WYAS Archaeological Services

East Leeds Orbital Route

West Yorkshire

Geophysical Survey

Report no. 2879
June 2016

Client: Mouchel Consulting

West Yorkshire Joint Services

East Leeds Orbital Route, West Yorkshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 90 hectares in total, was carried out on agricultural land to the east of the city of Leeds; north of Whinmoor and east of Scholes, West Yorkshire. Archaeological anomalies which correspond to cropmarks have been identified indicating enclosures, field systems and a trackway. Responses associated with post medieval quarrying have also been identified. Numerous further anomalies which are likely to be of archaeological interest have been detected throughout.

Former field boundaries have been identified throughout the site that correlate to old mapping. Anomalies indicative of the underlying geology, field drains, service pipes and modern disturbance have also been detected. The archaeological potential of the survey area, is deemed medium to high in fields south of the A64 and low elsewhere.

WYAS
Archaeological Services

Report Information

Client:	Mouchel Consulting
Address:	Kier Construction, Unit 2180, 1st Floor, Thorpe Park, Century Way, Leeds, LS15 8ZB
Report Type:	Geophysical Survey
Location:	East Leeds
County:	West Yorkshire
Grid Reference:	SE 3482 3862 (north west) SE 3830 3444 (south)
Period(s) of activity:	Prehistoric to modern
Report Number:	2879
Project Number:	6342
Site Code:	ELO16
OASIS ID:	archaeol11-256071
Date of fieldwork:	March – May 2016
Date of report:	June 2016
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Contents

List of Figures

List of Plates

1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Mouchel Consulting (the Client) on behalf of their client, to undertake a geophysical (magnetometer) survey on land in East Leeds, to inform a proposed planning application. The work was undertaken in accordance with a Project Design (Brunning 2016). Guidance contained within the National Planning Policy Framework (DCLG 2012) was also followed, in line with current best practice (CIfA 2014; David *et al*. 2008). The survey was carried out between 13th March and 11th May 2016, to provide additional information on the archaeological resource of the survey area.

Site location, topography and land-use

The Proposed Development Area (PDA) consists of 26 fields totalling approximately 90 hectares. The PDA is located to the east of Leeds; to the north and east of Whinmoor, west of Scholes and east of Pendas Fields. The north west of the route lies at SE 3482 3862 and the south east at SE 3830 3444 (see Fig. 1). The site is currently under a cover of either pasture, wheat or oil seed rape. Area 20 had been recently rolled. Elevation of the site lies between 138m above Ordnance Datum (aOD) in the north and 76m aOD in the south.

Soils and geology

The bedrock geology of the survey area comprises of three different geologies; the Elland flags formation of sandstone to the area to the north of Skeltons Lane; Pennine lower coal measures formation of mudstone, siltstone and sandstone along the central section of the PDA; and thick sandstone belonging to Slack Bank Rock series to the north of Manston Lane in the south of the PDA. Superficial deposits that have been recorded belong to the Harrogate till formation consisting of clay, sand and gravels (BGS 2016). The soils of the survey area belong to the Dunkeswick (711p) association consisting of slowly permeable seasonally waterlogged fine loamy over clayey soils (SSEW 1983).

2 Archaeological Background

A search of the area on Pastscape (HE 2016) has revealed a number of heritage assets within the proposed route of the road. In the very south an Iron Age/roman field system, trackways and enclosures are visible as cropmarks on air photographs (monument no. 1386783). A post-medieval quarry (1386254) is also visible as an earthwork on air photographs covering 56ha. A prehistoric/roman rectilinear enclosure (1386217) is visible to the south of the A64. A ring ditch (1386208) visible as a cropmark on air photographs just to the north of the A64, measuring approximately 34m in diameter.

First edition Ordnance Survey mapping of the PDA states that Area 1 was an old burial ground adjacent to Red Hall (a 17th century house). A number of former field boundaries are also shown throughout.

3 Aims and Methodology

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact of the development on potential sub-surface archaeological remains and for further evaluation or mitigation proposals, if appropriate, to be recommended. To achieve this aim, a magnetometer survey covering all amenable parts of the survey area was undertaken (see Fig. 2).

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). The survey was undertaken using Bartington Grad601 magnetic gradiometers. These were employed 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. Figure 2 displays location of the survey areas at a scale of 1:20000. Figures 3 and 4 displays an overview of the processed magnetometer data at a scale of 1:10000, whilst Figures 5 and 6 shows an overview of the interpretation, at the same scale. The processed and minimally processed data, together with an interpretation of the survey results are presented in Figures 7 to 48 inclusive at a scale of 1:1250.

Technical information on the equipment used, data processing and survey methodologies are given in Appendix 1. Technical information on locating the survey area is provided in Appendix 2. Appendix 3 describes the composition and location of the archive. A copy of the completed OASIS form is included 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 7 to 48)

Ferrous anomalies

Ferrous anomalies, as individual 'spikes', or as large discrete areas 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 to suggest anything other than a random background scatter of ferrous debris in the plough-soil.

Along with numerous small scale ferrous anomalies seen throughout the survey area, a number of service pipes can be seen within the data, these are located in Areas 4 and 5 (Figures 10-12), Areas 19, 20, 21, 22, 25 and 26 (Figures 36-48). Large areas of magnetic disturbance seen adjacent to many of the survey area boundaries are due to metal fencing within the current field divisions, or the presence of roads. In the southwest of Area 1 the disturbance is due the location of high metal railings. In the southeast of Area 3 (Figures 10-12) a similar response can be seen, due to the location of farm buildings; corrugated iron panels have been used in the construction which have added to the increase of disturbance. A linear band of disturbance separating Areas 7 and 8 (Figures 13-18) is due to the location of a track.

A linear ferrous response (**1**) in Area 10 is due to the location of a temporary paddock wire fence. Area 26 is largely dominated by magnetic disturbance; the eastern section of the field had been largely landscaped which is a likely explanation.

Throughout the survey areas a number of boreholes had recently been excavated and the caps have created a large ferrous response. Some of these have been marked on the interpretation diagrams as **BH**.

Geological anomalies

Within Areas 20, 21 and 22 (Figures 37-45) large scale ferrous-type anomalies can be seen. These have been interpreted as being of a geological origin as they lie within a known post-medieval quarry which covers an area of 56.2ha (monument number: 1386254, HE 2016).

Smaller discrete low magnitude anomalies have been identified throughout and are thought to be caused by variations in the depth and composition of the soils and the superficial deposits from which they derive. Those in Area 23 (Figures 43-45) are likely to be associated with the adjacent Cock Beck and may represent a former water course.

Agricultural anomalies

Former field boundaries which correlate to old mapping have been detected in Areas 6 (Figures 13-15), Areas 9, 10, 11, 12, and 13, (Figures 19-24) Areas 16, 17, 18, 19 (Figures 25-36) and Areas 23, 24 and 25 (Figures 43-48). These appear on the first edition OS maps dating from 1888 and are shown until 1952 (OS 2016).

Ridge and furrow cultivation is visible in Areas 9, 10, 11, 12 (Figures 19-24), and Areas 20 and 21 (Figures37-42). The magnetically stronger linear anomalies within Area 11 are confined to the south of a former boundary (**2**). The cultivation within Area 12 (Figures 22-24) stops at a known old field boundary (**3**). Modern ploughing trends can also be seen within a number of the survey areas.

Magnetically strong parallel linear trends representing modern field drains have been detected in Areas 7 and 8 (Figures 13-18) on a northwest to southeast or north to south alignment. Drains have also been detected within Areas 1 (Figures 7-9), Area 12 (Figures 22-24) and Area 23 (Figures 43-45) but of a weaker magnetic strength.

Possible archaeological anomalies

Responses that have been interpreted as of a possible archaeological origin have been recorded in Areas 11, 12, 13, 14, 16 (Figures 19-27), and Areas 17, 18, 19, 20, 21 and 23 (Figures 30-45). For ease of discussion and to avoid repetition these are shown in the table below. Anomalies are annotated on the interpretation diagrams as **P1 - P13**.

Anomaly ID	Dimensions	Description
P1	N/A	Areas 11 – 12. Ditches likely to represent a former field system. Cropmark evidence within this field suggests a prehistoric/roman rectilinear enclosure (HER No. 1386217) but appears to lie outside the survey area (HE 2016). Ridge and furrow cultivation is present within this area (Figs 19-24).

P2	N/A	Area 13. A series of linear ditches forming probable former field systems (Figs 22-24).
P3	36m x 30m	Area 13. A rectilinear enclosure abutting one of the ditches **P2**. Possible internal pit-type responses are also visible (Figs 22-24).
P4	N/A	Areas 13 – 14. A series of fragmented ditch-type responses adjacent to Wood Lane (Figs 25-27).
P5	N/A	Area 16. A series of linear ditches forming probable former field systems (Figs 25-30).
P6	180m x 94m	Area 18. A large rectilinear enclosure consisting of well-defined ditches and trends. A feint linear trend can be seen bisecting the enclosure on an approximate east - west alignment (Figs 31-33).
P7-P8	N/A	Area 18. Two zones of increased response. **P7** located in the northwest of the large enclosure may be indicative of anthropogenic activity. **P8** has a lesser magnetic strength but still may be of archaeological interest (Figs 31-33).
P9	24m x 24m	Area 18. A square enclosure abutting the east of **P3**. Further weak linear trends can be seen to the east suggesting a continuation of responses outside the survey area (Figs 31-33).
P10	N/A	Area 18. A curving fragmented ditch-type anomaly, possibly a former field system. Appears to cut through **P6** (Figs 28-33).
P11	N/A	Area 19. A series of linear ditches forming probable former field systems (Figs 34-36).
P12	N/A	Area 22. A roughly circular anomaly within the area of quarrying which has a different magnetic signature suggesting a more archaeological origin (Figs 40-42).
P13	N/A	Area 23. A band of low magnetic anomalies on an approximate east to west alignment may represent a trackway or former boundary. There is an increase of cultivation trends to the south of this (Figs 43-45).

Table 1: Possible archaeological anomalies

Anomalies that have not been discussed which fall under this category can be seen surrounding many of the responses mentioned. It is likely that they are of an archaeological interest and relate to the highlighted responses.

Archaeological anomalies

Definite archaeological responses have been detected in Area 25 (Figures 46-48) in which some correspond to cropmarks suggesting an Iron Age/ Roman field system, enclosures and track (Monument Number: 1386783). The gradiometer survey has identified further features adding to the archaeological site. Parallel linear ditches (**A1**) are associated with the known trackway. Linear responses (**A2** and **A3**) appear to represent boundary ditches and enclose the majority of the internal features (**A4**). These internal responses comprise at least three enclosures each with their own internal divisions, adding to the complexity of the site. Abutting **A1** and **A3** further enclosures (**A5**) can be seen. Of which the easternmost enclosures measures 13m x 13m, whilst that to the west measures 15m x 20m.

A strong magnetic response (**A6**) could be indicative of industrial activity associated with the enclosures. A possibility for the response being a mine shaft is also plausible as many are noted on old mapping within the immediate vicinity.

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.

5 Conclusions

The results from the gradiometer survey have detected anomalies which correspond to cropmarks indicative of Iron Age / Roman field systems, enclosures and a track. Anomalies which were not previously identified have also been detected. A strong magnetic response in this area may suggest industrial activity. Anomalies that have been interpreted as having a potential archaeological origin have been recorded across the survey area consisting of field systems, enclosures, ditches and pits.

Medieval ridge and furrow cultivation have been identified within a number of areas and anomalies associated with a post medieval quarry have also been detected.

Former field boundaries that correlate to old mapping have been recorded throughout the survey area along with modern field drains areas of magnetic disturbance and service pipes.

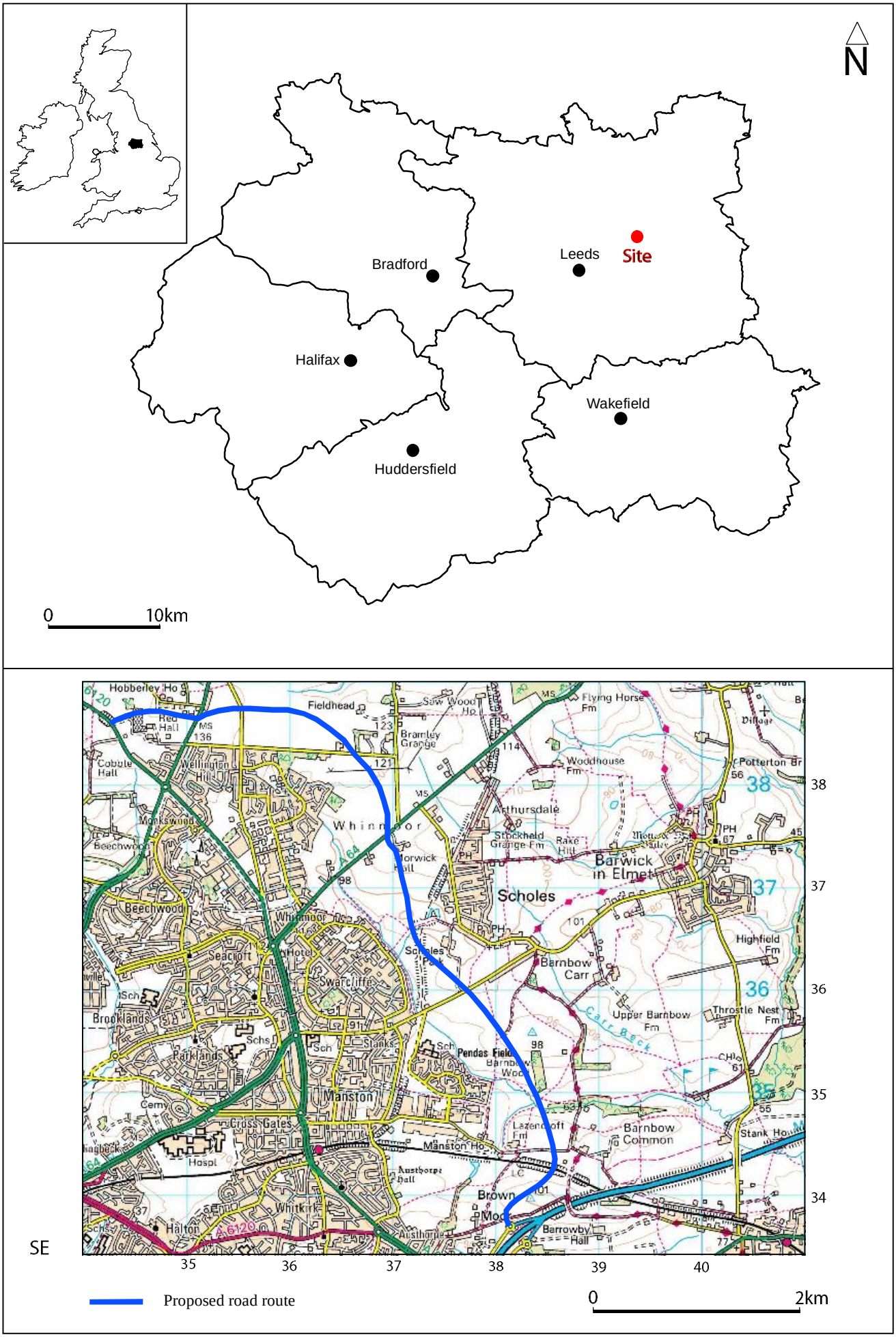

Fig. 1. Site location

	SURVEY BOUNDARY
	SURVEY BY GSB 2011
	CROPMARK DETAIL
	HER MONUMENT DATA

N

1386208

1386217

Barrfield

1386254

1386743

2.0

-1.0

nT

4390 00

4380 00

4370 00

4360 00

4350 00

4330 00

4340 00

4350 00

4360 00

4370 00

4380 00

4390 00

4400 00

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0 1000m

Fig. 2. Survey location showing greyscale magnetometer data (1:20,000 @ A3)

SECTOR BOUNDARY

LOCATION AND DIRECTION OF PLATES

SECTOR 1
SEE FIGS 7-9

SECTOR 2
SEE FIGS 10-12

SECTOR 3
SEE FIGS 13-15

SECTOR 4
SEE FIGS 16-18

SECTOR 5
SEE FIGS 19-21

SECTOR 6
SEE FIGS 22-24

Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7
Area 8
Area 9
Area 10
Area 11
Area 12
Area 13

N

439000
438000
437000

434000
435000
436000
437000

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0 500m

Fig. 3. Overview showing greyscale magnetometer data (1:10,000 @ A3)

SECTOR BOUNDARY

1 LOCATION AND DIRECTION OF PLATES

N

SECTOR 7
SEE FIGS 25-27

SECTOR 8
SEE FIGS 28-30

SECTOR 9
SEE FIGS 31-33

SECTOR 10
SEE FIGS 34-36

SECTOR 11
SEE FIGS 37-39

SECTOR 12
SEE FIGS 40-42

SECTOR 13
SEE FIGS 43-45

SECTOR 14
SEE FIGS 46-48

Area 13
Area 14
Area 15
Area 16
Area 17
Area 18
Area 19
Area 20
Area 21
Area 22
Area 23
Area 24
Area 25
Area 26

9
10
11
12
13

2.0
-1.0
nT

4390 00
4360 00
4350 00

4360 00
4370 00
4380 00
4390 00

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0 500m

Fig. 4. Overview showing greyscale magnetometer data (1:10,000 @ A3)

SECTOR BOUNDARY

SECTOR 1
SEE FIGS 7-9

SECTOR 2
SEE FIGS 10-12

SECTOR 3
SEE FIGS 13-15

SECTOR 4
SEE FIGS 16-18

SECTOR 5
SEE FIGS 19-21

SECTOR 6
SEE FIGS 22-24

TYPE OF ANOMALY		INTERPRETATION
•	DIPOLAR ISOLATED	FERROUS MATERIAL
	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	MAGNETIC ENHANCEMENT	FORMER FIELD BOUNDARY
++++++	LINEAR TREND	FIELD DRAIN
	LINEAR TREND	RIDGE AND FURROW
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY? - DITCH

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N

4390 00
4380 00
4370 00

4340 00
4350 00
4360 00
4370 00

0 500m

Fig. 5. Overview showing interpretation of magnetometer data and first edition Ordnance survey mapping of 1850 (1:10,000 @ A3)

SECTOR BOUNDARY

SECTOR 7
SEE FIGS 25-27

SECTOR 8
SEE FIGS 28-30

SECTOR 9
SEE FIGS 31-33

SECTOR 10
SEE FIGS 34-36

SECTOR 11
SEE FIGS 37-39

SECTOR 12
SEE FIGS 40-42

SECTOR 13
SEE FIGS 43-45

SECTOR 14
SEE FIGS 46-48

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	MAGNETIC ENHANCEMENT	FORMER FIELD BOUNDARY
	LINEAR TREND	FIELD DRAIN
	LINEAR TREND	RIDGE AND FURROW
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY? - DITCH
	LINEAR TREND	ARCHAEOLOGY
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY - DITCH

N

4390 00

4360 00

4350 00

4360 00 4370 00 4380 00 4390 00

0 500m

Fig. 6. Overview showing interpretation of magnetometer data and first edition Ordnance survey mapping of 1850 (1:10,000 @ A3)

SECTOR BOUNDARY

N

Co Const & Ward Bdy

Boro Const Bdy

Depot

Hobberley Cottage

MOOR LANE 1.22m RH

The Wellington (PH)

Path (um)

Drain

WETHERBY ROAD

Area 1

Redhall House

MS

2.0

-1.0

nT

4386 00

4348 00

4350 00

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0 50m

Fig. 7. Processed greyscale magnetometer data; Sector 1 (1:1250 @ A3)

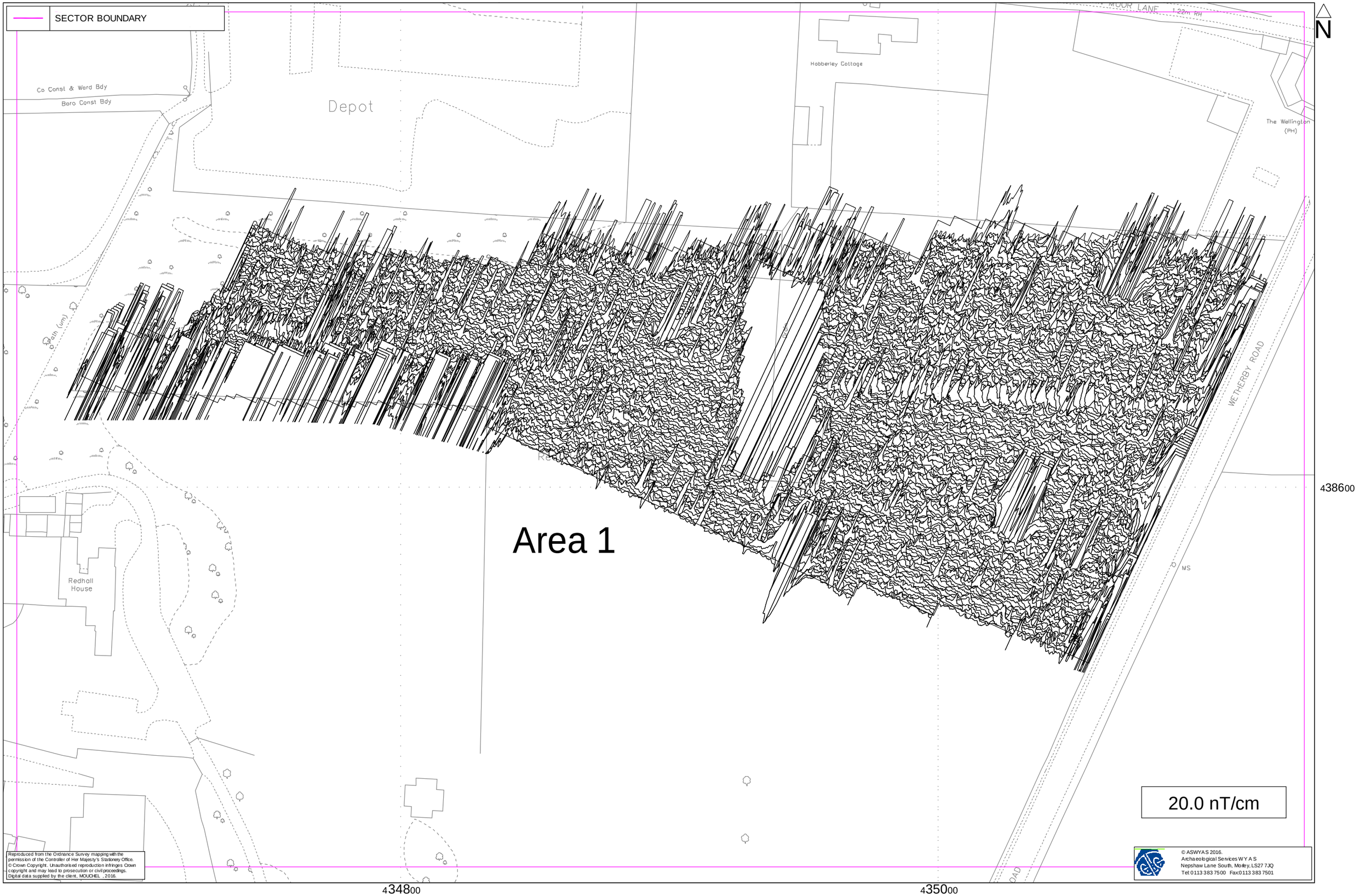

Fig. 8. XY trace plot of minimally processed magnetometer data; Sector 1 (1:1250 @ A3)

SECTOR BOUNDARY

N

Co Const & Ward Bdy

Boro Const Bdy

Depot

Hobberley Cottage

MOOR LANE 1.22m RH

The Wellington (PH)

Path (um)

Drain

WETHERBY ROAD

Red Hall Playing Fields

Area 1

Redhall House

MS

4386 00

4348 00

4350 00

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	FIELD DRAIN
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY

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0 50m

Fig. 9. Interpretation of magnetometer data; Sector 1 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 2

Area 4

Area 3

Area 5

1.22m RH

Bramley Grange Farm

Co Const & Ward Bdy

1.22m RH

Boro Const Bdy

SKELTONS LANE

2.0

-1.0

nT

4386 00

4384 00

4364 00

4366 00

0 50m

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Fig. 10. Processed greyscale magnetometer data; Sector 2 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 2

Area 4

Area 3

Area 5

Bramley Grange Farm

Boro Const & Ward Bdy

1.22m RH

Boro Const Bdy

SKELTONS LANE

20.0 nT/cm

4386 00

4384 00

4364 00

4366 00

0 50m

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Fig. 11. XY trace plot of minimally processed greyscale magnetometer data; Sector 2 (1:1250 @ A3)

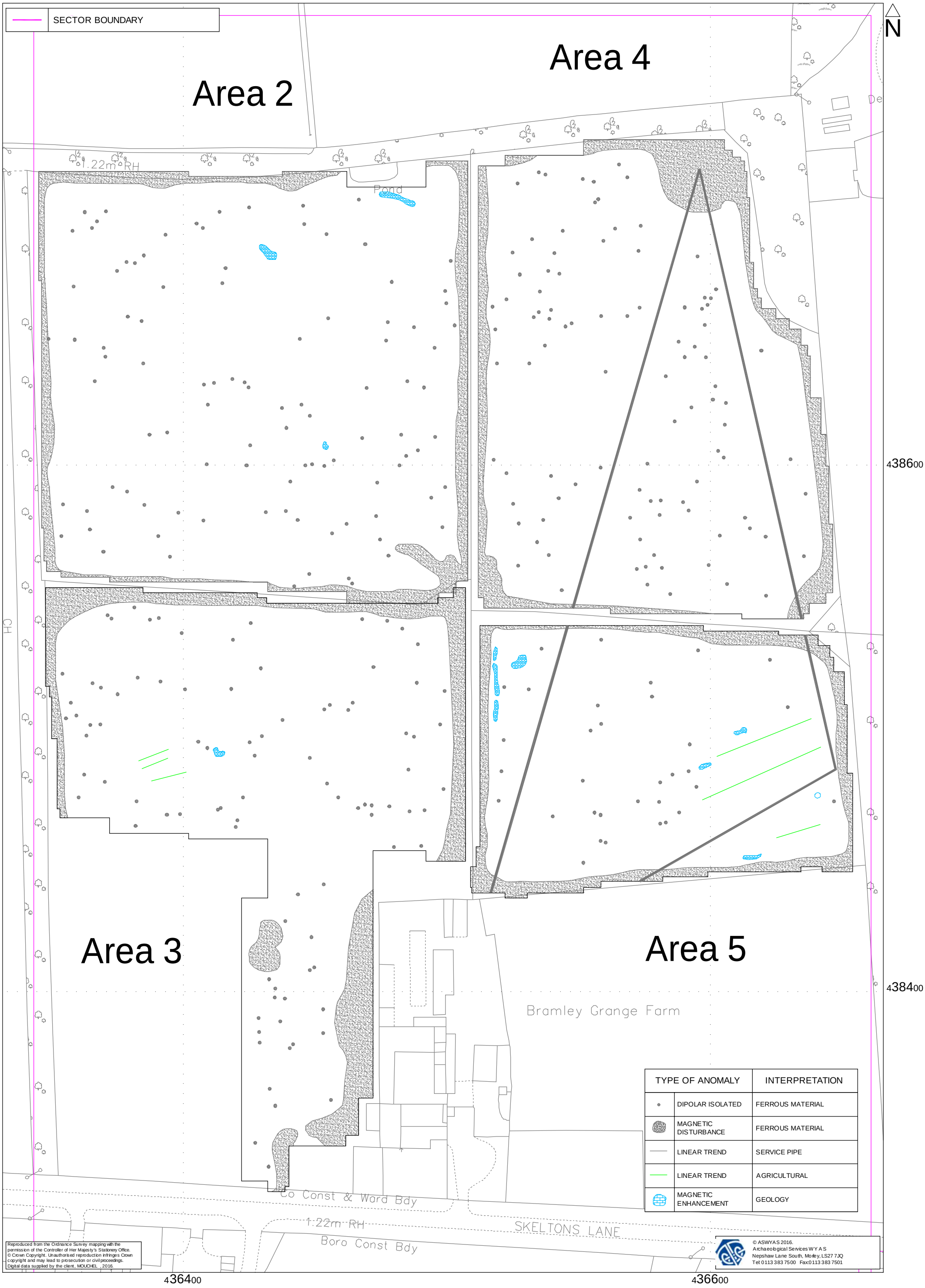

Fig. 12. Interpretation of greyscale magnetometer data; Sector 2 (1:1250 @ A3)

SECTOR BOUNDARY

Area 6

Area 7

Drain

Drain

120.7m

N

438200

438000

437000

436800

2.0

-1.0

nT

0

50m

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Fig. 13. Processed greyscale magnetometer data; Sector 3 (1:1250 @ A3)

SECTOR BOUNDARY

Area 6

Area 7

120.7m

Drain

Drain

N

438200

438000

436800

437000

20.0 nT/cm

0 50m

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Fig. 14. XY trace plot of minimally processed greyscale magnetometer data; Sector 3 (1:1250 @ A3)

SECTOR BOUNDARY

Area 6

Area 7

122.5m

120.7m

Drain

Drain

N

438200

438000

436800

437000

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	FIELD DRAIN

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0 50m

Fig. 15. Interpretation of processed greyscale magnetometer data; Sector 3 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 8

Drain

117.0m

THORNER LANE

Drain

Drain

Drain

A 64

2.0

-1.0

nT

4378 00

4376 00

4368 00

4370 00

0 50m

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Fig. 16. Processed greyscale magnetometer data; Sector 4 (1:1250 @ A3)

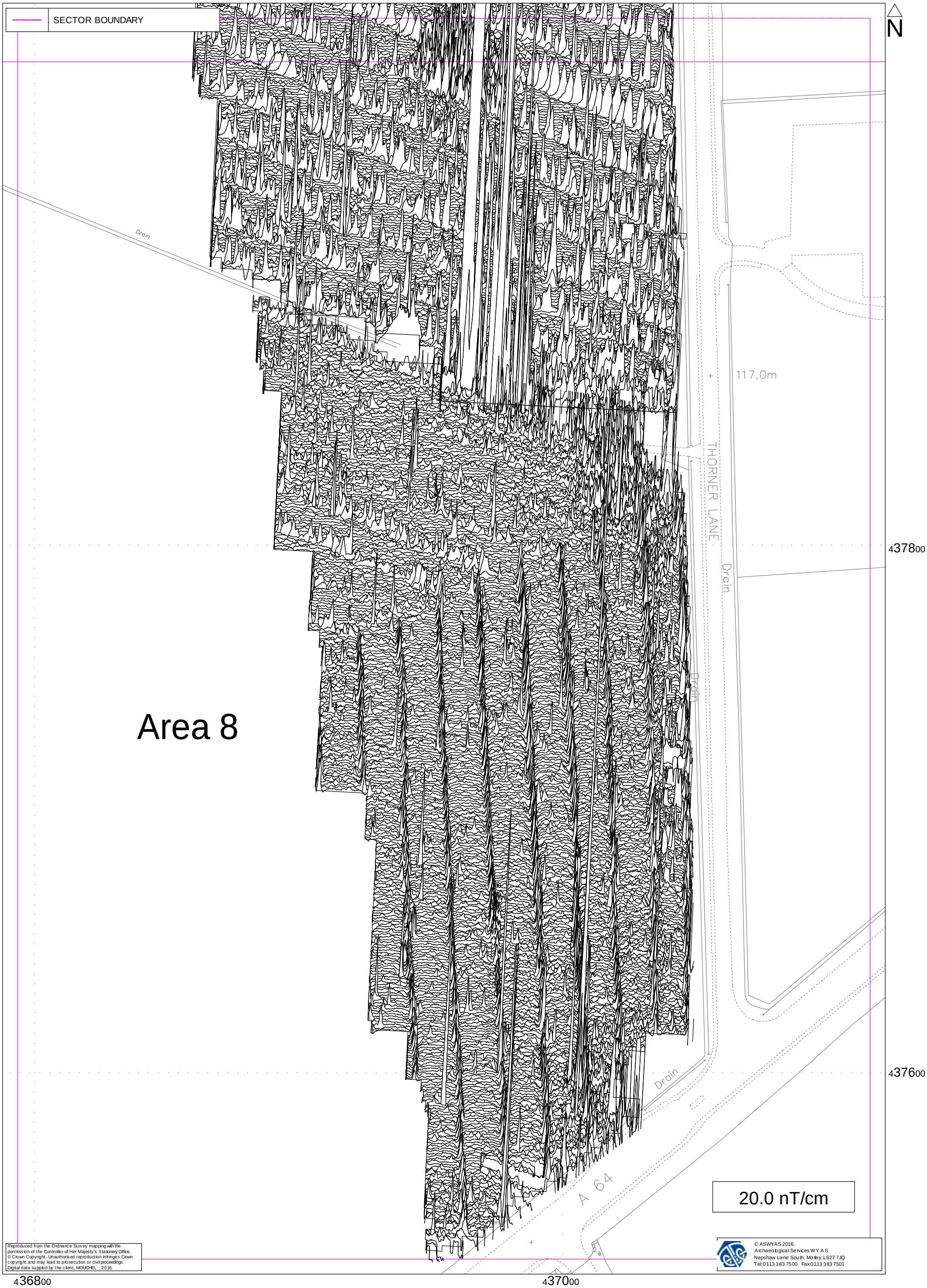

Fig. 17. XY trace plot of minimally processed greyscale magnetometer data; Sector 4 (1:1250 @ A3)

SECTOR BOUNDARY

N

Drain

117.0m

THORNER LANE

Drain

Drain

4378 00

Area 8

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	FIELD DRAIN

114.7m

A 64

4376 00

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4368 00

4370 00

0 50m

Fig. 18. Interpretation of greyscale magnetometer data; Sector 4 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 9

Area 11

Area 10

Morwick Hall

El Sub Sta

Mortec Pa

Morwick House

Und

Def

Co Const & Ward Bdy

Boro Const Bdy

El Ps

Drain

1

2

P1

P1

P1

2.0

-1.0

nT

4374 00

4372 00

4368 00

4370 00

0 50m

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Fig. 19. Processed greyscale magnetometer data; Sector 5 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 9

Area 11

Area 10

20.0 nT/cm

Morwick Hall

El Sub Sta

Morwick House

Mortec Pa

4374 00

4372 00

4368 00

4370 00

0 50m

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Fig. 20. XY trace plot of minimally processed greyscale magnetometer data; Sector 5 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 9

Area 11

Area 10

Morwick Hall

El Sub Sta

Morwick House

Und

Def

Co Const & Ward Bdy

Boro Const Bdy

Mortec Pa

El Ps

1

2

P1

P1

P1

TYPE OF ANOMALY		INTERPRETATION
•	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	MAGNETIC ENHANCEMENT	FORMER FIELD BOUNDARY
	LINEAR TREND	RIDGE AND FURROW
	LINEAR TREND	AGRICULTURAL
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY? - DITCH

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Tel 0113 383 7500 Fax:0113 383 7501

4374 00

4372 00

4368 00

4370 00

0 50m

Fig. 21. Interpretation of processed greyscale magnetometer data; Sector 5 (1:1250 @ A3)

SECTOR BOUNDARY

Area 12

Area 13

N

4370 00

4368 00

4366 00

Whinmoor

90.8m

Path (Dism)

Drain

2.0

-1.0

nT

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax 0113 383 7501

4368 00

4370 00

0 50m

Fig. 22. Processed greyscale magnetometer data; Sector 6 (1:1250 @ A3)

SECTOR BOUNDARY

Area 12

N

4370 00

4368 00

Whinmoor

90.8m

Path (um)

Drain

Area 13

4366 00

20.0 nT/cm

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel: 0113 383 7500 Fax: 0113 383 7501

4368 00

4370 00

0 50m

Fig. 23. XY trace plot of minimally processed greyscale magnetometer data; Sector 6 (1:1250 @ A3)

SECTOR BOUNDARY

Area 12

N

4370 00

P1

ETL

Co Const Bdy

Boro Const & Ward Bdy

Ind

3

3

BH

Whinmoor

4368 00

P2

P2

90.8m

95.4m

P2

P3

Def

ETL

ETL

Area 13

Path (Fm)

Drain

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	MAGNETIC ENHANCEMENT	FORMER FIELD BOUNDARY
	LINEAR TREND	FIELD DRAIN
	LINEAR TREND	RIDGE AND FURROW
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY? - DITCH

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax:0113 383 7501

4368 00

4370 00

4366 00

0 50m

Fig. 24. Interpretation of processed greyscale magnetometer data; Sector 6 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 14

Area 15

Area 16

Wood Lane

Cock Beck

FAWDON DRIVE

FAWDON PLACE

AINSLEY MEWS

AINSLEY VIEW

PENNWELL GREEN

Pennwell Dean

MATHEW WAY

97.5m

87.5m

84.4m

El Sub Sta

FB

4370 00

4368 00

4366 00

4368 00

4370 00

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax 0113 383 7501

0 50m

Fig. 25. Processed greyscale magnetometer data; Sector 7 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 14

Area 15

Area 16

20.0 nT/cm

4370 00

4368 00

4366 00

4368 00

4370 00

0 50m

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax 0113 383 7501

Fig. 26. XY trace plot of minimally processed greyscale magnetometer data; Sector 7 (1:1250 @ A3)

SECTOR BOUNDARY

N

P2

P2

P4

P5

P5

P5

Area 14

Area 15

Area 16

Wood Lane

Cock Beck

FAWDON DRIVE

FAWDON PLACE

AINSLEY VIEW

MATHEW WAY

PENNWELL

FB

El Sub Sta

97.5m

89.0m

87.5m

84.4m

4370 00

4368 00

4366 00

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	FORMER FIELD BOUNDARY
	LINEAR TREND	RIDGE AND FURROW
	LINEAR TREND	AGRICULTURAL
	LINEAR TREND	GEOLOGY
	MAGNETIC ENHANCEMENT	GEOLOGY
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY? - DITCH

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax 0113 383 7501

0 50m

Fig. 27. Interpretation of processed greyscale magnetometer data; Sector 7 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 17

4364 00

4362 00

4372 00

4374 00

2.0

-1.0

nT

0 50m

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax 0113 383 7501

Fig. 28. Processed greyscale magnetometer data; Sector 8 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 17

93.4m

ETL

Sinks

Path (um)

Dismantled Railway

Path (um)

Path (um)

20.0 nT/cm

4364 00

4362 00

4372 00

4374 00

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax:0113 383 7501

0 50m

Fig. 29. XY trace plot of minimally processed greyscale magnetometer data; Sector 8 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 17

P5

BH

P6

P7

P8

P10

P10

93.4m

ETL

ETL

Sinks

Path (um)

Dismantled Railway

Path (um)

Path (um)

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	FORMER FIELD BOUNDARY
	LINEAR TREND	RIDGE AND FURROW
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY? - DITCH

Archaeological Services WYAS
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax:0113 383 7501

4364 00

4362 00

4372 00

4374 00

0 50m

Fig. 30. Interpretation of processed greyscale magnetometer data; Sector 8 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 18

Track

ETL

LEEDS ROAD

83.5m

2.0

-1.0

nT

4362 00

4360 00

4374 00

4376 00

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax:0113 383 7501

0 50m

Fig. 31. Processed greyscale magnetometer data; Sector 9 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 18

4362 00

4360 00

20.0 nT/cm

ETL

Track

83.5m

4374 00

4376 00

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax 0113 383 7501

0 50m

Fig. 32. XY trace plot of minimally processed greyscale magnetometer data; Sector 9 (1:1250 @ A3)

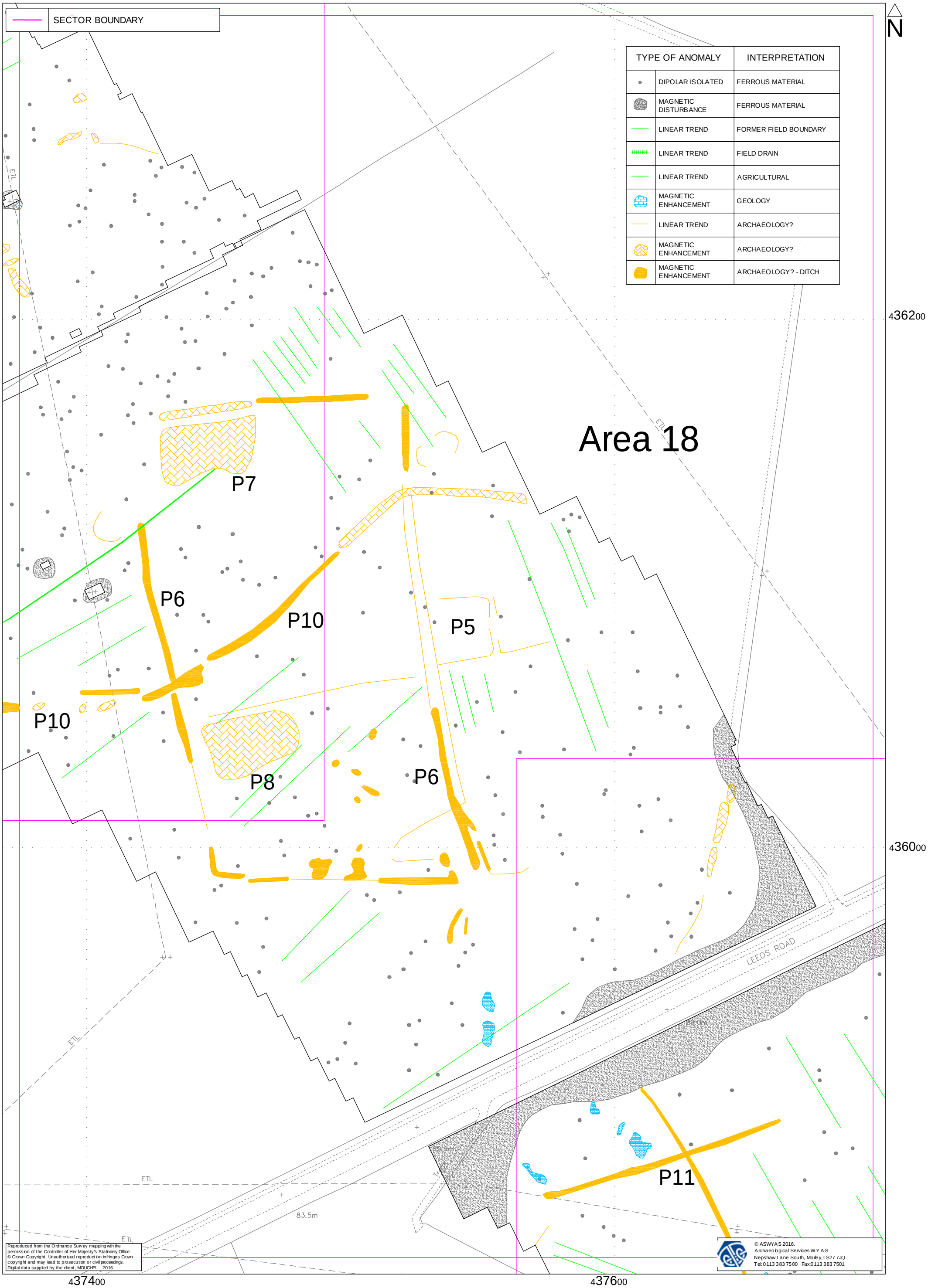

Fig. 33. Interpretation of processed greyscale magnetometer data; Sector 9 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 19

LEEDS ROAD

92.8m

5m

E/L

4360 00

4358 00

4356 00

4376 00

4378 00

2.0

-1.0

nT

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax 0113 383 7501

0 50m

Fig. 34. Processed greyscale magnetometer data; Sector 10 (1:1250 @ A3)

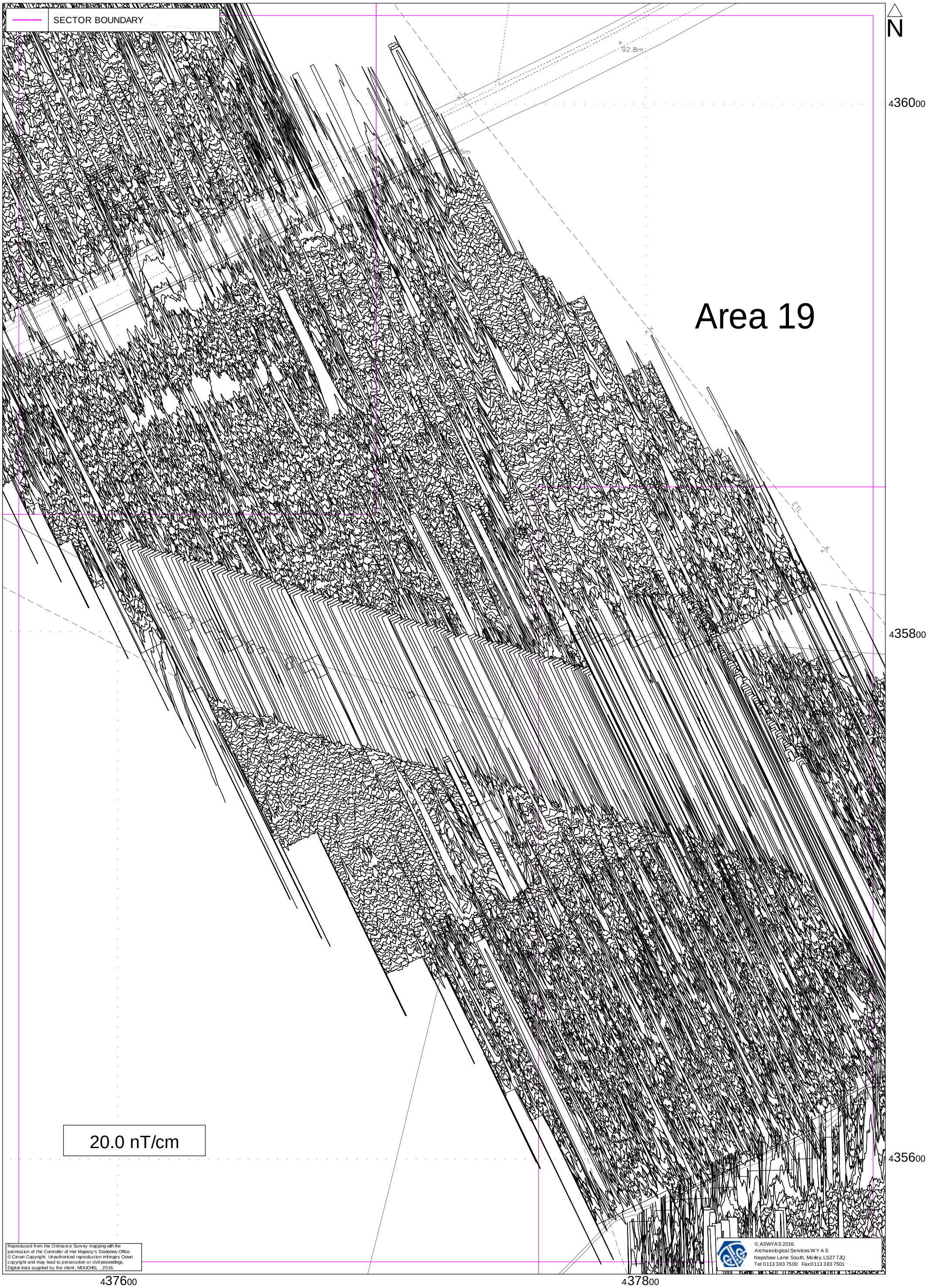

Fig. 35. XY trace plot of minimally processed greyscale magnetometer data; Sector 10 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 19

LEEDS ROAD

92.8m

P11

P11

ETL

ETL

ETL

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	FORMER FIELD BOUNDARY
	LINEAR TREND	RIDGE AND FURROW
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY? - DITCH

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax:0113 383 7501

4360 00
4358 00
4356 00
4376 00
4378 00

0 50m

Fig. 36. Interpretation of processed greyscale magnetometer data; Sector 10 (1:1250 @ A3)

Fig. 37. Processed greyscale magnetometer data; Sector 11 (1:1250 @ A3)

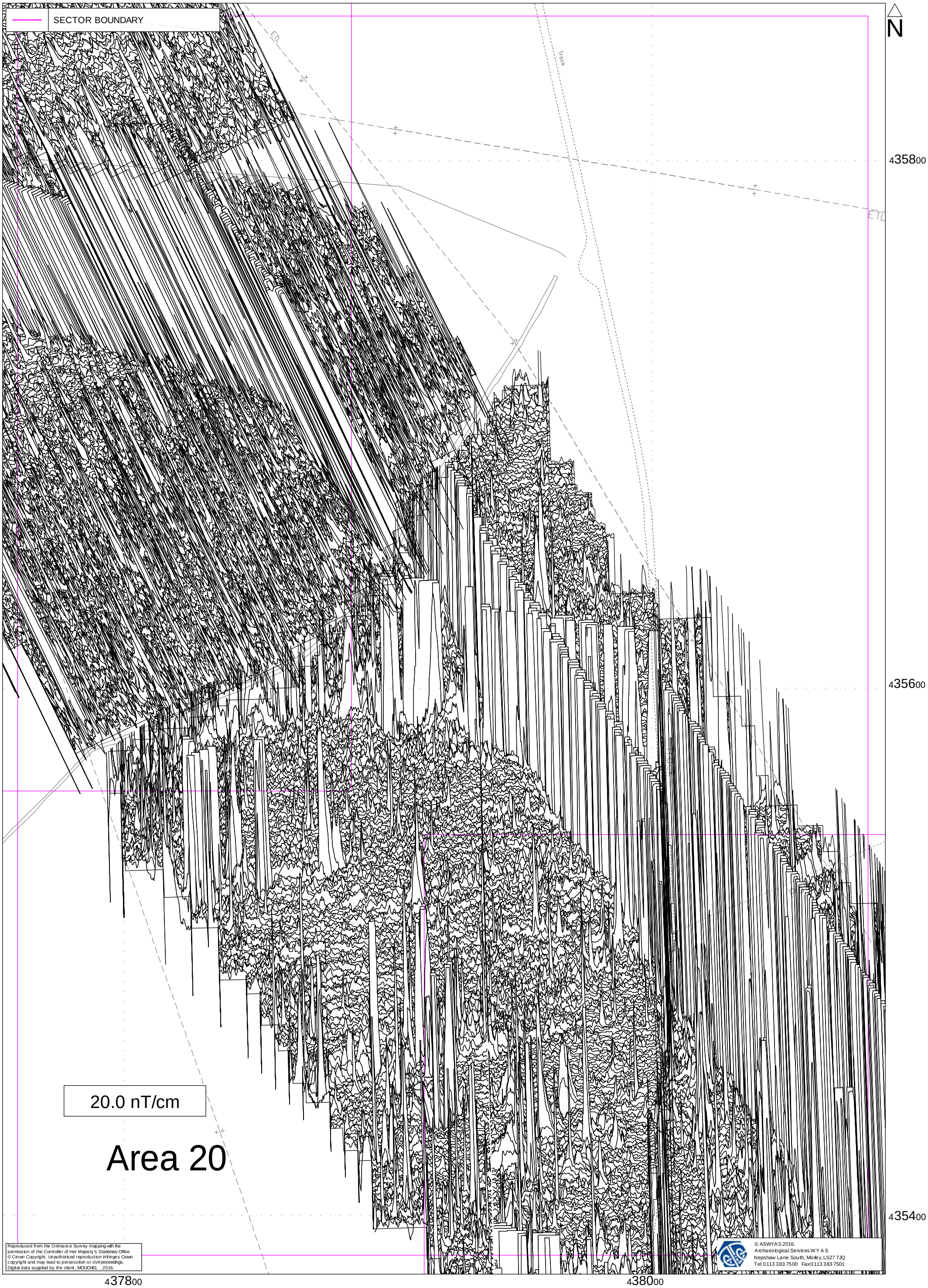

Fig. 38. XY trace plot of minimally processed greyscale magnetometer data; Sector 11 (1:1250 @ A3)

SECTOR BOUNDARY

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	FORMER FIELD BOUNDARY
	LINEAR TREND	RIDGE AND FURROW
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY?

N

ETL

ETL

Track

Track

Path (um)

Area 20

4358 00

4356 00

4354 00

4378 00

4380 00

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax 0113 383 7501

0 50m

Fig. 39. Interpretation of processed greyscale magnetometer data; Sector 11 (1:1250 @ A3)

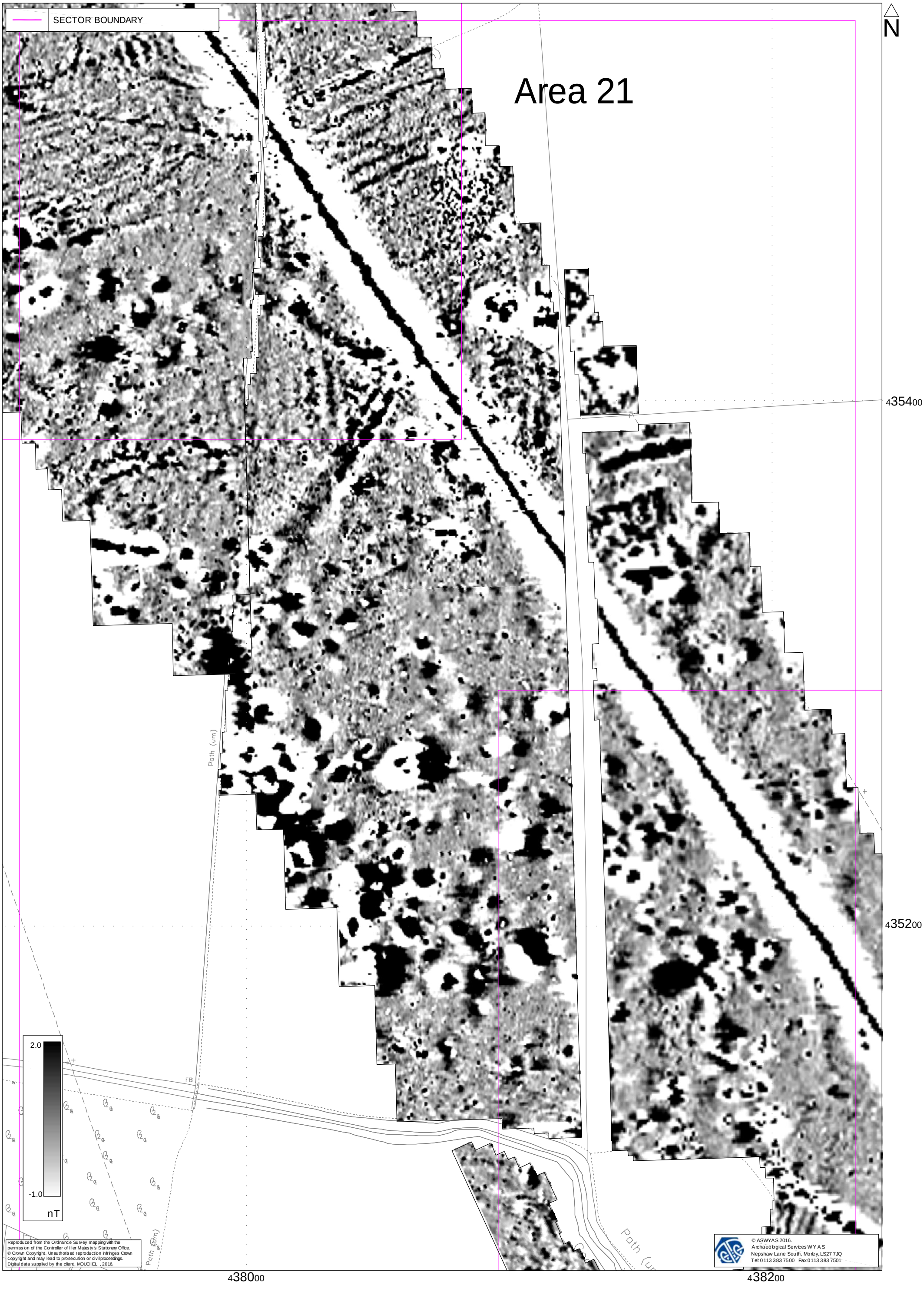

Fig. 40. Processed greyscale magnetometer data; Sector 12 (1:1250 @ A3)

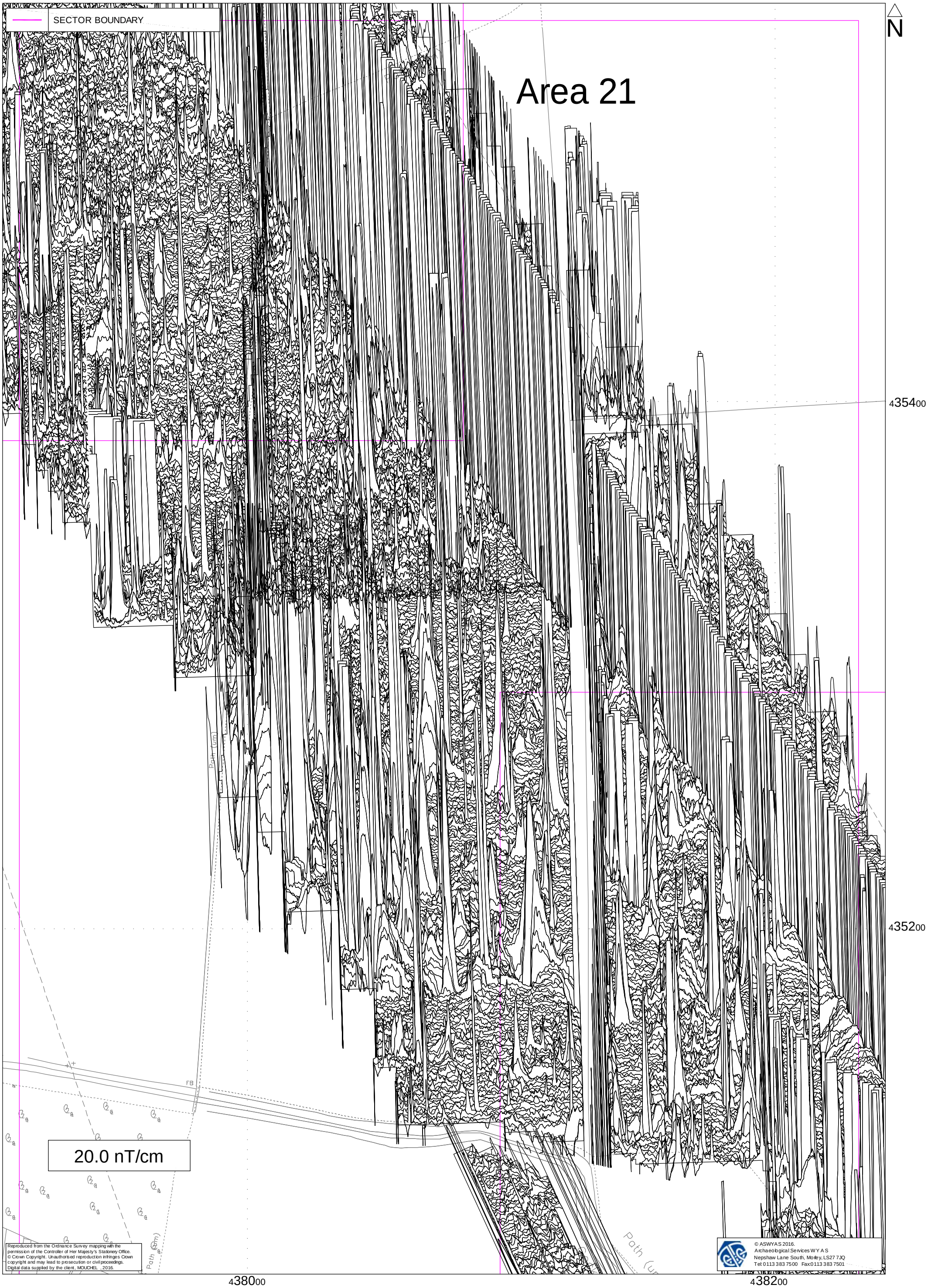

Fig. 41. XY trace plot of minimally processed greyscale magnetometer data; Sector 12 (1:1250 @ A3)

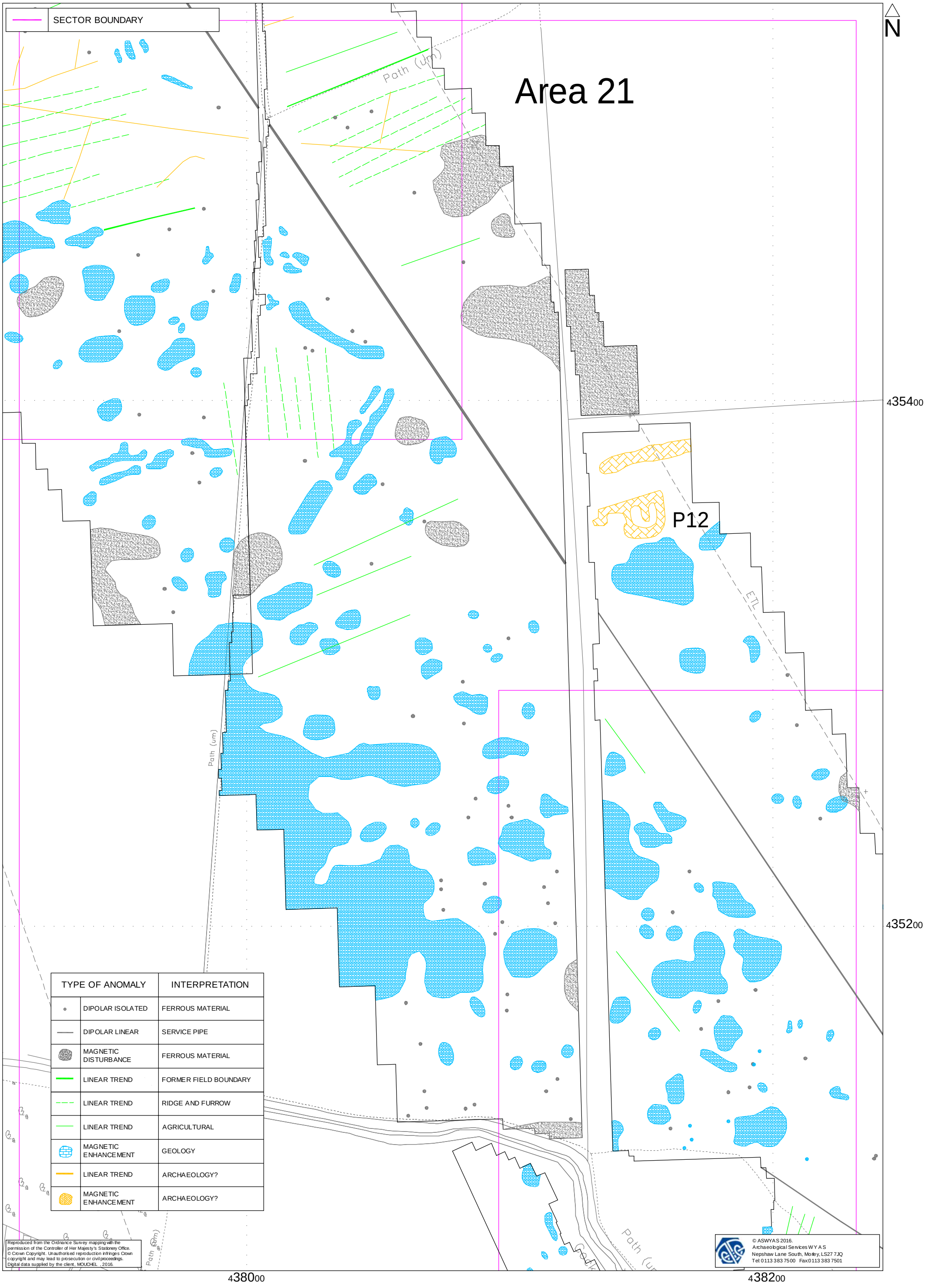

Fig. 42. Interpretation of processed greyscale magnetometer data; Sector 12 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 22

Area 23

Path (um)

4352 00

4350 00

4382 00

4384 00

2.0

-1.0

nT

0 50m

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax:0113 383 7501

Fig. 43. Processed greyscale magnetometer data; Sector 13 (1:1250 @ A3)

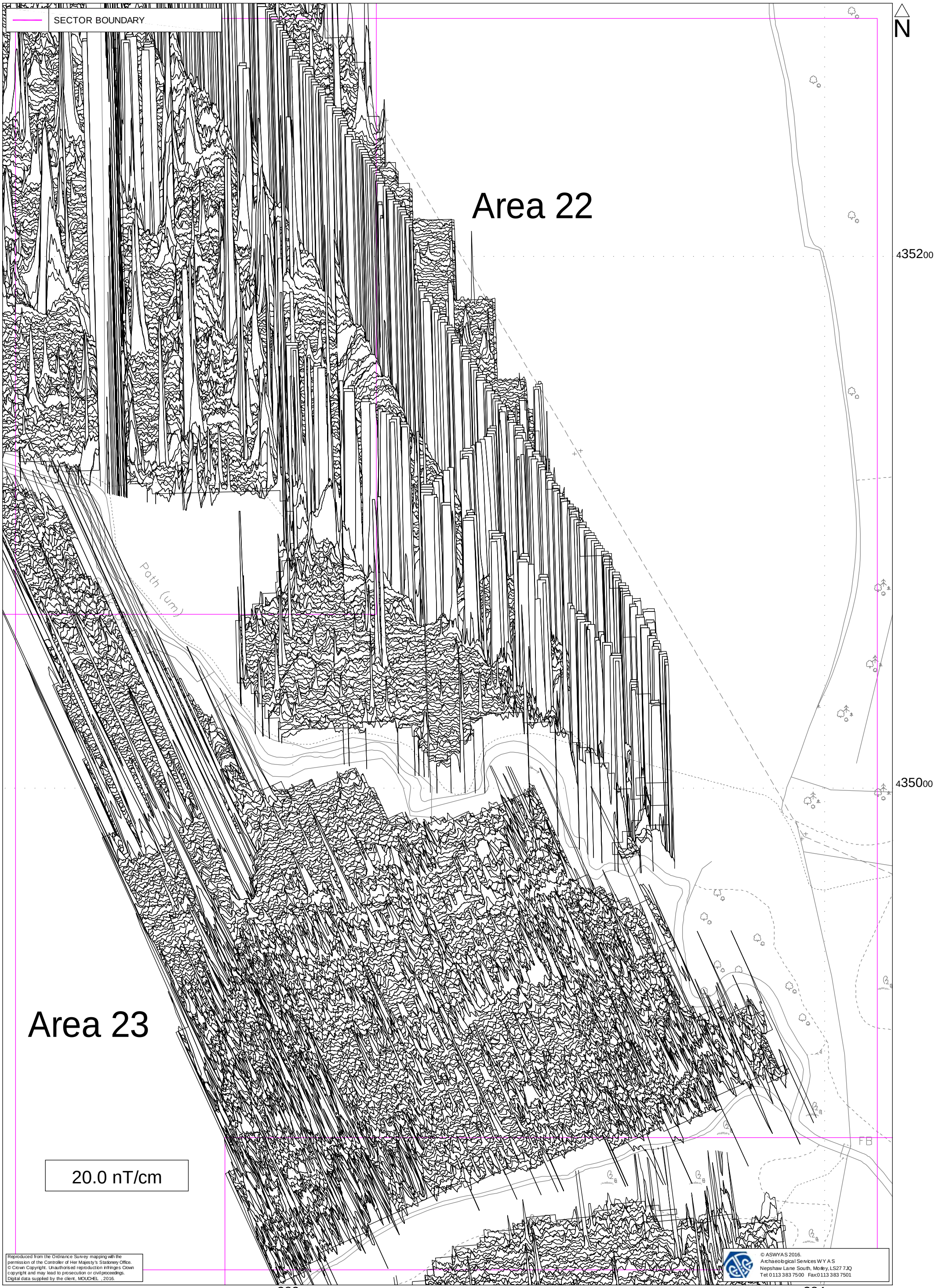

Fig. 44. XY trace plot of minimally processed greyscale magnetometer data; Sector 13 (1:1250 @ A3)

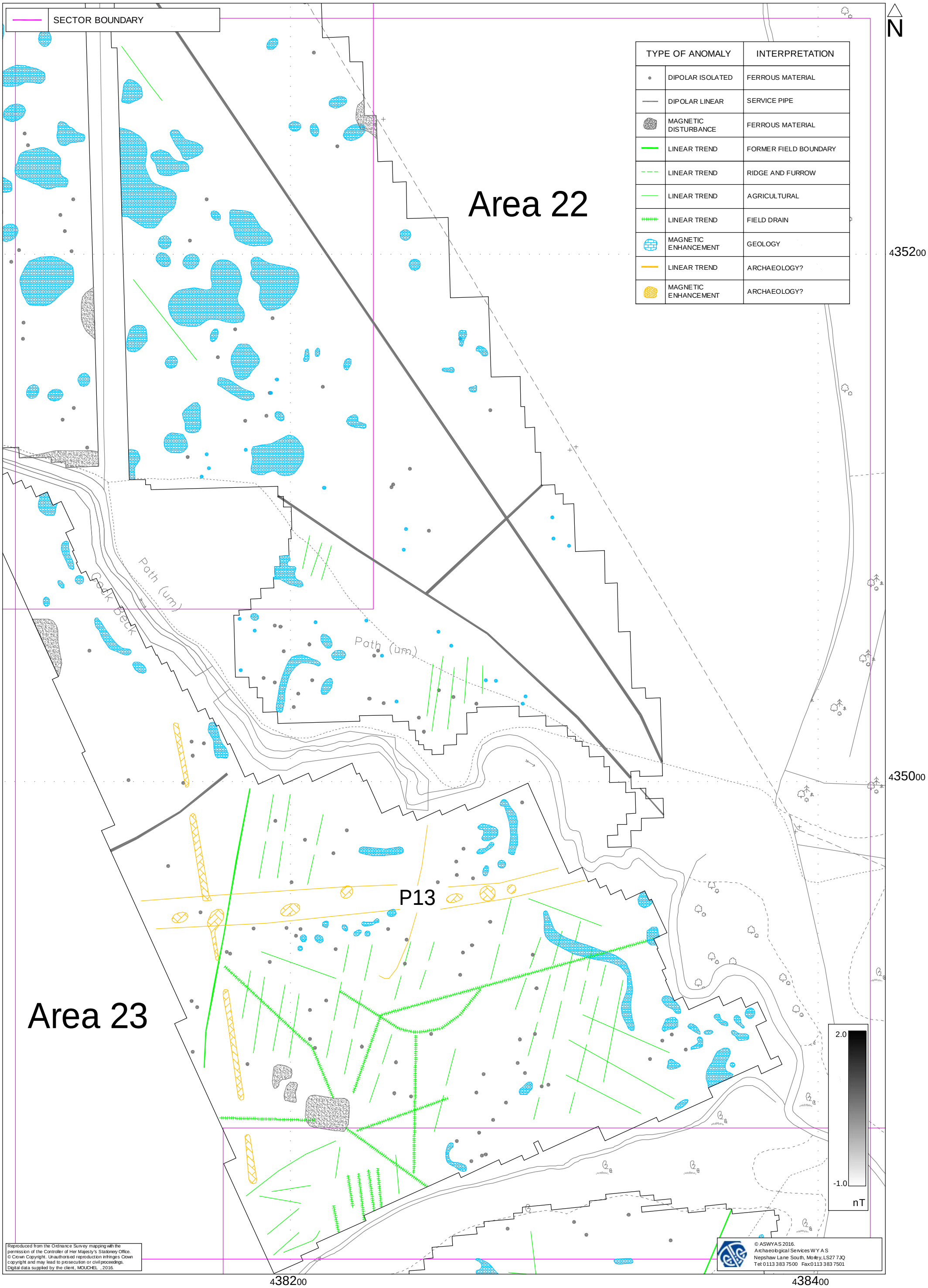

Fig. 45. Interpretation of processed greyscale magnetometer data; Sector 13 (1:1250 @ A3)

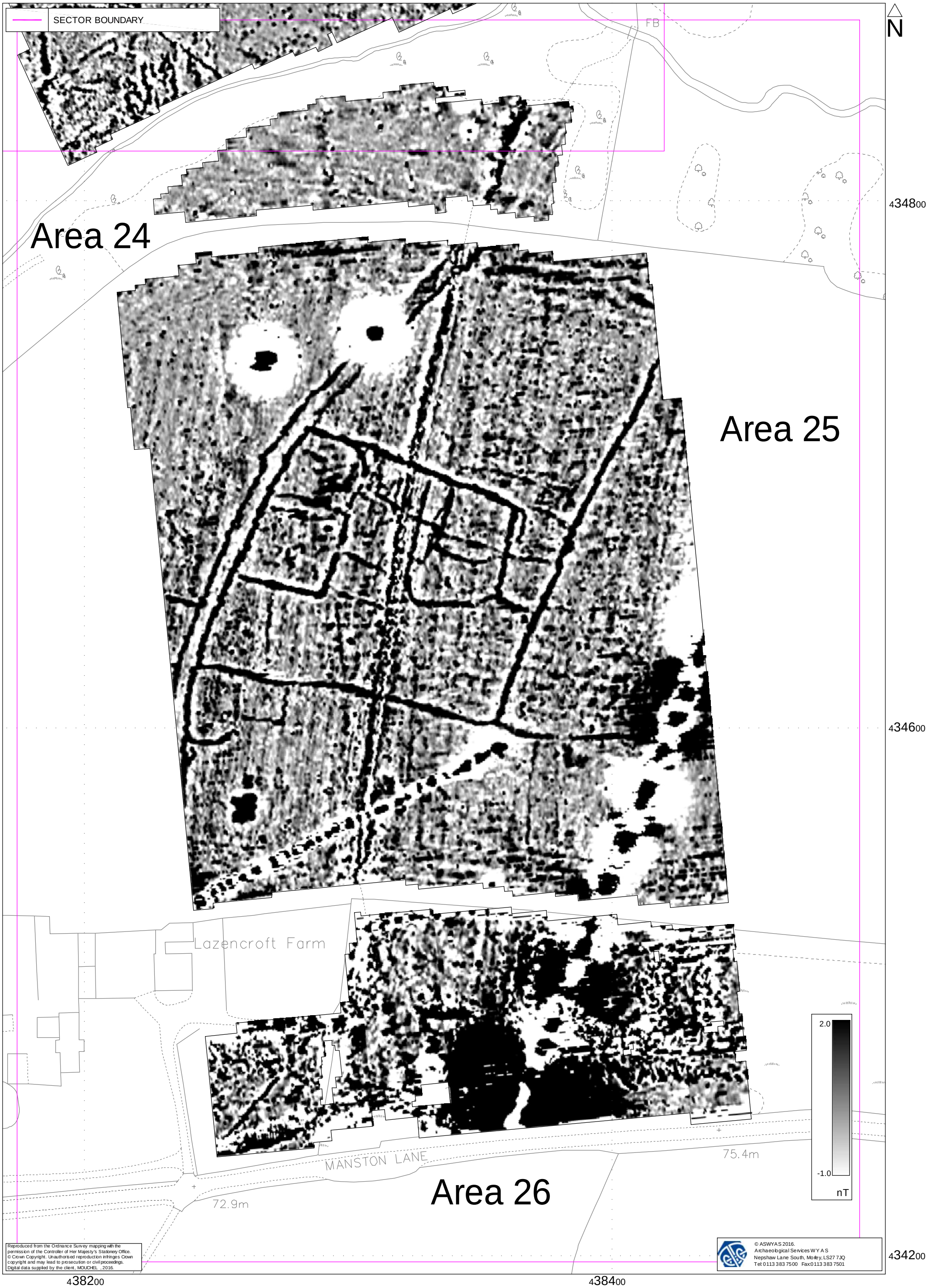

Fig. 46. Processed greyscale magnetometer data; Sector 14 (1:1250 @ A3)

SECTOR BOUNDARY

N

Area 24

Area 25

Area 26

FB

Lazencroft Farm

72.9m

20.0 nT/cm

4348 00

4346 00

4342 00

4382 00

4384 00

0 50m

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel 0113 383 7500 Fax 0113 383 7501

Fig. 47. XY trace plot of minimally processed greyscale magnetometer data; Sector 14 (1:1250 @ A3)

SECTOR BOUNDARY

TYPE OF ANOMALY		INTERPRETATION
	DIPOLAR ISOLATED	FERROUS MATERIAL
	DIPOLAR LINEAR	SERVICE PIPE
	MAGNETIC DISTURBANCE	FERROUS MATERIAL
	LINEAR TREND	FORMER FIELD BOUNDARY
	LINEAR TREND	FIELD DRAIN
	LINEAR TREND	AGRICULTURAL
	MAGNETIC ENHANCEMENT	GEOLOGY
	LINEAR TREND	ARCHAEOLOGY?
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY? - DITCH
	LINEAR TREND	ARCHAEOLOGY
	MAGNETIC ENHANCEMENT	ARCHAEOLOGY - DITCH

N

Area 24

Area 25

Area 26

A1

A1

A2

A3

A4

A5

A6

FB

Lazencroft Farm

MANSTON LANE

72.9m

75.4m

4348 00

4346 00

4342 00

4382 00

4384 00

Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel: 0113 383 7500 Fax:0113 383 7501

0 50m

Fig. 48. Interpretation of processed greyscale magnetometer data; Sector 14 (1:1250 @ A3)

Plate 1. General view of Area 1, looking east

Plate 2. General view of Area 2, looking west

Plate 3. General view of Area 3, looking north

Plate 4. General view of Area 4, looking southwest

Plate 5. General view of Area 7, looking southwest

Plate 6. General view of Area 8, looking south

Plate 7. General view of Area 10, looking north

Plate 8. General view of Area 12, looking south

Plate 9. General view of Area 16, looking east

Plate 10. General view of Area 17, looking southeast

Plate 11. General view of Area 18, looking west

Plate 12. General view of Area 19, looking south

Plate 13. General view of Area 20, looking northwest

Plate 14. General view of Area 24, looking east

Plate 15. General view of Area 25, looking south

Plate 16. General view of Area 26, looking southeast

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.

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 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.

The gradiometer data have been presented in this report in processed greyscale format. The data in the greyscale images have 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.

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

An initial survey station was established using a Trimble VRS differential Global Positioning System (Trimble R6 model). The data was geo-referenced using the geo-referenced survey station with a Trimble RTK differential Global Positioning System (Trimble R6 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 West Yorkshire Historic Environment Record).

Appendix 4: Oasis form

OASIS DATA COLLECTION FORM: England

OASIS ID: archaeol11-256071

Project details

Project name	ELOR
Short description of the project	A geophysical (magnetometer) survey, covering approximately 90 hectares in total, was carried out on agricultural land to the east of the city of Leeds; north of Whinmoor and east of Scholes, West Yorkshire. Archaeological anomalies which correspond to cropmarks have been identified indicating enclosures, field systems and a trackway. Responses associated with post medieval quarrying have also been identified. Numerous further anomalies which are likely to be of archaeological interest have been detected throughout. Former field boundaries have been identified throughout the site that correlate to old mapping. Anomalies indicative of the underlying geology, field drains, service pipes and modern disturbance have also been detected. The archaeological potential of the survey area, is deemed medium to high in fields south of the A64 and low elsewhere.
Project dates	Start: 13-03-2016 End: 11-05-2016
Previous/future work	Yes / Not known
Any associated project reference codes	1386783 - NMR No.
Any associated project reference codes	1386254 - NMR No.
Any associated project reference codes	6342 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 1 - Minimal cultivation
Current Land use	Grassland Heathland 4 - Regularly improved
Monument type	TRACKWAY Late Prehistoric
Monument type	ENCLOSURES Late Prehistoric
Monument type	QUARRY Post Medieval
Significant Finds	TRACKWAY Late Prehistoric
Significant Finds	ENCLOSURES Late Prehistoric

Significant Finds	QUARRY Post Medieval
Methods & techniques	''Geophysical Survey''
Development type	Road scheme (new and widening)
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology (other)	Pennine coal measures
Drift geology (other)	loam and clay
Techniques	Magnetometry

Project location

Country	England
Site location	WEST YORKSHIRE LEEDS LEEDS East Leeds Orbital Route
Study area	90 Hectares
Site coordinates	SE 348 383 53.839572794918 -1.471081875072 53 50 22 N 001 28 15 W Point
Height OD / Depth	Min: 76m Max: 138m

Project creators

Name of Organisation	Archaeological Services WYAS
Project brief originator	Mouchel
Project design originator	Mouchel
Project director/manager	E Brunning
Project supervisor	E Brunning

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Mouchel
Digital Contents	''Survey''
Digital Media available	''Images raster / digital photography'',''Text''
Paper Archive Exists?	No

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	East Leeds Orbital Route

Author(s)/Editor (s)	Brunning, E
Date	2016
Issuer or publisher	ASWYAS
Place of issue or publication	Morley, Leeds
Description	A4 report with A3 figures
Entered by	Emma Brunning (emma.brunning@aswyas.com)
Entered on	28 June 2016

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