh fort' (Roberts with Deegan and Berg 2010). The potential locations of the wader scrapes (survey areas) have been selected to avoid these cropmarks (see Fig. 2). A brief map regression shows that the only change in field layout since the mid-19th century has been the removal of two former boundaries in Area C (see Fig. 2).

3 Aims, Methodology and Presentation

The general objective of the geophysical survey was to provide information about the presence/absence, character, and extent of any archaeological remains identified within the PDA in order to aid future groundworks on the site.

Specifically, the 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 1.0m 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. A large scale (1:4000) survey location plan, showing the processed data, is provided as Figure 2 with an overall interpretation of the data at the same scale included as Figure 3. The processed and minimally processed data, together with an interpretation of the survey results are presented in Figures 4 to 18 inclusive, at a scale of 1:1000.

Technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and Appendix 2. Appendix 3 describes the composition and location of the archive. A copy of the OASIS form is in Appendix 4.

The survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the Chartered Institute for Archaeologists

(CIfA 2014). 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 Figures 4 to 18 inclusive)

Overall there is a fairly uniform magnetic background across the site as might be expected with the presence of superficial deposits of alluvium. Broad low magnitude anomalies in Area A suggest areas of flooding. Against this background anomalies have been identified which are classified into several categories and which are discussed below and cross-referenced to specific examples depicted on the interpretative figures, where appropriate.

Ferrous Anomalies

Ferrous anomalies, as individual 'spikes', are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. There is no obvious pattern or clustering to their distribution on this site to suggest anything other than a random background scatter of ferrous debris in the plough-soil.

Two extensive areas of magnetic disturbance are identified. To the north-west corner of Area A, anomaly **A**, is recorded. This disturbance is located immediately abutting the line of a dismantled railway (see Fig. 2) and is probably due to material used either in the construction or dismantling of the railway mixed into the topsoil. The second area of disturbed readings, **B**, is in the south-western corner of Area A and is probably also due to debris from the construction of a bridge and access track over the M18 motorway. Elsewhere linear bands of disturbed readings recorded around the edges of the fields are due to fencing and ferrous debris in the boundary.

Geological Anomalies

An area, **C**, characterised by a series of broad, low magnitude anomalies is identified to the east of Area A. These anomalies are geological in origin and are due to the accumulation of alluvium following periods of inundation. Other discrete anomalies throughout the site are also assumed to be due to minor variations within the upper soil horizons.

Agricultural Anomalies

Across most parts of the site regularly spaced linear anomalies, parallel with and at right angles to the current field boundaries, are identified. These anomalies are caused by field drains and are particularly prominent at the northern end of Area A and in Area C.

More closely spaced and less regular linear anomalies recorded in the southern half of Area A, aligned north-west/south-east, are due to ridge and furrow cultivation. It is possible that some of these linear trends may also be caused by field drains.

In Area C faint linear trend anomalies, **D**, **E**, **F** and **G** indicate the alignment and location of boundaries extant in the mid-19th century as illustrated on the first edition OS mapping (see Fig. 2).

Possible Archaeological Anomalies

Two anomalies of possible archaeological potential have been identified in Area A. Discontinuous linear anomaly, **H**, is identified in the centre of Area A and is aligned broadly east/west oblique to the current field orientation and is interpreted as a ditch forming part of the wider system of field division indicated by the cropmarks in the surrounding landscape (outside the current survey area). This anomaly is on the same alignment as a cropmark ditch feature just outside the survey area to the south (see Fig. 3).

A second discontinuous linear anomaly, **I**, in the south-western corner of Area A, is also interpreted as a possible ditch feature. In this case the anomaly continues the line of a cropmark recorded immediately to the west of the survey area and looks as if it intersects at right angles with another cropmark immediately east of the survey area (see Fig. 3).

5 Conclusions

The survey has identified two linear anomalies which are considered likely to be ditches forming part of the pattern of late prehistoric land division in the wider landscape as indicated by cropmarks. However, no anomalies indicative of settlement activity have been recorded and it would seem as if the proposed locations of the ‘wader scrapes’ successfully avoid areas of higher archaeological potential as indicated by the cropmarks. Elsewhere anomalies indicative of field drains, 19th century boundaries and geological variation have been recorded.

Whilst it might have been useful to have surveyed at least part of one of the cropmark enclosures to determine whether the features causing the cropmarks were detectable as magnetic anomalies, on the basis of the survey, the archaeological potential of the site is considered to be low except in the vicinity of the two likely archaeological features where it is assessed as moderate.

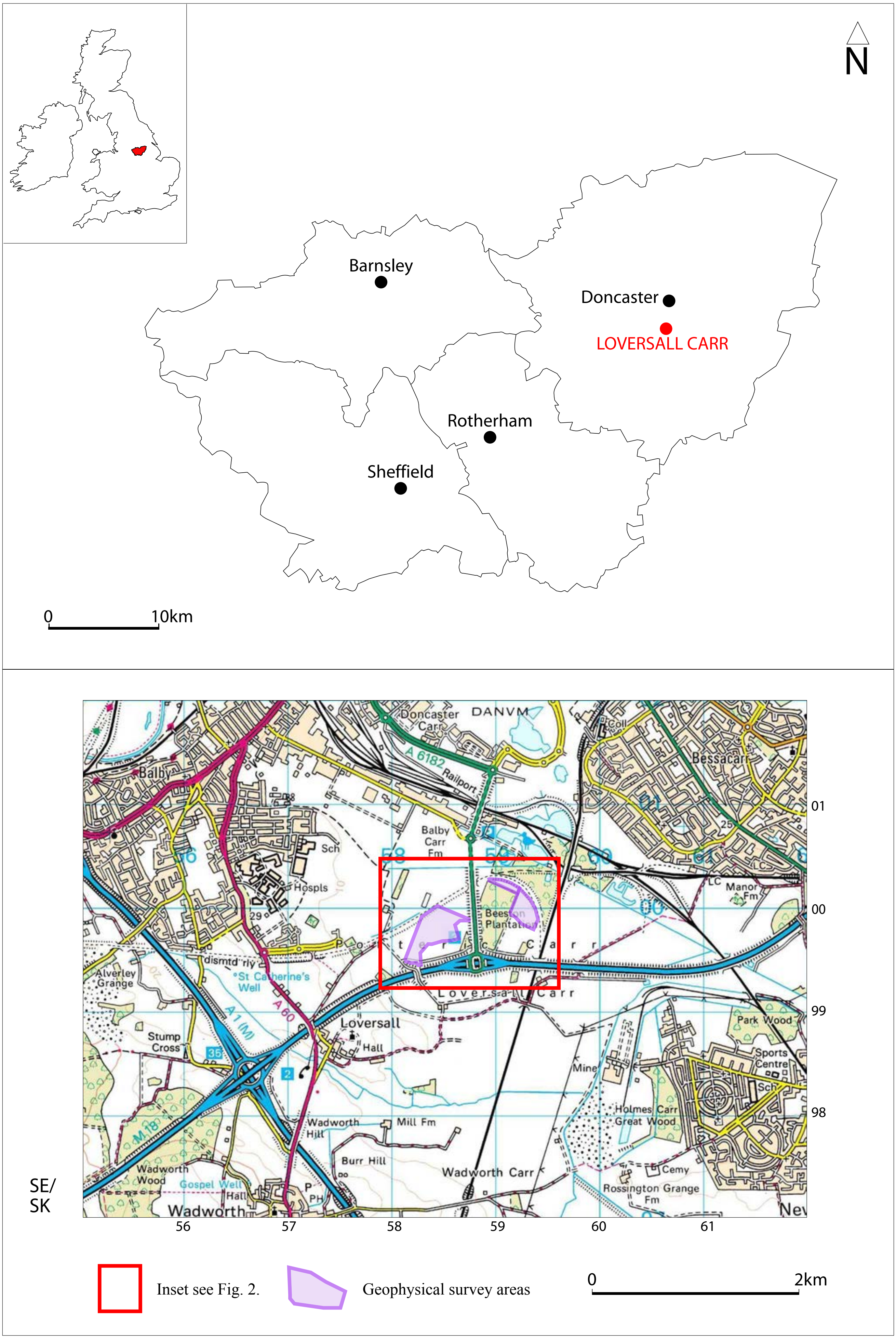

Fig. 1. Site location

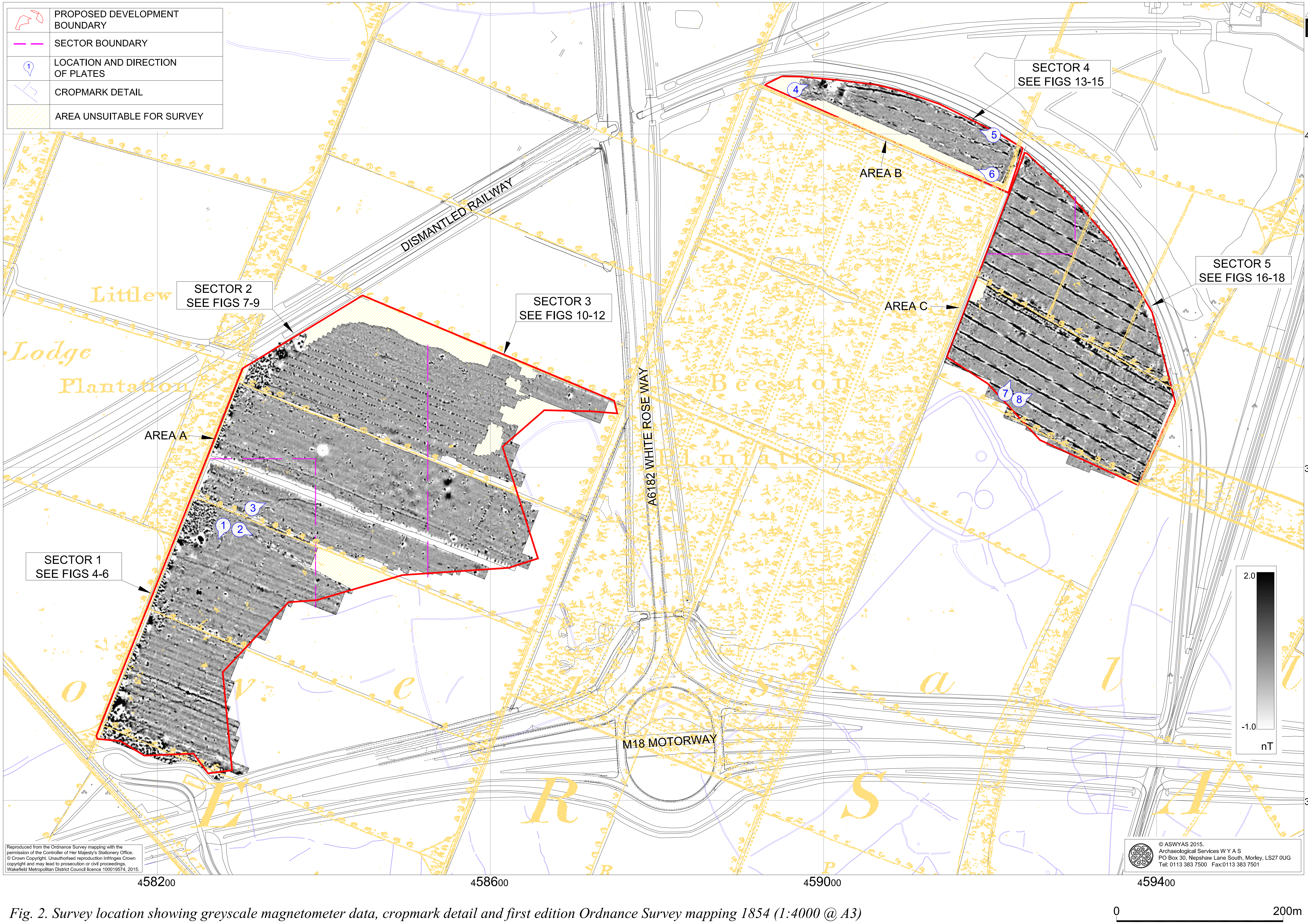

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Fig. 2. Survey location showing greyscale magnetometer data, cropmark detail and first edition Ordnance Survey mapping 1854 (1:4000 @ A3)

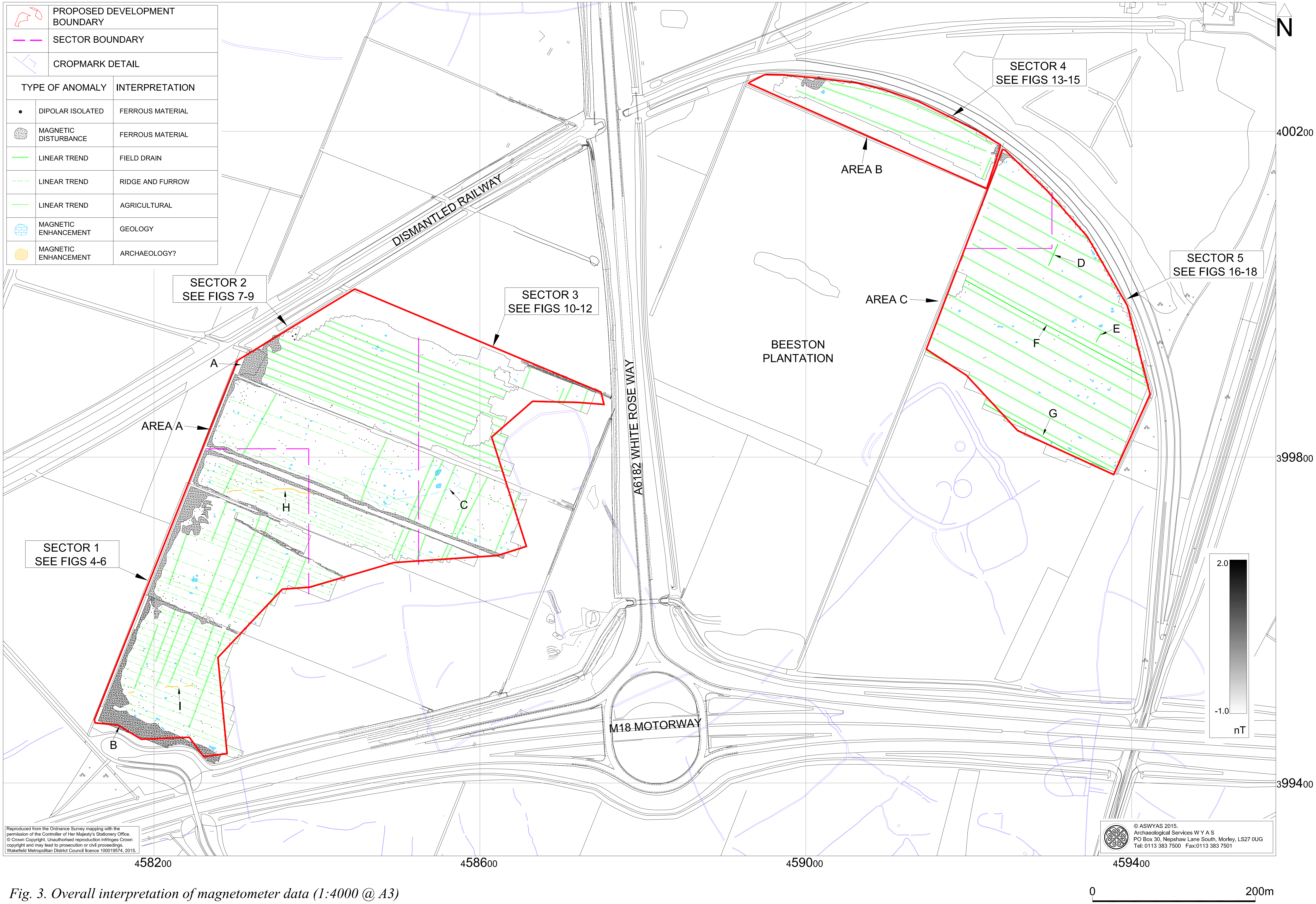

Fig. 3. Overall interpretation of magnetometer data (1:4000 @ A3)

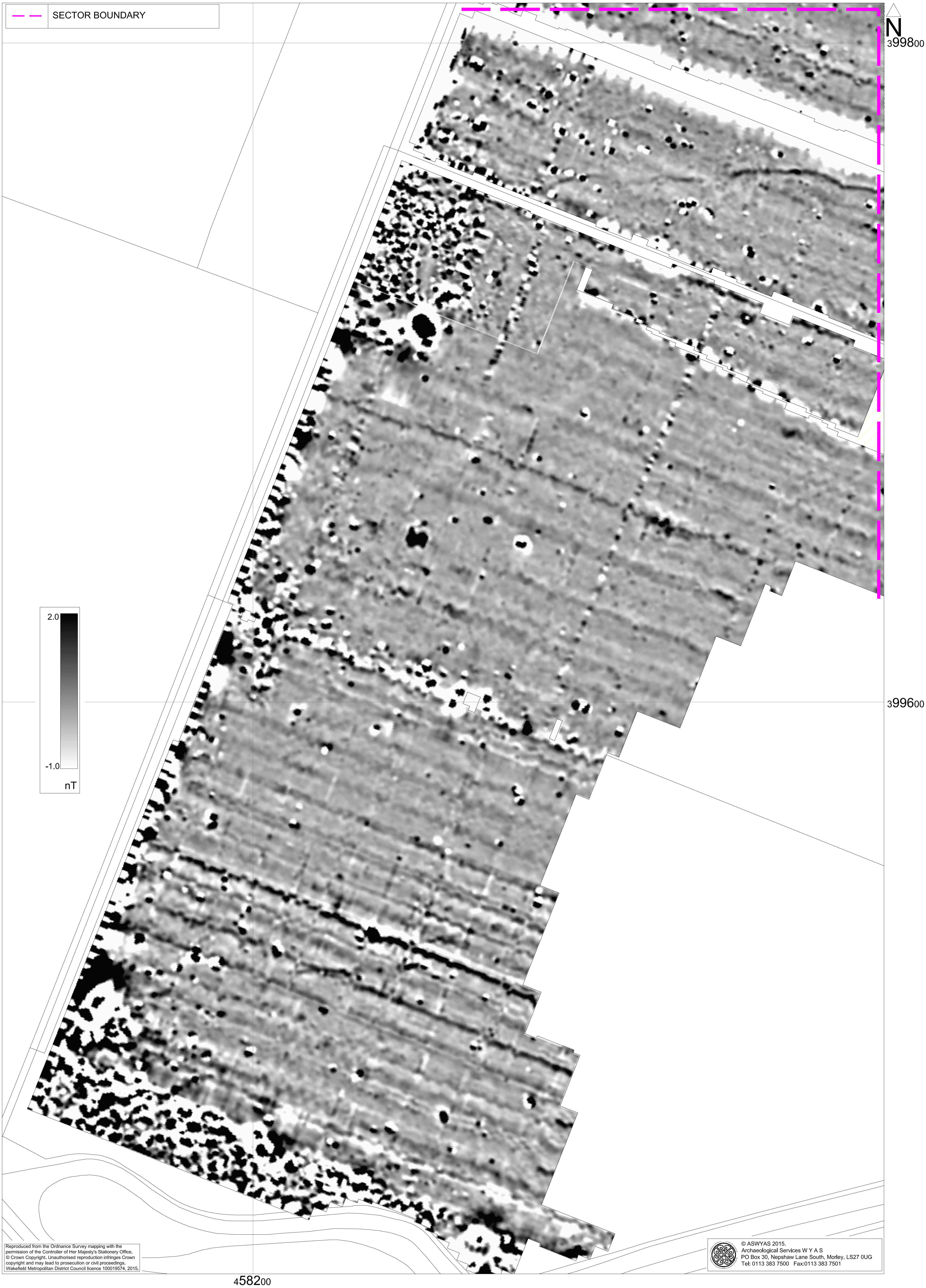

Fig. 4. Processed greyscale magnetometer data; Area A, Sector 1 (1:1000 @ A3)

0 30m

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

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

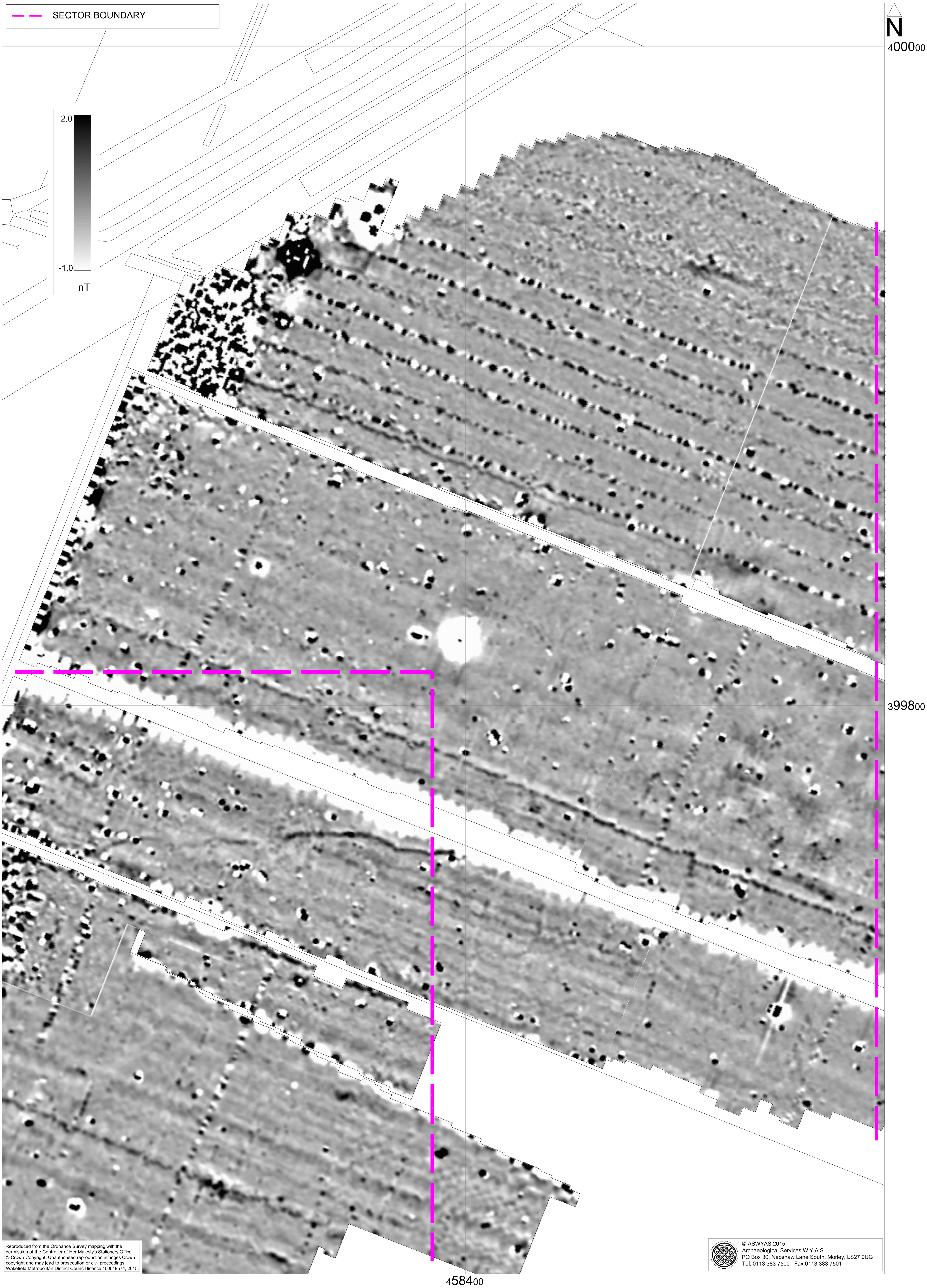

Fig. 7. Processed greyscale magnetometer data; Area A, Sector 2 (1:1000 @ A3)

0 30m

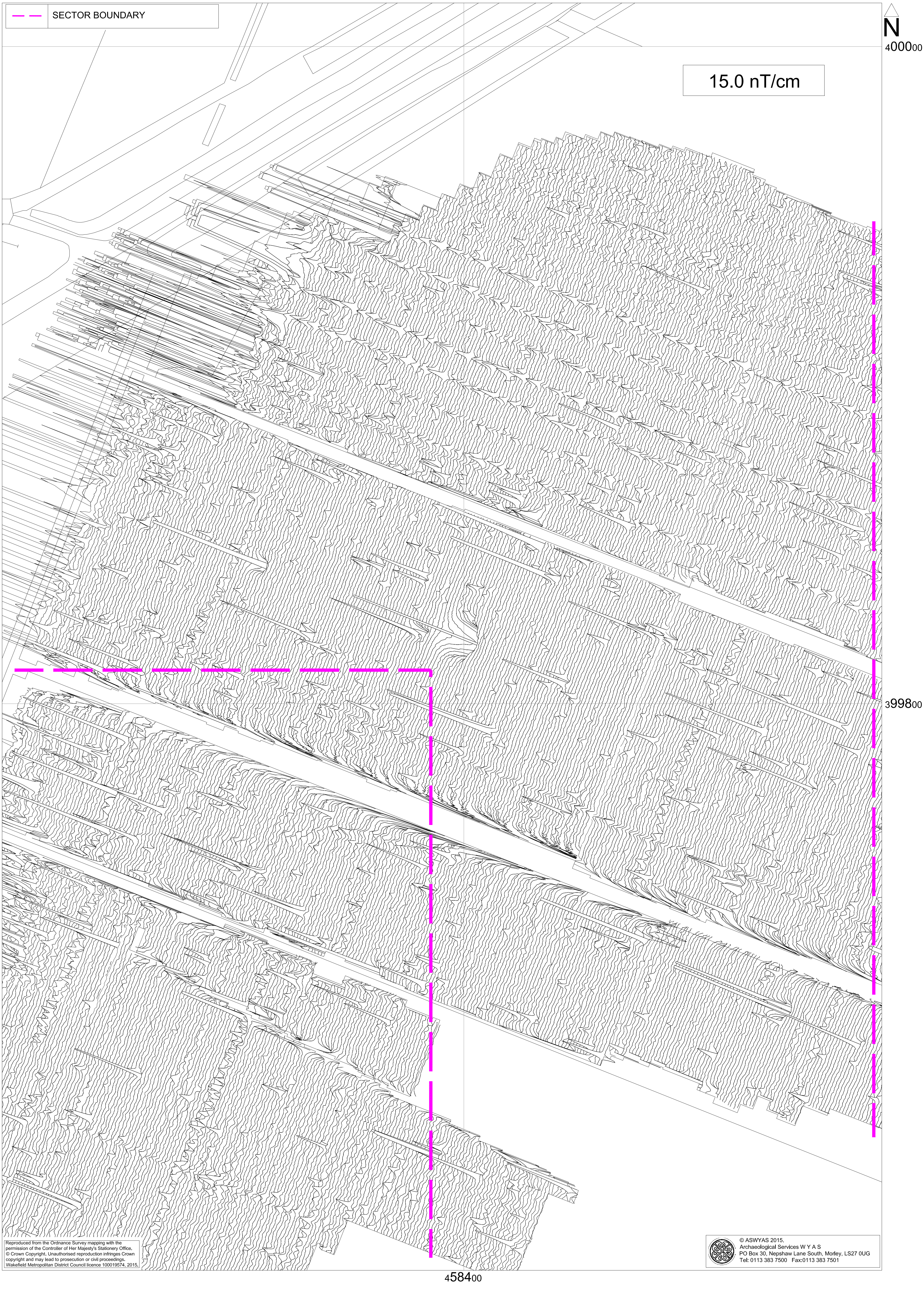

Fig. 8. XY trace plot of minimally processed magnetometer data; Area A, Sector 2 (1:1000 @ A3)

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

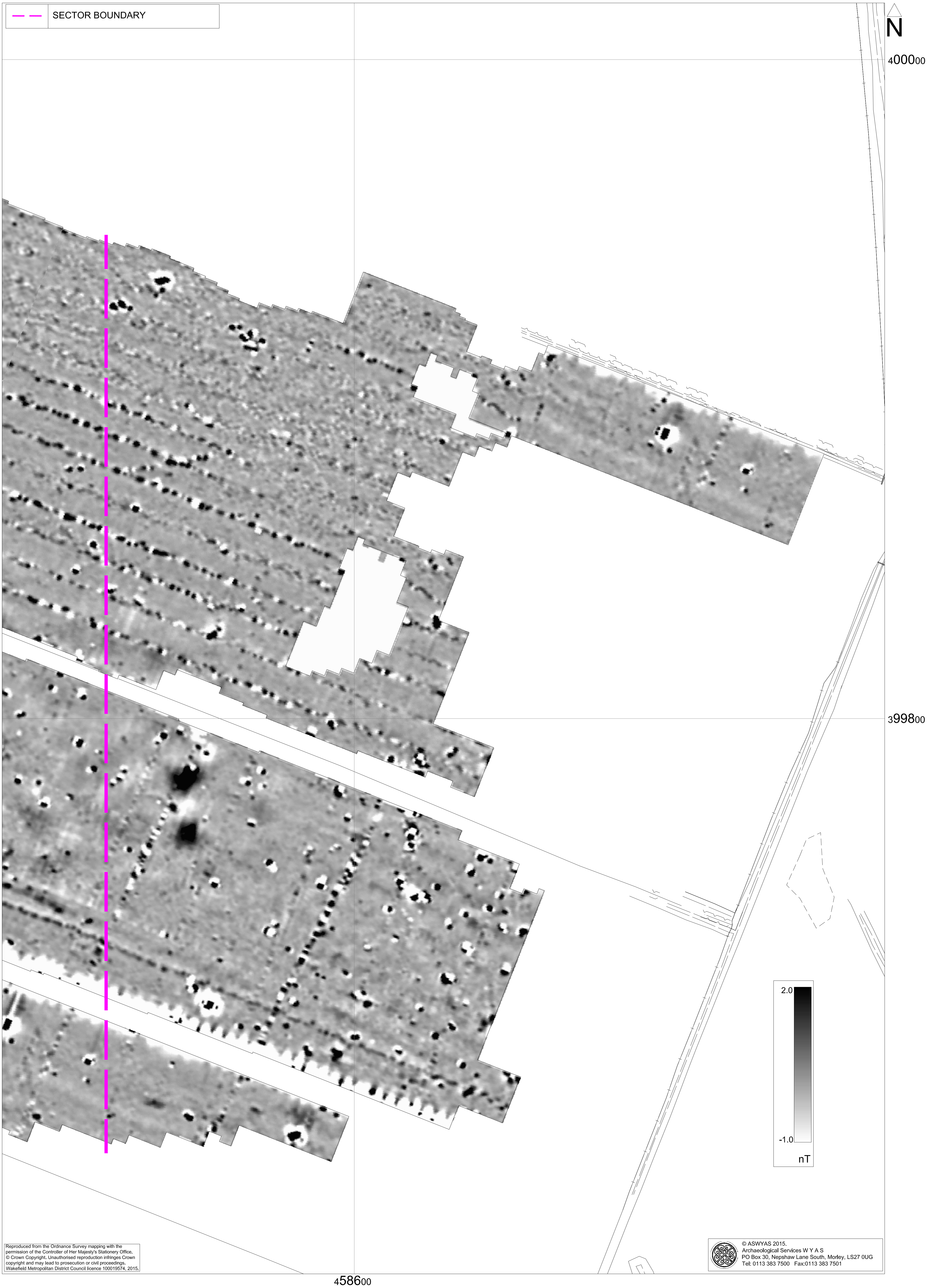

Fig. 10. Processed greyscale magnetometer data; Area A, Sector 3 (1:1000 @ A3)

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

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

0 30m

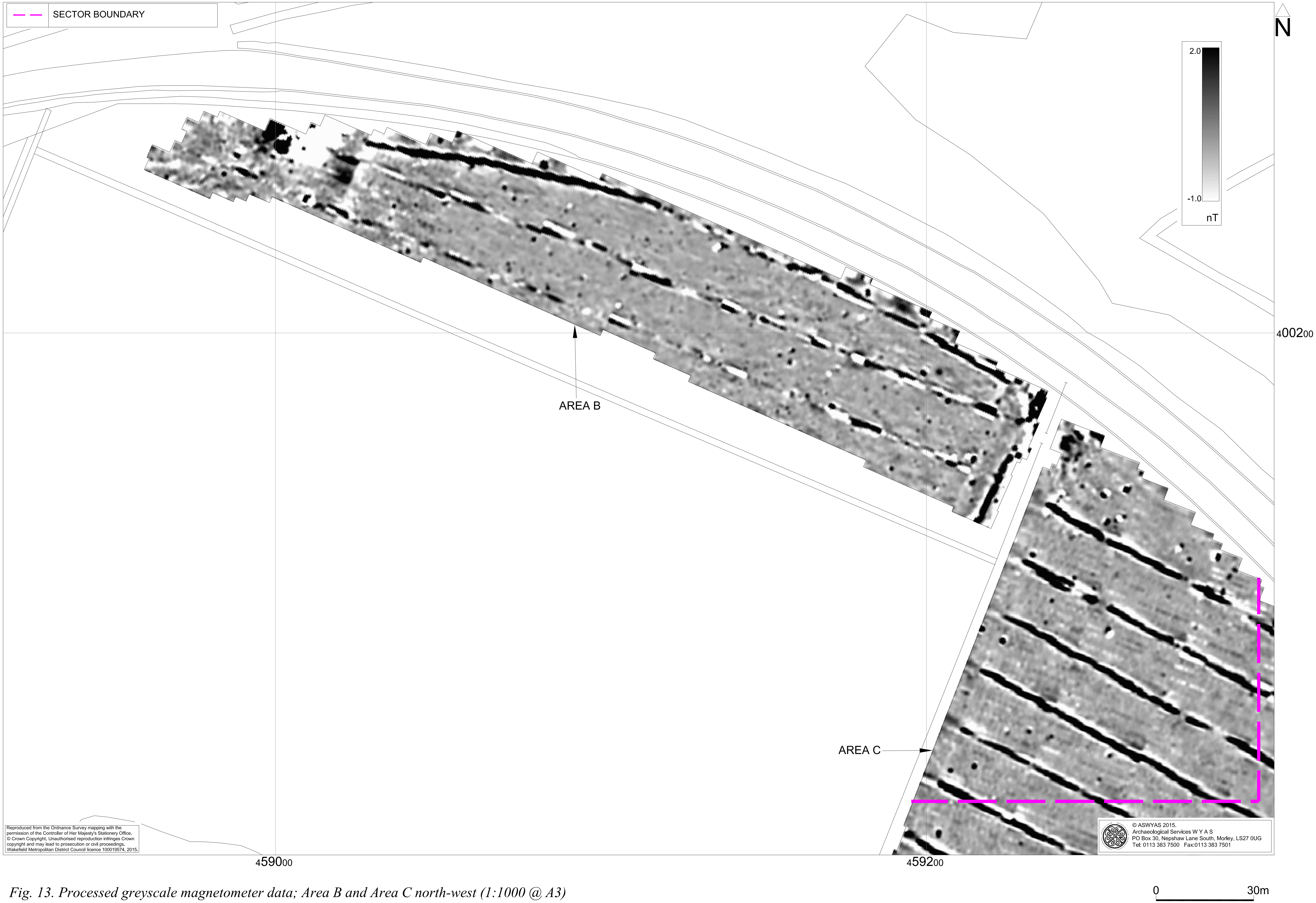

Fig. 13. Processed greyscale magnetometer data; Area B and Area C north-west (1:1000 @ A3)

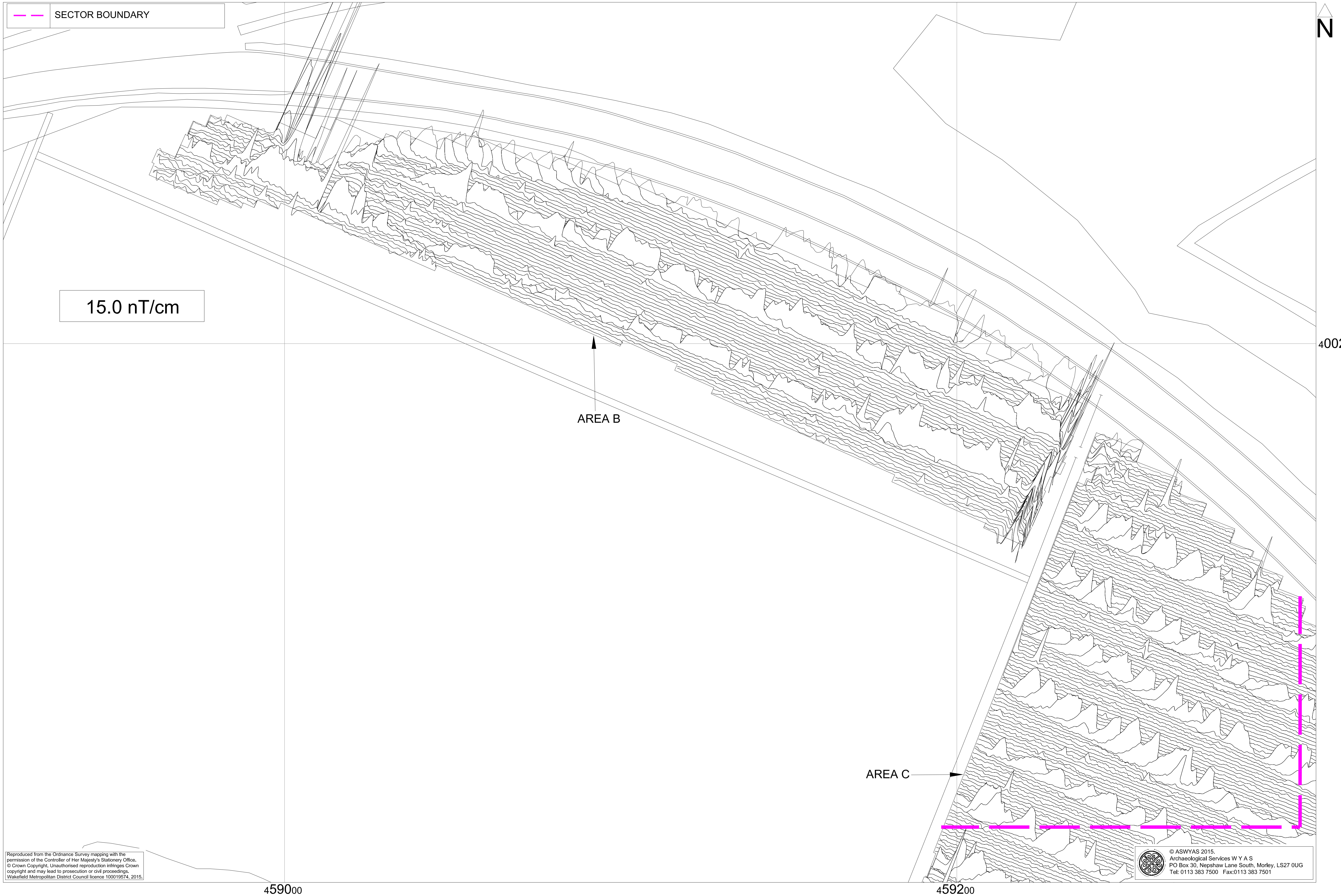

Fig. 14. XY trace plot of minimally processed magnetometer data; Area B and Area C north-west (1:1000 @ A3)

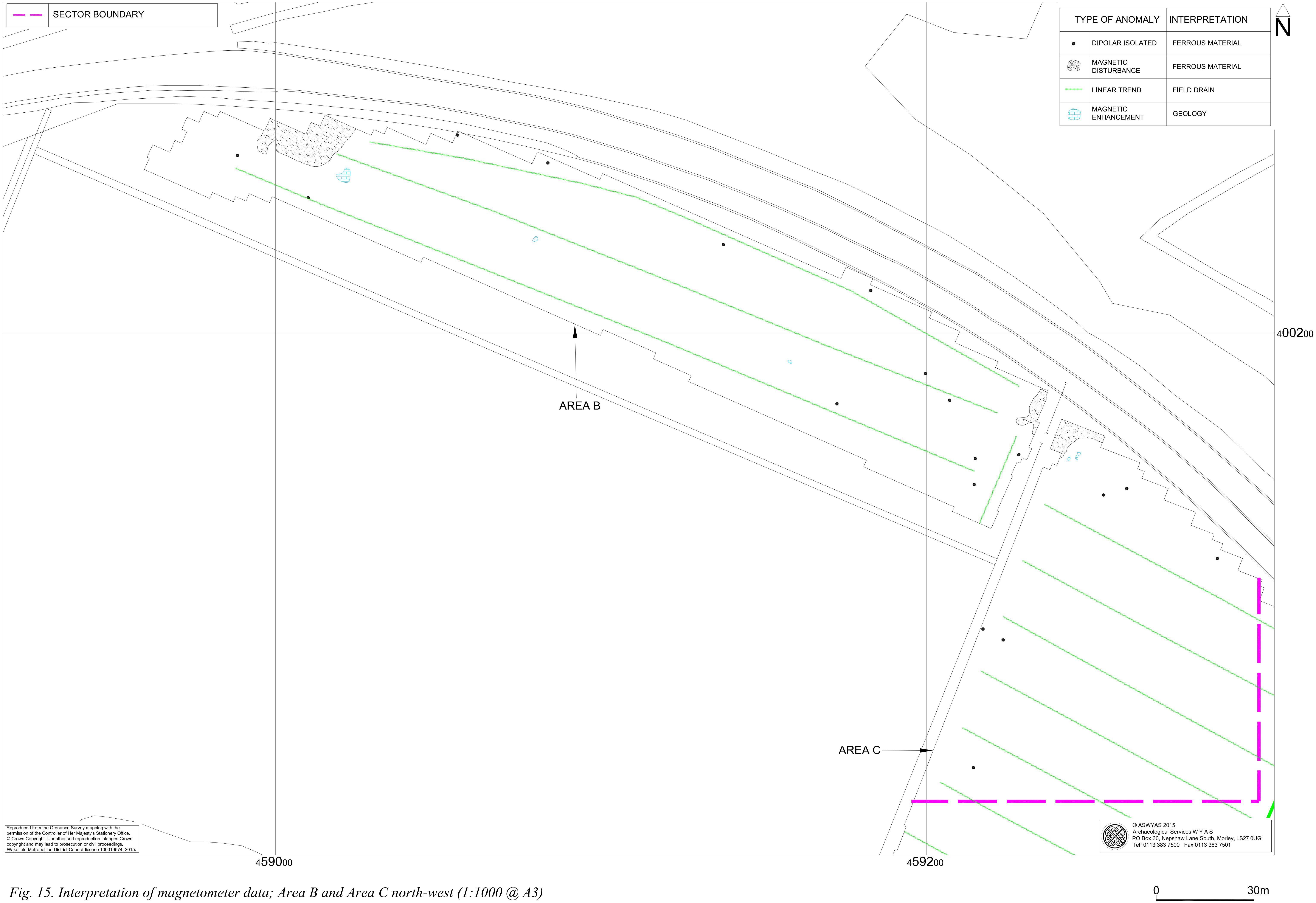

Fig. 15. Interpretation of magnetometer data; Area B and Area C north-west (1:1000 @ A3)

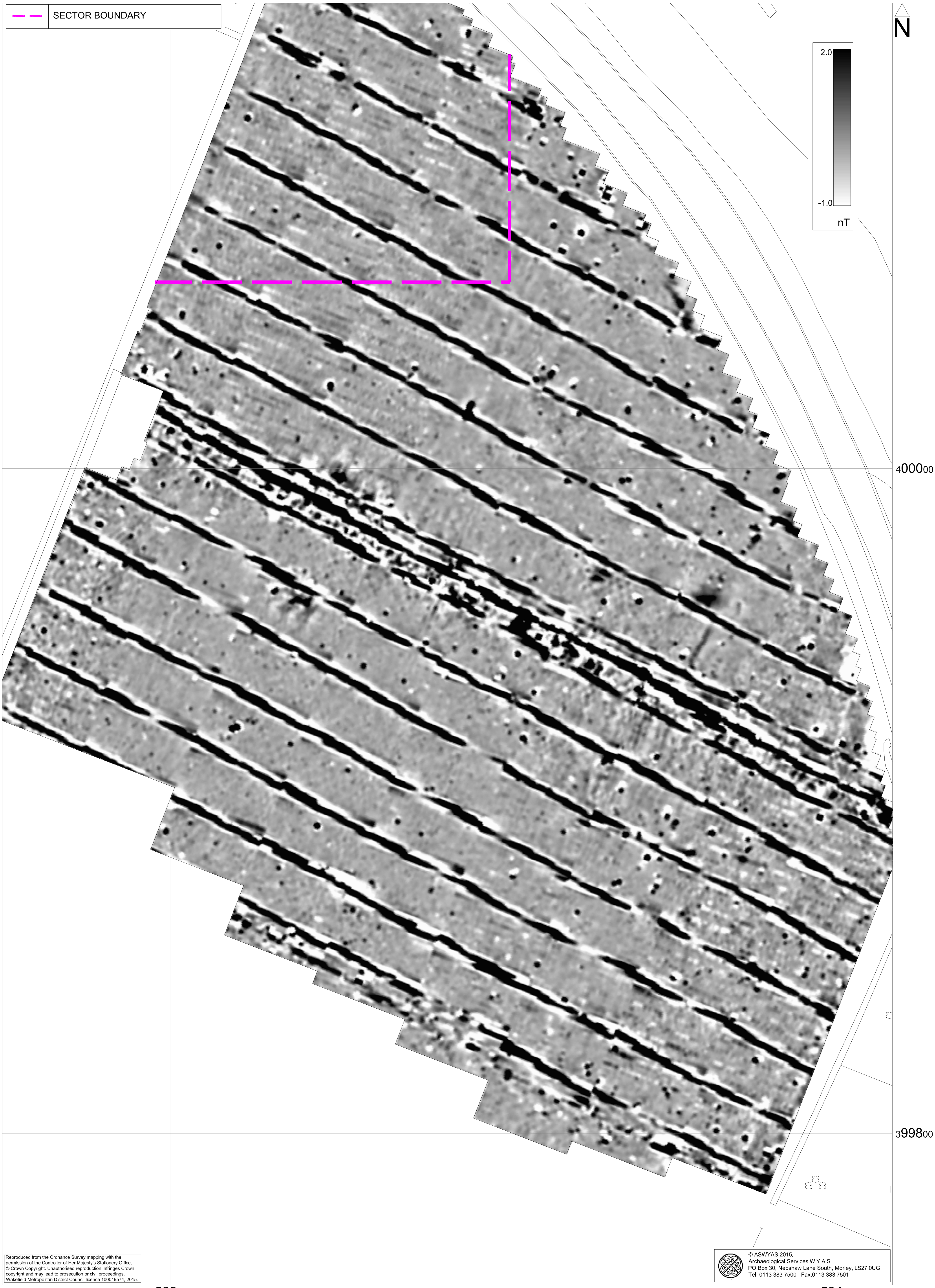

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Fig. 16. Processed greyscale magnetometer data; Area C (1:1000 @ A3)

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

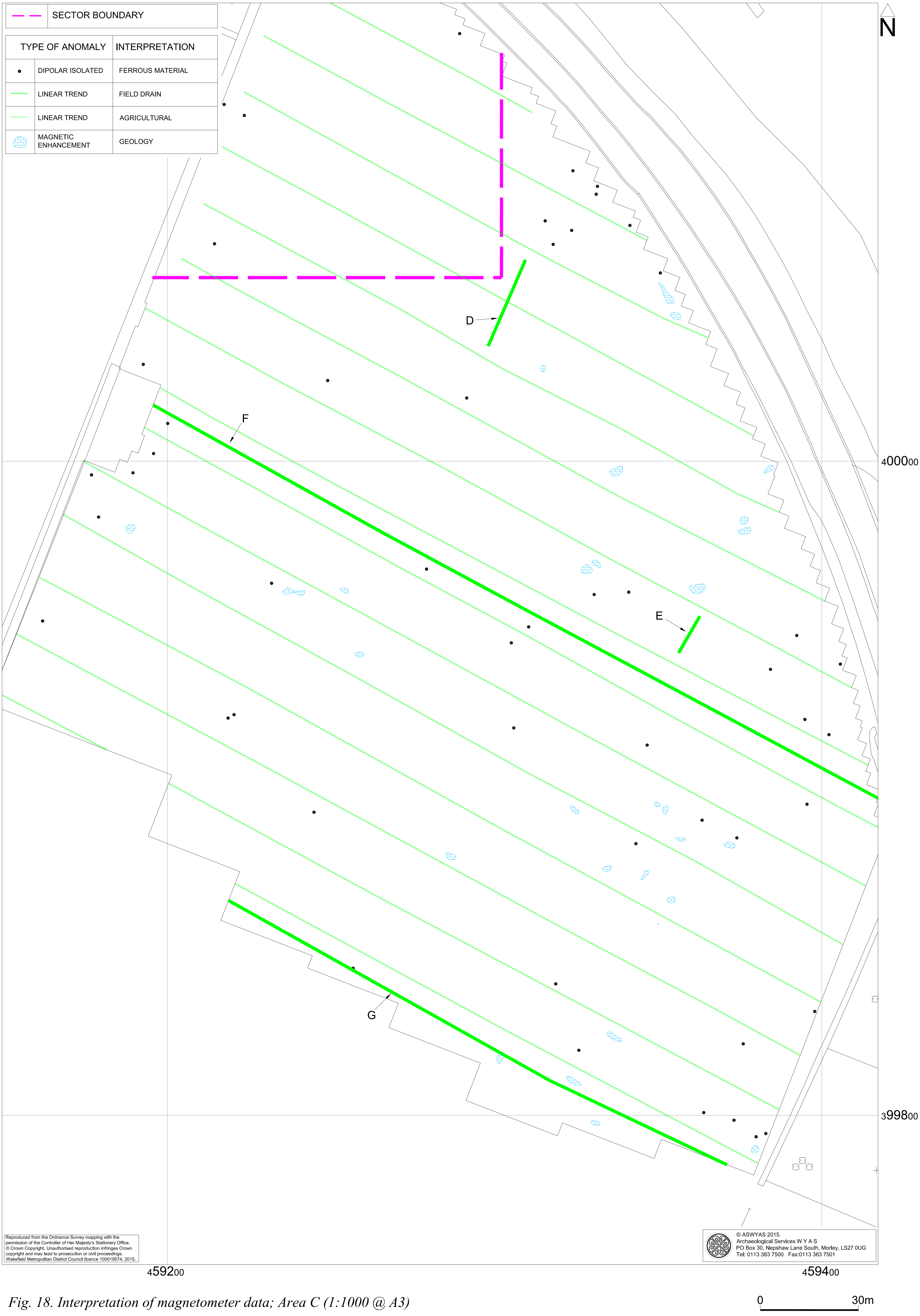

Fig. 18. Interpretation of magnetometer data; Area C (1:1000 @ A3)

Plate 1. General view of Area A, looking south

Plate 2. General view of Area A, looking east

Plate 3. General view of Area A, looking north-east

Plate 4. View of ground disturbance in the west of Area B

Plate 5. General view of Area B, looking north-west

Plate 6. View of tree screen along the southern boundary of Area B, looking north-west

Plate 7. General view of Area C, looking north

Plate 8. General view of Area C, 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. Areas of human occupation or settlement can then be identified by measuring the magnetic susceptibility of the topsoil because 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: Gradiometer Survey

The main method of using the fluxgate gradiometer for commercial evaluations is referred to as ***detailed survey*** and requires the surveyor to walk at an even pace carrying the instrument within a grid system. A sample trigger automatically takes readings at predetermined points, typically at 0.25m intervals, on traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation.

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 0.5m 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.

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.

Appendix 2: Survey location information

The site grid was laid out using a Trimble dual frequency Global Positioning System (GPS) with two Rovers (Trimble 5800 models) working in real-time kinetic mode. The accuracy of such equipment was better than 0.02m. 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 for relocation purposes.

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 South Yorkshire Historic Environment Record).

Appendix 4: OASIS Form

OASIS DATA COLLECTION FORM: England

Printable version

OASIS ID: archaeol11-208212

Project details

Project name	Loversall Carr, South Yorkshire
Short description of the project	A geophysical (magnetometer) survey covering approximately 24 hectares was carried out at Loversall Carr, near Doncaster, where it is proposed to create seasonally wet features ('wader scrapes') adjacent to Potteric Carr Nature Reserve. The survey has identified two linear anomalies which are considered likely to be ditches forming part of the pattern of late prehistoric land division in the wider landscape as indicated by cropmarks. However, no anomalies indicative of settlement activity have been recorded and it would seem as if the proposed locations of the 'wader scrapes' successfully avoid areas of higher archaeological potential as indicated by the cropmarks. Elsewhere anomalies indicative of field drains, 19th century boundaries, geological variation and modern activity have been recorded. On the basis of the survey, the archaeological potential of the site is considered to be low but with moderate potential around the identified ditch features.
Project dates	Start: 26-02-2015 End: 03-03-2015
Previous/future work	Not known / Not known
Any associated project reference codes	4374 - Contracting Unit No.
Any associated project reference codes	LVC15 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 4 - Character Undetermined
Monument type	N/A None
Monument type	N/A None
Significant Finds	N\A None
Significant Finds	N\A None
Methods & techniques	"Geophysical Survey"
Development type	wader scrapes
Prompt	National Planning Policy Framework - NPPF

Position in the planning process	Not known / Not recorded
Solid geology (other)	Brotherton Formation and Nottingham Castle Sandstone Formation
Drift geology	ALLUVIUM
Techniques	Magnetometry

Project location

Country	England
Site location	SOUTH YORKSHIRE DONCASTER LOVERSALL Loversall Carr, near Doncaster, South Yorkshire: Geophysical Survey
Study area	24.00 Hectares
Site coordinates	SE 5800 6810 54.1053327504 -1.11283545525 54 06 19 N 001 06 46 W Point

Project creators

Name of Organisation	Archaeological Services WYAS
Project brief originator	Natural England
Project design originator	Archaeological Services WYAS
Project director/manager	Harrison, S.
Project supervisor	Harrison, D.
Type of sponsor/funding body	Natural England

Project archives

Physical Archive Exists?	No
Digital Archive recipient	N/A
Digital Contents	"other"
Digital Media available	"Geophysics"
Paper Archive Exists?	No

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Loversall Carr, near Doncaster, South Yorkshire: Geophysical Survey
Author(s)/Editor(s)	Webb, A.
Other bibliographic details	Report No. 2746

Date	2015
Issuer or publisher	ASWYAS
Place of issue or publication	Morley
Description	A4 blue comb bound report
Entered by	Sam Harrison (sharrison@aswyas.com)
Entered on	7 April 2015

OASIS:

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