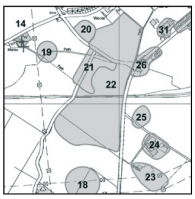
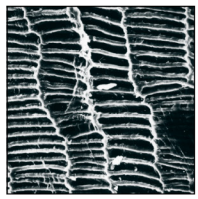
BRAM20










BRAMFORD SOLAR PV AND BATTERY, SUFFOLK

GEOPHYSICAL SURVEY REPORT

commissioned by Aardvark EM Ltd
on behalf of Bramford Green Ltd

August 2021

HEADLAND ARCHAEOLOGY

REGISTERED ORGANISATION CIfA

BRAMFORD SOLAR PV AND BATTERY, SUFFOLK

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August 2021

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

PROJECT INFO:

HA Project Code **BRAM20** / Parish Number. **SSH 041 & BUS 020** / NGR **TM 09087 47078** / Parish **Various** / Local Authority **Suffolk County Council** / Fieldwork Date **30/12/2020 – 07/12/2020 and 19/02/2021** / OASIS Ref. **headland5-409168**

PROJECT TEAM:

Project Manager **Alistair Webb** / Author **Alistair Webb** / Fieldwork **Glyn Sheldrick, Michael Puntorno, Olivier Vansassenbrouck, Peter Heykoop, Richard McGregor Edwards, Ross Bishop** / Graphics **Beata Wieczorek-Oleksy, Julia Bastek-Michalska, Sam Harrison**

Approved by **Alistair Webb** .....

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HEADLAND ARCHAEOLOGY

part of the RSK Group

REGISTERED ORGANISATION CIfA

PROJECT SUMMARY

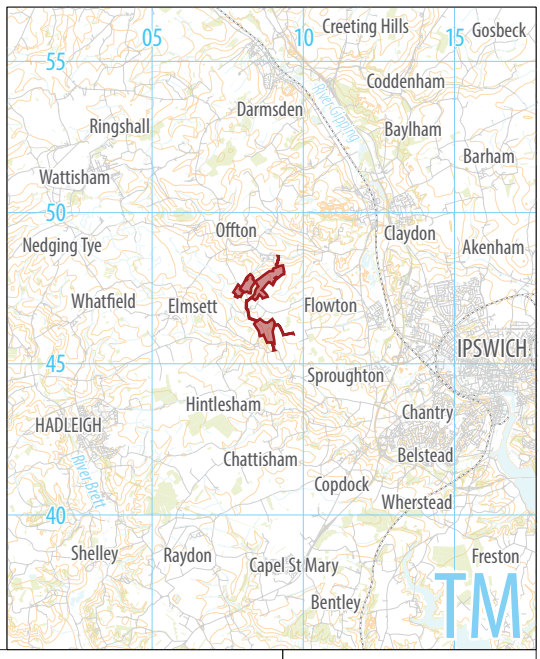
Headland Archaeology (UK) Ltd undertook a geophysical (magnetometer) survey on land covering approximately 89 hectares on agricultural land west of Bramford, Suffolk to provide baseline information for an Environmental Statement which will be submitted in support of a planning application for a solar farm development. The proposed development area (PDA) comprises six large arable fields.

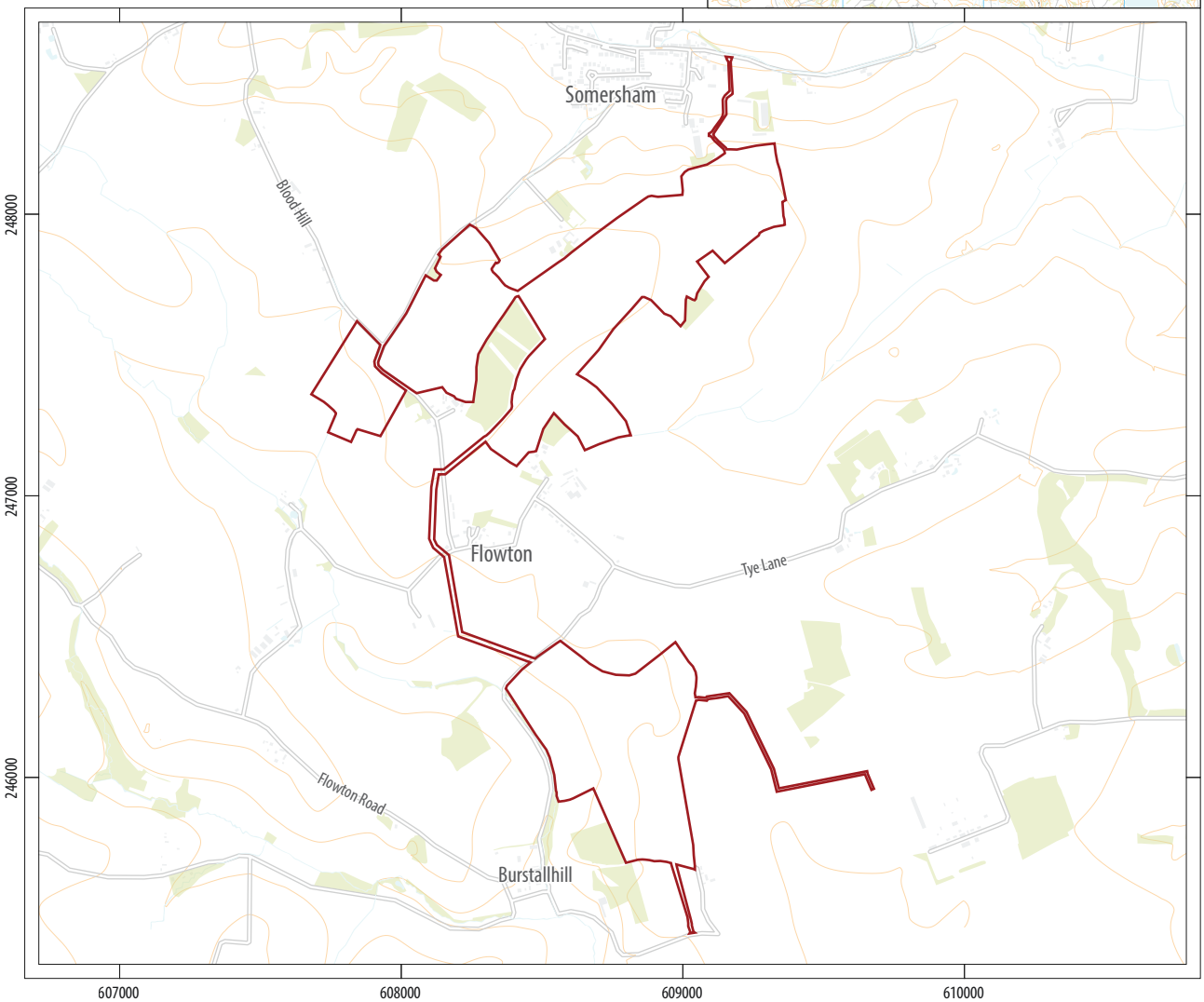
The survey has identified numerous anomalies locating former field boundaries, land drains and modern activity across the PDA. In addition, the survey has identified five areas of archaeological potential (AAPs), three of which contain enclosures of various sizes that are not recorded on historic mapping or listed on the Suffolk Historic Environment Record. The age and function of the enclosures is uncertain, although they are interpreted as being more likely to have been used for animals than for human occupation and their alignment is generally parallel with or perpendicular to 19th century and/or extant boundaries. In the absence of any other supporting information these enclosures are interpreted as of moderate archaeological potential. Two other areas of archaeological potential have been identified although no obvious pattern to the anomalies can be discerned at either location. In these two areas the potential archaeological significance is less certain and hence they are therefore assessed as of low to moderate archaeological potential. Most of the PDA contains no archaeological anomalies.

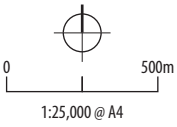
CONTENTS

LIST OF ILLUSTRATIONS

Bramford Solar PV and Battery
Bramford
Suffolk







proposed development area

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ILLUS 1 Site location

BRAMFORD SOLAR PV AND BATTERY, SUFFOLK

GEOPHYSICAL SURVEY REPORT

1 INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Aardvark EM Ltd, on behalf of Bramford Green Ltd (The Client) to undertake a geophysical (magnetometer) survey at Bramford, Suffolk, in advance of the submission of a planning application for a proposed solar farm development (Bramford Solar PV and Battery). The survey extended across six fields (F1 to F6 inclusive – nomenclature follows that provided by the Client) covering approximately 89 hectares (Illus 1).

The results of the survey will be submitted as part of an Environmental Statement (ES) submitted in support of support of a future planning application and will inform future archaeological strategy at the site, if required. The survey was undertaken to assess the impact of the proposed development on the historic environment. It was undertaken in accordance with an Archaeological Written Scheme of Investigation (WSI) (Headland 2020), approved by Gemma Stewart, Senior Archaeological Officer at Suffolk County Council Archaeological Service, who provide archaeological advice to Suffolk County Council, with guidance within the National Planning Policy Framework (MHCLG 2019) and in line with current best practice (Chartered Institute for Archaeologists 2014, Europae Archaeologia Consilium 2016).

The surveys were carried out between November 30th 2020 and December 7th 2020 and completed om March 19th 2021.

1.1 SITE LOCATION, TOPOGRAPHY AND LAND-USE

The Proposed Development Area (PDA – Illus 1) comprises land to the west and north of Bramford Sub-Station where banks of solar panels will be sited; the sub-station is currently being expanded to connect with the East Anglia 1 and East Anglia 3 Offshore Windfarms. The PDA is west of Bramford, east of Flowton and south of Somersham, centred at NGR 609687, 246342, and is bound by Flowton Brook to the west and Valley Farm Brook to the north. The land within the PDA is currently all under arable agricultural production (Illus 2 to Illus 4 inclusive) with open farmland extending to all sides. The survey did not include the route of the cable corridor.

Topographically the PDA undulates between approximately 47m above Ordnance Datum (AOD) and 64m AOD sloping generally from north to south.

1.2 GEOLOGY AND SOILS

The bedrock geology comprises Thanet Formation and Lambeth Group (Undifferentiated) – Clay, Silt and Sand overlain by superficial deposits of Lowestoft Formation – Diamicton (NERC 2020).

The soils are classified in the Soilscape 9 Association which are described as lime rich loams and clays with impeded drainage (Cranfield University 2020).

2 ARCHAEOLOGICAL BACKGROUND

The information below is abstracted from text from the Environmental Statement that was commissioned to assess the potential impact that the proposed solar park development site would have on the historic environment resource.

The assessment identified evidence of potentially late prehistoric and medieval settlements within the 1km Study Area. There is evidence of late Bronze Age field systems recorded approximately 1km to the east of the proposed development. Medieval artefacts and a single prehistoric flint flake have been found within part of the PDA.

ILLUS 2 F3, looking south-west

The DBA concluded that groundworks for the construction of the new solar farm and battery storage facility, new access roads, new utility trenches and new landscaping works would likely physically impact any previously unknown archaeological remains present within the PDA and that further information on the nature of any buried archaeological remains could be obtained through further investigation such as by geophysical survey. However, it was recognised that the lack of any evidence for archaeological remains is more likely to be reflective of a lack of investigation rather than an absence of any archaeological activity.

3 AIMS, METHODOLOGY AND PRESENTATION

The general aim of the geophysical survey was to provide enough information to establish the presence/absence, character and extent of any archaeological remains within the PDA. This will therefore enable an assessment to be made of the impact of the proposed development on any sub-surface archaeological remains, if present.

The specific archaeological objectives of the geophysical survey were:

- to gather enough information to inform the extent, condition, character and date (as far as circumstances permit) of any archaeological features and deposits within the PDA;
- to obtain information that will contribute to an evaluation of the significance of the scheme upon cultural heritage assets; and
- to prepare a report summarising the results of the survey.

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 V3.0.36.0 (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 1:12,500. Illus 2 to Illus 4 inclusive are site condition photographs. Illus 5 shows the GPS swaths at 1:10,000. Illus 6 presents the greyscale data for the whole PDA, showing Sector boundaries, with Illus 7 an overall

ILLUS 3 F4, looking north-east

interpretation of the data, both illustrations at a scale of 1:10,000. Fully processed (greyscale) data, minimally processed data (XY trace plot) data and an interpretative plot (by Sector) are presented, at a scale of 1:2,500, in Illus 8 to Illus 25 inclusive. The data for the five Areas of Archaeological Potential (AAPs) are also presented at 1:1,000 in Illus 26 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. A copy of the OASIS entry (Online Access to the Index of Archaeological Investigations) is reproduced in Appendix 5.

The survey methodology, report and any recommendations comply with the Written Scheme of Investigation (Headland 2020), guidelines outlined by Europae Archaeologia Consilium (EAC 2016) and by the Chartered Institute for Archaeologists (CIfA 2014). All illustrations from Ordnance Survey (OS) 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' (minimally processed) and processed formats and over a range of different display levels. All illustrations are presented to display and interpret the data to best effect. The interpretations are based on the experience and knowledge of management and reporting staff.

4 RESULTS AND DISCUSSION

Ground conditions were generally good throughout the PDA, although heavy underfoot in places. Data quality was also good with only minimal processing. At the time of the first phase of survey Field 4 was under an oil seed rape crop above 0.3m in height and was unsuitable for survey (Illus 3). This field was subsequently surveyed following harvest in March 2021. A narrow strip of wild bird cover along the western edge of F5 precluded survey here.

Overall, the magnetic background was homogenous across the PDA (but with some well-defined localised variations – see below) with numerous anomalies, agricultural, geological, archaeological and modern being identified. This confirms that the soils and geology are suitable for magnetometry and that the results likely provide a good indication of the extent of sub-surface archaeological features within the PDA.

The non-archaeological anomalies can be classified into categories and are discussed generally. Anomalies of possible and probable archaeological origin have been identified at five locations and these areas of archaeological potential are discussed separately, and in more detail, below.

4.1 FERROUS AND MODERN 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 on most sites, often being introduced into the topsoil during

ILLUS 4 F5, looking south-east

manuring or tipping/infilling. There is no obvious clustering to the ferrous anomalies within any of the fields or across the PDA more generally to 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.

A linear band of magnetic disturbance is identified along the northern edge of F3 south of Park Farm. This is due to modern tipping or spreading of ferrous debris adjacent to the farm. A smaller disturbed area is also identified south of Church Farm, also in F3. Neither of these two areas of anomalous response is considered of any archaeological interest.

A high magnitude linear anomaly along the southern edge of F3 is caused by a sub-surface pipe. A much higher magnitude linear anomaly that crosses F6 and F7 on a north-west/south-east alignment is caused by a high-pressure gas main.

A high magnitude discrete anomaly in F3 is due to the proximity of an electricity pylon.

4.2 AGRICULTURAL ANOMALIES

Analysis of the first edition Ordnance Survey (OS) County series mapping from the late 19th century shows that numerous boundaries have been removed over the past 130 years to create larger fields. Almost all these former boundaries are identified in the magnetic data as linear anomalies and are displayed in green on the illustrations.

Regularly spaced parallel linear anomalies identified within two former fields across F3 are caused by field drains. Other linear trend anomalies identified in most parts of the PDA are also interpreted as being caused by drains.

4.3 GEOLOGICAL ANOMALIES

Broad, amorphous low magnitude anomalies due to variation in the superficial deposits and the soils are identified south of the gas pipe in F6 with another cluster at the north-eastern end of F3.

4.4 AREAS OF ARCHAEOLOGICAL POTENTIAL

Anomalies of probable and possible archaeological origin have been identified at five locations across the PDA. These areas of archaeological potential (AAPs) are described below.

AAP1 (Illus 26–28)

In Field 1 linear anomalies defining at least three sides of a rectangular enclosure are identified. The enclosure is aligned along a north-west/south-east axis straddling, or perhaps attached to, a former (19th) century boundary. At the eastern end of the enclosure a cluster of discrete anomalies indicates activity within the enclosure. Linear low magnitude ditch type linear anomalies to the south-west perhaps define a previously unrecorded land parcel perhaps attached to the enclosure. A cluster of anomalies up against the extant boundary east of the enclosure are also interpreted as of possible archaeological origin.

AAP 2 (Illus 29–31)

No definite features or pattern stand out in AAP2, but a small area of enhanced responses clearly demarcates an area of some archaeological potential in F3. The edge of the AAP to the west is demarcated by a 19th century boundary.

AAP3 (Illus 32–34)

A second rectangular enclosure is identified, also in F3. This enclosure respects the extant 19th century boundary to which it aligns along its north-western side and which may imply the two features are contemporaneous. The anomalies defining the south-eastern end of the enclosure are extremely weak and poorly defined and very little definite detail or pattern can be seen. However, a small area of generally enhanced magnetic responses does stand out against the homogenous magnetic background in this part of the PDA effectively serving to define the extent of the archaeological activity.

AAP 4 (Illus 35–37)

AAP 4 includes a third enclosure, which straddles the extant boundary between F5 and F6, as well as a disparate aggregation of linear trends on varying alignments to the north-east of the enclosure. These anomalies are also interpreted as of possible archaeological origin and have therefore been included within the AAP. The basic playing card shape of the enclosure is augmented by a curvilinear anomaly on the south-western corner, although a more detailed appraisal of its form is not possible due to the massive 'masking' response from the high-pressure gas main immediately to the south-east. There is also an irregularly shaped annex on the north-eastern side of the enclosure. A few discrete anomalies are identified both within and immediately adjacent to the enclosure. These have been interpreted as of possible archaeological origin based on their proximity to the enclosure although a geological origin is considered equally plausible.

AAP 5 (Illus 38–40)

AAP5 is in F5 just to the south of the gas pipe and AAP4. As in AAP2, no definite shape or form can be distinguished, although a degree of linearity can be discerned (north/south and east/west) within the broad mass of anomalies possibly suggestive of two adjoining square enclosures. The area of activity does appear to be broadly rectangular and is clearly defined by a cluster of responses that are of higher magnitude than the general magnetic background.

4.5 OTHER ANOMALIES OF POSSIBLE ARCHAEOLOGICAL POTENTIAL

In F2 (Illus 11 to Illus 13 inclusive) two small clusters of discrete anomalies are identified immediately to the north of a former boundary. The orientation of the former boundary appears to deviate to avoid one of the clusters of anomalies.

In F4 (Illus 20 to Illus 22 inclusive) linear anomalies aligned parallel with or orthogonal to the current field boundary are identified. These anomalies are of uncertain origin and therefore a potential archaeological cause cannot be dismissed although an agricultural cause is considered equally plausible.

To the south of AAP5 in F5 two curvilinear ditch type anomalies that appear to join at approximate right angles to a linear anomaly interpreted as a 19th century boundary are identified (Illus 23 to Illus 25 inclusive). A break in the response of the former boundary could indicate an entrance between the fields either side.

5 CONCLUSION

The survey has identified numerous anomalies locating former field boundaries, land drains and modern activity across the PDA. In addition, the survey has identified five areas of archaeological potential, three of which contain enclosures of archaeological potential that are not recorded on historic mapping or recorded on the Suffolk HER. The age and function of the enclosures is uncertain, but their alignment is generally parallel with or perpendicular to 19th century and/or extant boundaries, albeit that two of them straddle across former boundaries. In the absence of any other supporting information these enclosures are interpreted as of moderate archaeological potential.

Two other AAPs have been identified. Although no obvious pattern to the anomalies can be discerned at either location (as the anomalies are weak and discontinuous) the magnetic background is low and homogenous allowing them to be identified. In these two areas the potential archaeological significance is less certain and hence they are therefore assessed as of low to moderate archaeological potential as are possible anomalies of archaeological potential at three other locations.

6 REFERENCES

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Headland Archaeology 2020 ***Bramford Solar Farm, Suffolk: Archaeological Desk-based Assessment*** [unpublished client document] Ref. P20–187

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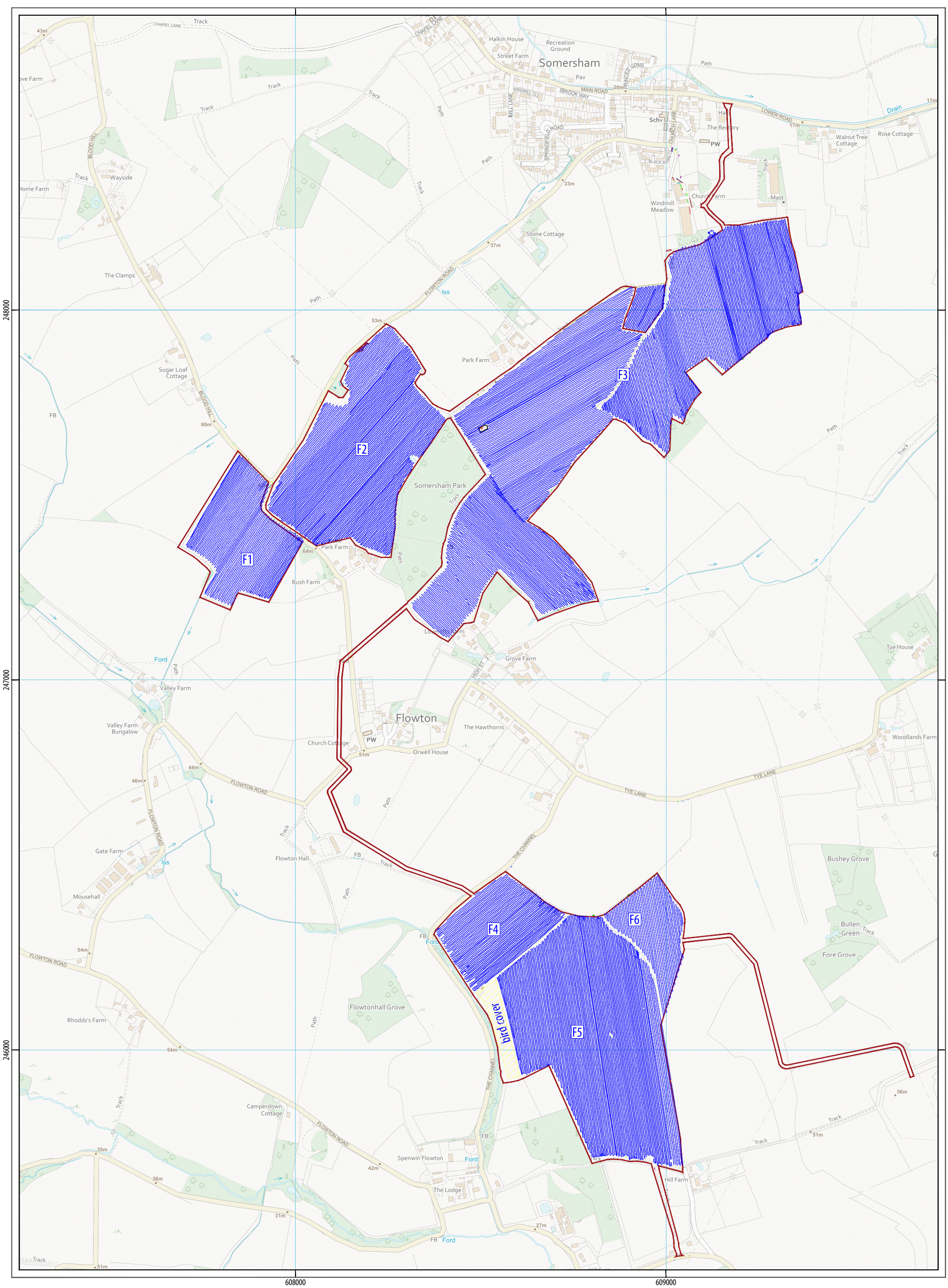

geophysical survey area
GPS swaths
area unsuitable for survey
location and direction of ILLUS 2-4

0 200m
1:10,000 @ A3

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Ipswich
Suffolk

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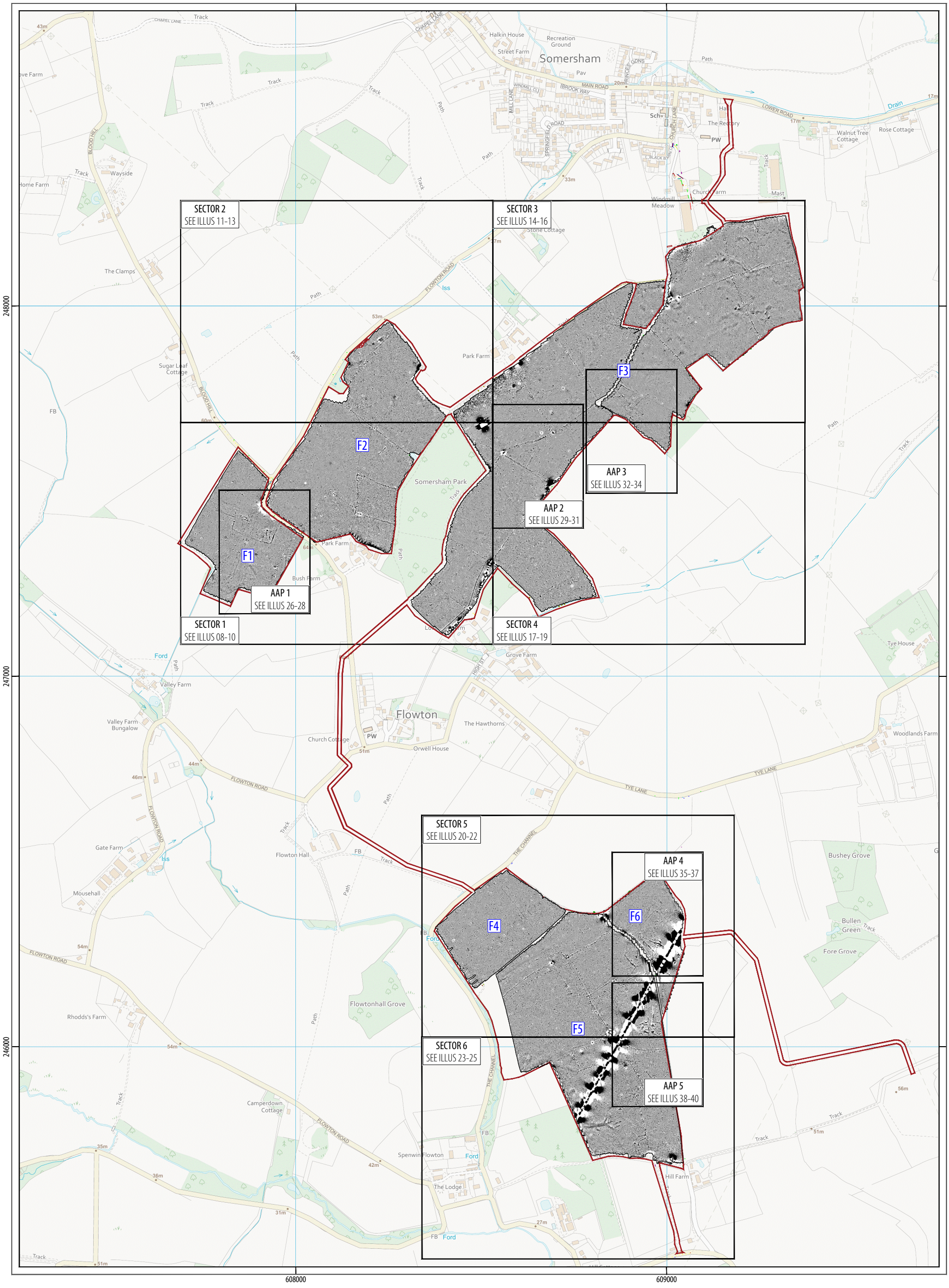
ILLUS 5 Survey location showing GPS swaths



geophysical survey area

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200m
1:10,000 @ A3

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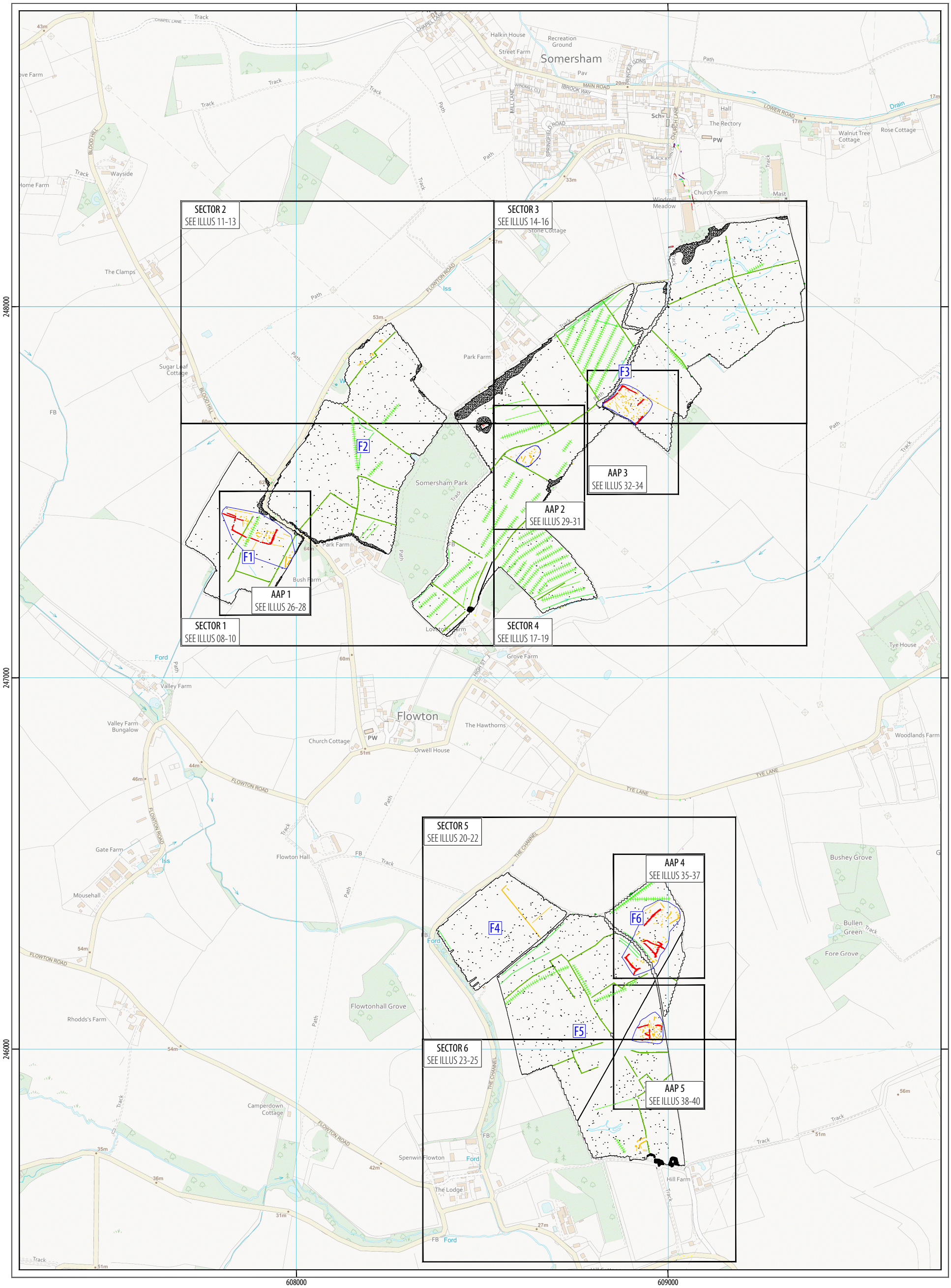
ILLUS 6 Processed greyscale magnetometer data



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

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

AAP

0 200m
1:10,000 @ A3

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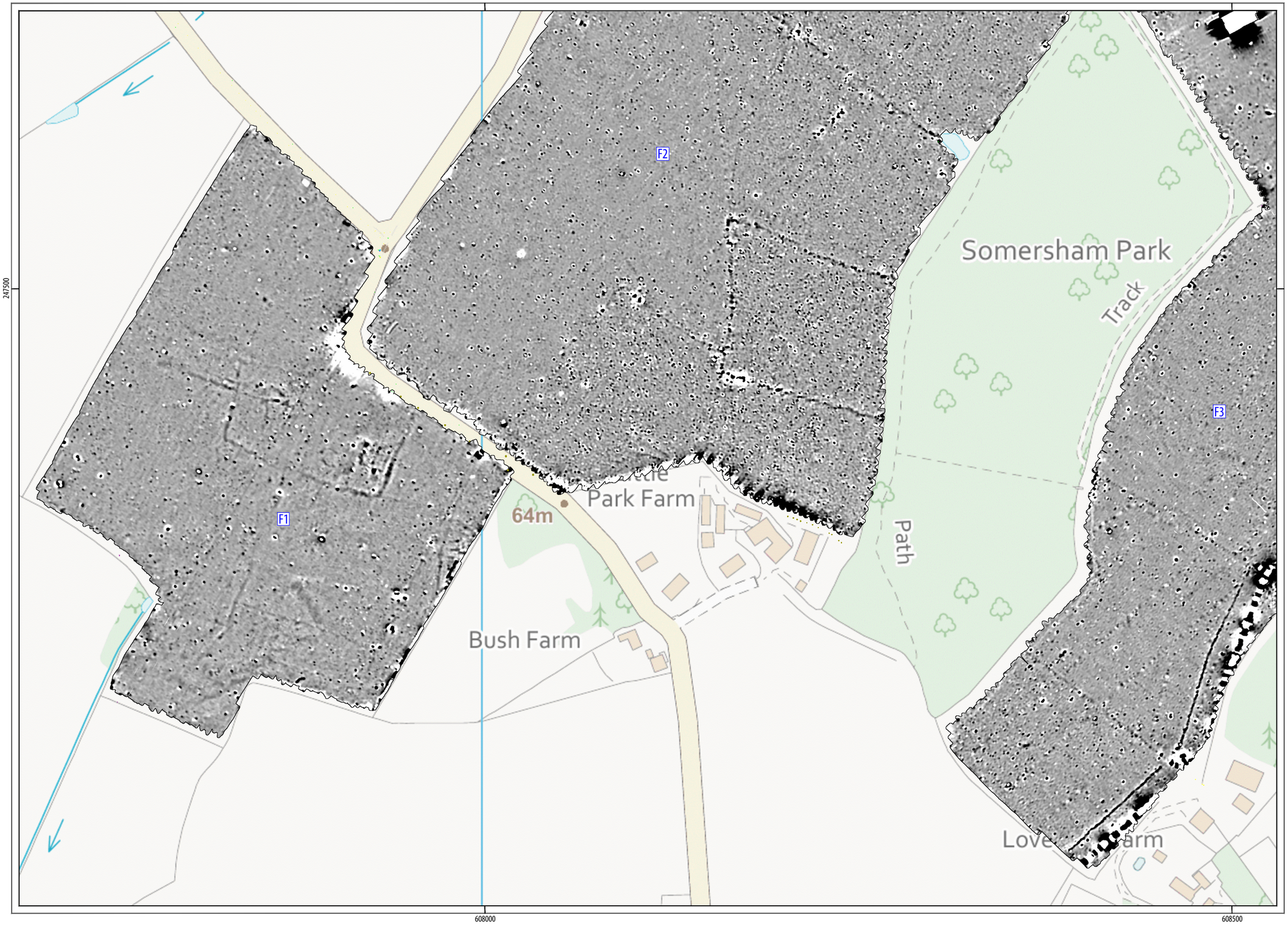
ILLUS 7 Overall interpretation of magnetometer data



nT
-1.0
2.0

0
50m
1:2,500 @ A3

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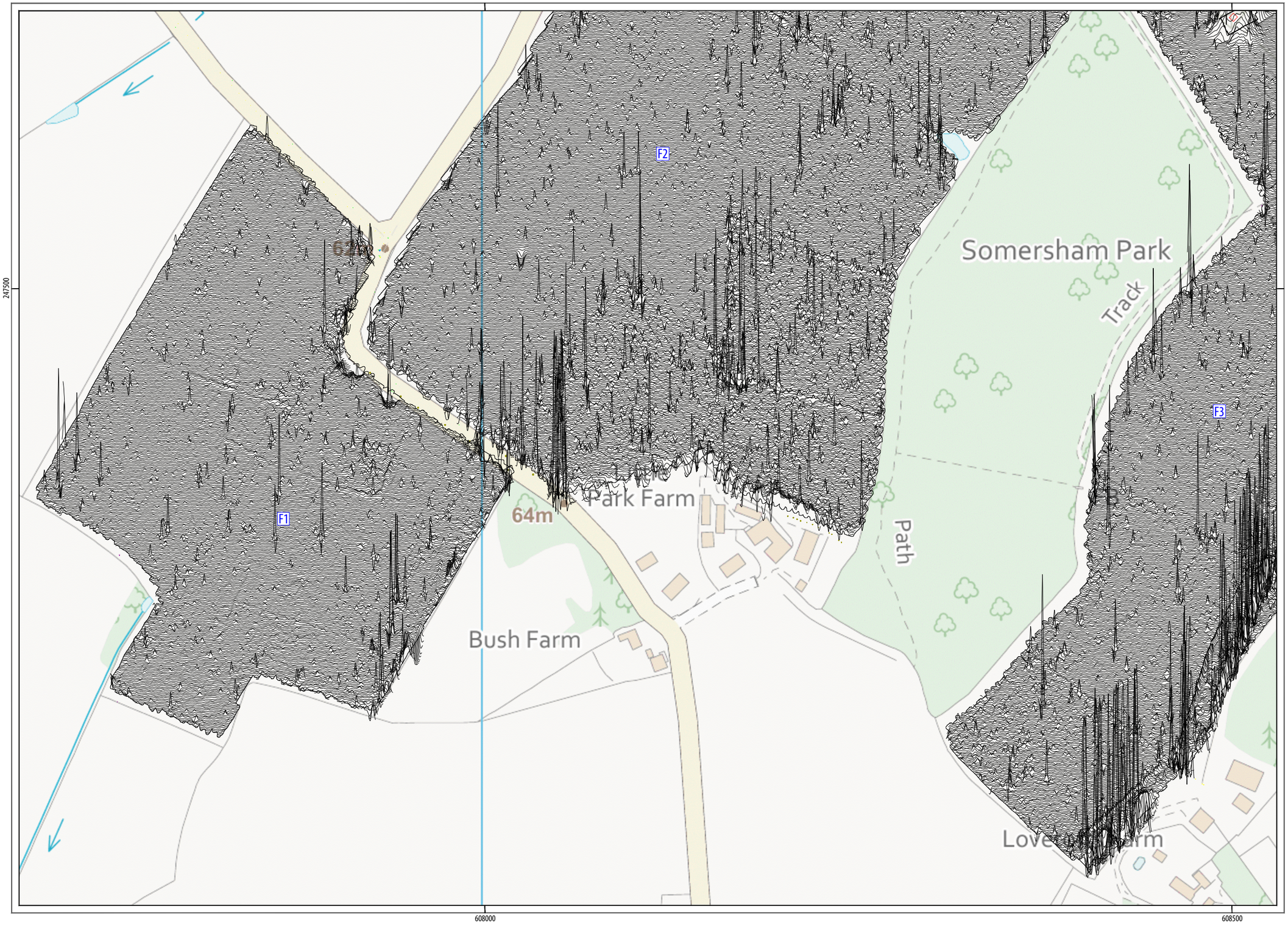
ILLUS 8 Processed greyscale magnetometer data, Sector 1



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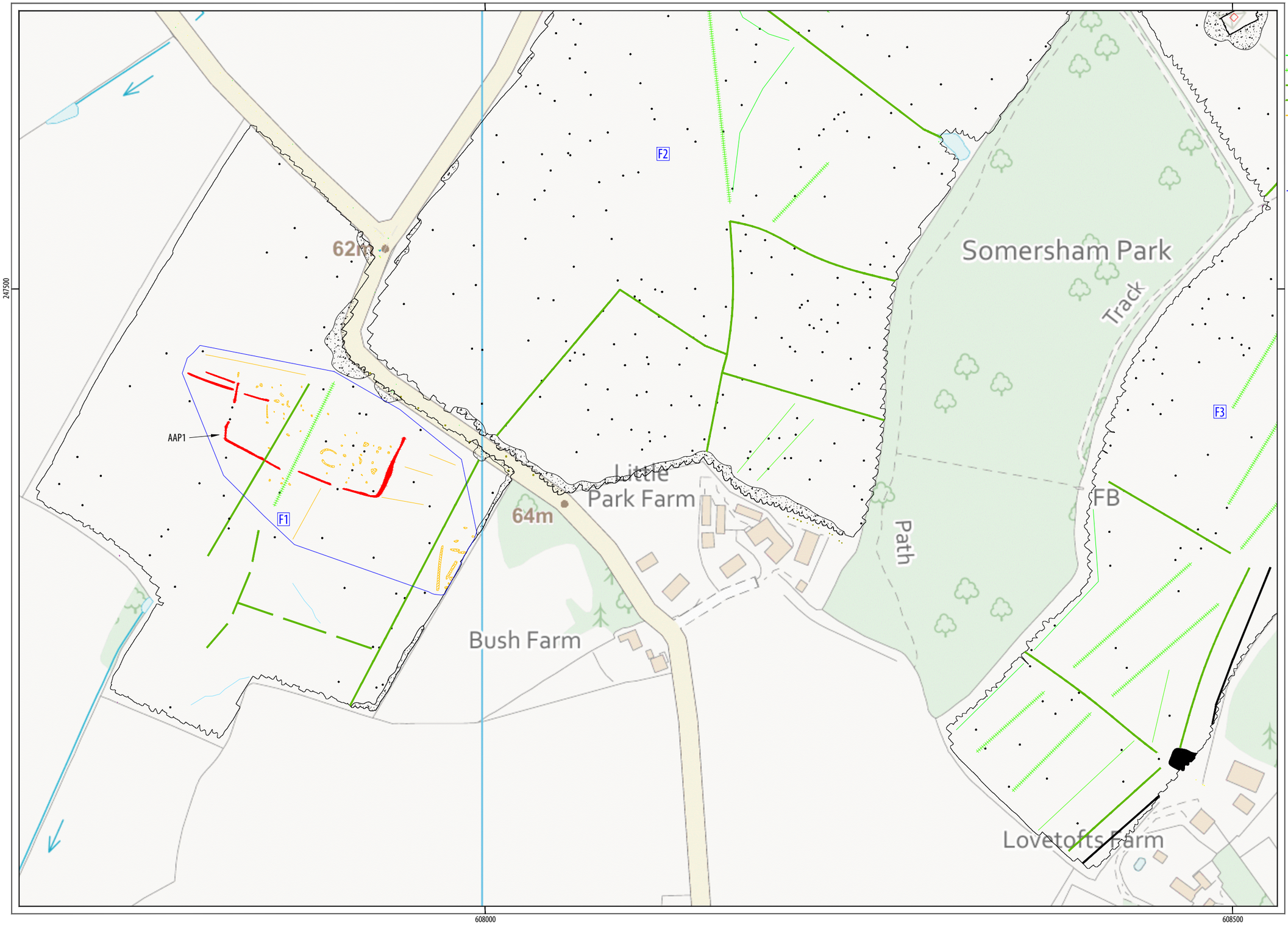
ILLUS 9 XY trace plot of minimally processed magnetometer data, Sector 1



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

AAP

0 50m
1:2,500 @ A3

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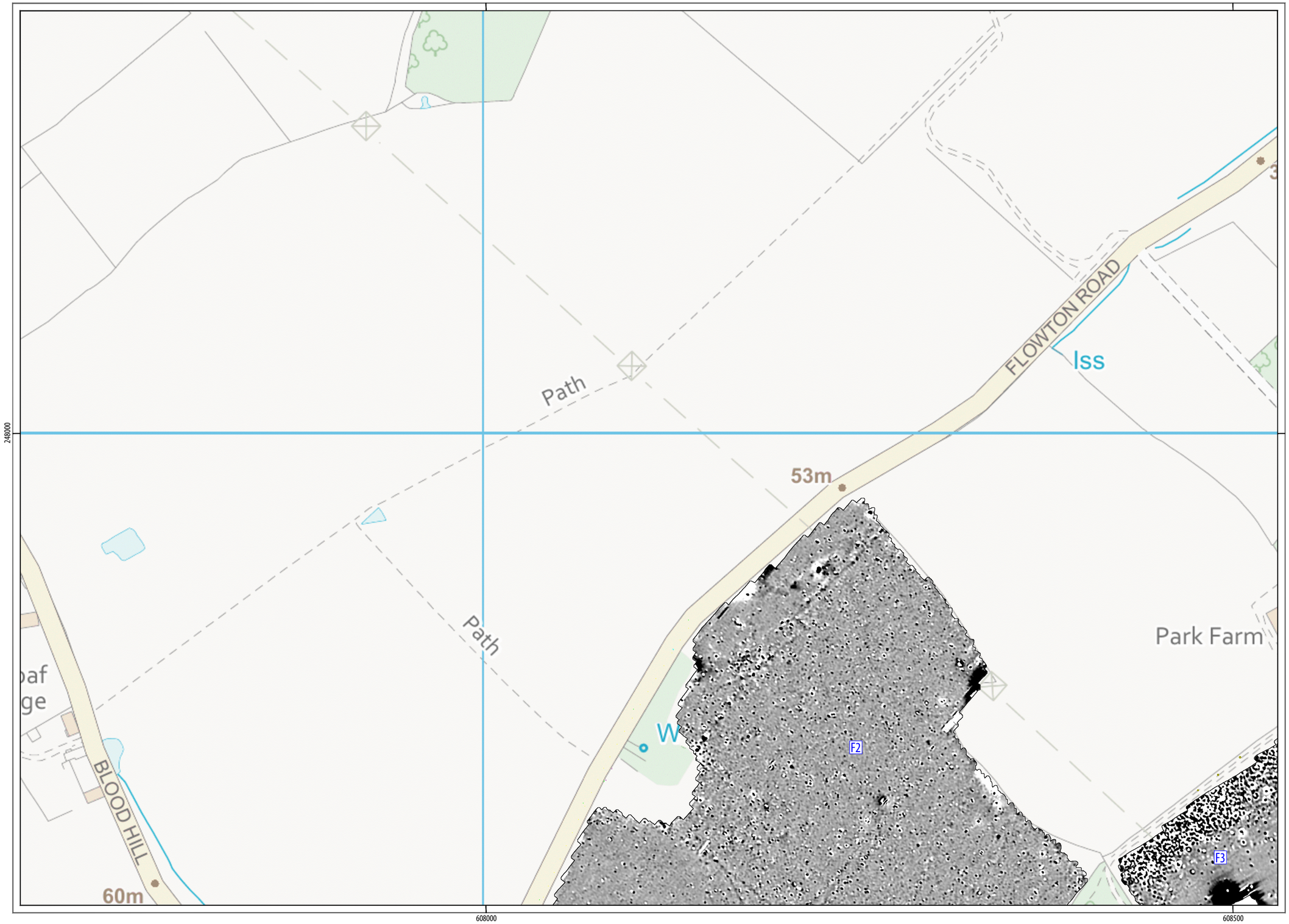
ILLUS 10 Interpretation of magnetometer data, Sector 1



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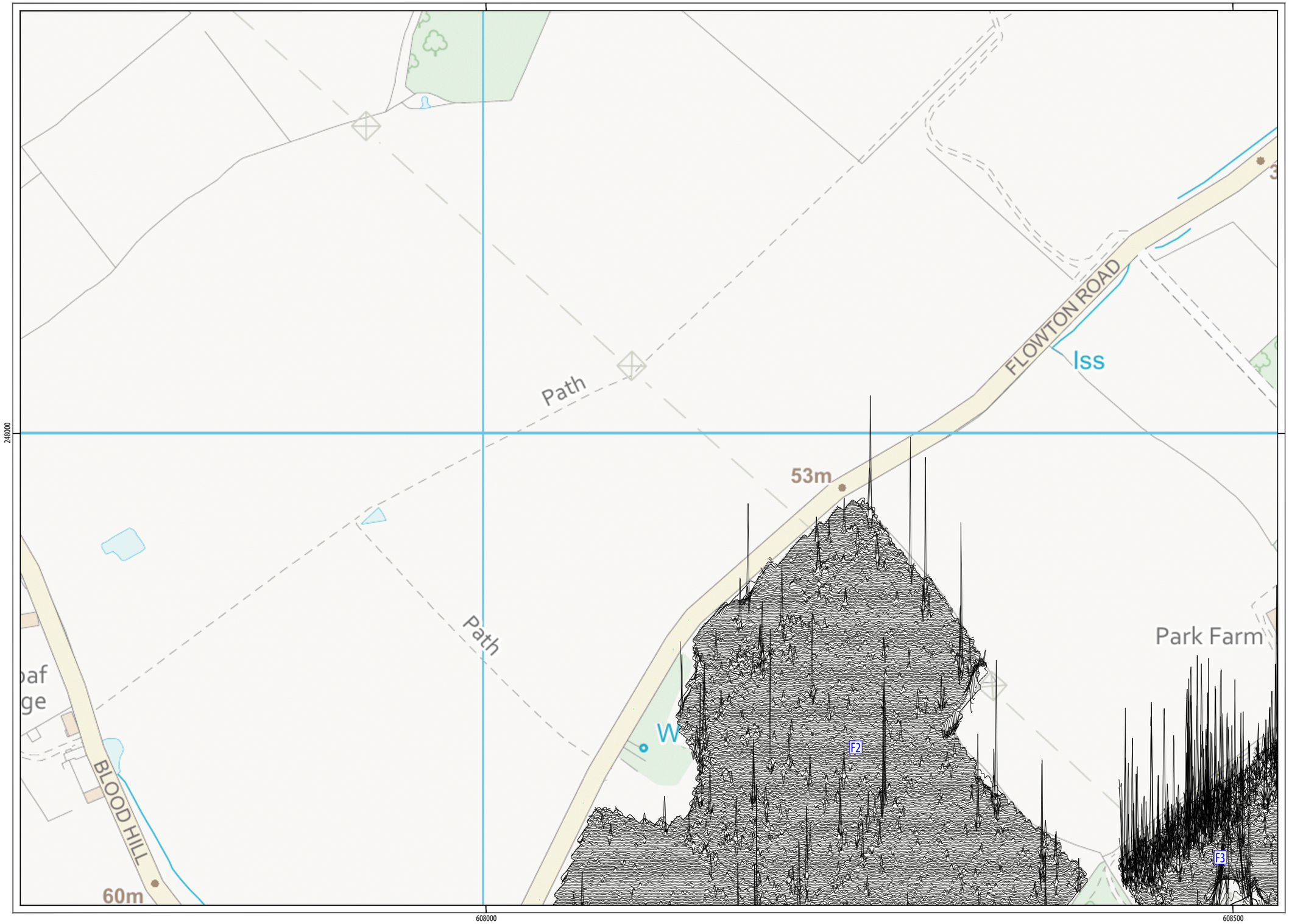
ILLUS 11 Processed greyscale magnetometer data, Sector 2



25.0nT/cm

0 50m

1:2,500 @ A3

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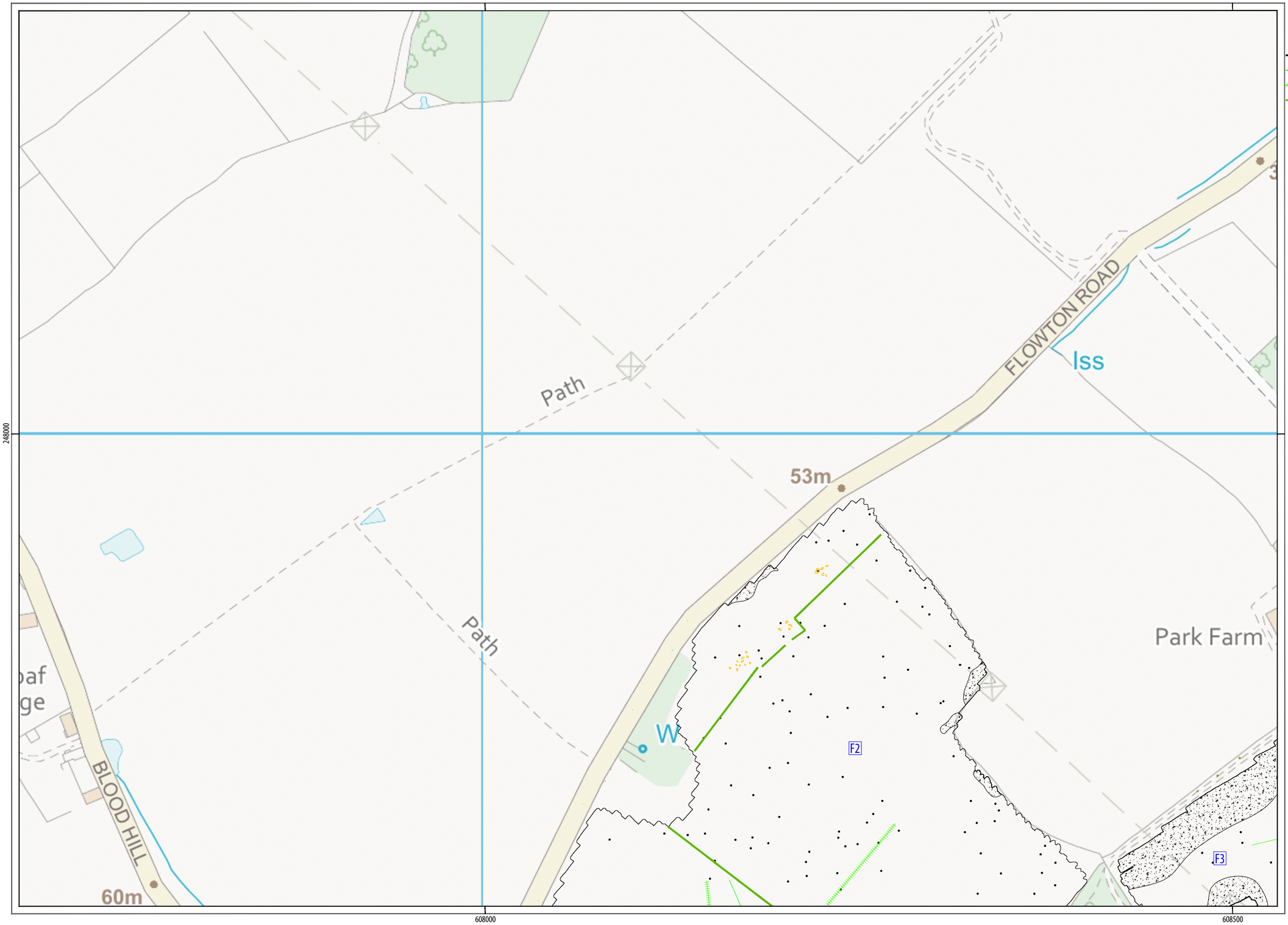
ILLUS 12 XY trace plot of minimally processed magnetometer data, Sector 2



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
magnetic enhancement	archaeology?

0 50m
1:2,500 @ A3

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ILLUS 13 Interpretation of magnetometer data, Sector 2

-1.0 nT 2.0

0 50m

1:2,500 @ A3

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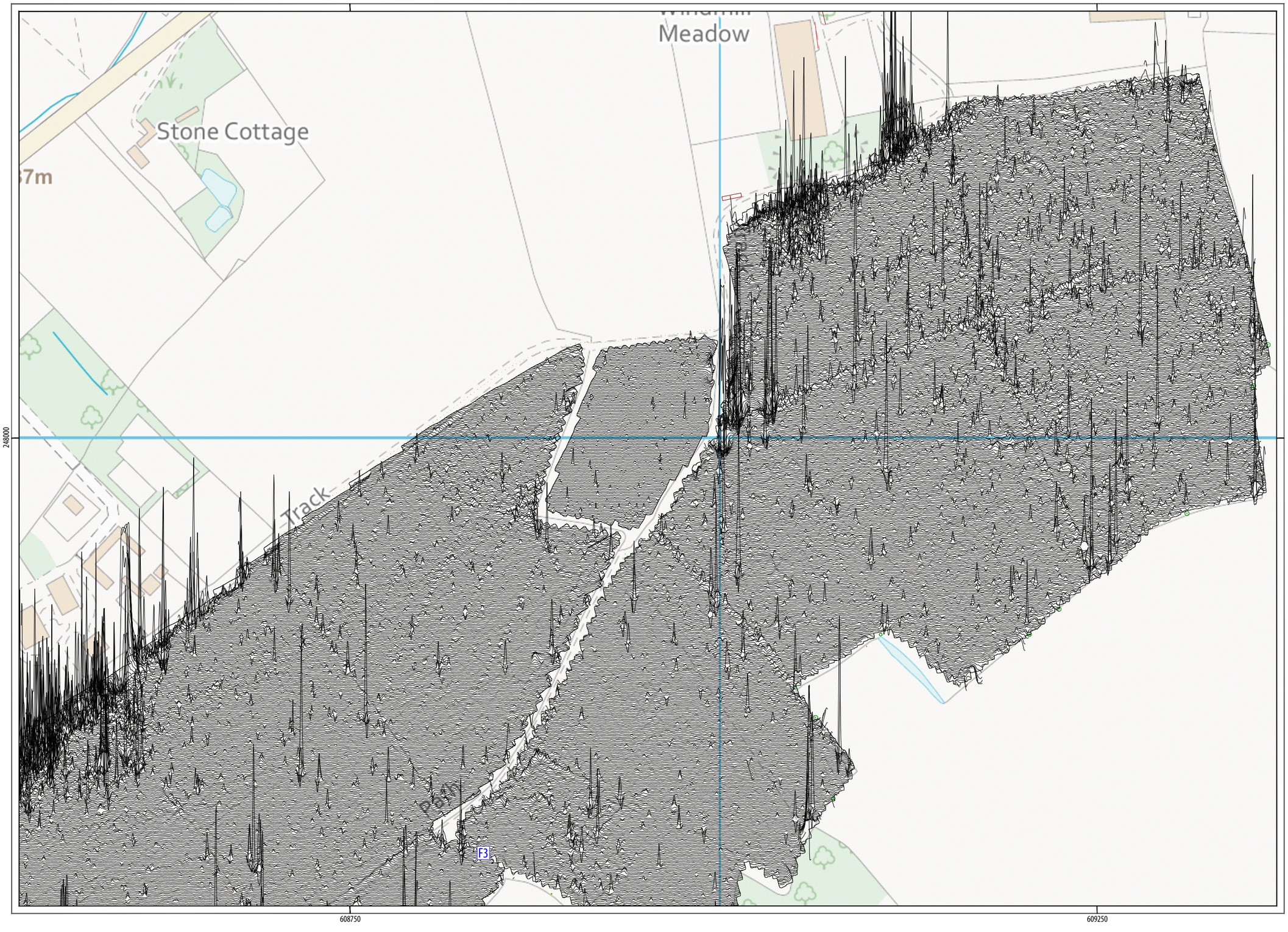
ILLUS 14 Processed greyscale magnetometer data, Sector 3



25.0nT/cm

0 50m

1:2,500 @ A3

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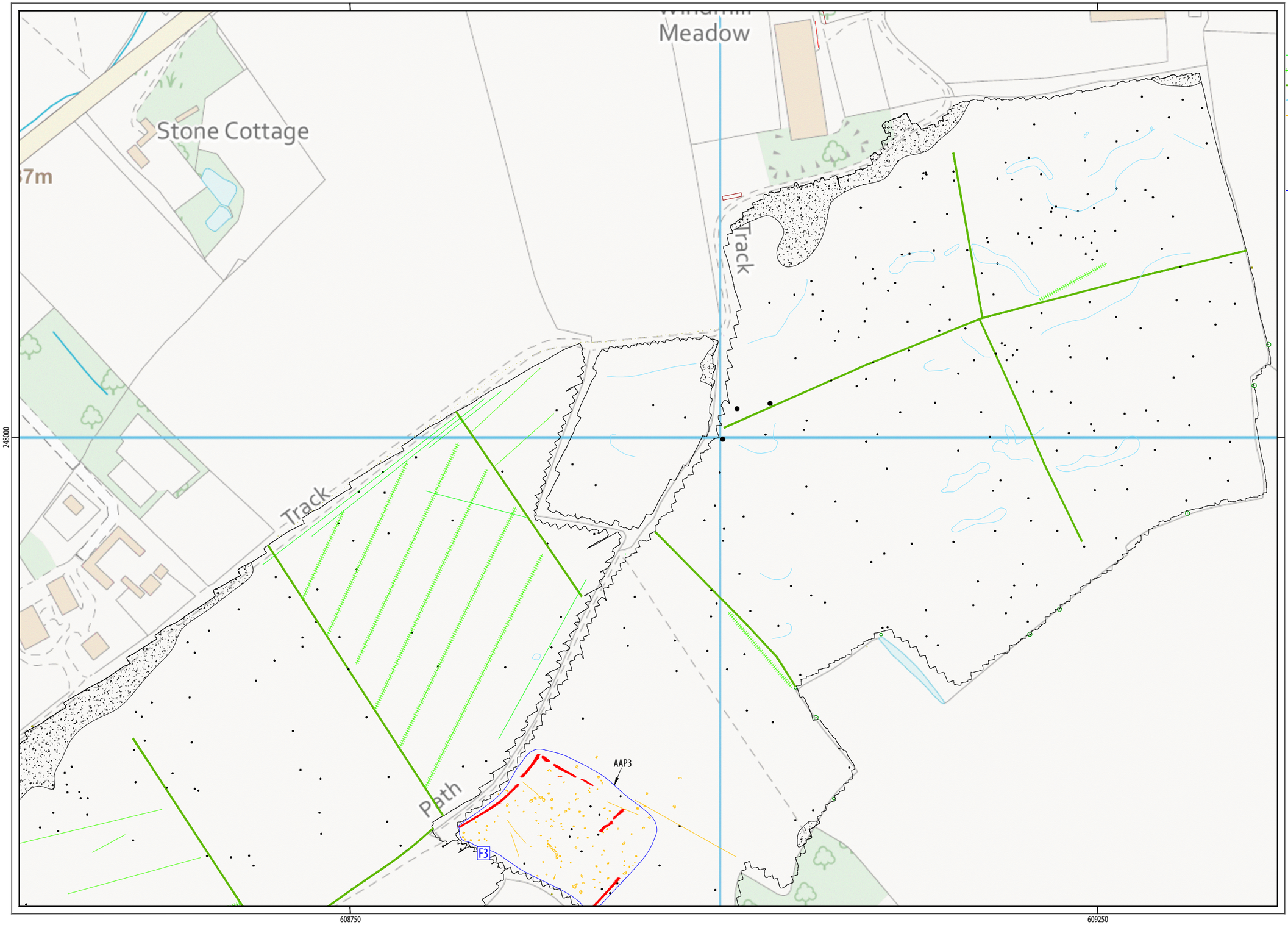
ILLUS 15 XY trace plot of minimally processed magnetometer data, Sector 3



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

AAP

0 50m
1:2,500 @ A3

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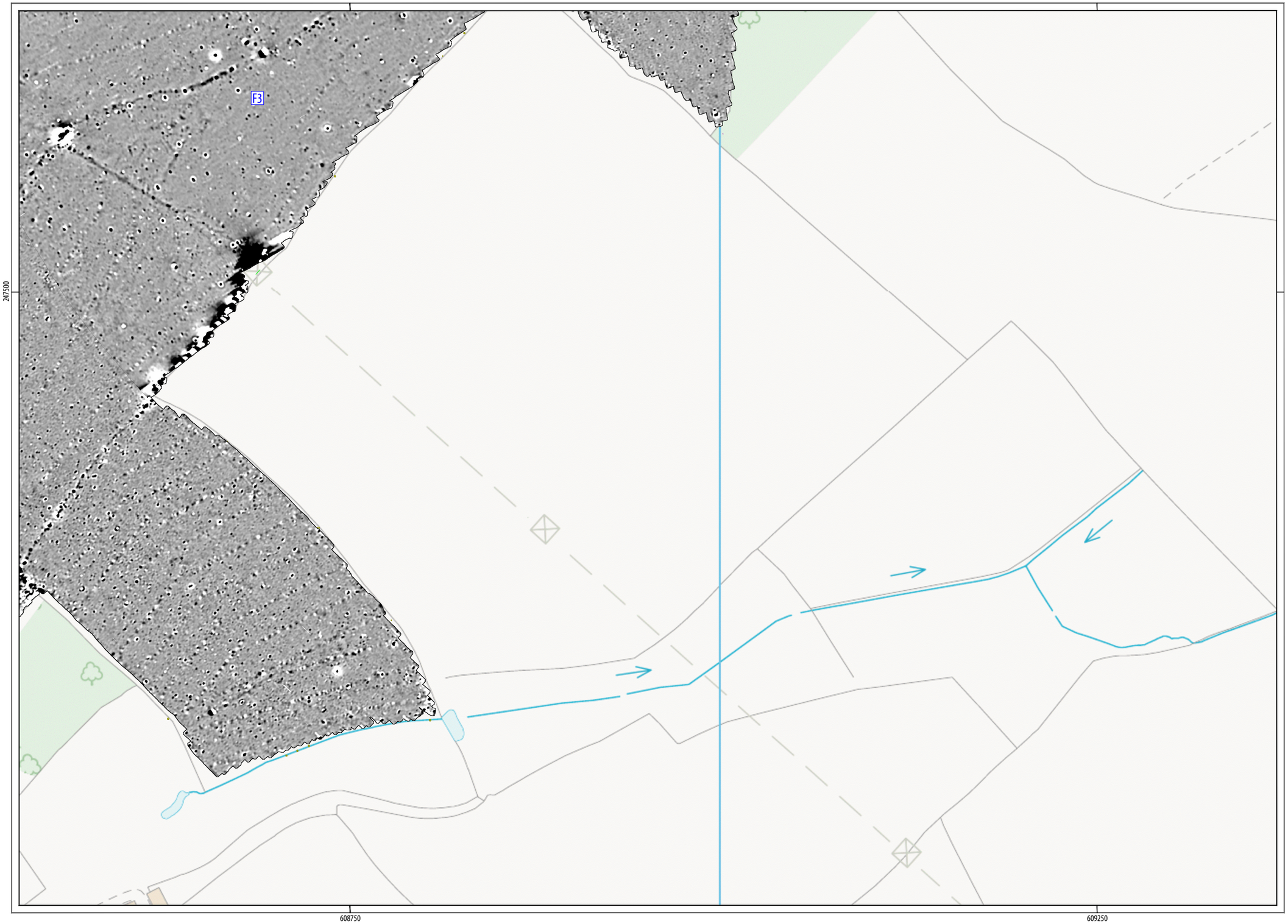
ILLUS 16 Interpretation of magnetometer data, Sector 3



-1.0 nT 2.0

0 50m

1:2,500 @ A3

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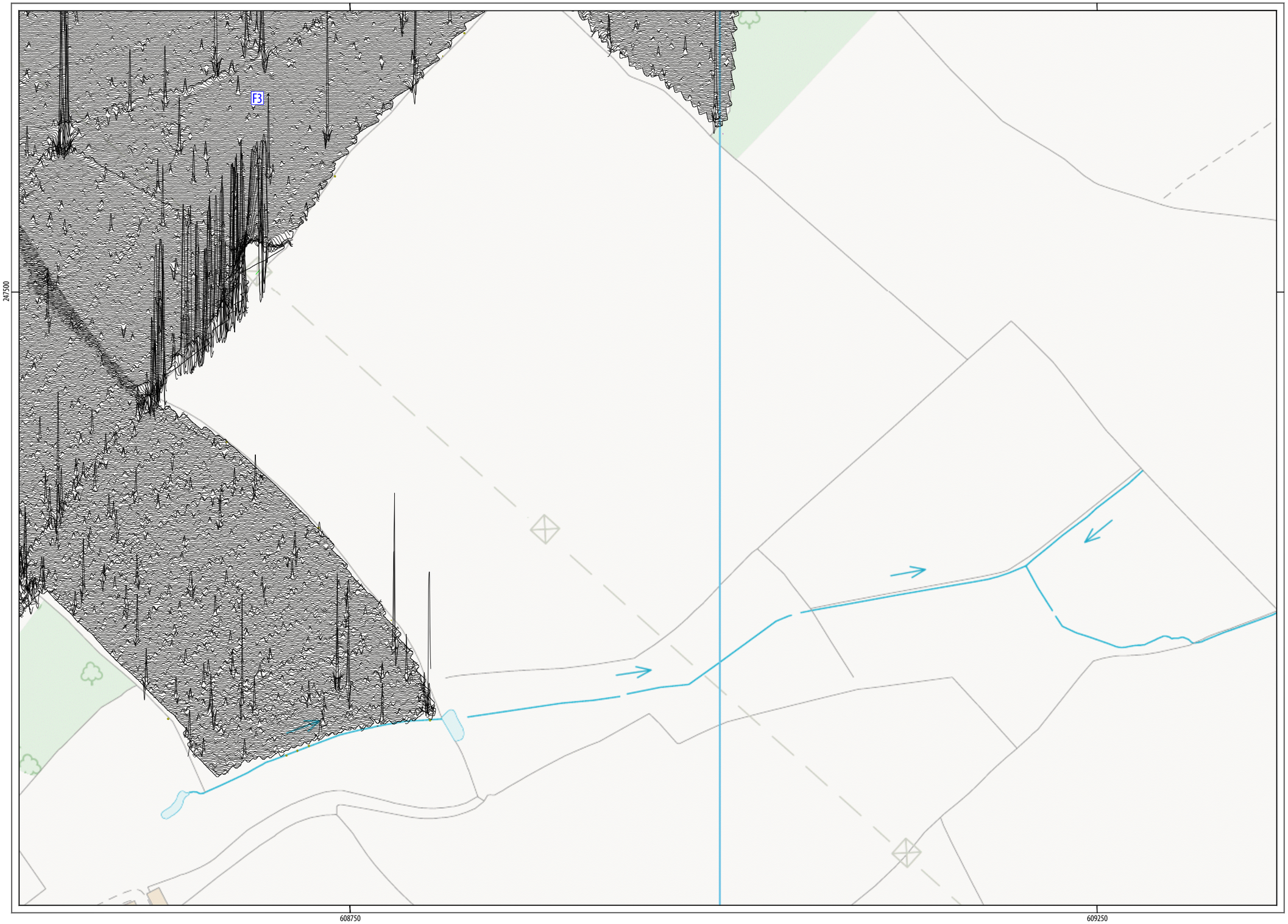
ILLUS 17 Processed greyscale magnetometer data, Sector 4



25.0nT/cm

0 50m

1:2,500 @ A3

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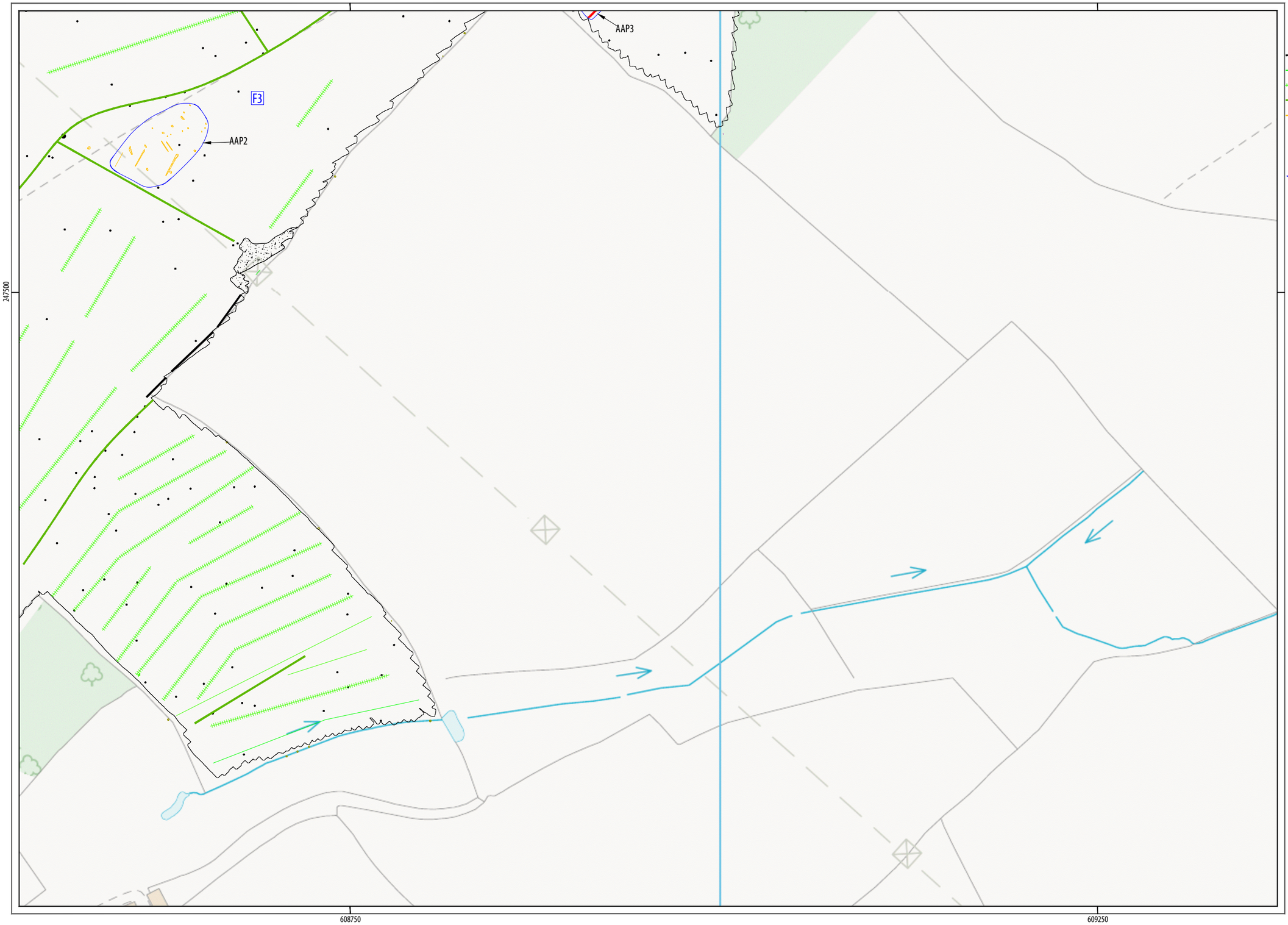
ILLUS 18 XY trace plot of minimally processed magnetometer data, Sector 4



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	archaeology?
magnetic enhancement	archaeology?

AAP

0 50m
1:2,500 @ A3

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ILLUS 19 Interpretation of magnetometer data, Sector 4

-1.0 nT 2.0

0 50m

1:2,500 @ A3

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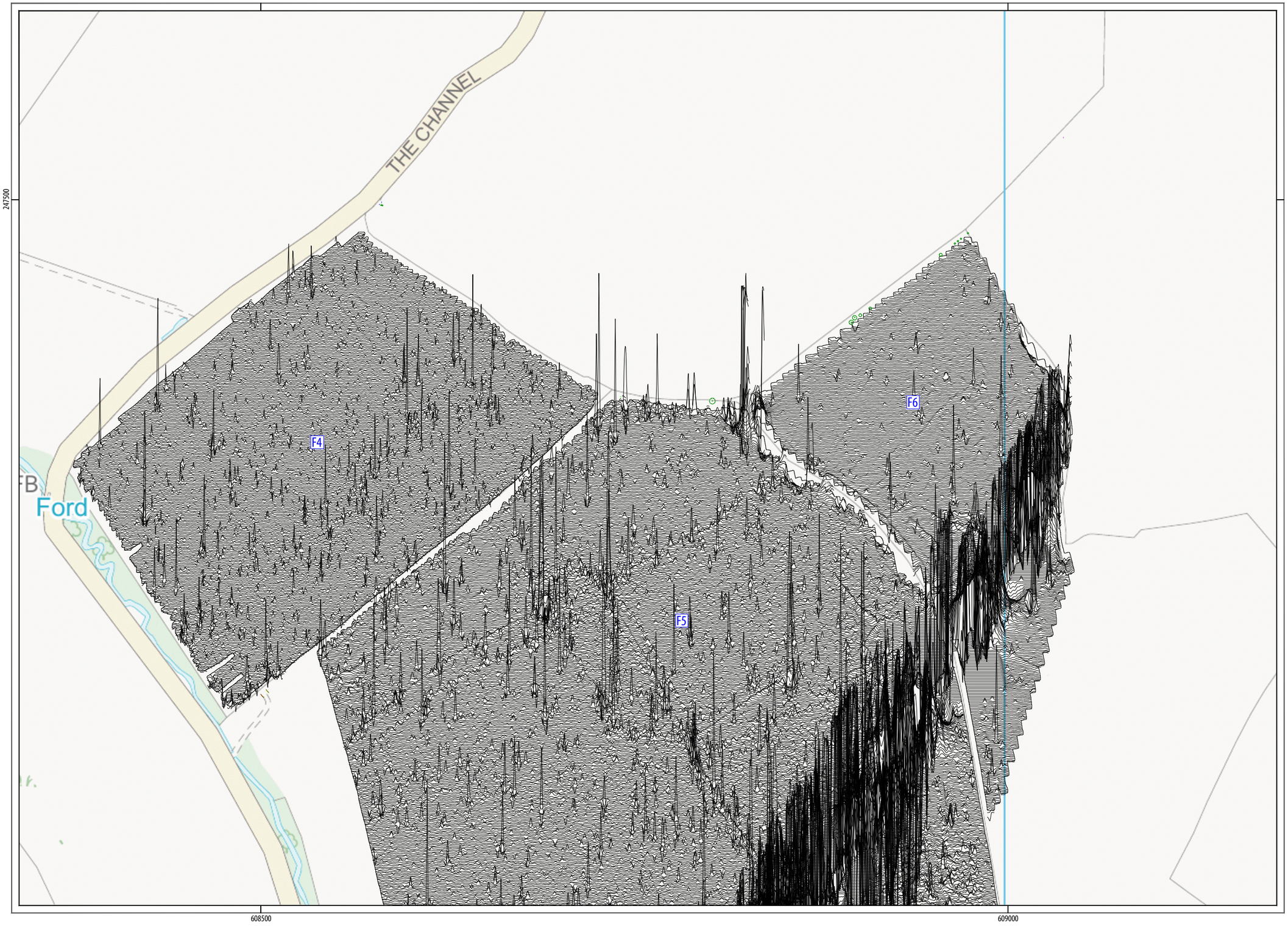
ILLUS 20 Processed greyscale magnetometer data, Sector 5



25.0nT/cm

0 50m

1:2,500 @ A3

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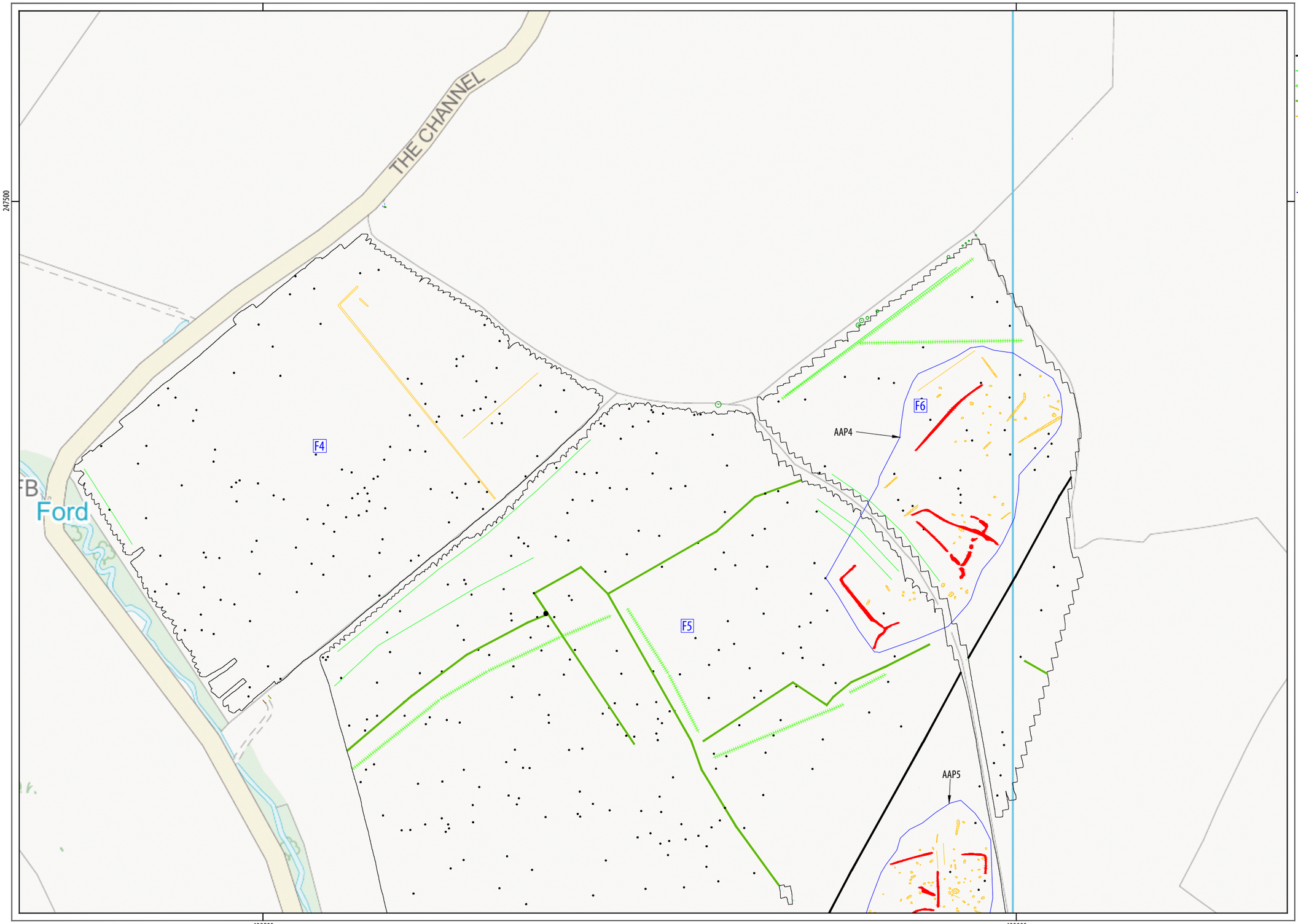
ILLUS 21 XY trace plot of minmally processed magnetometer data, Sector 5



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	archaeology?
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

AAP

0 50m
1:2,500 @ A3

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ILLUS 22 Interpretation of magnetometer data, Sector 5

nT
-1.0 2.0

0 50m
1:2,500 @ A3

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ILLUS 23 Processed greyscale magnetometer data, Sector 6

25.0nT/cm

0 50m

1:2,500 @ A3

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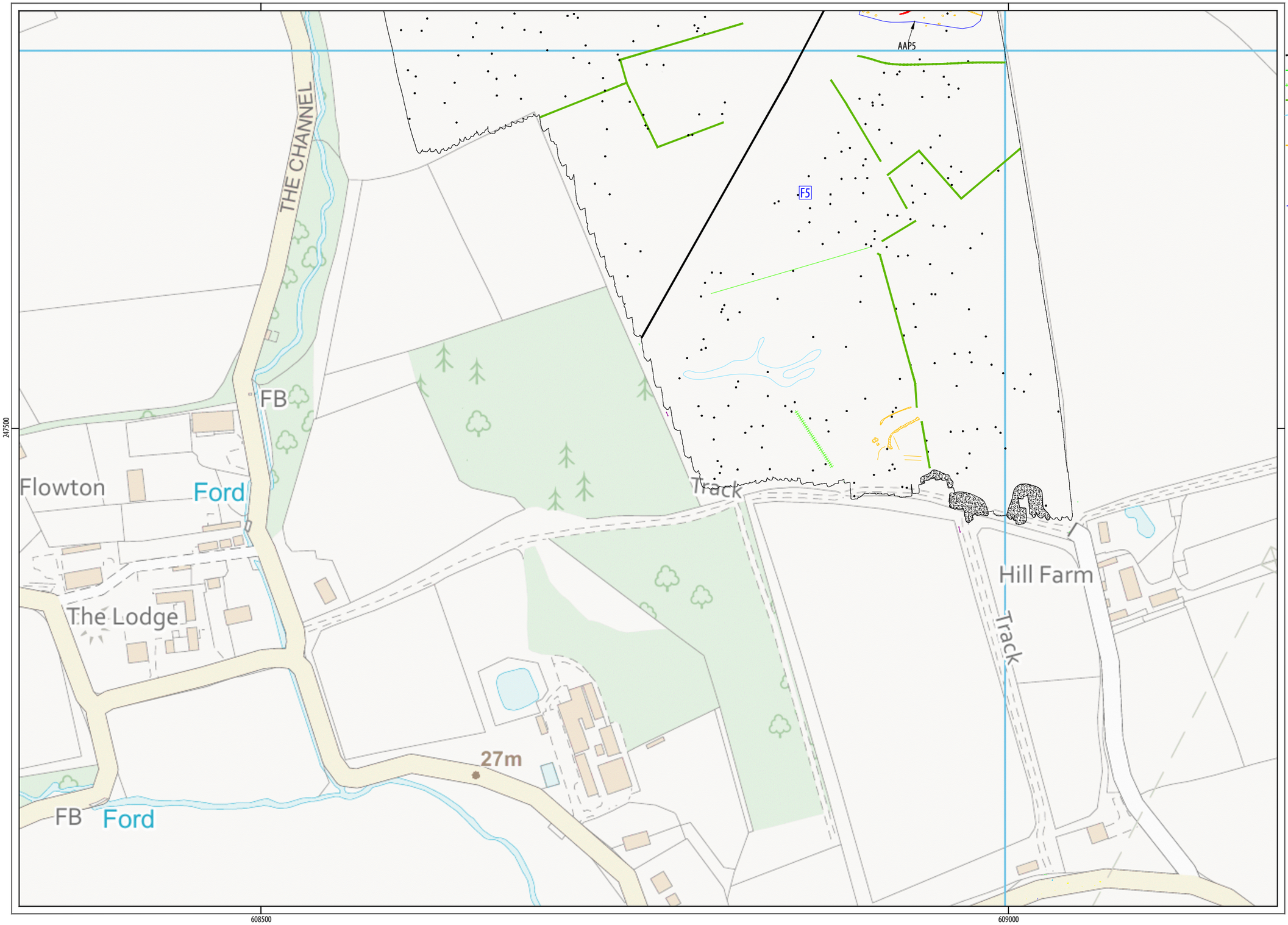
ILLUS 24 XY trace plot of minimally processed magnetometer data, Sector 6



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
linear trend	archaeology?
magnetic enhancement	archaeology?

AAP

0 50m
1:2,500 @ A3

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ILLUS 25 Interpretation of magnetometer data, Sector 6

247500

247250

608000

64m

Bush F

nT
-1.0 2.0

0 25m
1:1,000 @ A3

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ILLUS 26 Processed greyscale magnetometer data; AAP1

247500

247250

608000

62.5nT/cm

0 25m

1:1,000 @ A3

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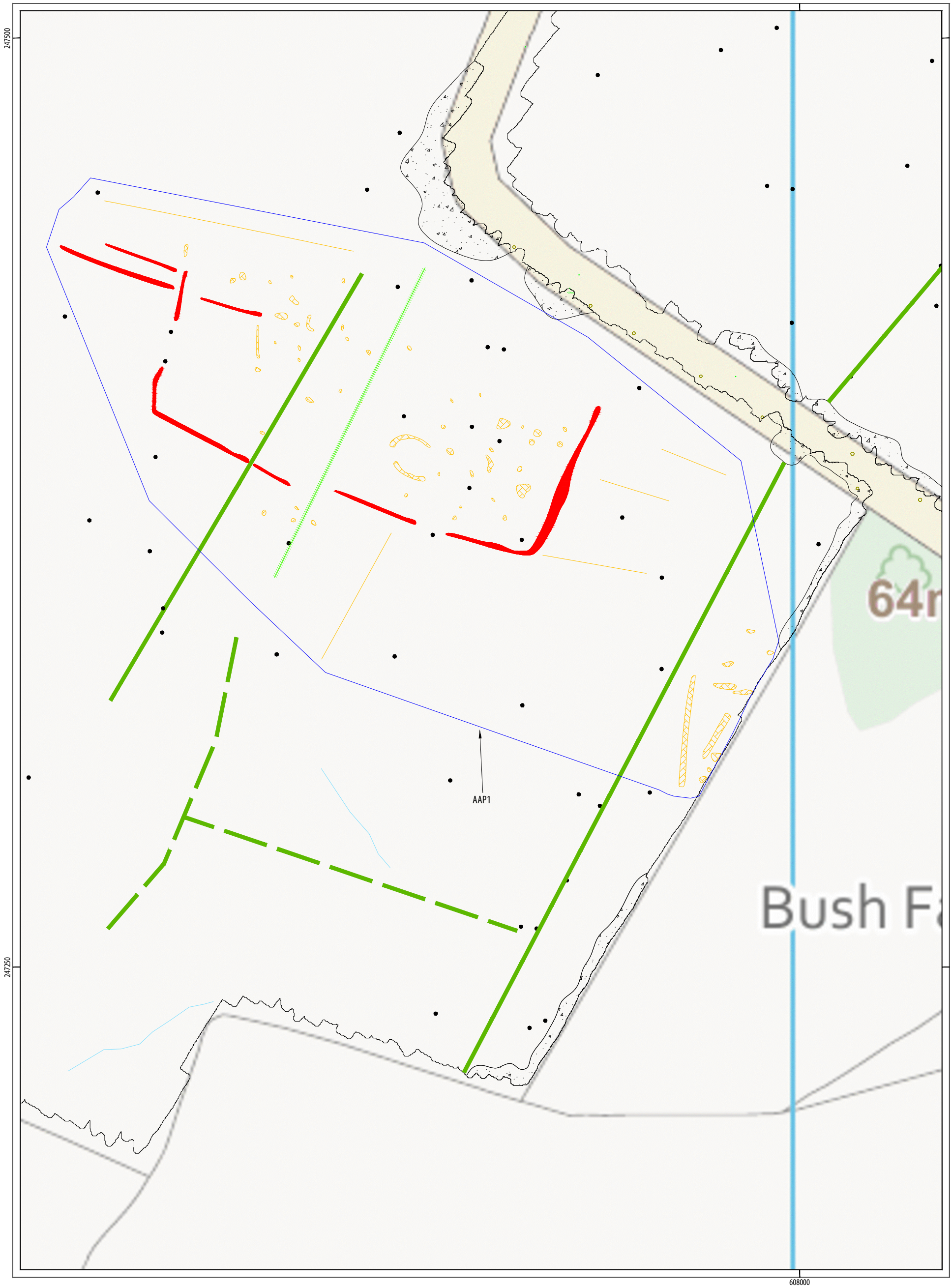
ILLUS 27 XY trace plot of minimally processed magnetometer data; AAP1



TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
magnetic disturbance	ferrous material
linear	former field boundary
linear	former field boundary?
linear trend	geological variation
linear trend	archaeology?

TYPE OF ANOMALY	INTERPRETATION
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

AAP

0 25m
1:1,000 @ A3

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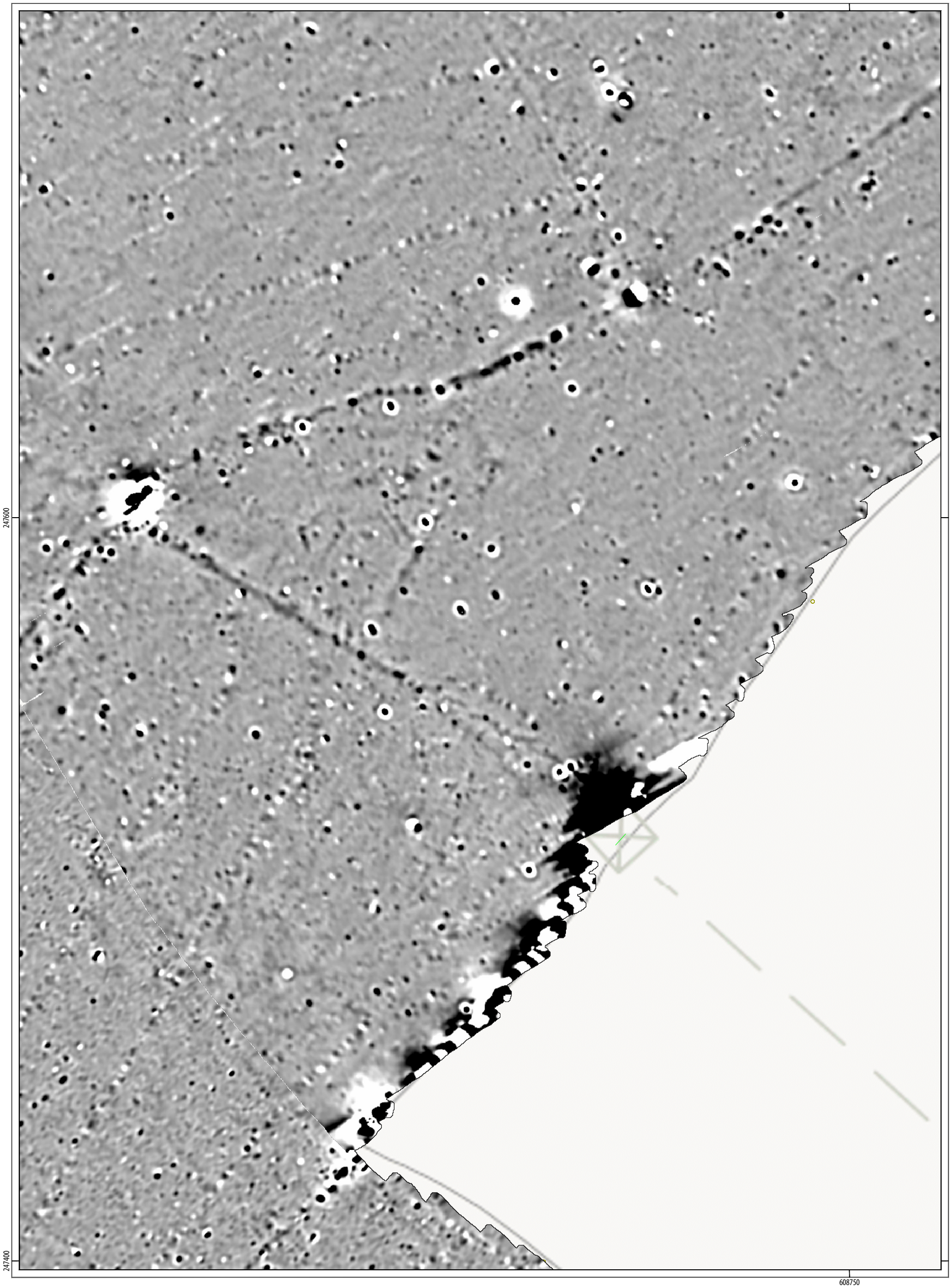
ILLUS 28 Interpretation of magnetometer data; AAP1



nT
-1.0
2.0

0
25m
1:1,000 @ A3

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ILLUS 29 Processed greyscale magnetometer data; AAP2

247600

247400

608750

62.5nT/cm

0 25m

1:1,000 @ A3

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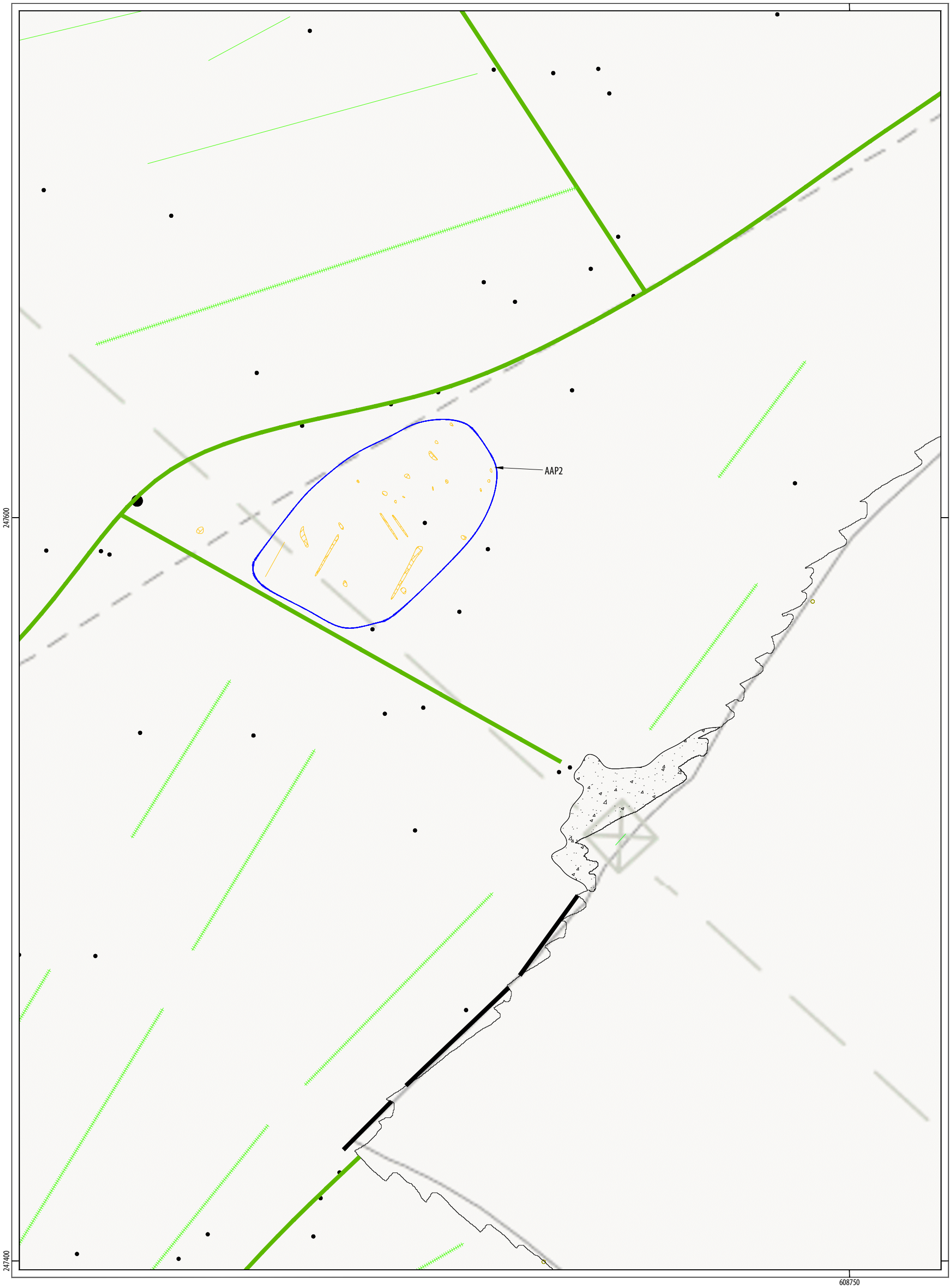
ILLUS 30 XY trace plot of minimally processed magnetometer data; AAP2



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

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

AAP

0 25m
1:1,000 @ A3

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ILLUS 31 Interpretation of magnetometer data; AAP2

247750

247500

609000

nT
-1.0
2.0

0
25m
1:1,000 @ A3

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ILLUS 32 Processed greyscale magnetometer data; AAP3

247750

247500

609000

62.5nT/cm

0 25m

1:1,000 @ A3

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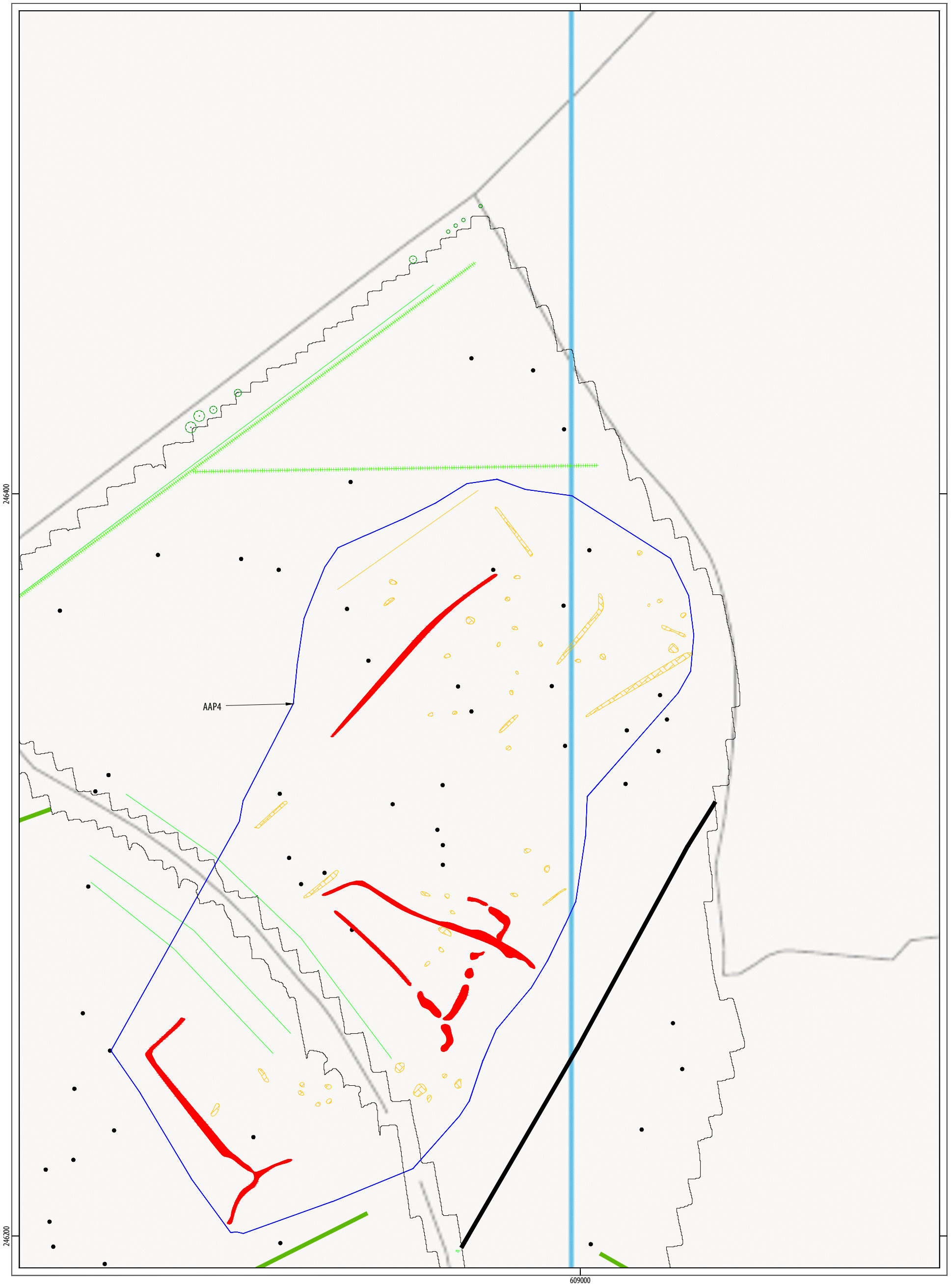
ILLUS 33 XY trace plot of minimally processed magnetometer data; AAP3



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

TYPE OF ANOMALY	INTERPRETATION
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

AAP

0 25m

1:1,000 @ A3

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ILLUS 34 Interpretation of magnetometer data; AAP4

246400

246200

609000

nT
-1.0
2.0

0
25m
1:1,000 @ A3

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ILLUS 35 Processed greyscale magnetometer data; AAP4

246400

246200

609000

62.5nT/cm

0 25m

1:1,000 @ A3

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ILLUS 36 XY trace plot of minimally processed magnetometer data; AAP4

246400

AAP4

246200

609000

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

TYPE OF ANOMALY	INTERPRETATION
magnetic enhancement	archaeology?
magnetic enhancement	archaeology

AAP

0 25m

1:1,000 @ A3

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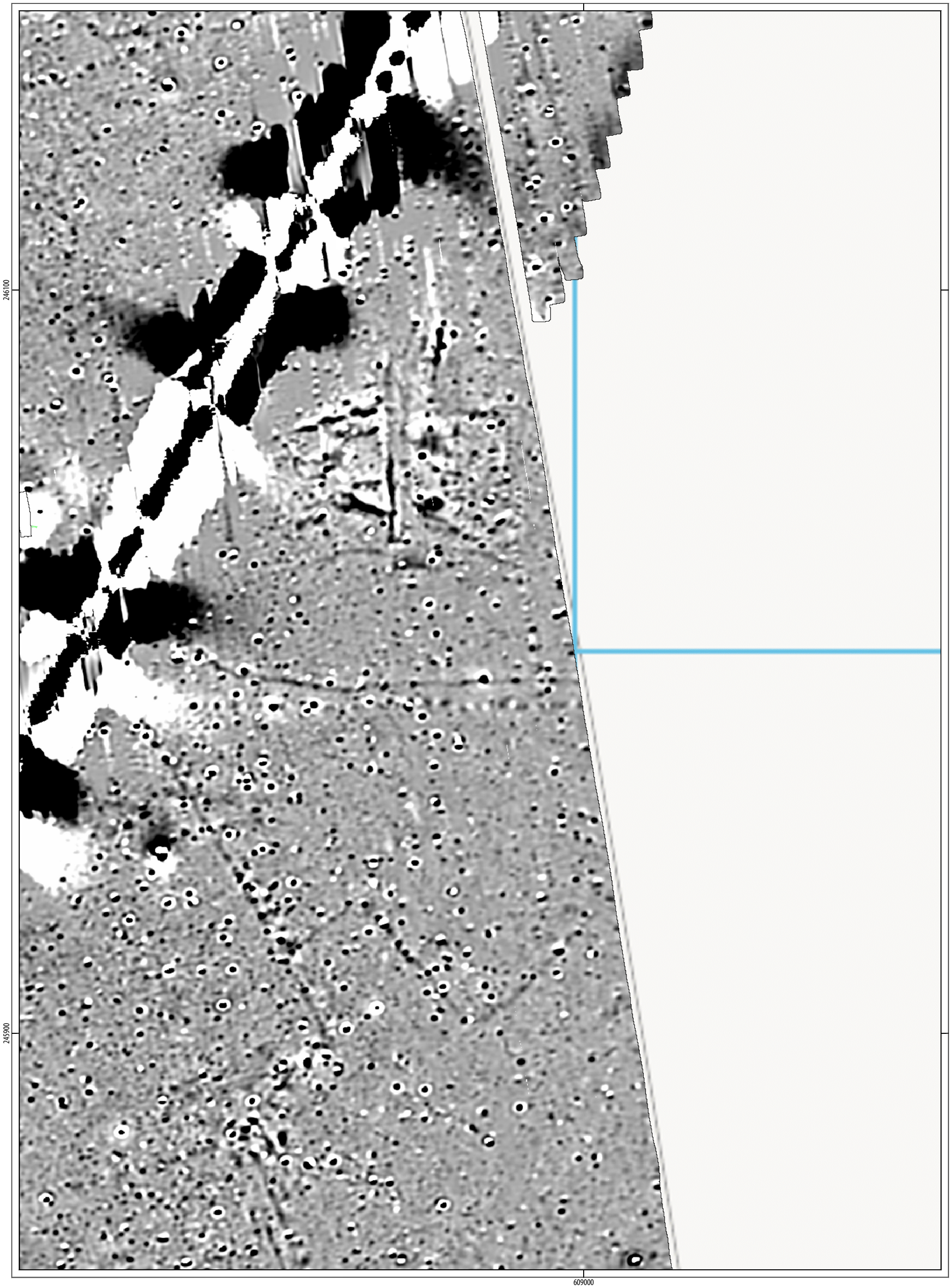
ILLUS 37 Interpretation of magnetometer data; AAP4



-1.0 nT 2.0

0 25m
1:1,000 @ A3

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ILLUS 35 Processed greyscale magnetometer data; AAP5

246100

245900

609000

62.5nT/cm

0 25m

1:1,000 @ A3

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ILLUS 39 XY trace plot of minimally processed magnetometer data; AAP5

246100

AAP5

245900

609000

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

TYPE OF ANOMALY	INTERPRETATION
magnetic enhancement	archaeology

AAP

0 25m

1:1,000 @ A3

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ILLUS 40 Interpretation of magnetometer data; AAP5

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.

Lightning-induced remnant magnetisation (LIRM) LIRM anomalies are thought to be caused in the near surface soil horizons by the flow of an electrical current associated with lightning strikes. These observed anomalies have a strong bipolar signal which decreases with distance from the spike point and often appear as linear or radial in shape.

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: headland5-409168

PROJECT DETAILS	
Project name	Bramford Solar PV and Battery
Short description of the project	Geophysical Survey
Project dates	Start: 30-11-2020 End: 10-12-2020
Previous/future work	No / Not known
Any associated project reference codes	BRAM2020 - Contracting Unit No.
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 2 - Operations to a depth less than 0.25m
Monument type	None
Monument type	None
Significant Finds	None
Significant Finds	None
Methods & techniques	'Geophysical Survey'
Development type	solar farm
Prompt	National Planning Policy Framework - NPPF
Position in the planning process	Pre-application
Solid geology (other)	Thanet Formation and Lambeth Group - Clay, Silt, Sand
Drift geology (other)	Diamicton
Techniques	Magnetometry
PROJECT LOCATION	
Country	England
Site location	Suffolk Mid Suffolk Bramford Bramford
Postcode	IP8 4LA
Study area	88 Hectares
Site coordinates	TM 096650 426540 52.042042415515 1.057611140655 52 02 31 N 001 03 27 E Point
Height OD / Depth	Min: 25m Max: 30m
PROJECT CREATORS	
Name of Organisation	Headland Archaeology
Project brief originator	Headland Archaeology
Project design originator	Headland Archaeology
Project director/manager	Alistair Webb
Project supervisor	Ross Bishop
Type of sponsor/funding body	Developer
Name of sponsor/funding body	ENSO
Entered by	Alistair Webb (alistair.webb@headlandarchaeology.com)
Entered on	27 November 2020

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