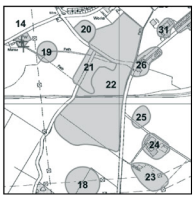
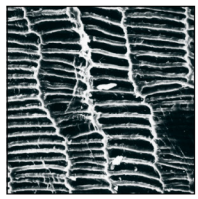
BLQE18










BULL'S LODGE QUARRY: PARK FARM AND BRICK FARM CHELMSFORD, ESSEX

GEOPHYSICAL SURVEY

commissioned by AECOM

October 2018

HEADLAND ARCHAEOLOGY

REGISTERED CIfA ORGANISATION

BULL'S LODGE QUARRY: PARK FARM AND BRICK FARM CHELMSFORD, ESSEX

GEOPHYSICAL SURVEY

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October 2018

This report adheres to the quality standard of ISO 9001:2015

PROJECT INFO:

HA Project Code **BLQE18** / NGR **TL 7290 1110, TL 7548 1086** / Parish **Boreham** / Local Authority **Chelmsford** / OASIS Ref. **headland5-331526**

PROJECT TEAM:

Project Manager **Sam Harrison** / Author **Alistair Webb, Olivier Vansassenbrouck** / Fieldwork **Krasimir Dyulgerski, Mark Evans, Olivier Vansassenbrouck, Richard McGregor Edwards, Ross Bishop** / Graphics **Caroline Norrman, Eleanor Winter, Olivier Vansassenbrouck**

Approved by **Sam Harrison** .....

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HEADLAND ARCHAEOLOGY

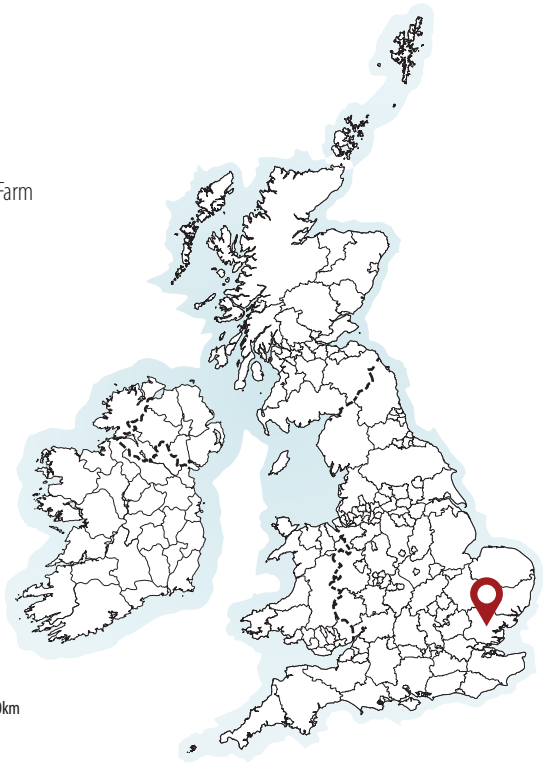
PROJECT SUMMARY

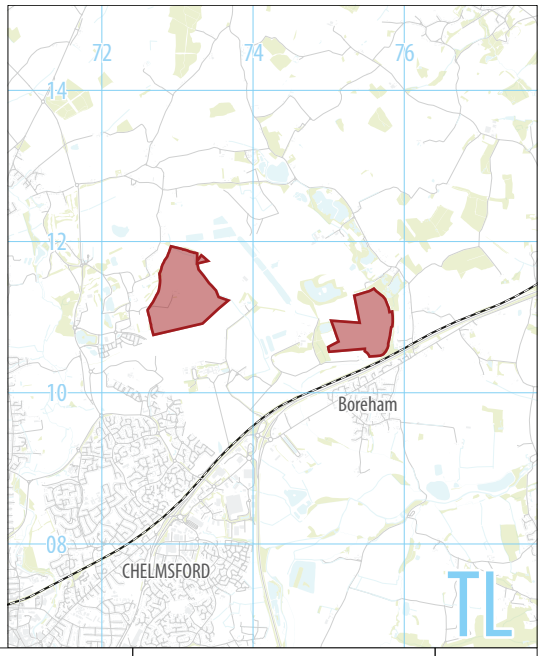
Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey on land at Bulls Lodge Quarry, Chelmsford, Essex in advance of the submission of planning proposals to extend the quarry workings. The survey comprised two areas, at Park Farm and Brick Farm, approximately 2.5 km apart, and covered 116 hectares. At the Park Farm site two areas of archaeological potential have been identified. Although no coherent pattern of activity is discerned, due to the weak magnitude and discontinuous nature of the responses, the anomalies are indicative of enclosures, with possible settlement activity. The archaeological activity is fairly extensive at both locations. There are no anomalies of obvious archaeological potential at the Brick Farm site although anomalies locating the site of an early 20th century rifle range have been identified. These features may be of local historical interest. Although the majority of the two survey areas are devoid of archaeological anomalies the low magnetic contrast and weak and discontinuous nature of the archaeological anomalies could mean that any archaeological remains are more extensive than revealed by the geophysical survey.

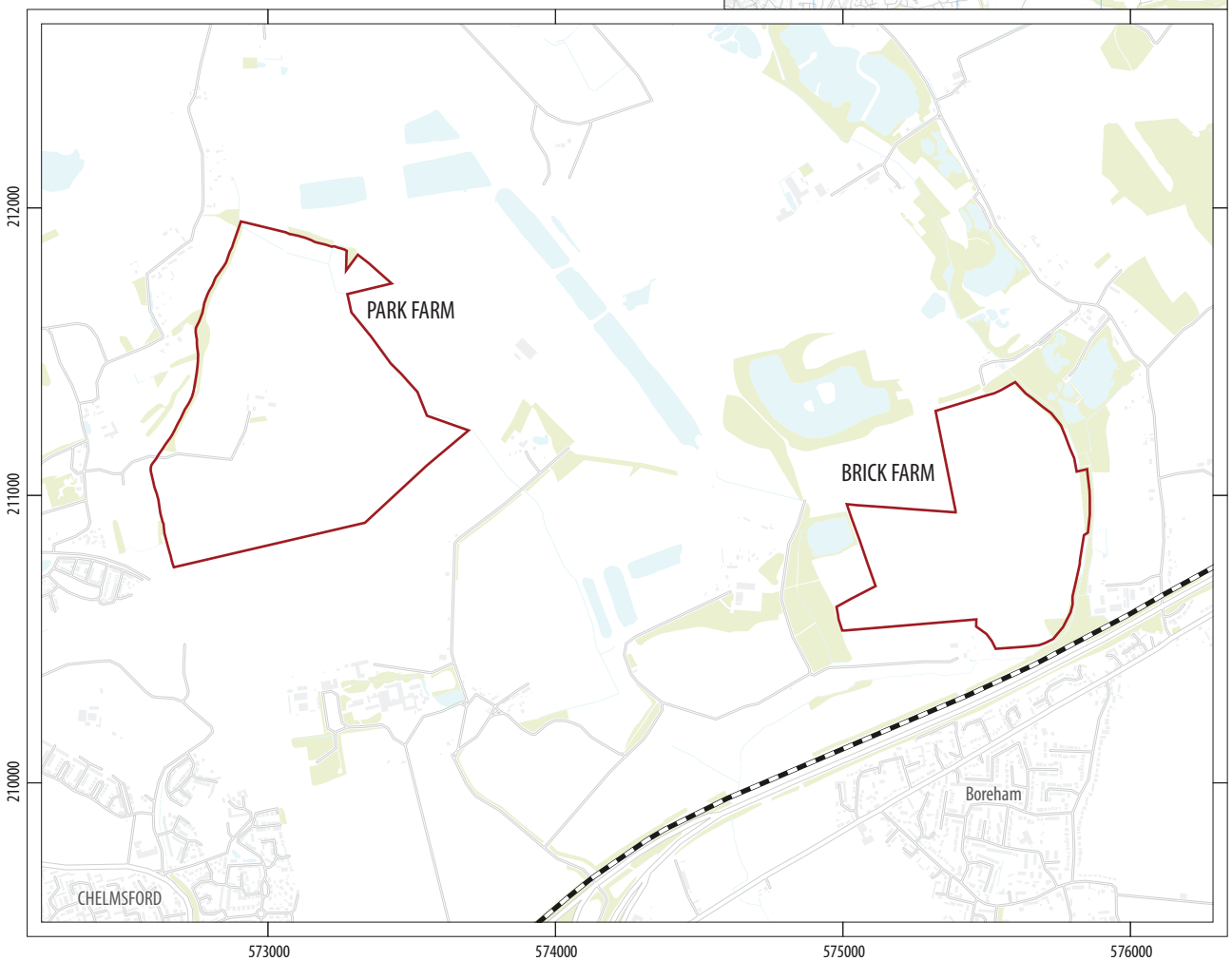
CONTENTS

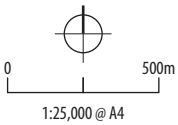
LIST OF ILLUSTRATIONS

Bulls Lodge Quarry
Park Farm and Brick Farm
Chelmsford
Essex









geophysical survey area

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ILLUS 1 Site location

BULL'S LODGE QUARRY: PARK FARM AND BRICK FARM CHELMSFORD, ESSEX

GEOPHYSICAL SURVEY

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by AECOM (The Client), to undertake a geophysical (magnetometer) survey on land at Bulls Lodge Quarry, Chelmsford, centred on Park Farm and Brick Farm (Illus 1), in advance of the submission of a planning application to extend the quarry. The survey was undertaken in order to inform planning proposals by assessing the archaeological potential of the survey areas and, therefore the impact of any proposed development on the historic environment.

The work was undertaken in accordance with a Written Scheme of Investigation (AECOM 2018) which was approved by Alison Bennett, Historic Environment Advisor at Essex County Council, and in line with current best practice (Chartered Institute for Archaeologists 2016, EAC 2015).

The survey was carried out between 5th May and 22nd August 2018 as access was granted and crops were harvested.

1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

The survey covered two irregularly shaped parcels of land covering a combined area of 116 hectares. The westernmost geophysical survey area (GSA) was centred on Park Farm at TL 7290 1110, and comprised 17 fields (F1a, F1b, F1c, F2a, F2b, F3, F4, F5, F6a, F6b, F7a, F7b, F8a, F8b, F9, F10, F11) which are bound by Beaulieu Park Quarry to the south, Boreham Airfield to the east and Channels Golf Course to the west.

The eastern GSA was centred on Brick Farm at TL 7548 1086 and comprised four fields (F12, F13, F14, F15) which are bound by Park Farm and the A12 to the south, Hanson Aggregates to the west and a large body of water to the north. The two GSA's are approximately 2.5 km apart.

Both GSA's comprise relatively flat, low-lying ground at a height of between 48m Above Ordnance Datum (AOD) to 56m AOD at Park Farm, and 36m AOD to 39 AOD at Brick Farm.

The land within both GSA's were under agricultural production at the time of survey with all fields being sowed with either winter wheat or oil seed rape (Illus 2–7 inclusive). The exception was F6b which was a horse paddock.

1.2 GEOLOGY AND SOILS

The bedrock geology comprises London Clay Formation (clay, silt and sand) which is overlain by superficial deposits of Lowestoft Formation Diamicton across most of the survey areas. There is also a band of Head (clay, silt, sand and gravel) at the eastern limit of the survey areas at both Park Farm and Brick Farm. (NERC 2018).

The soils are classified in the Soilscape 8 association, characterised as slightly acid loamy and clayey soils with impeded drainage (Cranfield University 2018).

2 ARCHAEOLOGICAL BACKGROUND

An excavation just south of the Park Farm GSA (south of F7a – see Illus 8) located a complex series of multi-period archaeological features dating from the Early Bronze Age until the post-medieval period. The focus of the activity was an Iron Age enclosed settlement comprising a roundhouse, a four-post structure and two ovens.

Three ring ditches on a rough east-west alignment, and 20m in diameter, were interpreted as tree stands within a former managed garden.

Analysis of Ordnance Survey (OS) maps has identified a few changes in the pattern of enclosure across both GSA's since the publication of the first edition map (Old-maps.co.uk, 2018), with several boundaries being removed over the last 150 years or so.

3 AIMS, METHODOLOGY AND PRESENTATION

The general aim of the geophysical survey was to provide sufficient information to establish the presence/absence, character and extent of any archaeological remains within the GSA.

The specific archaeological objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the likely presence/absence and extent of any buried archaeological features; and
- to produce a comprehensive site archive and report.

3.1 MAGNETOMETER SURVEY

Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. A feature such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the earth's magnetic field. In mapping these slight variations, detailed plans of sites can be obtained as buried features often produce reasonably characteristic anomaly shapes and strengths (Gaffney & Gater 2003). Further information on soil magnetism and the interpretation of magnetic anomalies is provided in Appendix 1.

The survey was undertaken using four Bartington Grad601 sensors mounted at 1m intervals (1m traverse interval) onto a rigid carrying frame. The system was programmed to take readings at a frequency of 10Hz (allowing for a 10-15cm sample interval) on roaming traverses (swaths) 4m apart. These readings were stored on an external weatherproof laptop and later downloaded for processing and interpretation. The system was linked to a Trimble R8s Real Time Kinetic (RTK) differential Global Positioning System (dGPS) outputting in NMEA mode to ensure a high positional accuracy for each data point.

MLGrad601 and MultiGrad601 (Geomar Software Inc.) software was used to collect and export the data. Terrasurveyor V3.0.32.4 (DWConsulting) software was used to process and present the data.

3.2 REPORTING

A general site location plan is shown in Illus 1 at a scale of 1:25,000. Illus 2 to 7 inclusive are site condition photographs. Illus 8, 9 and 10 are 1:5,000 survey location plans showing the direction of the site condition photographs, processed greyscale data and interpretation from Park Farm. Illus 11, 12 and 13 show the same information for Brick Farm. Plots of the fully processed (greyscale) and minimally processed (XY trace plot) data, together with interpretation plots from both GSA's are presented at a scale of 1:2,500 as Illus 14 to Illus 34 inclusive. More detailed plots of the fully processed (greyscale) and minimally processed (XY trace plot) data, together with interpretation plots of two areas of archaeological potential (AAP1 and AAP2) are presented at a scale of 1:1,000 in Illus 35 to Illus 40 inclusive.

Technical information on the equipment used, data processing and magnetic survey methodology is given in Appendix 1. Appendix 2 details the survey location information and Appendix 3 describes the composition and location of the site archive. Data processing details are presented in Appendix 4.

The survey methodology, report and any recommendations comply with the Written Scheme of Investigation for Archaeological Geophysical Survey (AECOM 2018), guidelines outlined by European Archaeological Council (EAC 2015) and by the Chartered Institute for Archaeologists (CIfA 2016). All illustrations from Ordnance Survey mapping are reproduced with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The illustrations 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 illustrations are presented to most suitably display and interpret the data from this site based on the experience and knowledge of management and reporting staff.

4 RESULTS AND DISCUSSION

The ground conditions were good for survey throughout both GSA's (see Illus 2–7 inclusive) and contributed to high data quality across both areas. The magnetic background is mostly homogeneous throughout, but with some broad and amorphous high magnitude anomalies characteristic of bands of the superficial head deposits. Against this background, discrete and linear anomalies have been identified and these are discussed below and cross-referenced to specific examples on the interpretive figures, where appropriate.

Ferrous, agricultural and geological anomalies are discussed first, as all three types of anomalies are common to both GSA's. Historical and archaeological anomalies are discussed for each survey area separately, as appropriate.

4.1 FERROUS ANOMALIES

Ferrous anomalies, characterised 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 is common

ILLUS 2 Field 11, looking west **ILLUS 3** Field 8a, looking north-west **ILLUS 4** Field 1b, looking north-east

on most sites, often being present due to manuring or tipping/ infilling. There is no obvious clustering to these individual ferrous anomalies which might indicate an archaeological origin. Far more probable is that the 'spike' responses are likely caused by the random distribution of ferrous debris in the upper soil horizons.

Linear bands of magnetic disturbance around field edges and bordering roads are due to ferrous material within the field boundaries.

At Park Farm, two dipolar linear anomalies are identified as service pipes. SP1 traverses the GSA on a broadly north-east/south-east alignment from F4 and continuing beyond the survey boundary at the southern end of F11.

SP2 runs west/east from the middle of F10 through to the stream which defines the edge of this field and the eastern edge of the survey area. It is almost certainly a drain collecting the water from the system of field drains in this field and discharging into the stream.

Two short, dipolar linear anomalies, SP3 and SP4, are identified at Brick Farm as service pipes. SP3 is located in the south-west of F15, orientated east-west, and leads towards the farm buildings. SP4 is located alonf the eastern edge of F12, orientated north-south.

Areas of magnetic disturbance along the line of overhead power lines at Brick Farm are caused by interference from the low-hanging lines and from the proximity of pylons (see F12, Illus 29-31; F13, Illus 23–25).

ILLUS 5 Field 12, looking west **ILLUS 6** Field 14, looking south-east **ILLUS 7** Field 15, looking south-west

4.2 AGRICULTURAL ANOMALIES

Linear anomalies or linear trends in the data are identified throughout both GSA's. Most of these trends are characteristic of field drains. At Brick Farm most of these drains are orientated east/west or south-east/north-west (in F13 and F14 respectively – Illus 23 to 34 inclusive), with several drains running south-west/north-east (in F12 – Illus 23–25 and 29–31). There is no consistent pattern to the field drains at Park Farm, with some orientated north/south (F11) and others north-west/south-east (F10).

Only two linear trends are identified as being caused by recent agricultural activity. One linear anomaly running parallel to the southern field boundary of F3 and a short linear trend in the middle of the western boundary of F4 (Illus 17–19).

Former field boundaries, recorded on historic mapping, are identified as linear anomalies FB1 in F2b/F3 (Illus 14–16), FB2 in F7a (Sector 2, Illus 17–19), FB4–10 in F12 (Illus 23–25, 29–31), FB11–12 in F13 (Illus 23–28) and FB14–15 in F14 (Illus 23–28, 32–34).

4.3 GEOLOGICAL ANOMALIES

Anomalies interpreted as having a natural (geological) origin are identified across both GSA's. These include numerous small isolated anomalies (discrete areas of magnetic enhancement), which are ubiquitous throughout and are due to variation in the composition of the superficial deposits and the soils from which they derive, as well as more pronounced sinuous and broader trends in the data which are described in more detail below.

The linear anomalies at Park Farm which bisect F6a aligned north-east/south-west, correspond with a dry valley with the anomalies being caused by the accumulation of soil along the bottom of the slope. At the north of the Park Farm GSA, following the boundaries between F1b, F1c, F1a and 2a, the sinuous trends and variable magnetic background are also natural in origin being due to the deposition of alluvial material either side of the stream which crosses the survey area at this point.

At Brick Farm, a single broad anomaly is identified aligned east/west in F12.

4.4 HISTORICAL AND ARCHAEOLOGICAL ANOMALIES

Park Farm

Two areas of archaeological potential (AAP) have been identified (see Illus 35 to Illus 40 inclusive) at Park Farm. AAP1 covers an area of approximately 8ha, to the south of the GSA, covering fields F6a and the eastern side of F7a. AAP2 is at the north-eastern edge of the GSA in F1b, and covers an area of approximately 2.5ha. AAP2 is situated approximately 440m north of AAP1.

AAP1 comprises two distinct parts, a northern component in F6a and a southern component in F7a, both of which contain relatively well-defined circular anomalies (RD1 and RD2 - Illus 35-37), 16m and 20m in diameter respectively, which are interpreted as ring ditches, probably locating the sub-surface remains of a ploughed out round barrow. Around these two circular anomalies are numerous discontinuous low magnitude linear anomalies which are interpreted as likely ditch type features of possible archaeological origin. This interpretation is based on their proximity to the round barrows and to the area of known archaeology located immediately to the south of the GSA and the fact that the anomalies are aligned at an oblique angle to the current pattern of enclosure and are therefore less likely to have an agricultural origin. However, these anomalies do not have a clear pattern to them. The magnetic background, particularly in F7a, is particularly homogenous and the anomalies are of also of low magnitude, possibly as a consequence of the low magnetic contrast on the Oxford Clay geology, making a confident interpretation difficult. The northern component is located either side of the dry valley. Here the anomalies are slightly better defined and coherent with conjoining anomalies hinting at the presence of two rectangular enclosures.

Features recorded during the Oxford Archaeology East excavation at Beaulieu Park Quarry which head towards the Park Farm survey area have not been detected by the geophysical survey. This may be because there is a lack of magnetic contrast between the fill of those particular features and the surrounding soils and therefore that the features cannot be detected by the survey. An alternative explanation is that the features are no longer present having been truncated or destroyed by modern agricultural activity.

Confidently interpreting the anomalies in AAP2 (Illus 38-40) is equally problematic. At this part of the GSA the magnetic background is much more variable. The linear anomalies here describe two possible rectilinear enclosures, the more northerly a negative anomaly defined on three sides. There are also numerous discrete anomalies which may be due to features such as pits. However, as mentioned above the magnetic background is variable and the anomalies may equally be interpreted as geological in origin. Nevertheless, they are interpreted as possibly archaeological based on their location.

Brick Farm

Three well defined linear areas of magnetic disturbance are identified at Brick Farm in F14 (Illus 26-28, 32-34). Anomalies RF1 and RF2 are aligned south-west/north-east and are interpreted as locating the remains of the Boreham Rifle Range, recorded on the 1922-1924 OS maps. RF1 corresponds to the location of the targets with RF2, approximately 160m away, marking the firing line. A third anomaly, M1, orientated east-west is also identified within the firing range site but there is no corresponding feature recorded on the OS maps. This anomaly is also interpreted as being likely associated with the range although no specific origin is known. The rifle range features are assessed as of likely local historical origin.

No archaeological anomalies were identified at Brick Farm.

5 CONCLUSION

The geophysical survey has successfully evaluated the two survey areas which are being proposed as possible sites for extensions to Bulls Lodge Quarry. Two areas of possible archaeological activity have been identified at the Park Farm GSA. Two probable ring ditch features have been identified together with numerous linear ditch type features which may form part of enclosures. The likely low magnetic contrast on the Oxford Clay geology may suggest that there may be more surviving archaeological remains present than have been identified by the survey. At Brick Farm anomalies locating the site of an early 20th century rifle range have been identified. This may be of local historical interest. No anomalies of archaeological potential were identified at Brick Farm.

6 REFERENCES

Chartered Institute for Archaeologists (CIfA) 2016 ***Standard and guidance for archaeological geophysical survey*** (Reading) http://www.archaeologists.net/sites/default/files/CIfAS%26GGeophysics_2.pdf accessed 5 October 2018

Cranfield University 2018 ***Cranfield Soil and Agrifood Institute Soilscapes*** http://www.landis.org.uk/soilscapes/ accessed 5 October 2018

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Gaffney C & Gater J (2003) ***Revealing the Buried Past: Geophysics for Archaeologists*** Stroud

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SECTOR 1
SEE ILLUS 14-16

SECTOR 2
SEE ILLUS 17-19

SECTOR 3
SEE ILLUS 20-21

AAP1
SEE ILLUS 35-37

AAP2
SEE ILLUS 38-40

F1a
F1b
F1c
F2a
F2b
F3
F4
F5
F6a
F6b
F7a
F7b
F8a
F8b
F9
F10
F11

2
3
4

212000
211500
211000
210500
573000
573500

geophysical survey area
location and direction of ILLUS 2-4
GPS swaths

0 100m
1:5,000 @ A3

PROJECT BLQE18
Bulls Lodge Quarry
Park Farm and Brick Farm
Chelmsford
Essex
CLIENT AECOM

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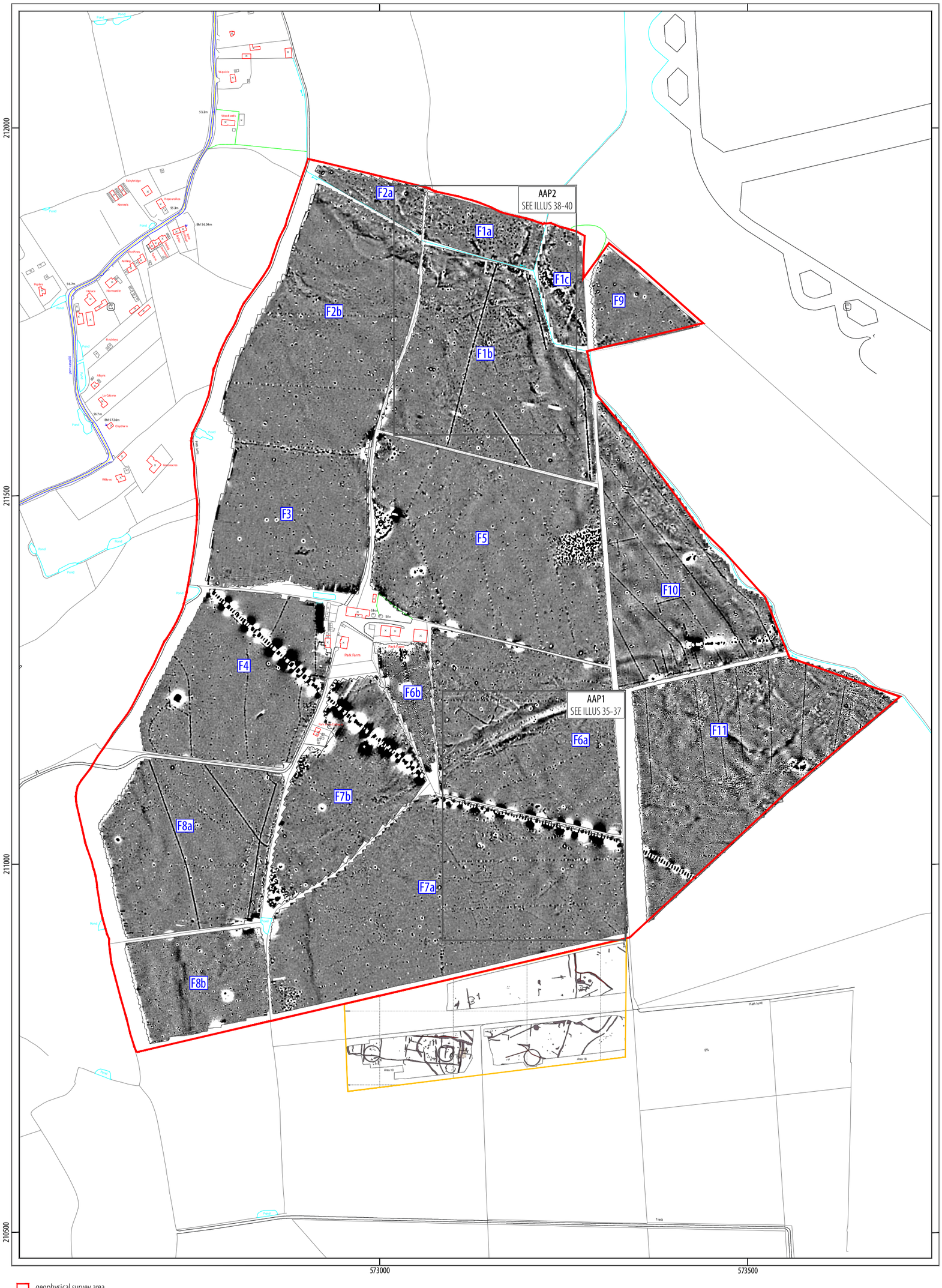
ILLUS 8 Survey location showing GPS swaths and photo locations; Park Farm (1:5,000)



geophysical survey area
Oxford Archaeology East excavation area

nT
-1.0 1.0

0 100m
1:5,000 @ A3

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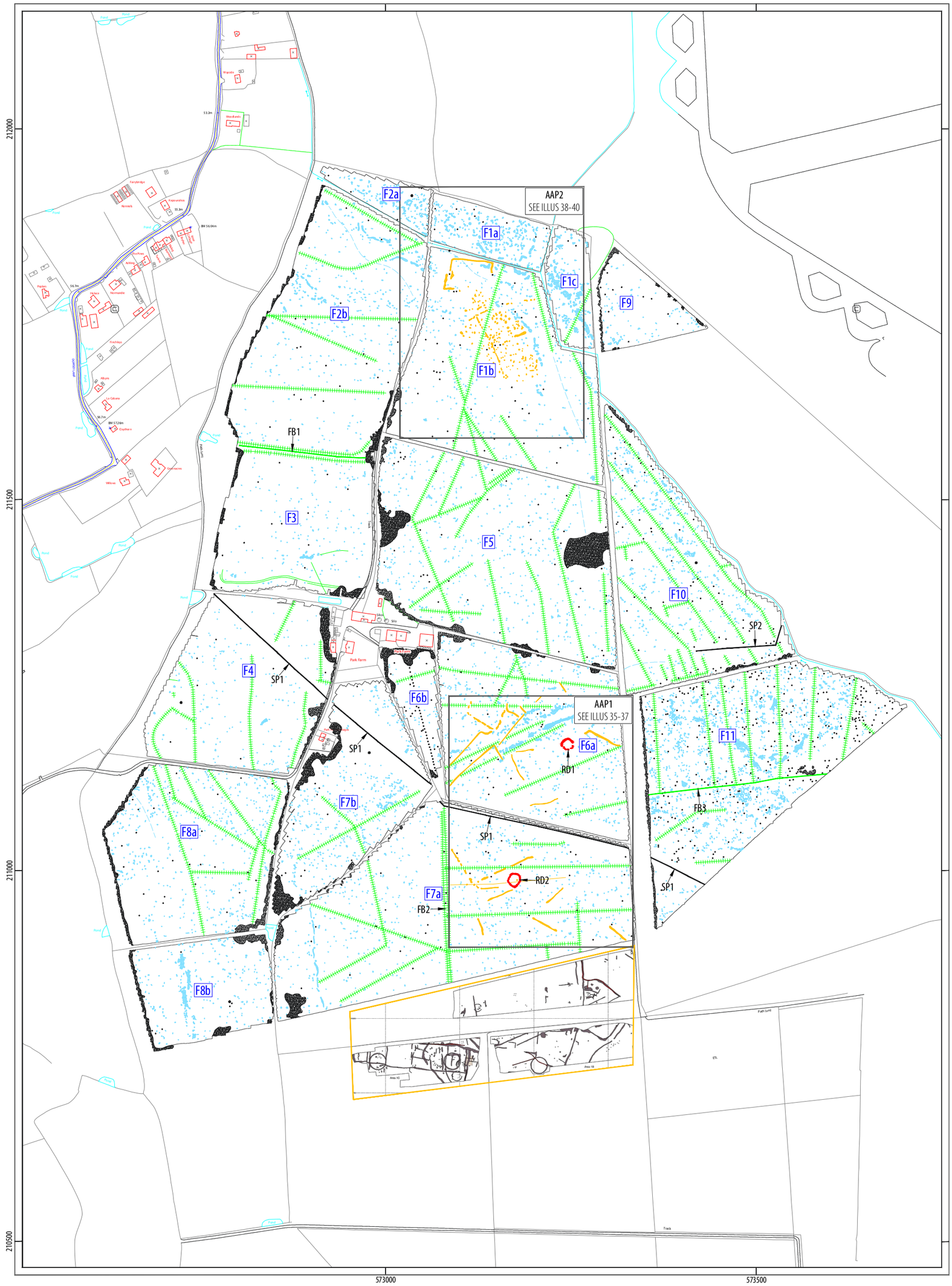
ILLUS 9 Processed greyscale magnetometer data; Park Farm (1:5,000)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
linear trend	agricultural
linear trend	former boundary
linear trend	field drain

TYPE OF ANOMALY	INTERPRETATION
linear trend	geological variation
magnetic enhancement	geology
magnetic enhancement	possible archaeology
magnetic enhancement	archaeology

ABBREVIATIONS

FB	former boundary
RD	ring ditch
SP	service pipe

Oxford Archaeology East excavation area

0 100m
1:5,000 @ A3

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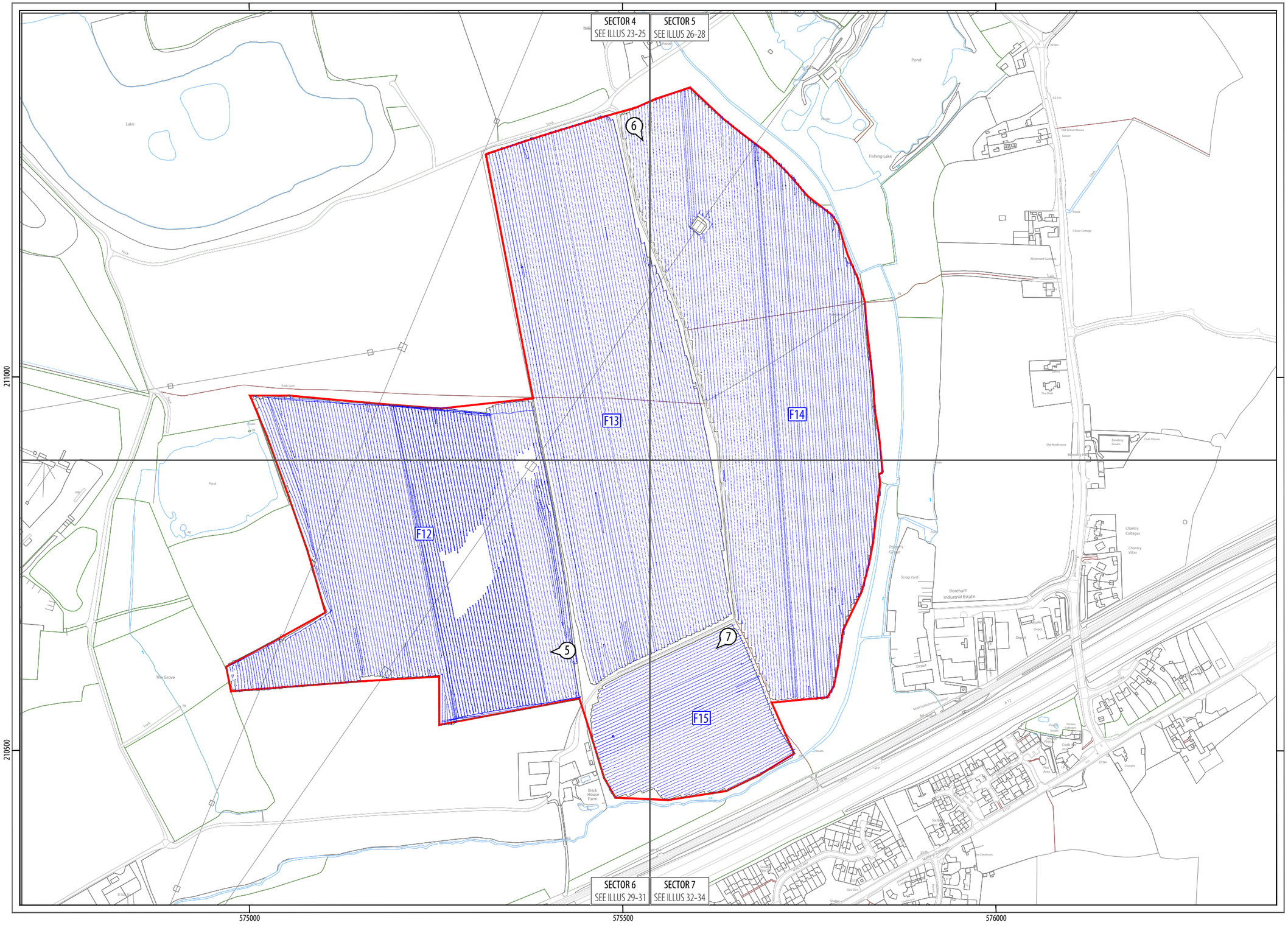
ILLUS 10 Interpretation of magnetometer data; Park Farm (1:5,000)



geophysical survey area
location and direction of ILLUS 5-7
GPS swaths

0 100m
1:5,000 @ A3

PROJECT BLQE18
Bulls Lodge Quarry:
Park Farm and Brick Farm
Chelmsford
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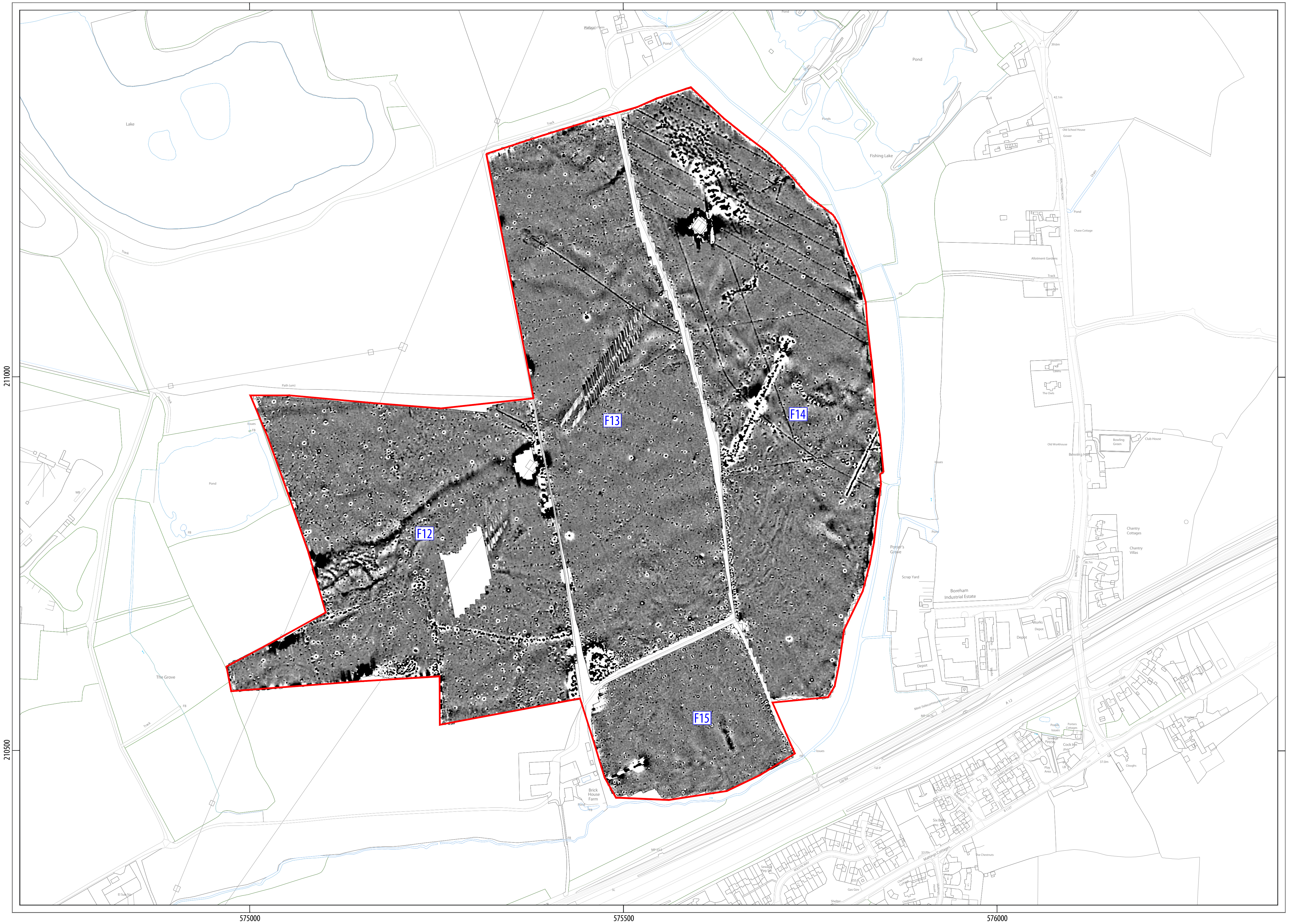
ILLUS 11 Survey location showing GPS swaths and photo locations; Brick Farm (1:5,000)



geophysical survey area

nT
-1.0 1.0

0 100m
1:5,000 @ A3

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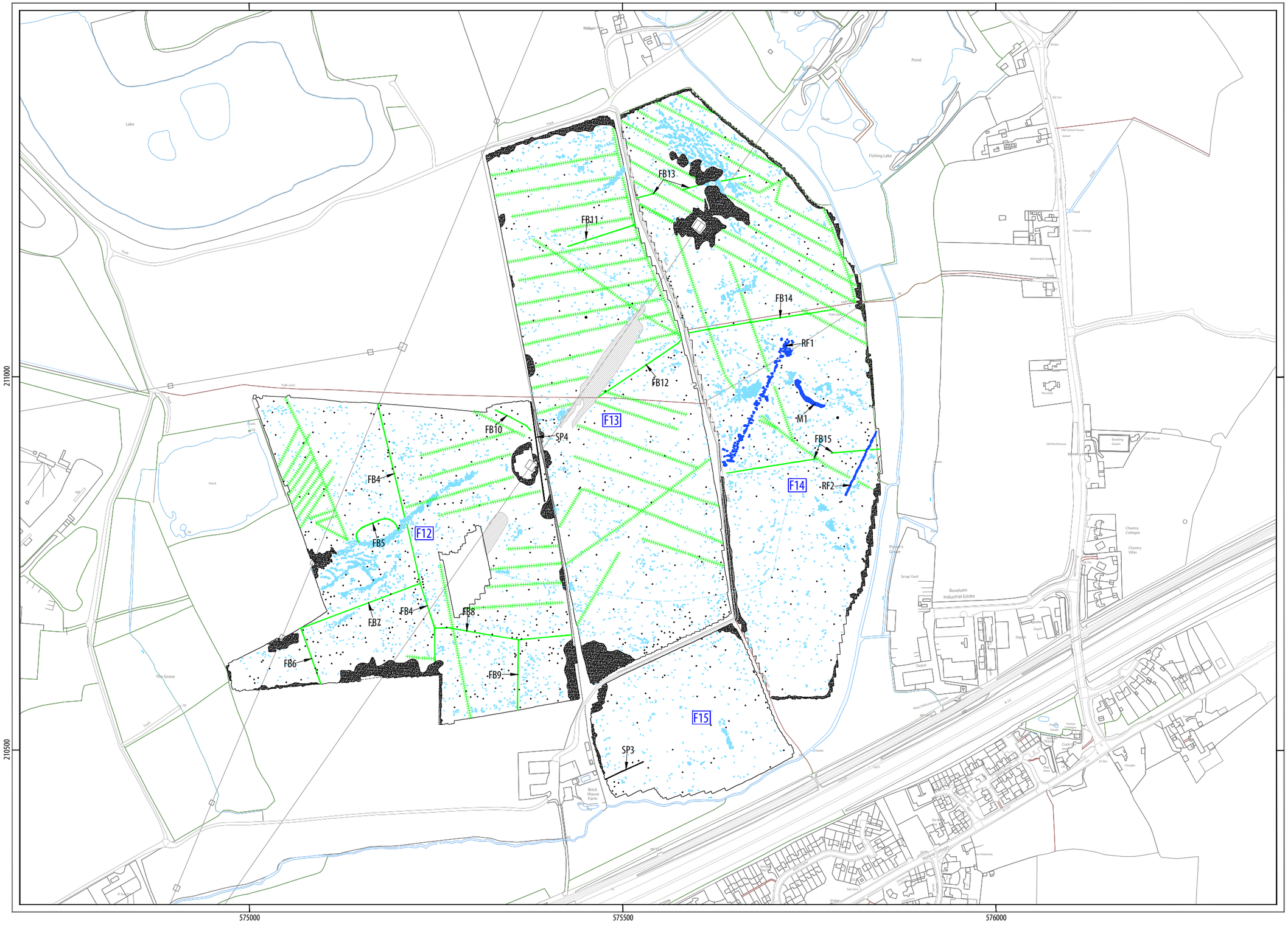
ILLUS 12 Processed greyscale magnetometer data; Brick Farm (1:5,000)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
dipolar linear	service pipe
magnetic disturbance	ferrous material
magnetic disturbance	modern
magnetic disturbance	powerline disturbance
linear trend	agricultural
linear	former field boundary
linear trend	field drain
linear trend	geological variation
magnetic enhancement	geology

ABBREVIATIONS

FB	former boundary
M	modern
RF	rifle range
SP	service pipe

0 100m
1:5,000 @ A3

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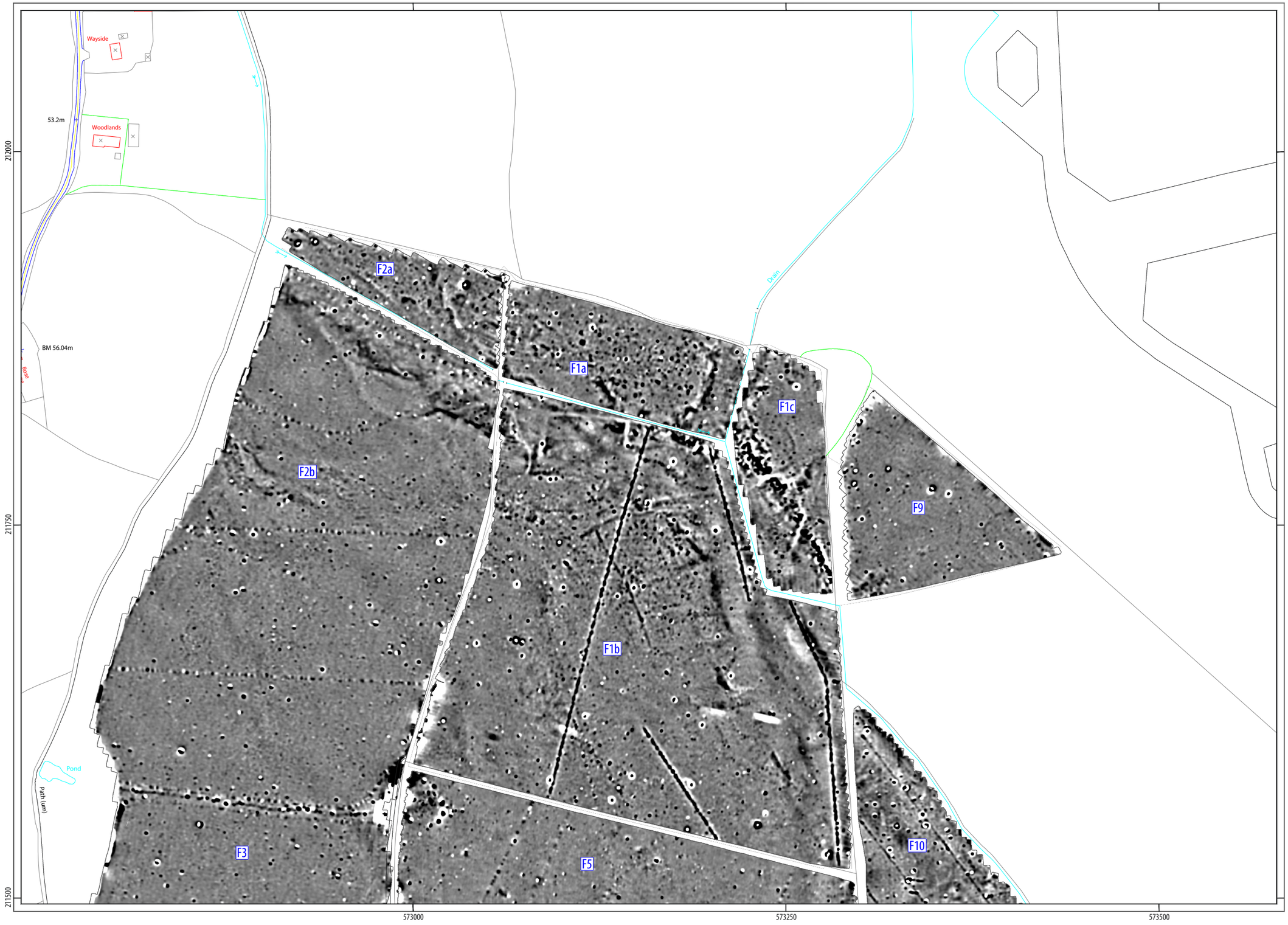
ILLUS 13 Interpretation of magnetometer data; Brick Farm (1:5,000)



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Essex

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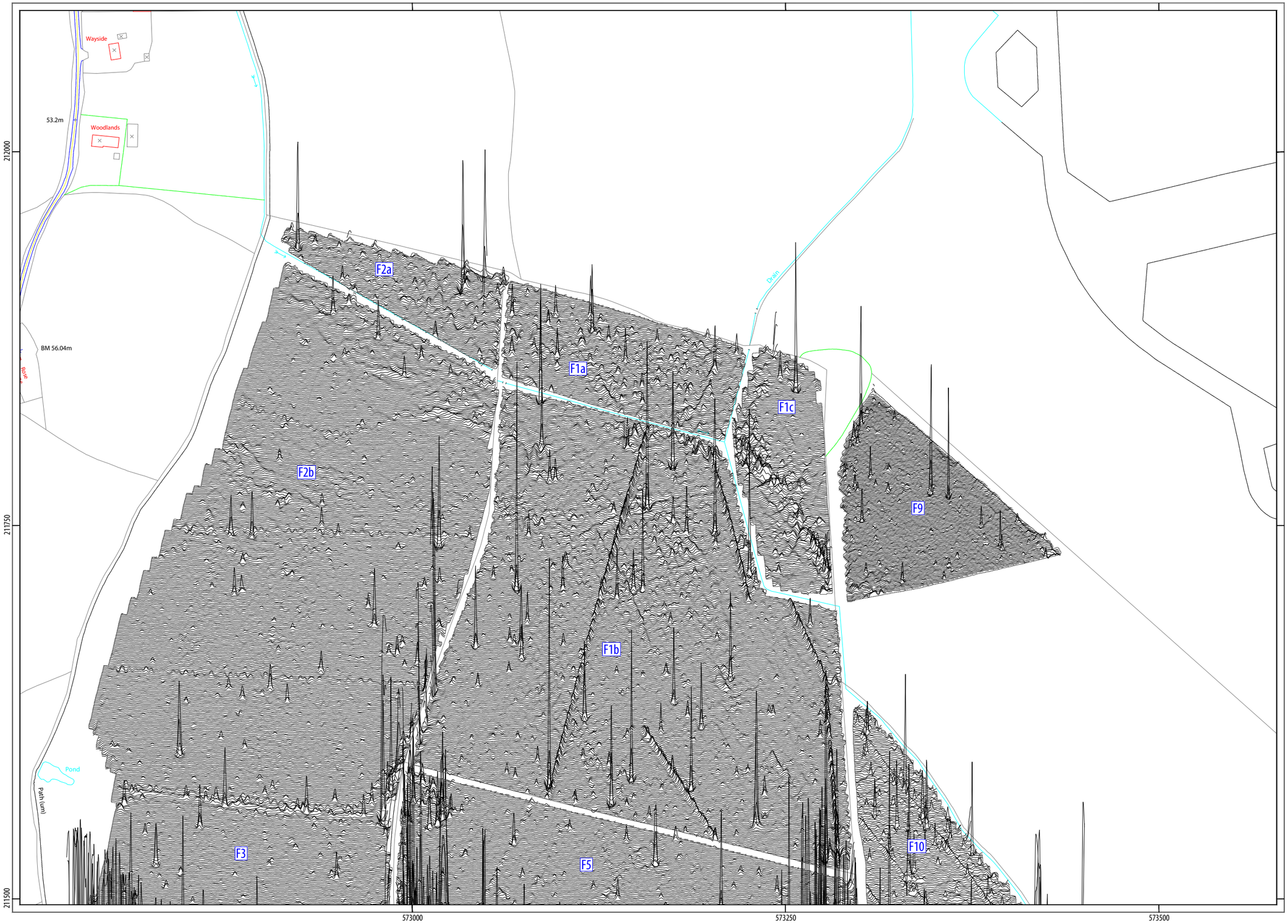
ILLUS 14 Processed greyscale magnetometer data; Sector 1 (1:2,500)



14.0nT/cm

0 50m

1:2,500 @ A3

PROJECT BLQE18
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Park Farm and Brick Farm
Chelmsford
Essex

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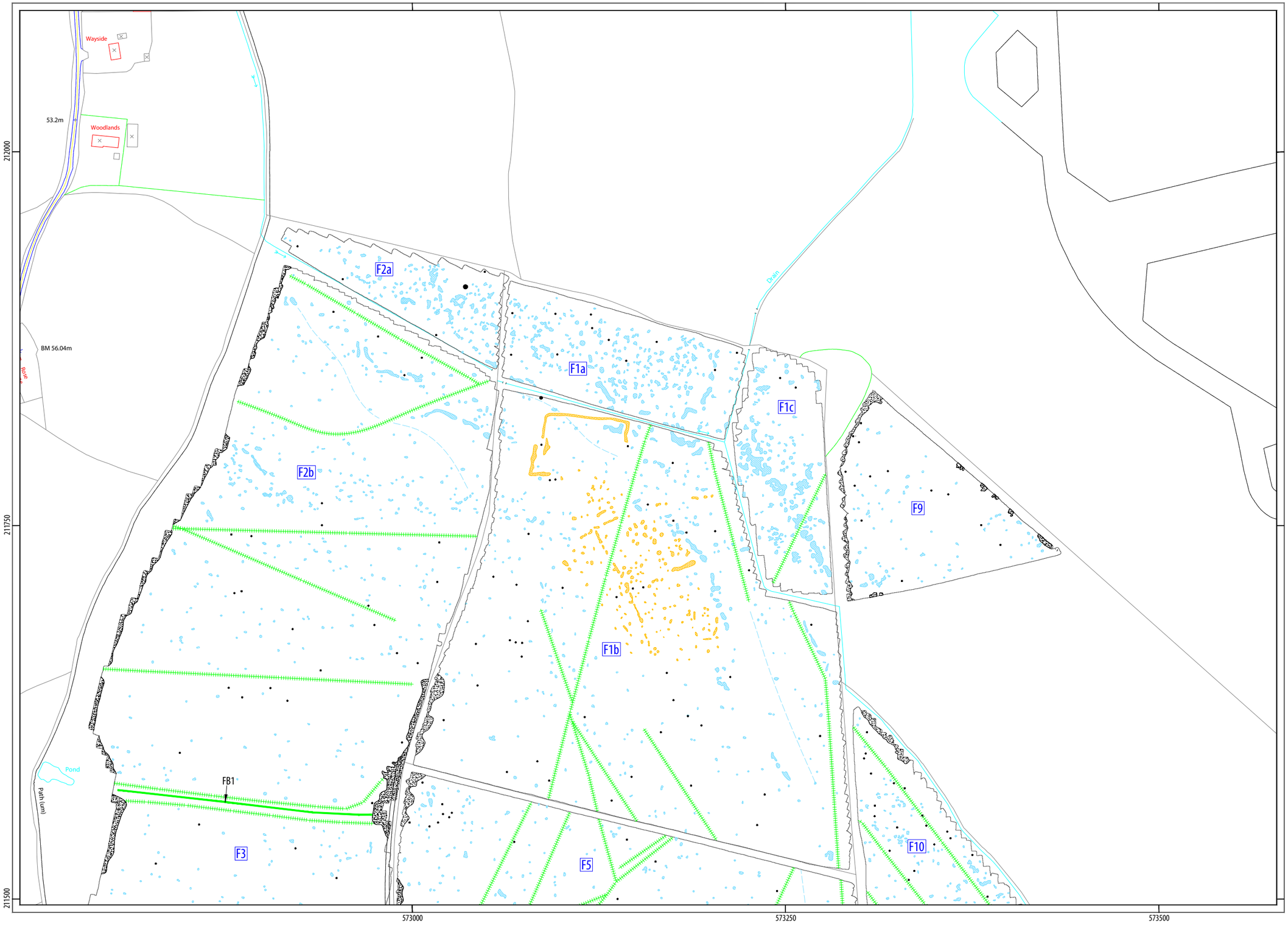
ILLUS 15 XY trace plot of minimally processed magnetometer data; Sector 1 (1:2,500)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
linear trend	agricultural
linear trend	field drain
linear	former field boundary
linear trend	geological variation
magnetic enhancement	geology
magnetic enhancement	archaeology?

ABBREVIATIONS

FB	former boundary
RD?	ring ditch?

0 50m
1:2,500 @ A3

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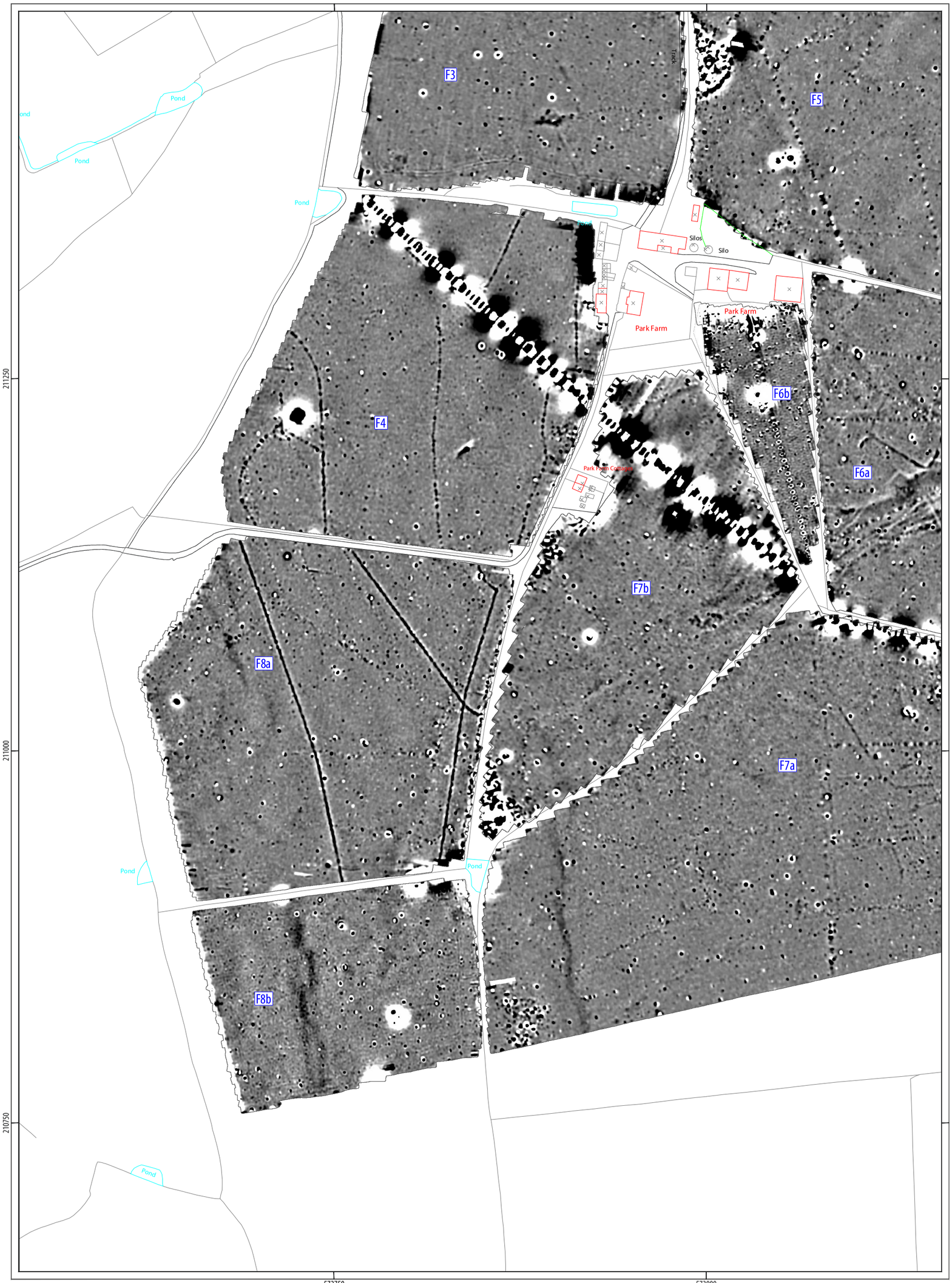
ILLUS 16 Interpretation of magnetometer data; Sector 1 (1:2,500)



nT -1.0 1.0

0 50m
1:2,500 @ A3

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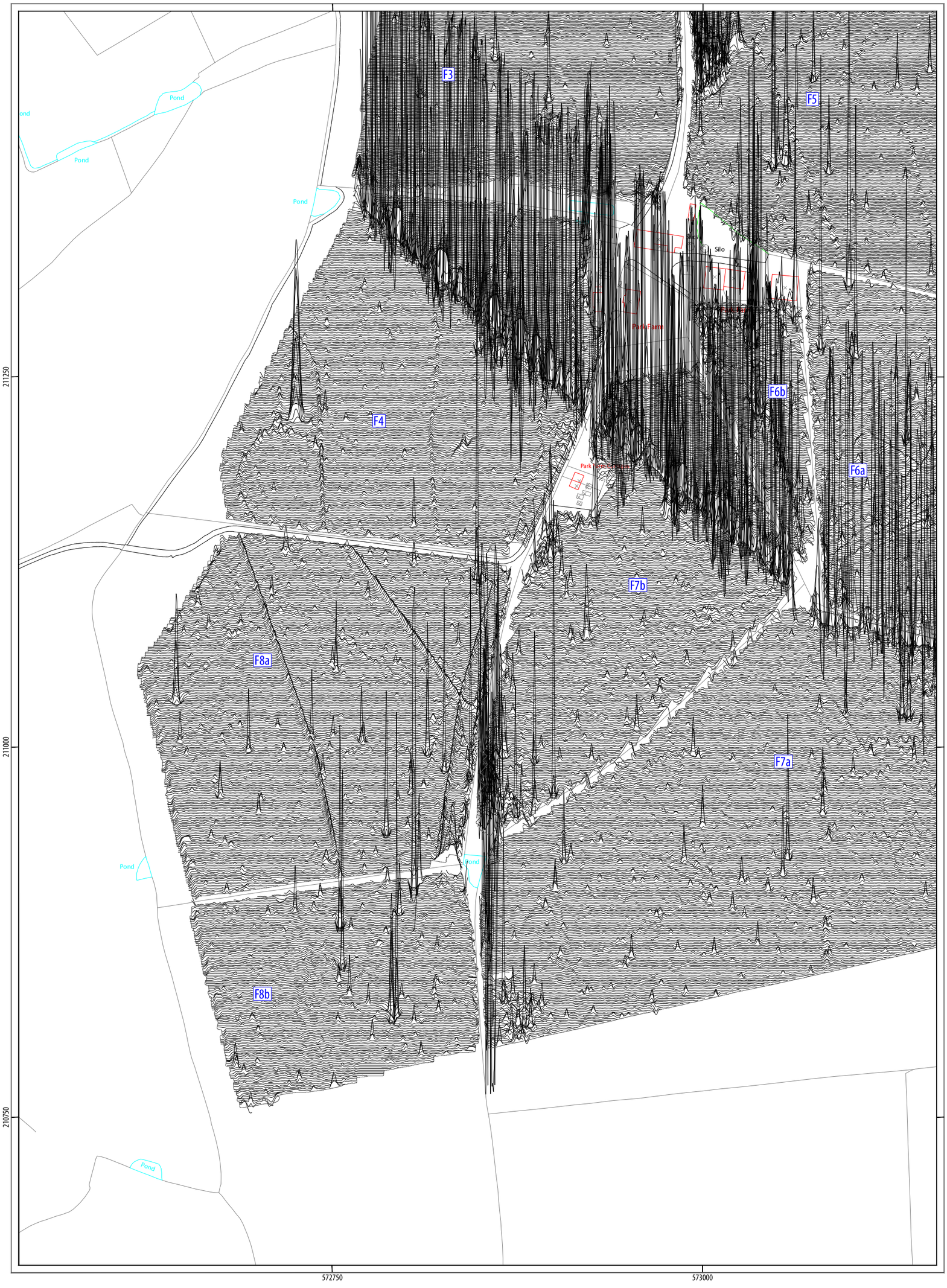
ILLUS 17 Processed greyscale magnetometer data; Sector 2 (1:2,500)



14.0nT/cm

0 50m

1:2,500 @ A3

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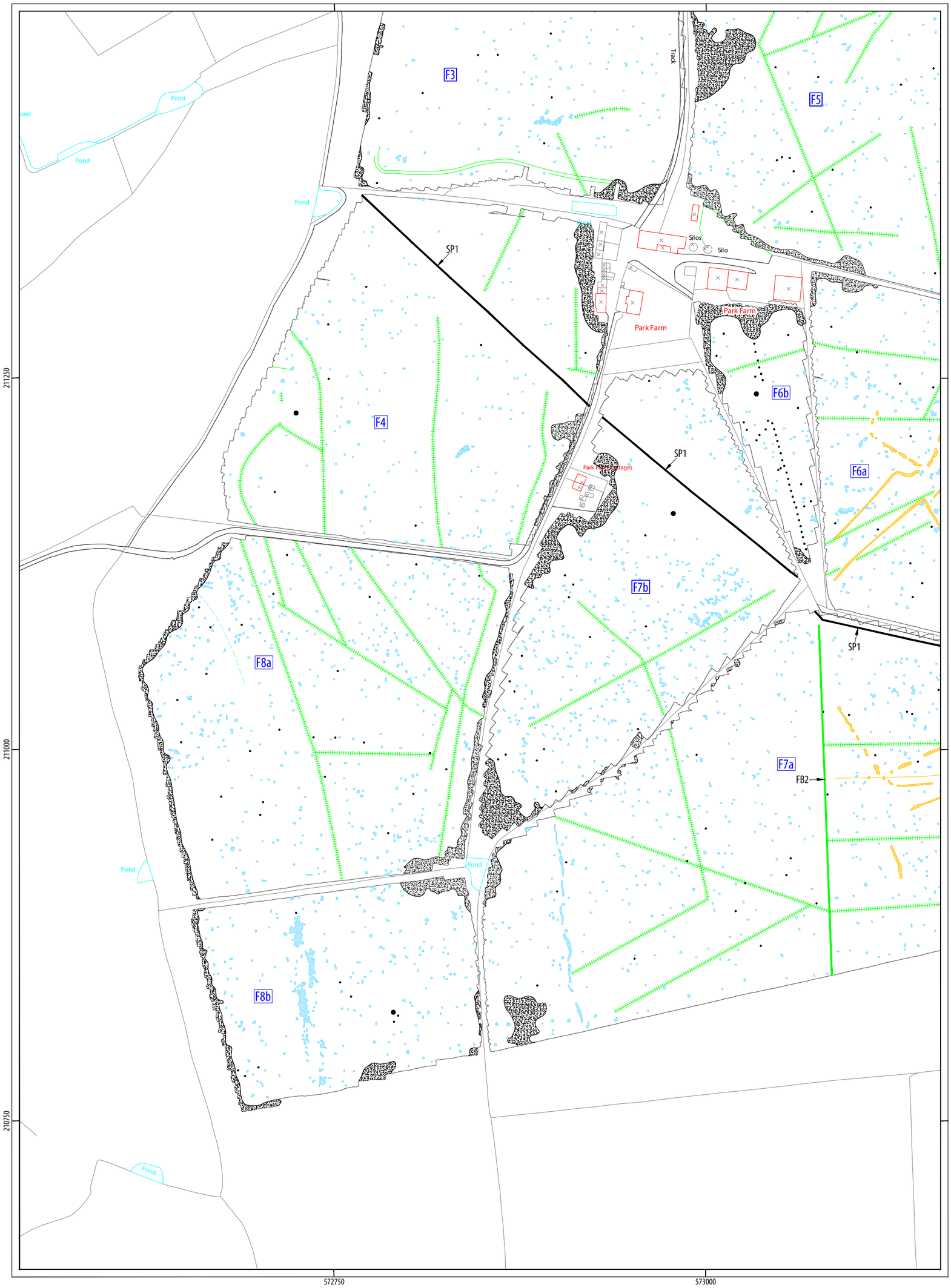
ILLUS 18 XY trace plot of minimally processed magnetometer data; Sector 2 (1:2,500)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
linear trend	agricultural
linear trend	former field boundary
linear trend	field drain

TYPE OF ANOMALY	INTERPRETATION
linear trend	geology
magnetic enhancement	geology
magnetic enhancement	archaeology?

ABBREVIATIONS	
FB	former boundary
SP	service pipe

0 50m
1:2,500 @ A3

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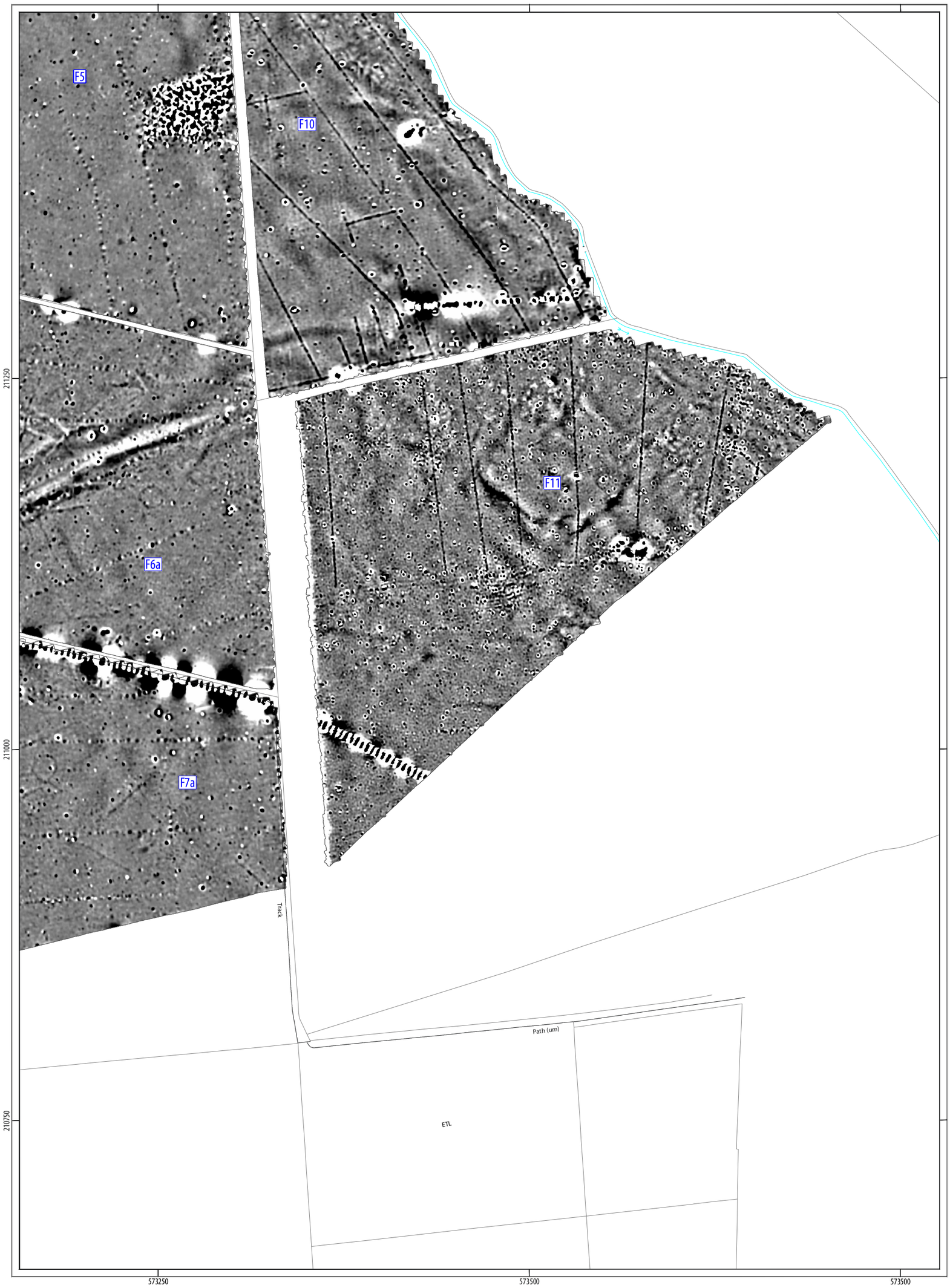
ILLUS 19 Interpretation of magnetometer data; Sector 2 (1:2,500)



nT
-1.0 1.0

0 50m
1:2,500 @ A3

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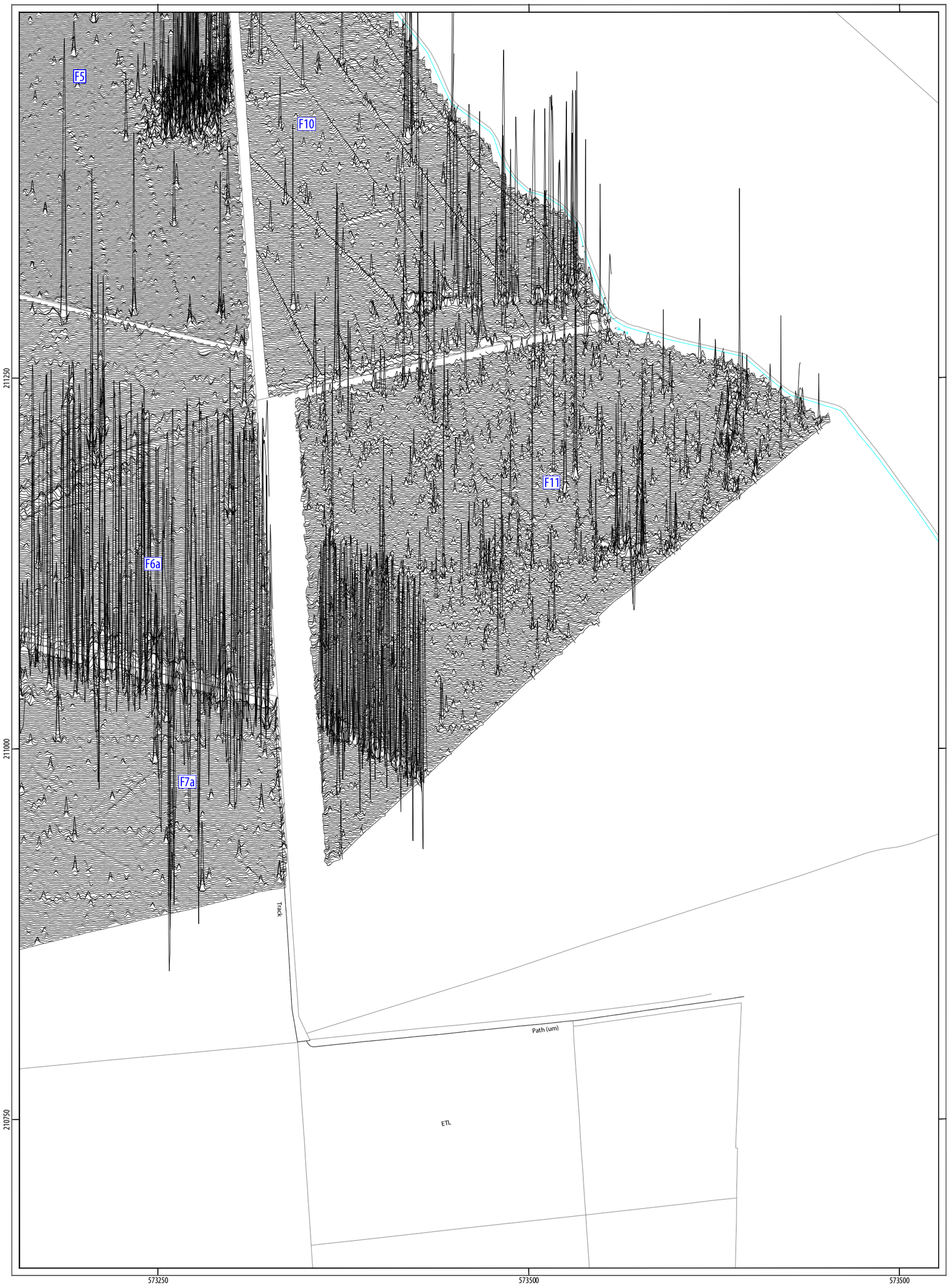
ILLUS 20 Processed greyscale magnetometer data; Sector 3 (1:2,500)



14.0nT/cm

0 50m

1:2,500 @ A3

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ILLUS 21 XY trace plot of minimally processed magnetometer data; Sector 3 (1:2,500)

F5
F10
SP2
F11
RD1
F6a
FB3
SP1
RD2
F7a
Track
Path (um)
ETL
211250
211000
210750
573250
573500
573500

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
dipolar linear	service pipe
linear trend	former field boundary
linear trend	field drain

TYPE OF ANOMALY	INTERPRETATION
linear trend	geological variation
magnetic enhancement	geology
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

ABBREVIATIONS	
FB	former boundary
RD	ring ditch
SP	service pipe

0 50m
1:2,500 @ A3

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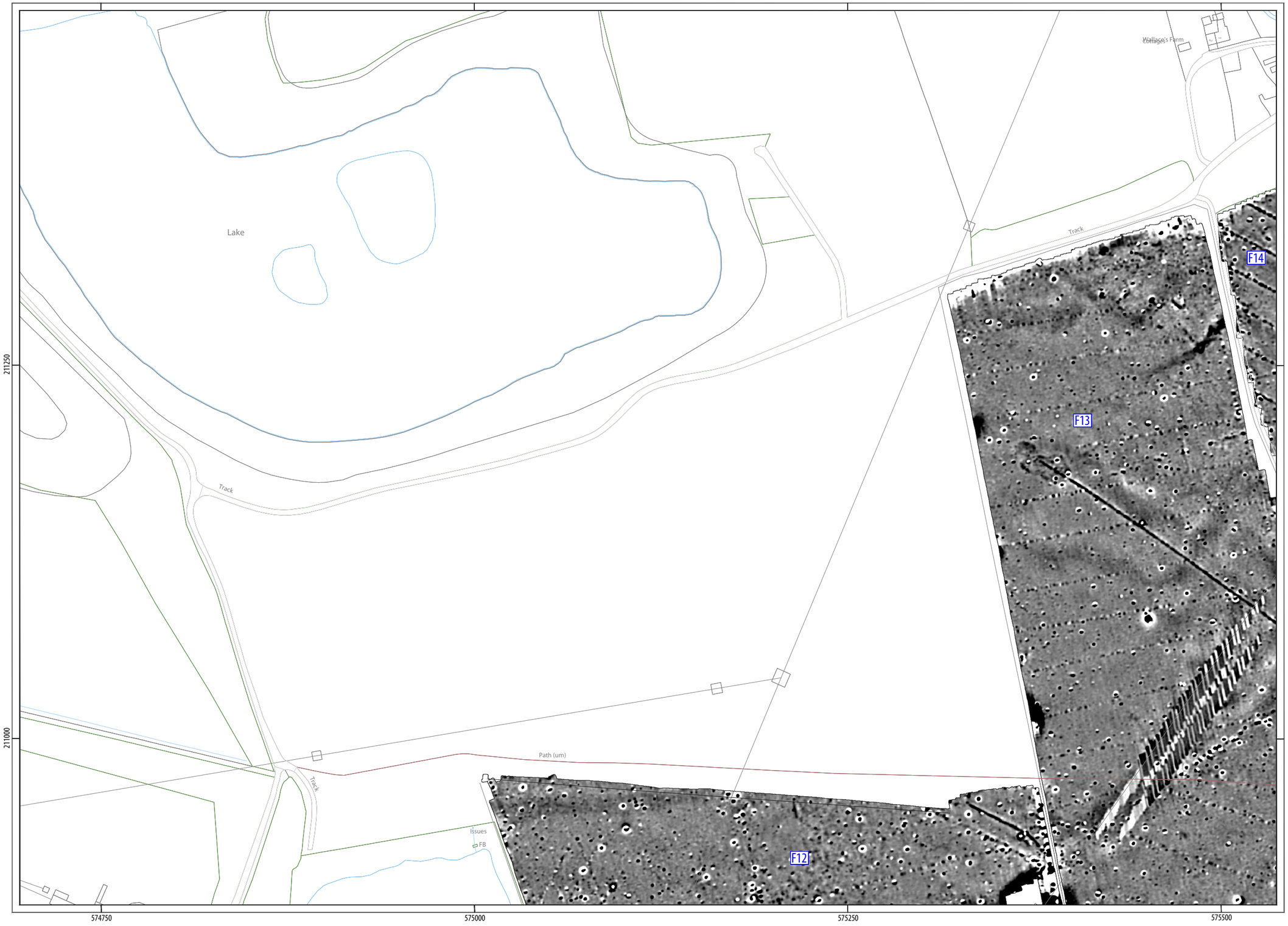
ILLUS 22 Interpretation of magnetometer data; Sector 3 (1:2,500)



nT
-1.0 1.0

0 50m
1:2,500 @ A3

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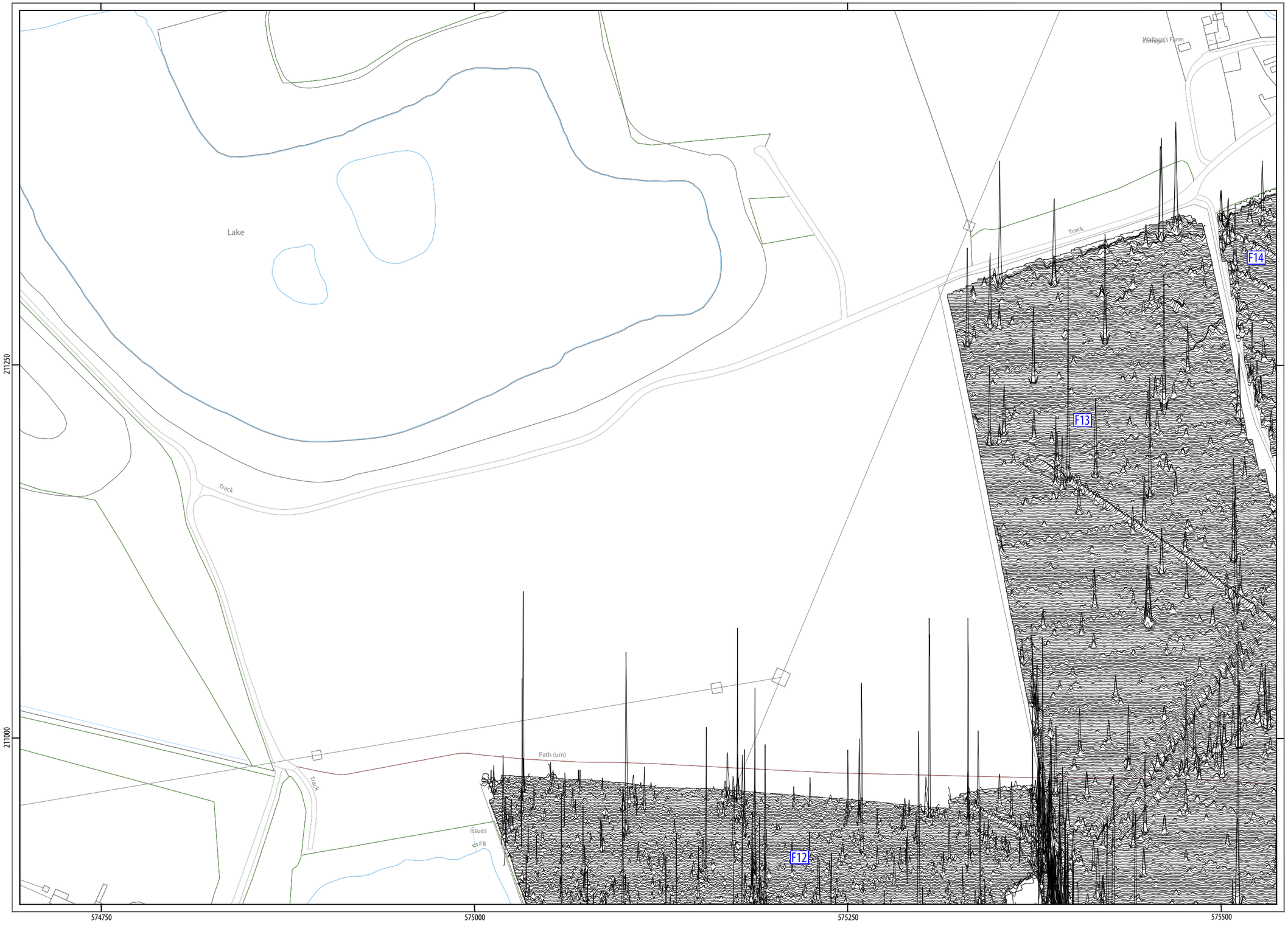
ILLUS 23 Processed greyscale magnetometer data; Sector 4 (1:2,500)



12.5nT/cm

0 50m

1:2,500 @ A3

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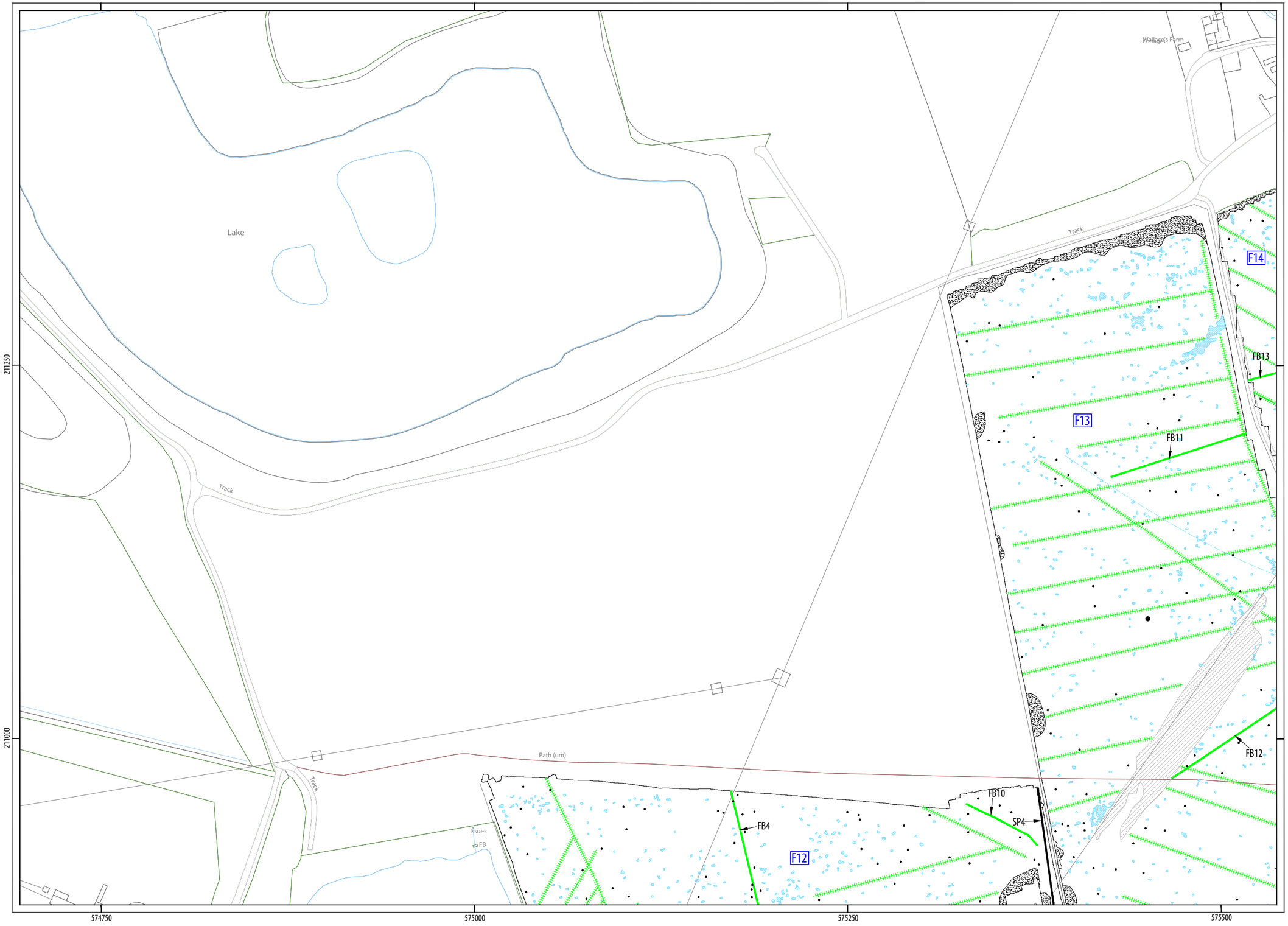
ILLUS 24 XY trace plot of minimally processed magnetometer data; Sector 4 (1:2,500)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
dipolar linear	service pipe
magnetic disturbance	ferrous material
magnetic enhancement	powerline disturbance
linear	former field boundary
linear trend	field drain
linear trend	geological variation
magnetic enhancement	geology

ABBREVIATIONS

FB	former boundary
SP	service pipe

0 50m
1:2,500 @ A3

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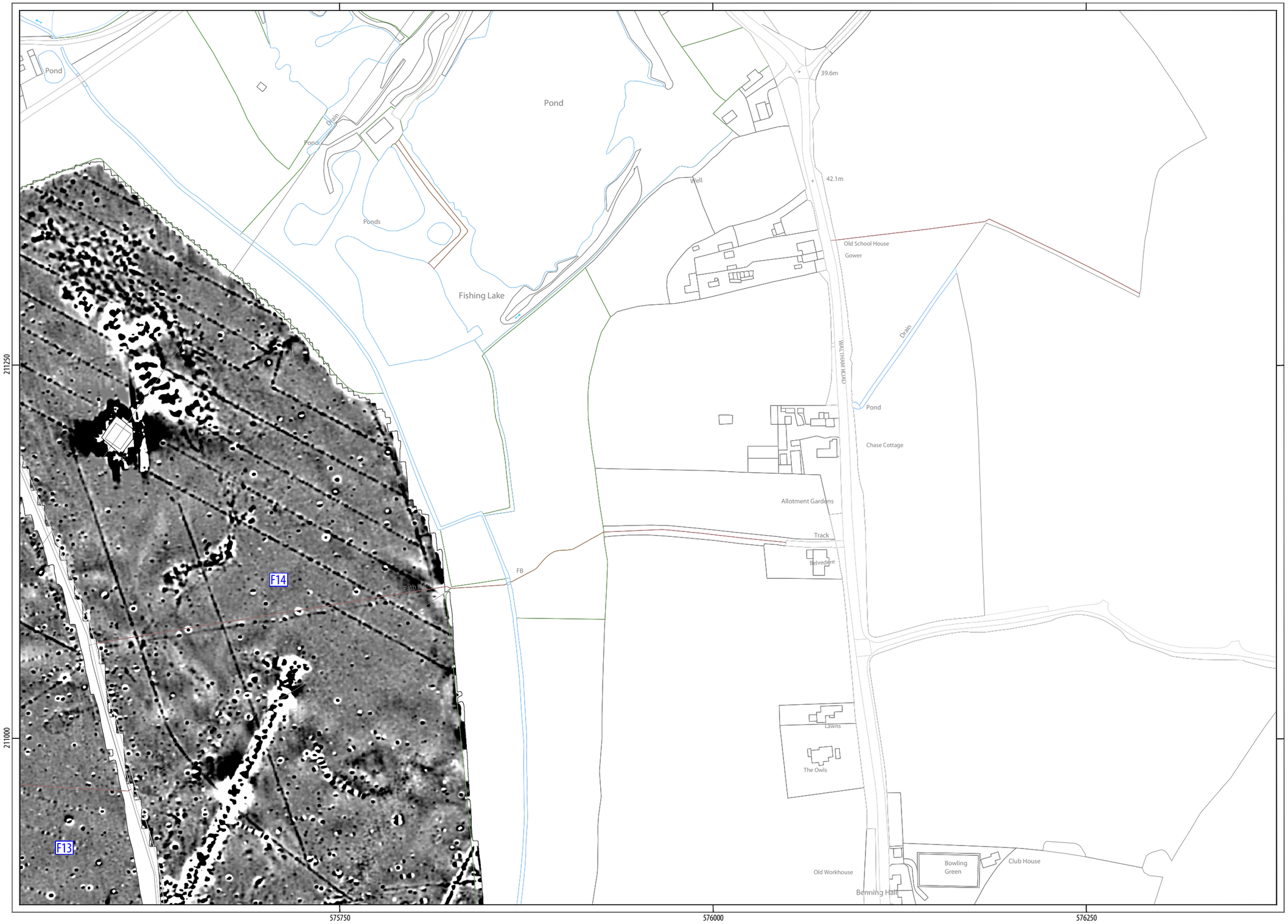
ILLUS 25 Interpretation of magnetometer data; Sector 4 (1:2,500)



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ILLUS 26 Processed greyscale magnetometer data; Sector 5 (1:2,500)

12.5nT/cm

0 50m
1:2,500 @ A3

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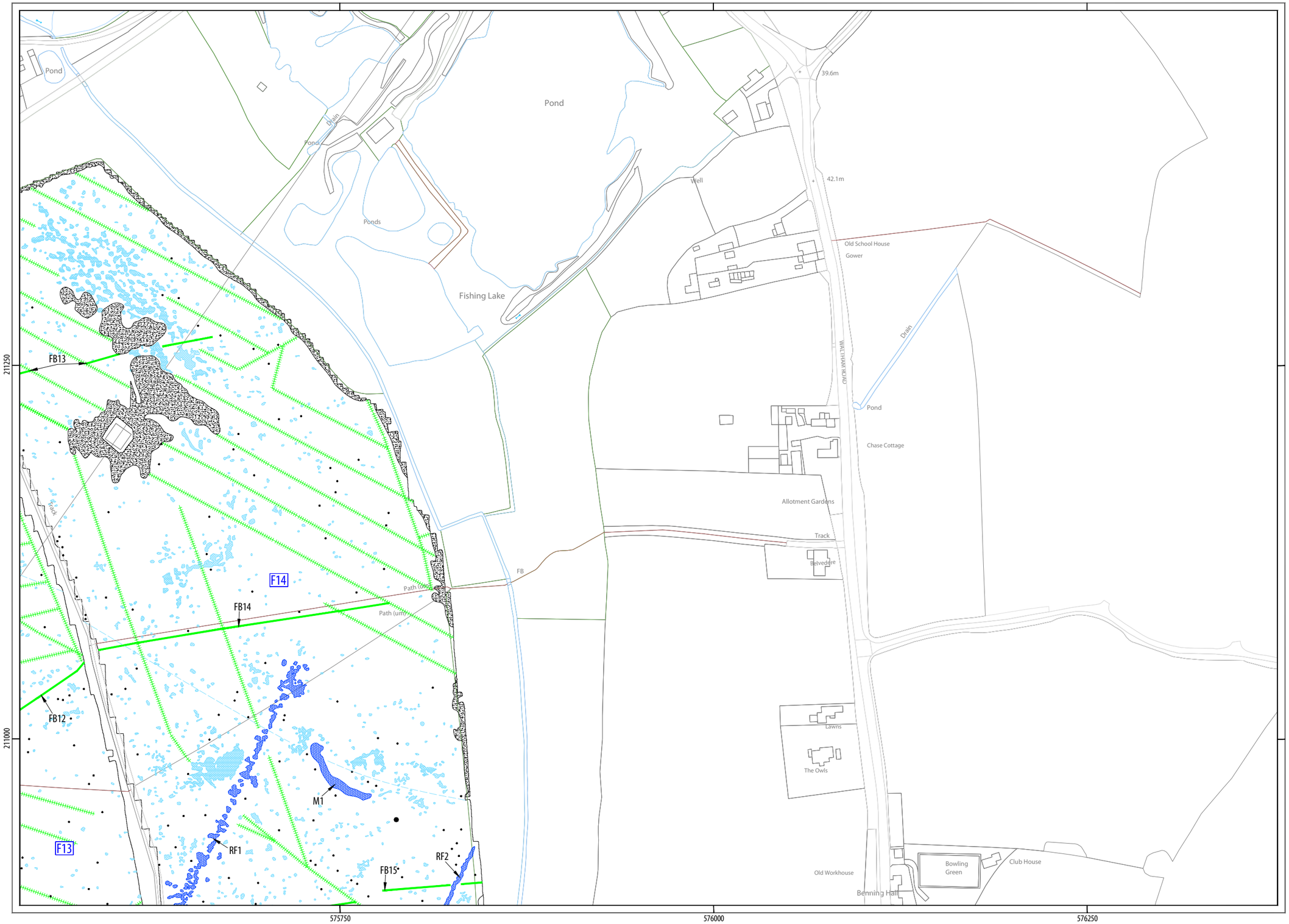
ILLUS 27 XY trace plot of minimally processed magnetometer data; Sector 5 (1:2,500)



TYPE OF ANOMALY / INTERPRETATION

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic disturbance	modern
linear	former field boundary
linear trend	field drain
linear trend	geological variation
magnetic enhancement	geology

ABBREVIATIONS

FB	former boundary
M	modern
RF	rifle range

0 50m
1:2,500 @ A3

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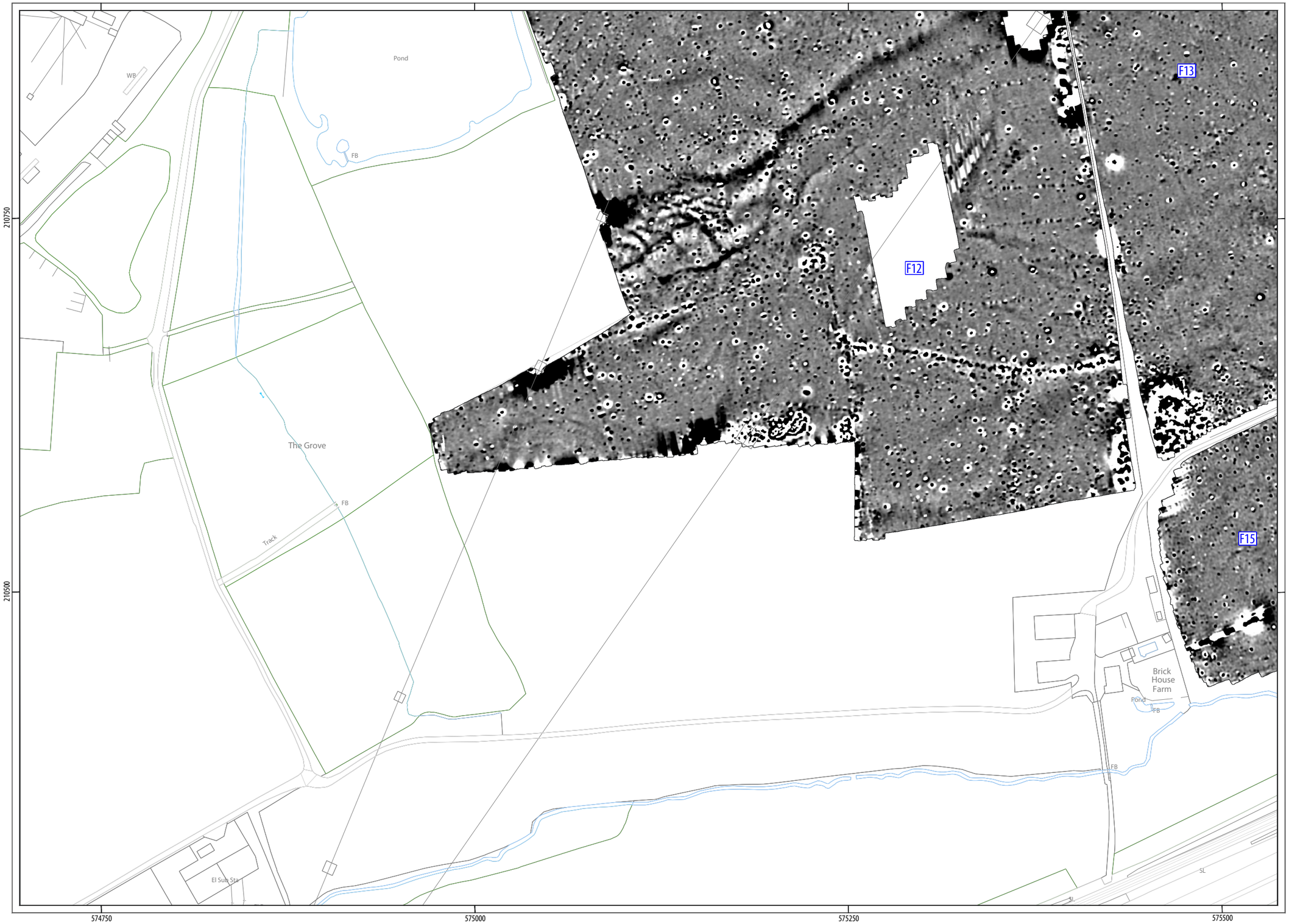
ILLUS 28 Interpretation of magnetometer data; Sector 5 (1:2,500)



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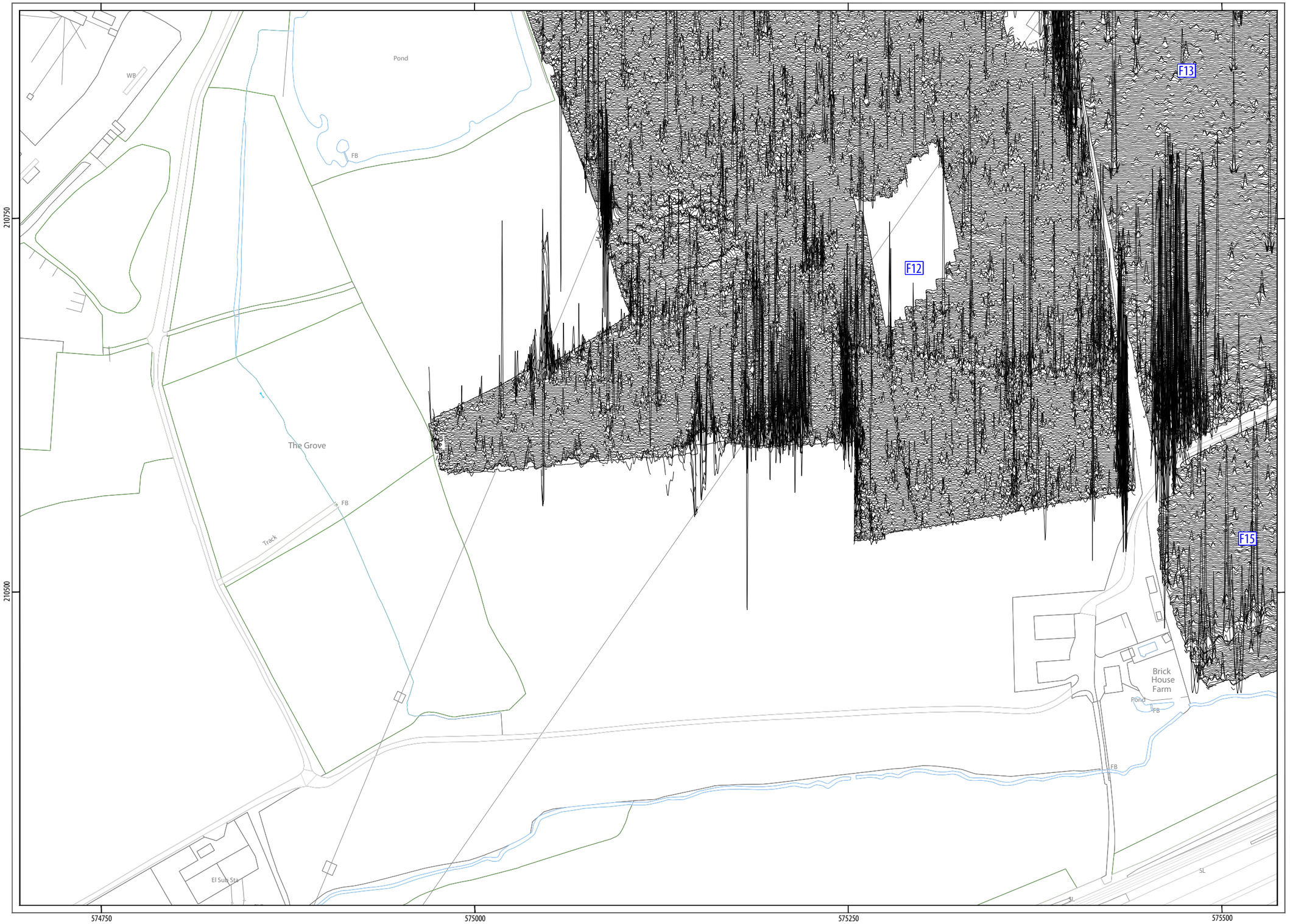
ILLUS 29 Processed greyscale magnetometer data; Sector 6 (1:2,500)



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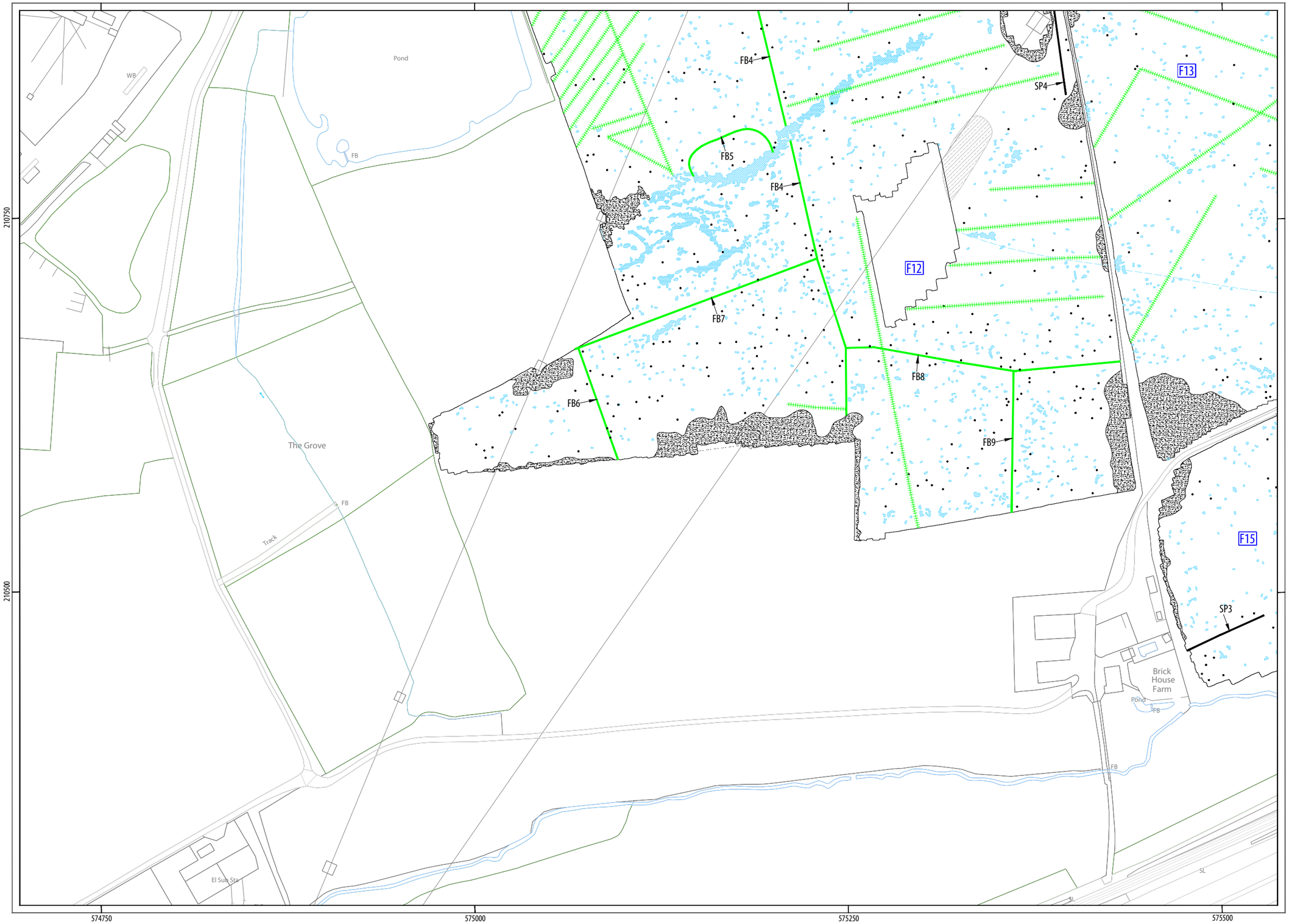
ILLUS 30 XY trace plot of minimally processed magnetometer data; Sector 6 (1:2,500)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
dipolar linear	service pipe
magnetic disturbance	powerline disturbance
magnetic disturbance	ferrous material
linear trend	agricultural
linear	former field boundary
linear trend	field drain
linear trend	geological variation
magnetic enhancement	geology

ABBREVIATIONS

FB	former boundary
SP	service pipe

0 50m
1:2,500 @ A3

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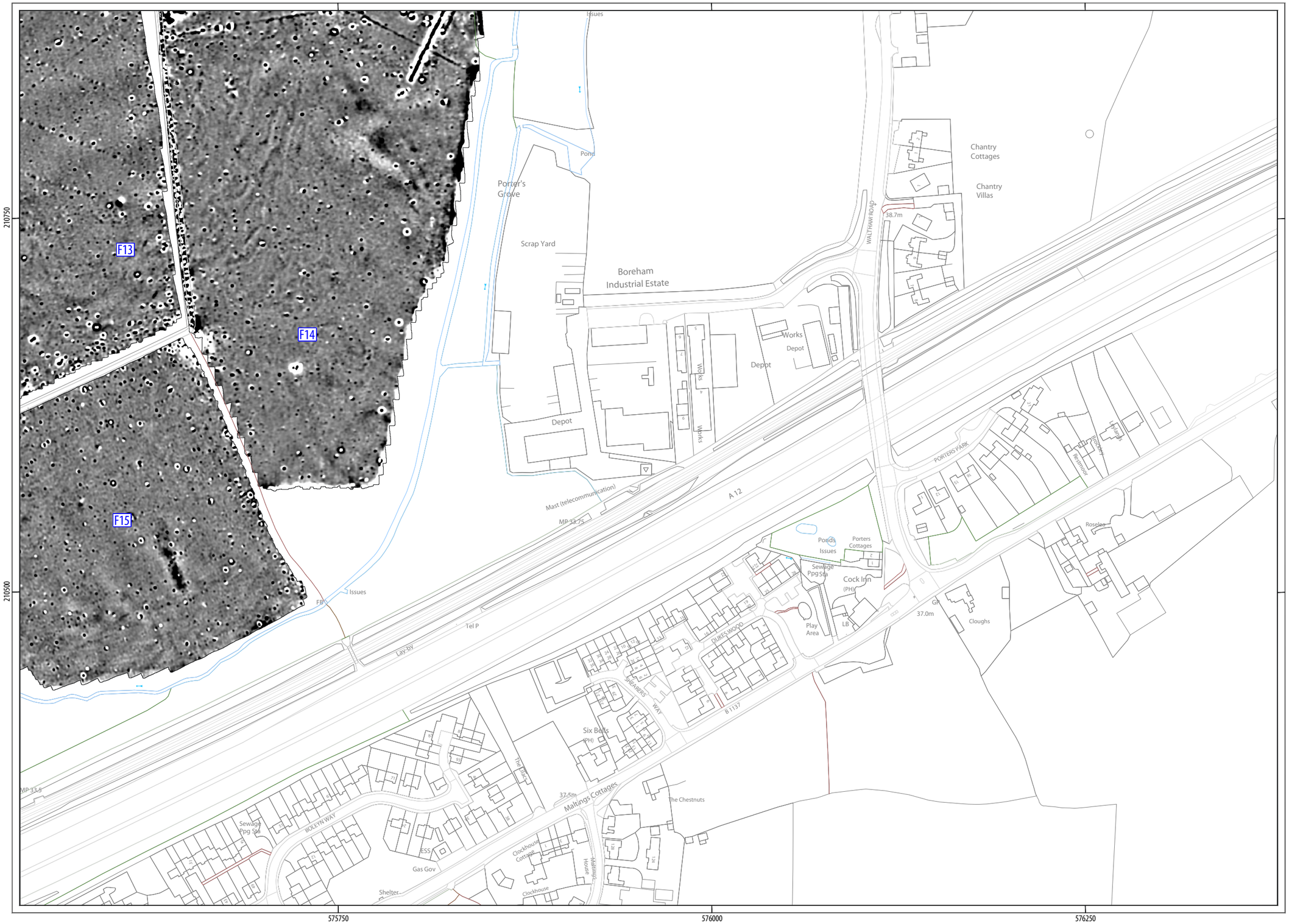
ILLUS 31 Interpretation of magnetometer data; Sector 6 (1:2,500)



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ILLUS 32 Processed greyscale magnetometer data; Sector 7 (1:2,500)

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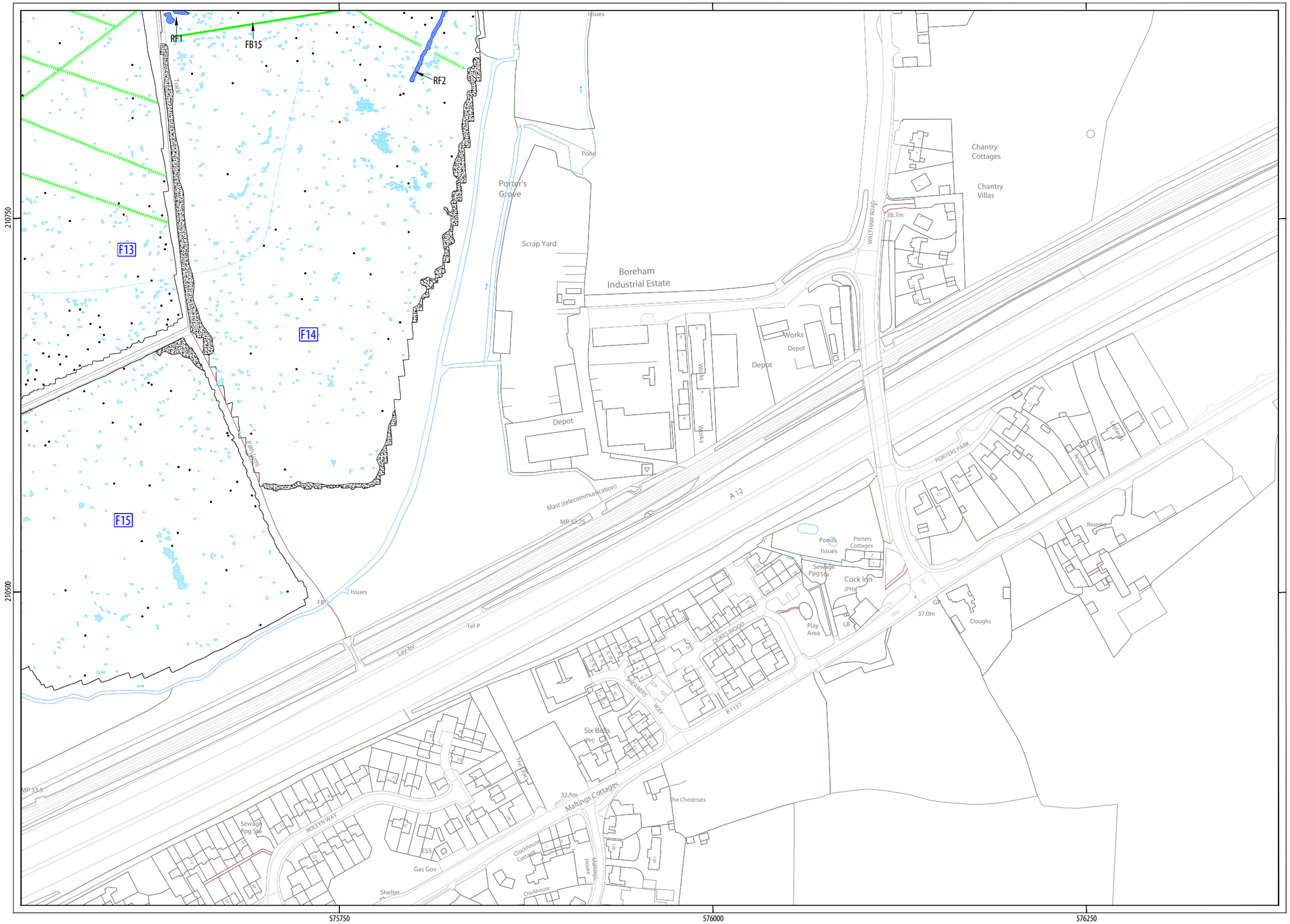
ILLUS 33 XY trace plot of minimally processed magnetometer data; Sector 7 (1:2,500)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
magnetic disturbance	modern
linear trend	agricultural
linear	former field boundary
linear trend	field drain
linear trend	geological variation
magnetic enhancement	geology

ABBREVIATIONS

FB	former boundary
RF	rifle range

0 50m
1:2,500 @ A3

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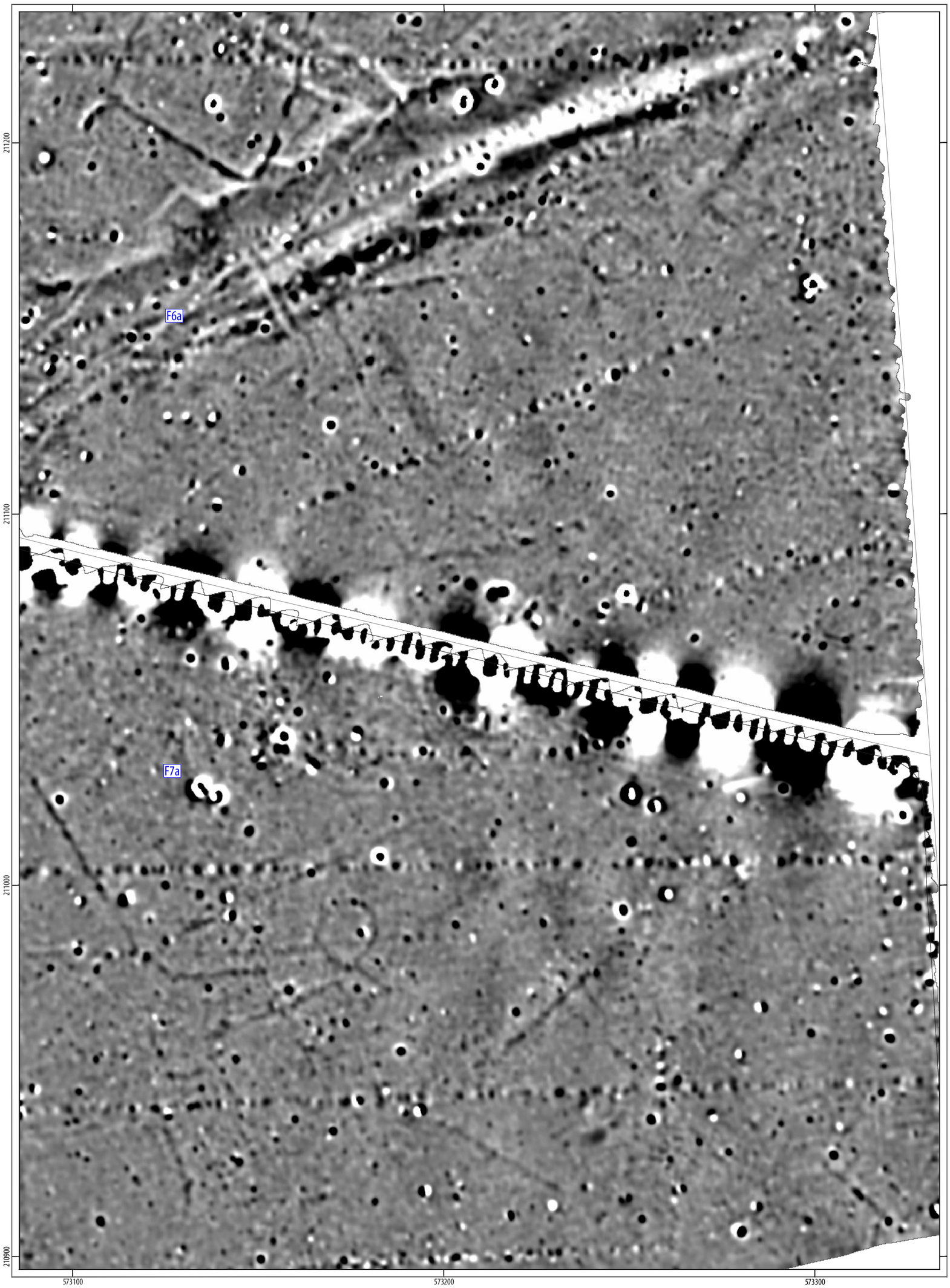
ILLUS 34 Interpretation of magnetometer data; Sector 7 (1:2,500)



nT
-1.0 2.0

0 25m
1:1,000 @ A3

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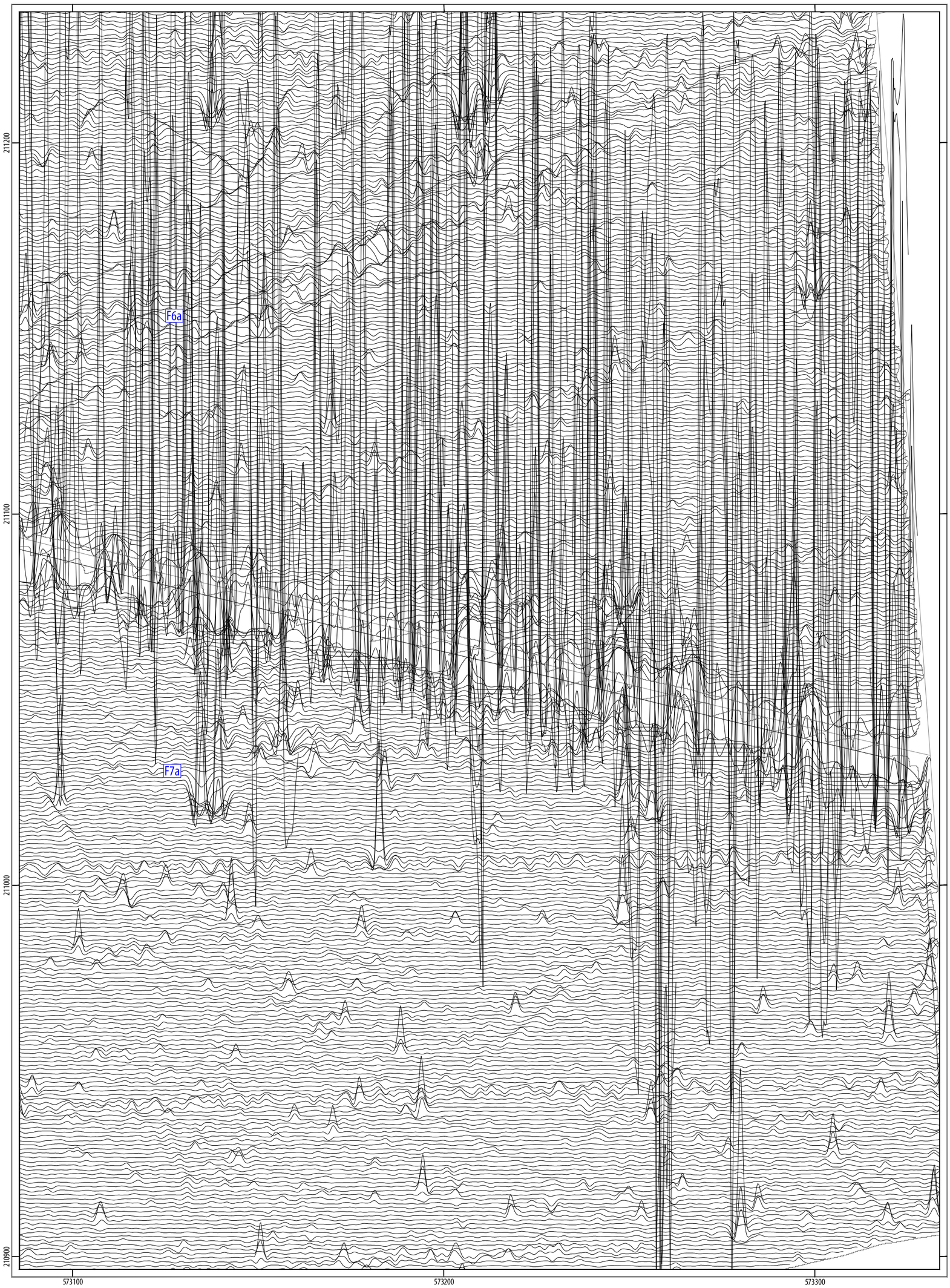
ILLUS 35 Processed greyscale magnetometer data; AAP1 (1:1,000)



8.5nT/cm

0 25m

1:1,000 @ A3

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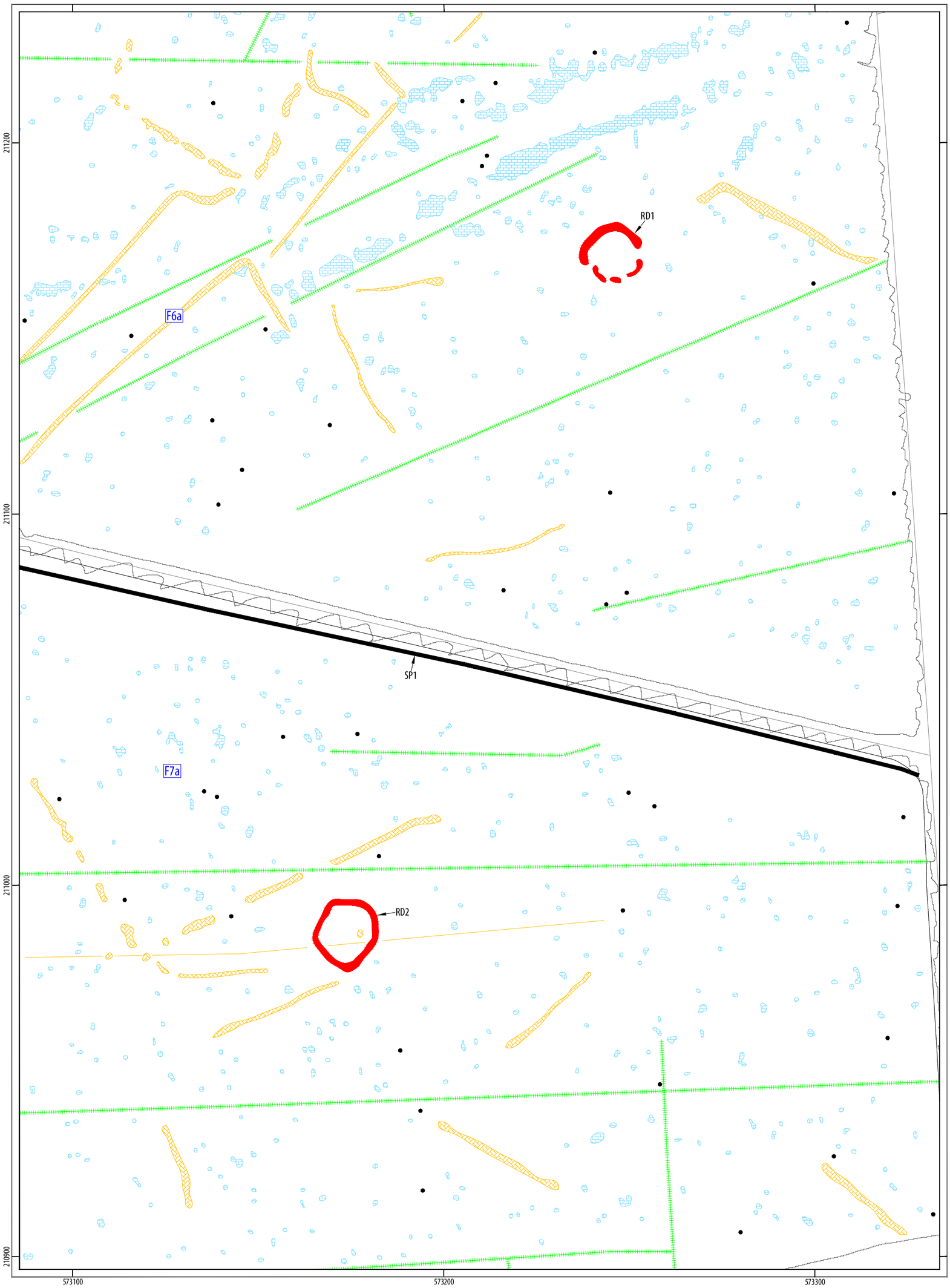
ILLUS 36 XY trace plot of minimally processed magnetometer data; AAP1 (1:1,000)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
dipolar linear	service pipe
linear trend	former field boundary
linear trend	field drain

TYPE OF ANOMALY	INTERPRETATION
linear trend	geological variation
magnetic enhancement	geology
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

ABBREVIATIONS

RD ring ditch
SP service pipe

0 25m
1:1,000 @ A3

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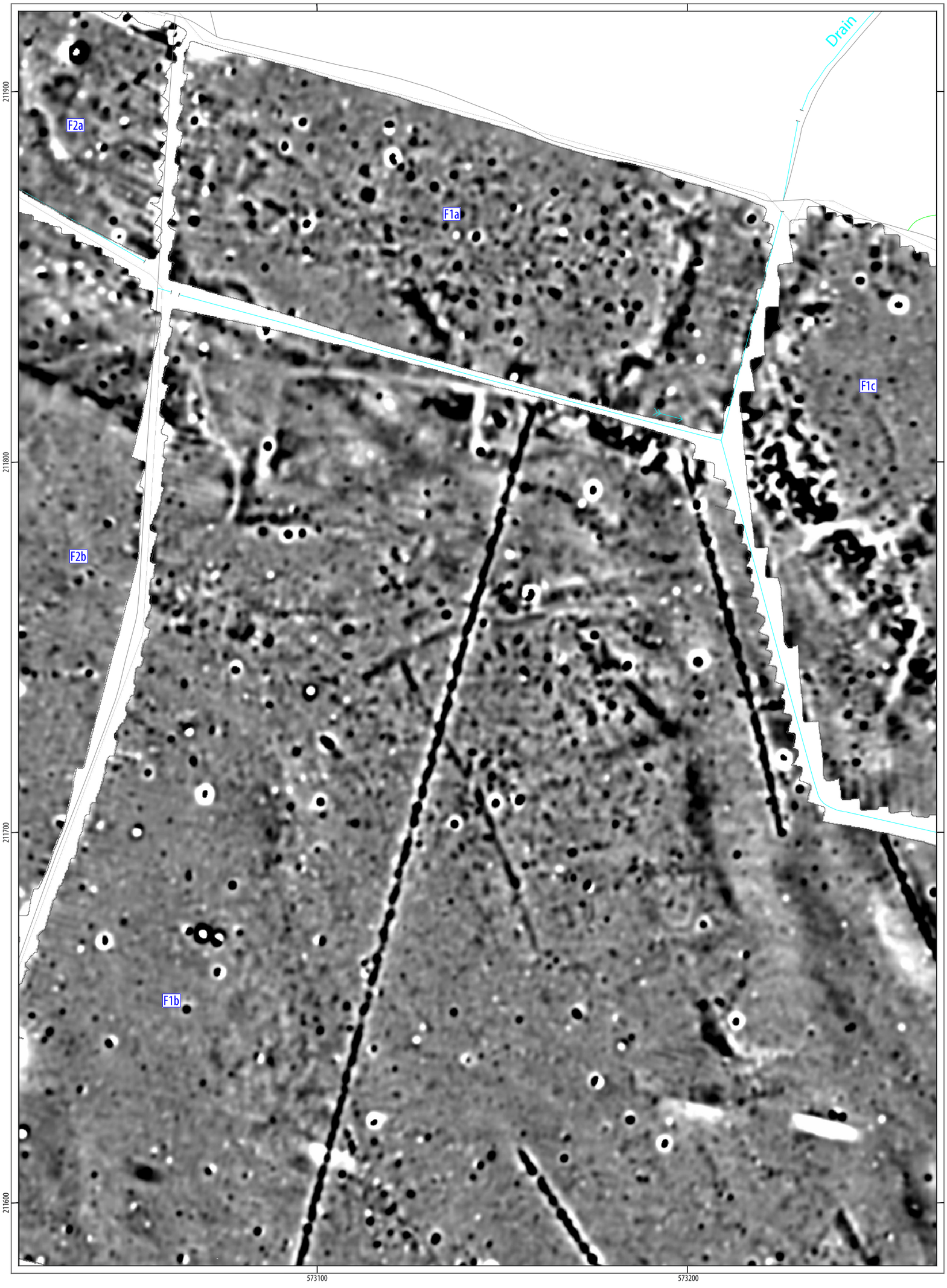
ILLUS 37 Interpretation of magnetometer data; AAP1 (1:1,000)



nT
-1.0 1.0

0 25m
1:1,000 @ A3

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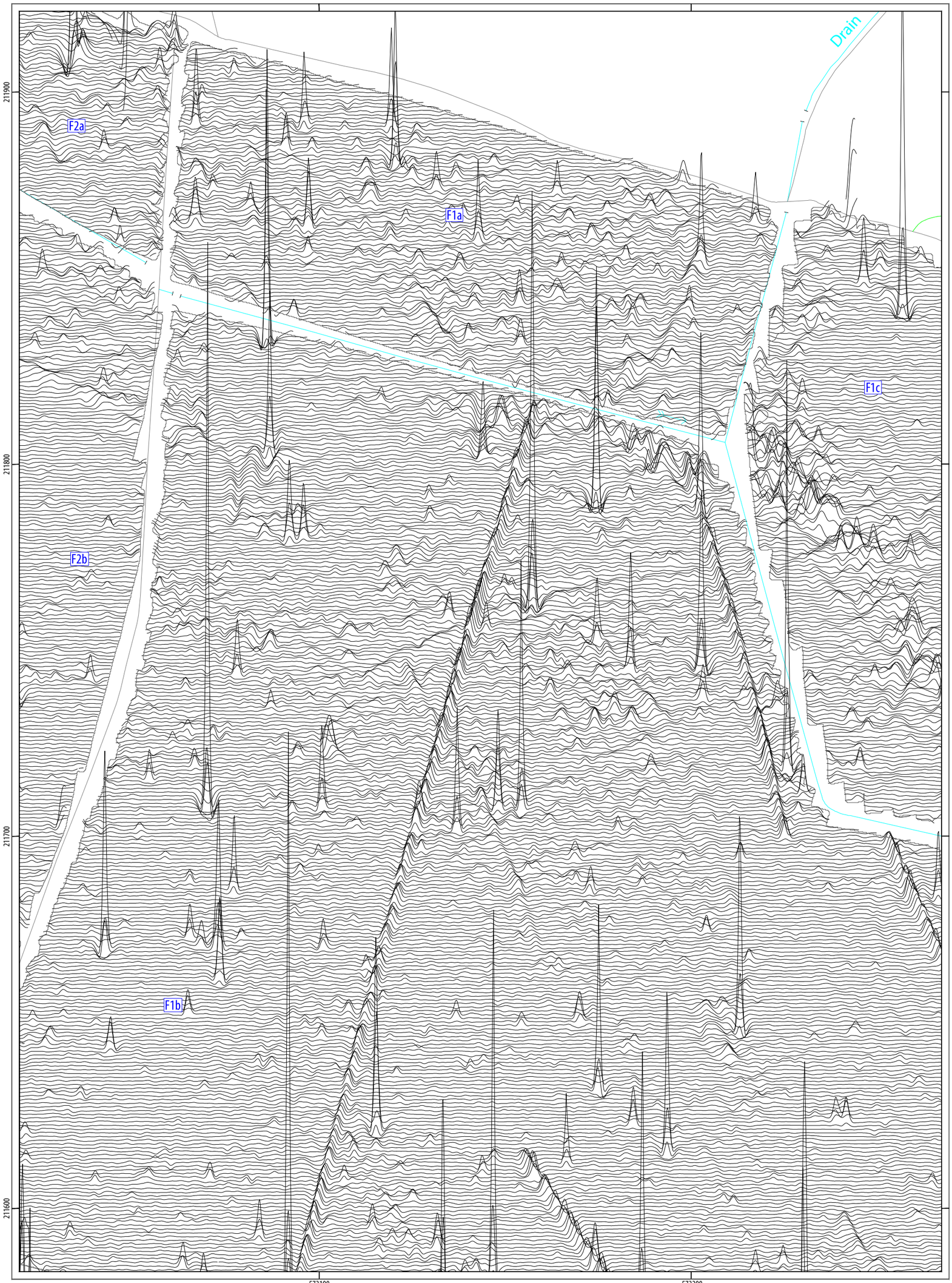
ILLUS 38 Processed greyscale magnetometer data; AAP2 (1:1,000)



8.5nT/cm

0 25m

1:1,000 @ A3

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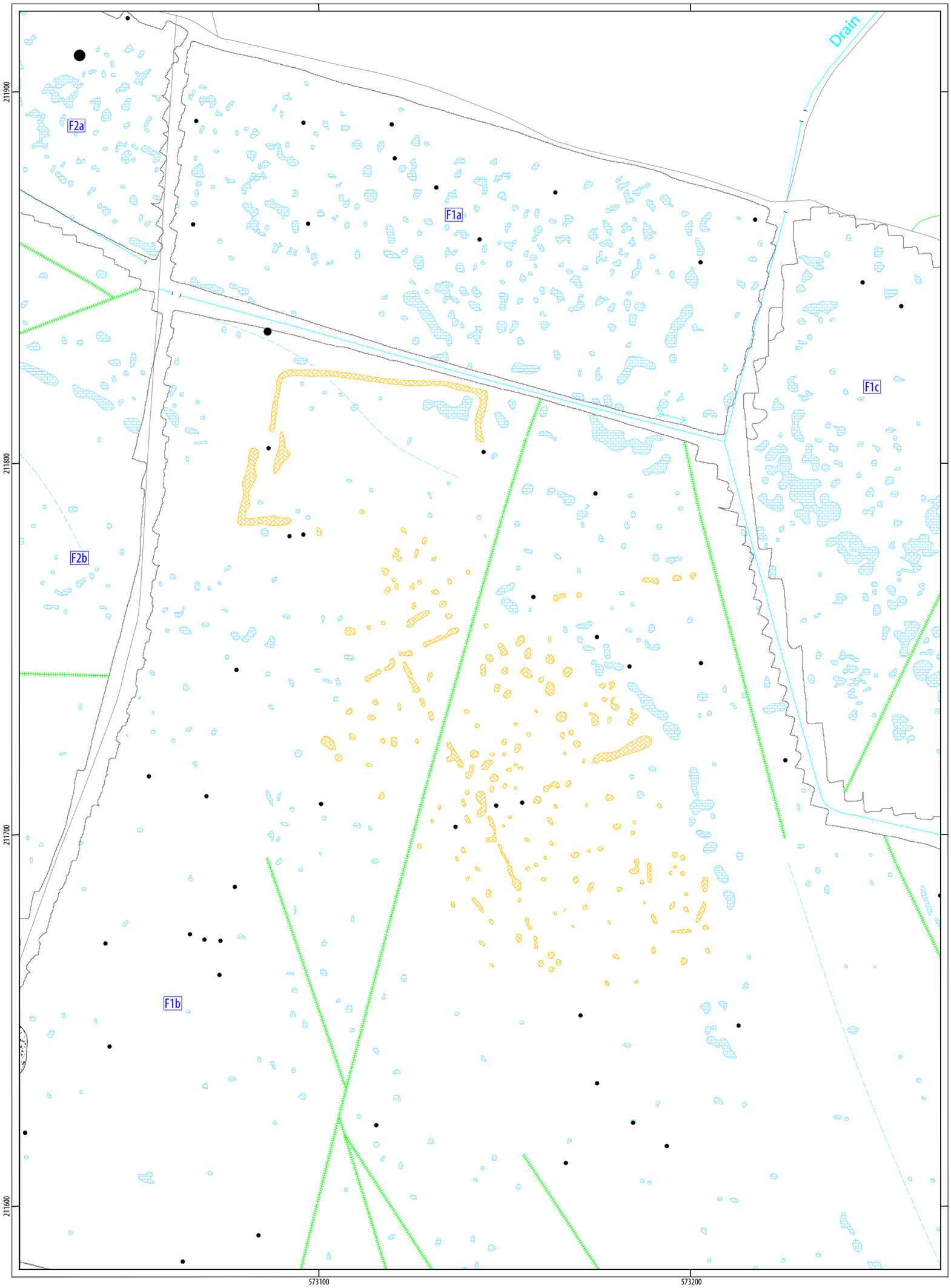
ILLUS 39 XY trace plot of minimally processed magnetometer data; AAP2 (1:1,000)



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
linear trend	former field boundary
linear trend	field drain

TYPE OF ANOMALY	INTERPRETATION
linear trend	geological variation
magnetic enhancement	geology
magnetic enhancement	archaeology?

0 25m
1:1,000 @ A3

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ILLUS 40 Interpretation of magnetometer data; AAP2 (1:1,000)

7 APPENDICES

APPENDIX 1 MAGNETOMETER SURVEY

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 haematite. 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. This effect can lead to the detection of features such as hearths, kilns or areas of burning.

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.

APPENDIX 2 SURVEY LOCATION INFORMATION

An initial survey base station was established using a Trimble VRS differential Global Positioning System (dGPS). The magnetometer data was georeferenced using a Trimble RTK differential Global Positioning System (Trimble R8s model).

Temporary sight markers were laid out using a Trimble VRS differential Global Positioning System (Trimble R8s model) to guide the operator and ensure full coverage. The accuracy of this dGPS equipment is better than 0.01m.

The survey data 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 coordinates are measured off hard copies of the mapping rather than using the digital coordinates.

Headland Archaeology cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

APPENDIX 3 GEOPHYSICAL SURVEY ARCHIVE

The geophysical archive comprises an archive disk containing the raw data in XYZ format, a raster image of each greyscale plot with associate world file, and a PDF of the report.

The project will be archived in-house in accordance with recent good practice guidelines (http://guides.archaeologydataservice.ac.uk/g2gp/Geophysics_3). The data will be stored in an indexed archive and migrated to new formats when necessary.

APPENDIX 4 DATA PROCESSING

The gradiometer data has been presented in this report in processed greyscale and minimally processed XY trace plot format.

Data collected using RTK GPS-based methods cannot be produced without minimal processing of the data. The minimally processed data has been interpolated to project the data onto a regular grid and de-striped to correct for slight variations in instrument calibration drift and any other artificial data.

A high pass filter has been applied to the greyscale plots to remove low frequency anomalies (relating to survey tracks and modern agricultural features) in order to maximise the clarity and interpretability of the archaeological anomalies.

The data has also been clipped to remove extreme values and to improve data contrast.

APPENDIX 5 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: headland5-331526

PROJECT DETAILS	
Project name	Bull's Lodge Quarry: Park Farm and Brick Farm
Short description of the project	Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey on land at Bulls Lodge Quarry, Chelmsford, Essex in advance of the submission of planning proposals to extend the quarry workings. The survey comprised two areas, at Park Farm and Brick Farm, approximately 2.5 km apart, and covered 116 hectares. At the Park Farm site two areas of archaeological potential have been identified. Although no coherent pattern of activity is discerned, due to the weak magnitude and discontinuous nature of the responses, the anomalies are indicative of enclosures, with possible settlement activity. The archaeological activity is fairly extensive at both locations. There are no anomalies of obvious archaeological potential at the Brick Farm site although anomalies locating the site of an early 20th century rifle range have been identified. These features may be of local historical interest. Although the majority of the two survey areas are devoid of archaeological anomalies the low magnetic contrast and weak and discontinuous nature of the archaeological anomalies could mean that any archaeological remains are more extensive than revealed by the geophysical survey.
Project dates	Start: 05-05-2018 End: 22-08-2018
Previous/future work	Not known / Not known
Any associated project reference codes	BLQE18 - Contracting Unit No.
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	Mineral extraction (e.g. sand, gravel, stone, coal, ore, etc.)
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology	LONDON CLAY
Drift geology	BOULDER CLAY AND MORAINIC DRIFT
Drift geology	COLLUVIUM
Techniques	Magnetometry
PROJECT LOCATION	
Country	England
Site location	ESSEX CHELMSFORD BOREHAM Bull's Lodge Quarry: Park Farm and Brick Farm
Study area	116 Hectares
Site coordinates	TL 7290 1110 51.771332120996 0.50623618081 51 46 16 N 000 30 22 E Point
Site coordinates	TL 7548 1086 51.768370418678 0.543473358177 51 46 06 N 000 32 36 E Point
PROJECT CREATORS	
Name of Organisation	Headland Archaeology
Project brief originator	AECOM
Project design originator	Headland Archaeology
Project director/manager	Harrison, S
Project supervisor	Vansassenbrouck, O.

Type of sponsor/funding body	Developer
PROJECT ARCHIVES	
Physical Archive Exists?	No
Digital Archive recipient	In house
Digital Contents	"Survey"
Digital Media available	"Geophysics"
Paper Archive Exists?	No
PROJECT BIBLIOGRAPHY 1	
Publication type	Grey literature (unpublished document/manuscript)
Title	Bull's Lodge Quarry: Park Farm and Brick Farm, Chelmsford, Essex; Geophysical Survey
Author(s)/Editor(s)	Vansassenbrouck, O.
Author(s)/Editor(s)	Webb, A.
Date	2018
Issuer or publisher	Headland Archaeology
Place of issue or publication	Leeds
Description	PDF [A]
Entered by	David Harrison (david.harrison@headlandarchaeology.com)
Entered on	22 October 2018

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