East Anglia ONE North and East Anglia TWO Offshore Windfarms

Onshore Archaeology: Geophysical Survey Report

Part 9 of 9

Applicants: East Anglia ONE North Limited and East Anglia TWO Limited
Document Reference: ExA.AS-14.D1.V1
SPR Reference: EA1N_EA2-DWF-ENV-REP-IBR-001113

Date: 2nd November 2020
Revision: Version 01
Author: Headland Archaeology

Applicable to East Anglia ONE North and East Anglia TWO

East Anglia ONE North and East Anglia TWO, Suffolk

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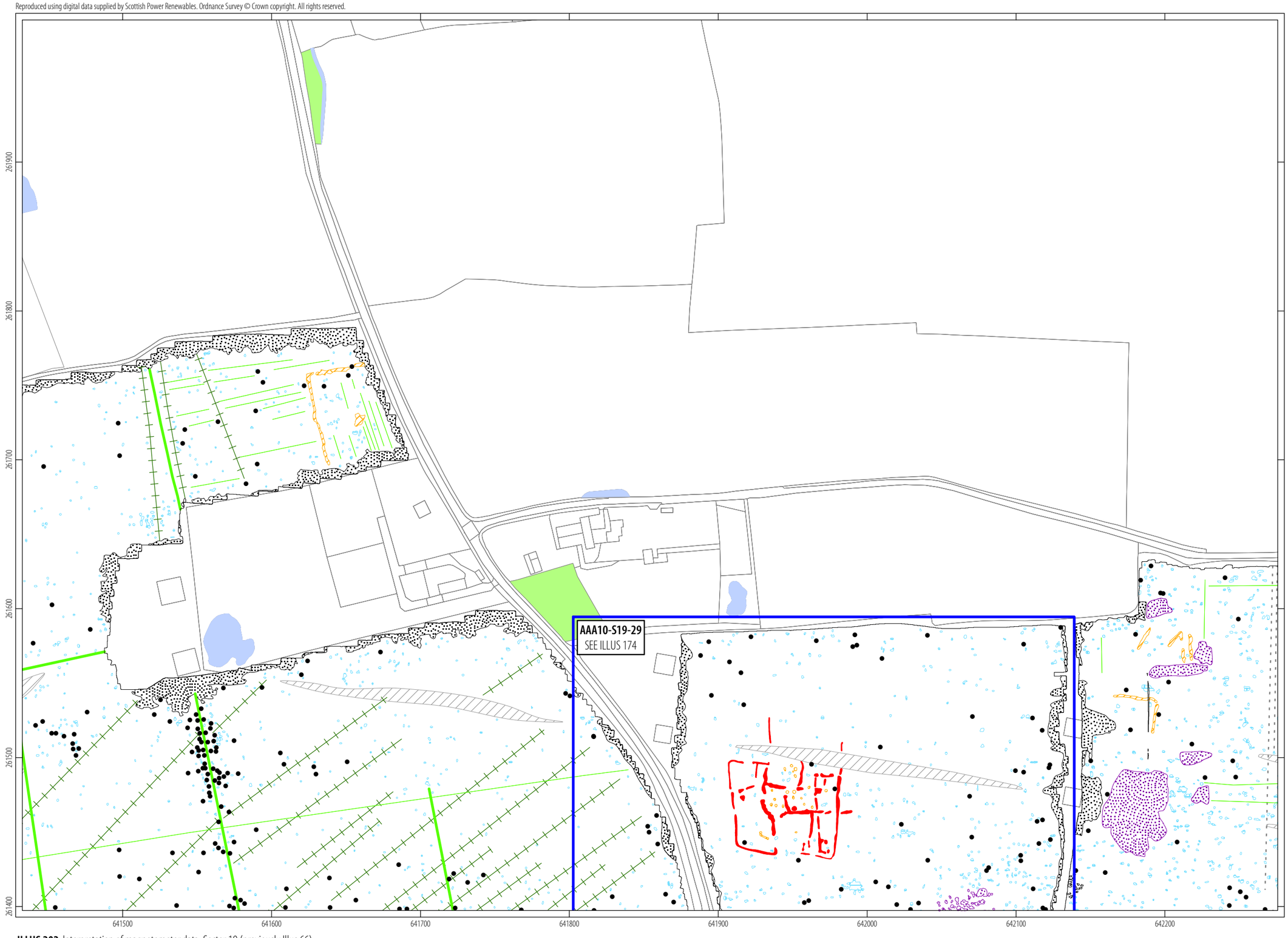

TYPE OF ANOMALY		INTERPRETATION
dipolar isolated	-	ferrous material
linear trend	-	bad data
linear trend	-	agricultural
linear trend	-	former field boundary
linear trend	-	field drain
magnetic disturbance	-	ferrous material
magnetic disturbance	-	quarrying
magnetic enhancement	-	archaeology
magnetic enhancement	-	archaeology?
magnetic enhancement	-	geology
null value	-	overhead cables

0 50m

1:2,500 @ A3

PROJECT **EAON18**
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Suffolk

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ILLUS 202 Interpretation of magnetometer data; Sector 19 (previously Illus 66)

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261900
261800
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ILLUS 203 Processed greyscale magnetometer data; Sector 22 (previously Illus 73)

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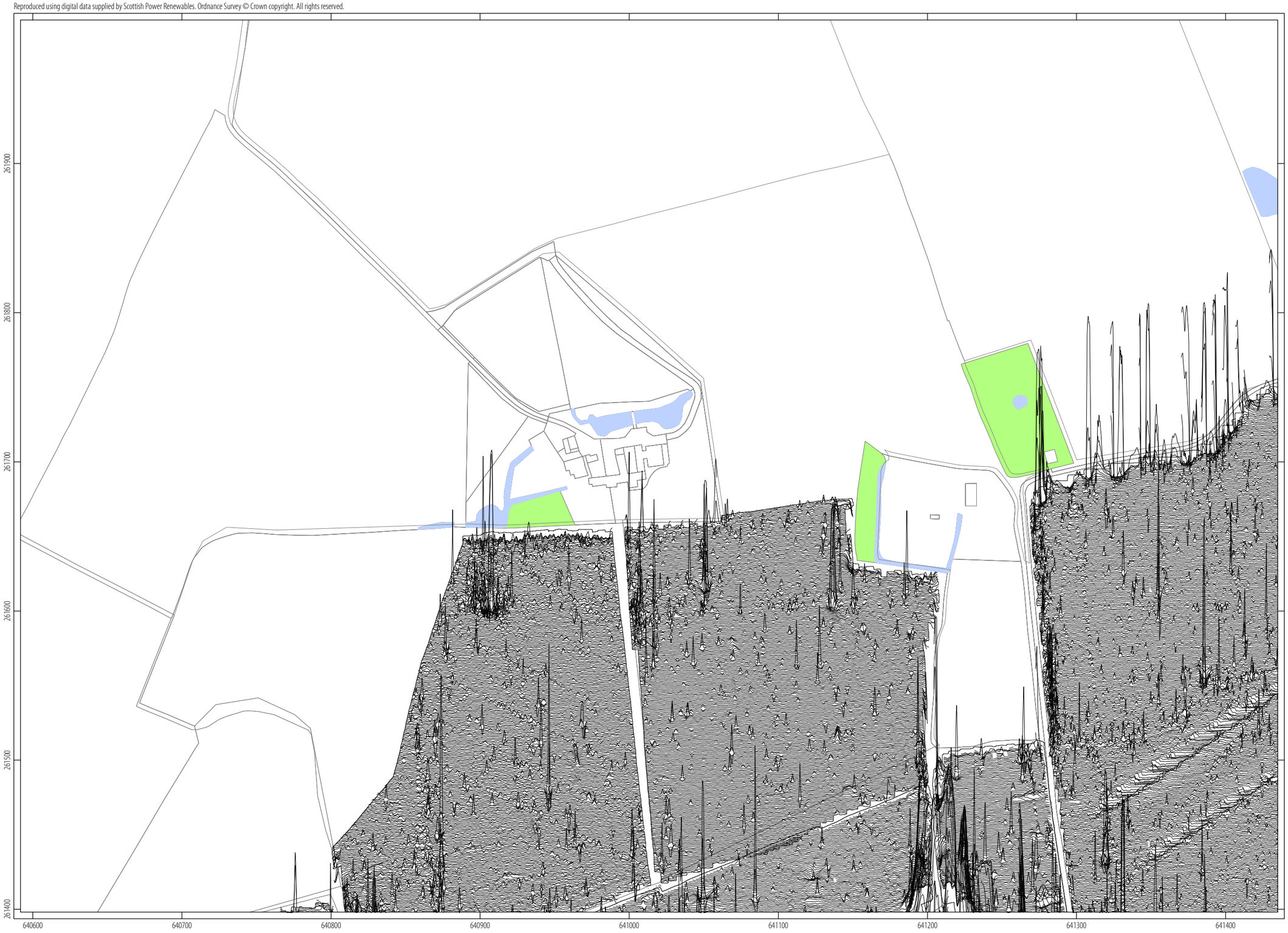

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ILLUS 204 XY trace plot of minimally processed magnetometer data; Sector 22 (previously Illus 74)

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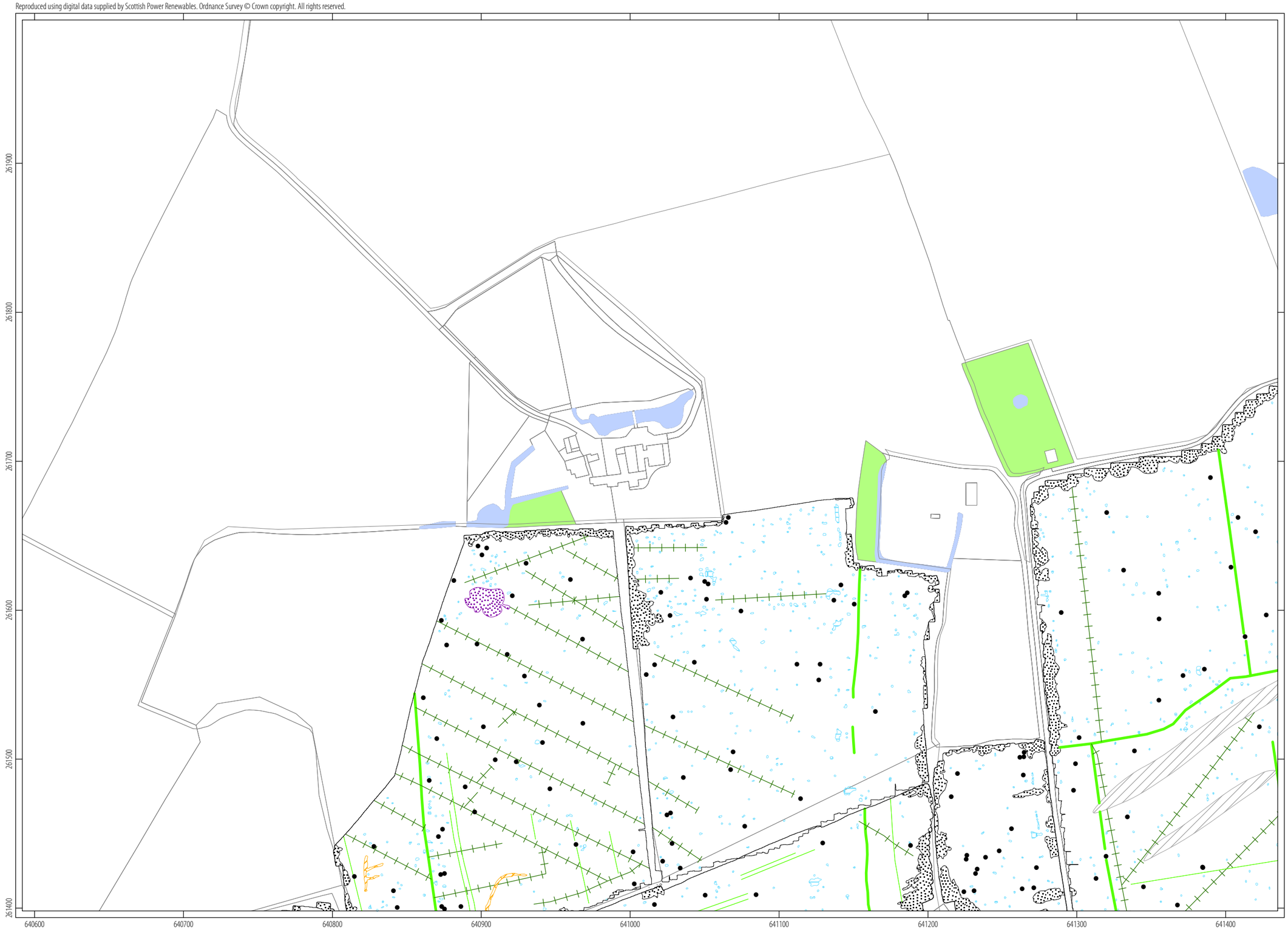

TYPE OF ANOMALY	- INTERPRETATION
dipolar isolated	- ferrous material
linear trend	- agricultural
linear trend	- former field boundary
linear trend	- field drain
magnetic disturbance	- ferrous material
magnetic disturbance	- quarrying
magnetic enhancement	- archaeology?
magnetic enhancement	- geology
null value	- overhead cables

0 50m

1:2,500 @ A3

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ILLUS 205 Interpretation of magnetometer data; Sector 22 (previously Illus 75)

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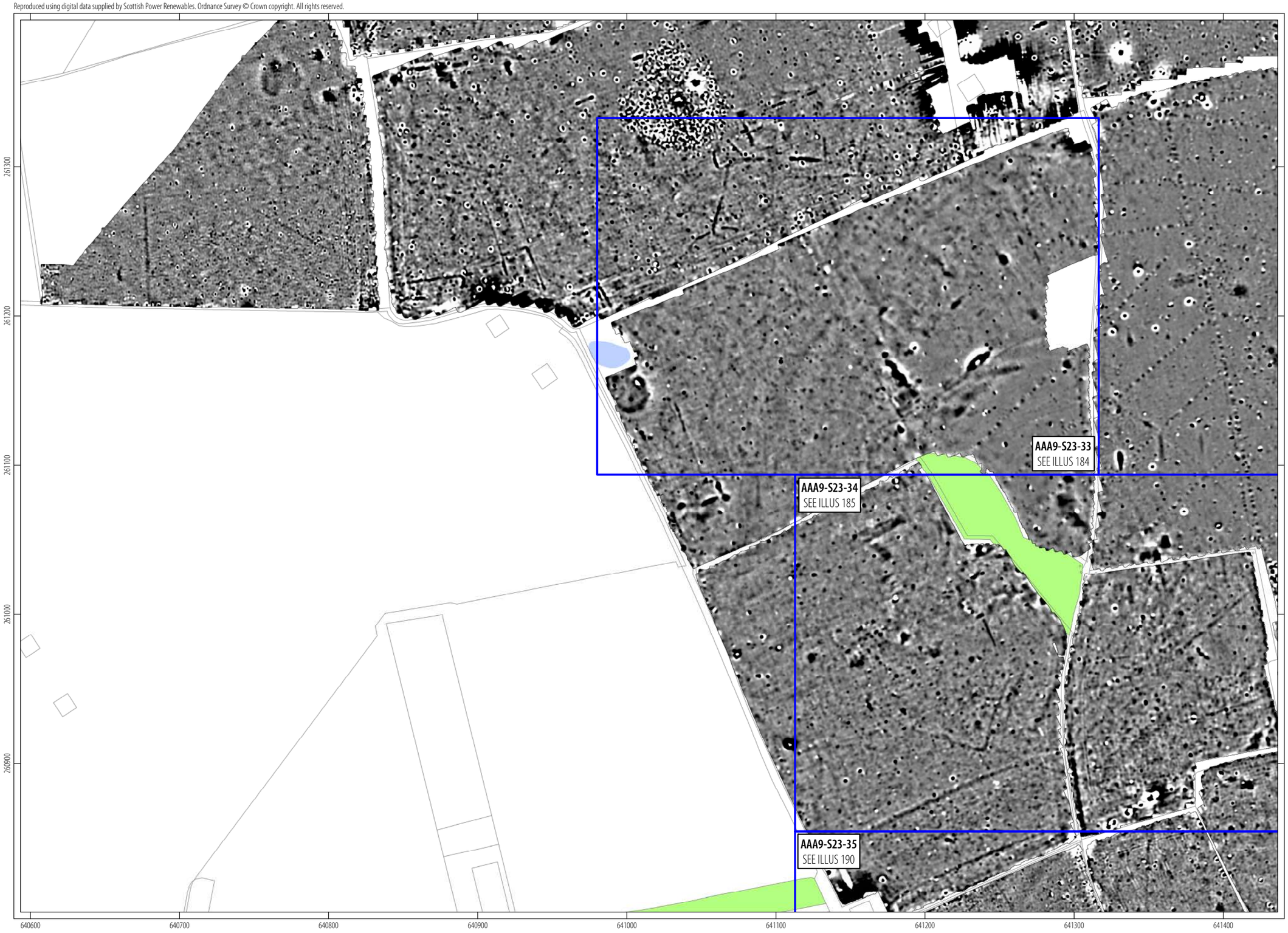

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ILLUS 206 Processed greyscale magnetometer data; Sector 23 (previously Illus 76)

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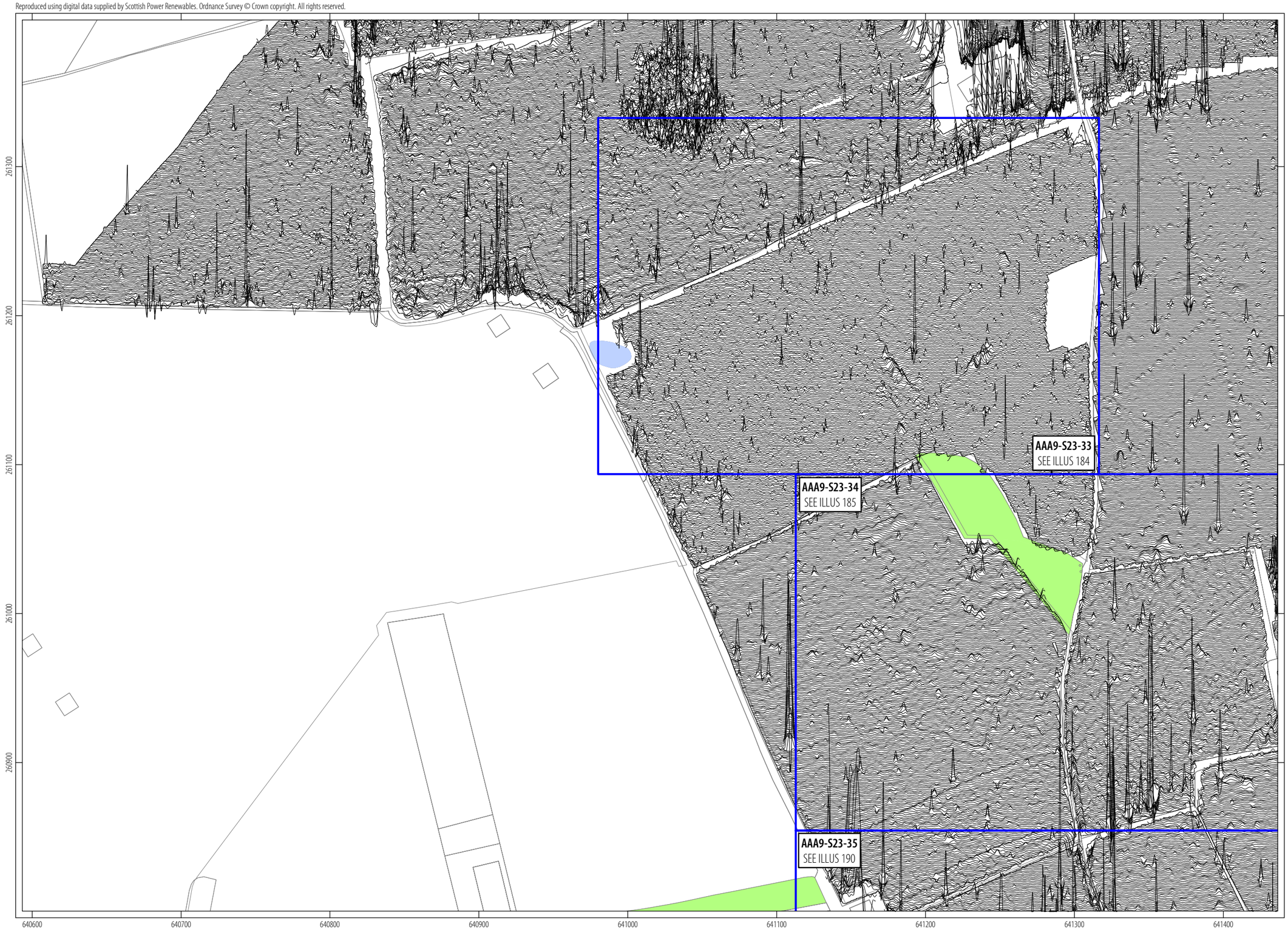

ILLUS 207 XY trace plot of minimally processed magnetometer data; Sector 23 (previously Illus 77)

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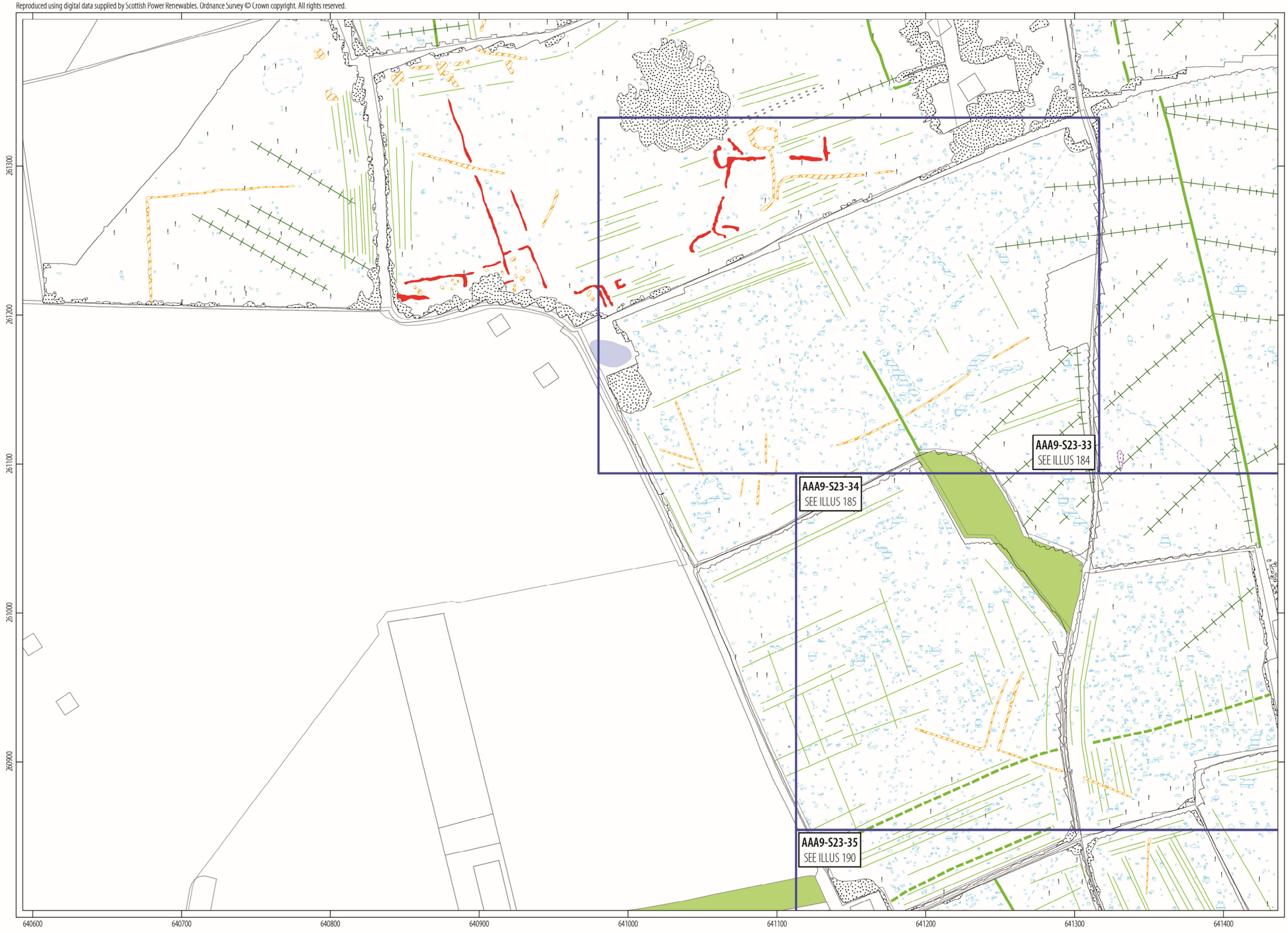

TYPE OF ANOMALY	INTERPRETATION
dipolar isolated	ferrous material
linear trend	bad data
linear trend	agricultural
linear trend	former field boundary
linear trend	former field boundary?
linear trend	field drain
linear trend	geological variation
magnetic disturbance	ferrous material
magnetic disturbance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

0 50m

1:2,500 @ A3

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ILLUS 208 Interpretation of magnetometer data; Sector 23 (previously Illus 78)

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ILLUS 209 Processed greyscale magnetometer data; Sector 25 (previously Illus 82)

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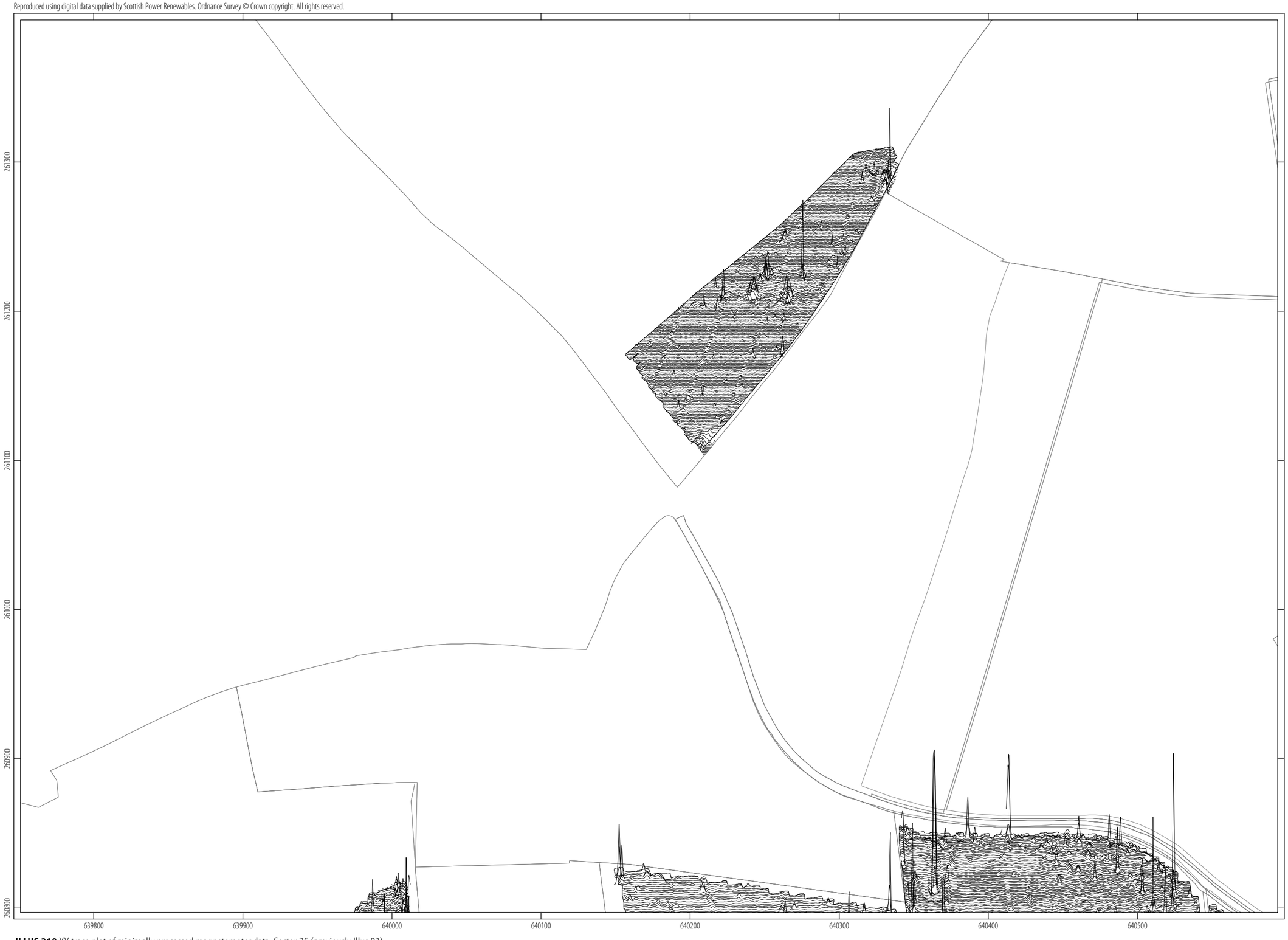

18.0nT/cm

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1:2,500 @ A3

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ILLUS 210 XY trace plot of minimally processed magnetometer data; Sector 25 (previously Illus 83)

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0 50m

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ILLUS 211 Interpretation of magnetometer data; Sector 25 (previously Illus 84)

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.

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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) to maximise the clarity and interpretability of the archaeological anomalies.

Data is also clipped to remove extreme values and to improve data contrast.

APPENDIX 5 OASIS DATA COLLECTION FORM: ENGLAND

OASIS ID: headland5-317948

PROJECT DETAILS	
Project name	East Anglia 1 North
Short description of the project	540 hectare corridor
Project dates	Start: 01-06-2018 End: 31-03-2019
Previous/future work	No / Yes
Type of project	Field evaluation
Site status	None
Current Land use	Cultivated Land 3 – Operations to a depth more than 0.25m
Monument type	Uncertain
Monument type	Uncertain
Significant Finds	Uncertain
Significant Finds	Uncertain
Methods & techniques	"Geophysical Survey"
Development type	Wind farm developments
Prompt	Planning condition
Position in the planning process	Not known / Not recorded
Solid geology	Unknown
Drift geology	Unknown
Techniques	Magnetometry
PROJECT LOCATION	
Country	England
Site location	SUFFOLK IPSWICH IPSWICH Leiston
Postcode	IP16 4LT
Study area	540 Hectares
Site coordinates	TM 645357 261217 51.87011214314 1.843336076086 51 52 12 N 001 50 36 E Point
Height OD / Depth	Min: 10m Max: 20m
PROJECT CREATORS	
Name of Organisation	Headland Archaeology
Project brief originator	Headland Archaeology
Project design originator	Headland Archaeology
Project director/manager	[redacted]
Project supervisor	[redacted]
Type of sponsor/funding body	Electricity Authority/Company
Name of sponsor/funding body	Scottish Power Renewables
PROJECT ARCHIVES	
Physical Archive Exists?	No

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Digital Archive recipient	In house
Digital Contents	"other"
Digital Media available	"Geophysics"
Paper Archive Exists?	No

PROJECT BIBLIOGRAPHY 1

Publication type	Grey literature (unpublished document/manuscript)
Title	East Anglia One North/Two Offshore Windfarms Proposed Onshore Cable Corridor And Substation Sites
Author(s)/Editor(s)	[redacted]
Other bibliographic details	EAON18
Date	2019
Issuer or publisher	Headland Archaeology
Place of issue or publication	Leeds
Description	A4/A3 Bound report
Entered by	[redacted])
Entered on	4 July 2019

APPENDIX 6 GEOPHYSICAL SURVEY (AUGUST – OCTOBER 2019)

Independent from the DCO applications (submitted October 2019) geophysical survey continued as access and ground conditions permitted and a further 30 hectares was surveyed in a 6-week period between late August and early October 2019. All of the survey areas were at the north-western end of the ODA (Illus 196), north-east of the proposed substation site and were completed after the submission of the original geophysical survey report in July 2019. These new areas comprised six fields, IR-01, IR-02, IR-03, IR-04, IR-08, the remainder of IR-07 and IR-11 (Illus 197). The results and interpretation of these surveys are included here as an Appendix to the main geophysical survey report. All the survey parameters and presentational standards of the graphics are unchanged from those used previously and described in the main body of the text.

Summary (Illus 198 to Illus 211 inclusive)

These latest surveys have identified a full range of anomaly types. Numerous linear anomalies indicative of infilled ditches have been identified although in contrast to the remainder of the ODA no clear areas of definite archaeological activity have been defined. These ditches are likely indicative of former field boundary and enclosure which could date from the prehistoric up to the 20th century. No areas of obvious settlement activity have been identified. Anomalies caused by field drains, modern ferrous contamination, former localised small-scale extraction, overhead electricity cables and recent agricultural activity are also noted.

Results and discussion

For ease of presentation these survey areas are discussed by field from west to east.

Field IR-11

No anomalies of archaeological potential are identified in this field. Field drains and anomalies caused by modern activity are present.

Field IR-04

As well as linear anomalies indicative of field drains and modern cultivation an area of geological variation is recorded to the north-eastern corner of the field. In addition, an L-shaped rectilinear anomaly orthogonal to the current field boundaries is identified and interpreted as of possible archaeological interest. This is probably an enclosure of likely medieval or post-medieval date. Two discrete anomalies to the north-eastern corner of the field are also interpreted as of possible archaeological origin although a modern or geological origin is also considered possible.

Field IR-02

Immediately to the north-east of IR-04 is IR-02. Land drains and a former boundary are identified as is an area of modern disturbance in the north-west corner of the survey area. In the south-western corner of the field a discontinuous and irregular arrangement of linear and curvilinear anomalies is interpreted as possibly archaeological. There is no clear pattern to the anomalies and a modern agricultural origin (possibly drains) is again possible.

Field IR-03

To the south of IR-02 is IR-03. The data from this field is dominated by a large area of magnetic disturbance in the centre of the field. This is due to a recent episode of levelling.

To the south-west and south-east of the disturbance two areas of probable archaeological activity are noted. In the south-west corner of the field three or four probable enclosures are identified immediately north of the extant boundary. The regularity and alignment of these enclosures is possibly indicative of a relatively modern origin although this is not certain. To the south-east of the disturbance a less coherent pattern of anomalies is identified. Two sides of a possible enclosure are identified with discontinuous anomalies describing no clear pattern surrounding. A possible sub-circular anomaly is also immediately to the north of the possible enclosure.

An area of discrete anomalies in the north-west corner of the field is also interpreted as of possible archaeological origin. Again, there is no pattern and the proximity to the modern boundary could also indicate a modern origin, perhaps associated with small scale extraction.

Field IR-01

To the east of IR-02 is IR-01. A former field boundary and a few linear trend anomalies of uncertain origin are the only anomalies of note identified in this field.

Field IR-08

Magnetic anomalies caused by the low-slung electricity cables are clearly seen aligned south-west/north-east in this field. Former field boundaries and drains are also prominent. In the north-eastern corner of the field a small square enclosure set within a much larger field, immediately north of, and on the same alignment as, the current house plot which it borders is identified. This is likely of 19th century origin.

Field IR-07

No anomalies of significance are identified in this small triangular block forming the north-eastern corner of IR-07.

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