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SERVICES
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for
CgMs Consulting
on behalf of
EnergieKontor

Fen Lane Wind Farm
Fulstow
Lincolnshire

geophysical survey

report 3310
December 2013

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1. Summary

The project

- 1.1 This report presents the results of a geophysical survey conducted in advance of the proposed development of a wind farm at Fen Lane, Fulstow, in Lincolnshire. The works comprised the geomagnetic survey of seven areas totalling approximately 7ha.
- 1.2 The works were commissioned by CgMs Consulting, on behalf of EnergieKontor, and conducted by Archaeological Services Durham University.

Results

- 1.3 The probable courses of two former drainage channels have been identified in Areas 2 and 3.
- 1.4 The majority of anomalies detected in each area are very weak and irregular and almost certainly reflect natural variation within the tidal flat deposits across the study area.
- 1.5 A service pipe has been detected in the east of the study area, crossing proposed turbine Areas 1 and 5.
- 1.6 No features of likely archaeological significance have been identified in any of the survey areas.

2. Project background

Location (Figure 1)

- 2.1 The survey areas lie in fen land to the north of the village of Fulstow, approximately 10km south of Cleethorpes and 10km north of Louth, East Lindsey district, Lincolnshire (NGR centre: TF 3310 9892).
- 2.2 Seven surveys measuring 1ha each were undertaken in five fields to the south of Fen Lane, near New Dike, west of Louth Canal.

Development proposal

- 2.3 The proposal is to construct a seven-turbine wind farm. Each 1ha survey area was centred on a proposed turbine location.

Objective

- 2.4 The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological significance within the proposed development area so that an informed decision may be made regarding the nature and scope of any further scheme of archaeological works that may be required in relation to the proposed development.

Methods statement

- 2.5 The surveys have been undertaken in accordance with instructions from the client and with national standards and guidance (see para. 5.1 below).

Dates

- 2.6 Fieldwork was undertaken on the 27th - 29th November 2013. This report was prepared for December 2013.

Personnel

- 2.7 Fieldwork was conducted by Patricia Edwards (Supervisor) and Nathan Thomas. The geophysical data were processed by Nathan Thomas and Duncan Hale (the Project Manager). This report was prepared by Duncan Hale, with illustrations by David Graham.

Archive/OASIS

- 2.8 The site code is FFL13, for Fulstow Fen Lane 2013. The survey archive will be supplied on CD to the client for deposition with the project archive in due course. Archaeological Services Durham University is registered with the Online AccesS to the Index of archaeological investigationS project (OASIS). The OASIS ID number for this project is **archaeol3-166858**.

3. Historical and archaeological background

- 3.1 A 'Cultural Heritage Desk-Based Assessment' is in preparation (CgMs forthcoming).
- 3.2 Fulstow is listed in the 1086 Domesday survey as 'Fuglestow'. There is a Grade II listed Anglican church in the village, dedicated to St Lawrence, which dates back to the early 13th century.

- 3.3 Ordnance Survey (OS) map editions, starting in 1888, show that the only changes in the local landscape have been the removal of several smaller drains in the second half of the 20th century, in order to create larger fields.

4. Landuse, topography and geology

- 4.1 At the time of fieldwork the survey areas were all in arable fields bounded by open drainage channels.
- 4.2 The land was predominantly level with a mean elevation of 2m OD.
- 4.3 The underlying solid geology comprises Late Cretaceous chalk of the Burnham Chalk Formation, which is overlain by Holocene tidal flat deposits of clay and silt.

5. Geophysical survey Standards

- 5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation* (David, Linford & Linford 2008); the Institute for Archaeologists (IfA) *Standard and Guidance for archaeological geophysical survey* (2011); the IfA Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Guide to Good Practice: Geophysical Data in Archaeology* (Schmidt & Ernenwein 2011).

Technique selection

- 5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.
- 5.3 In this instance, it was considered possible that cut features such as ditches and pits might be present on the site, and that other types of feature such as trackways, wall foundations and fired structures (for example kilns and hearths) could also be present.
- 5.4 Given the anticipated depth of targets and the non-igneous geological environment of the study area, a geomagnetic technique, fluxgate gradiometry, was considered appropriate for detecting the types of feature mentioned above. This technique involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

Field methods

- 5.5 A 30m grid was established across each survey area and related to the Ordnance Survey National Grid using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections typically providing 10mm accuracy.
- 5.6 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad601-2 dual fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 30m grid units. The instrument sensitivity was nominally 0.03nT, the sample interval was 0.25m and the traverse interval was 1m, thus providing 3,600 sample measurements per 30m grid unit.
- 5.7 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

- 5.8 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (minimally processed) data. The greyscale images and interpretations are presented in Figures 2-9; the trace plots are provided in Figure 10. In the greyscale image, positive magnetic anomalies are displayed as dark grey and negative magnetic anomalies as light grey. A palette bar relates the greyscale intensities to anomaly values in nanoTesla.

- 5.9 The following basic processing functions have been applied to the data:

<i>clip</i>	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
<i>zero mean traverse</i>	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities
<i>destagger</i>	corrects for displacement of geomagnetic anomalies caused by alternate zig-zag traverses
<i>interpolate</i>	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

Interpretation: anomaly types

- 5.10 Colour-coded geophysical interpretations are provided. Three types of geomagnetic anomaly have been distinguished in the data:

<i>positive magnetic</i>	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches
<i>negative magnetic</i>	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic

susceptibility such as wall footings and other concentrations of sedimentary rock or voids

dipolar magnetic paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths

Interpretation: features

General comments

- 5.11 Colour-coded archaeological interpretations are provided.
- 5.12 Small, discrete dipolar magnetic anomalies have been detected in all of the survey areas. These almost certainly reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation drawings, however, they have been omitted from the archaeological interpretations and the following discussion.
- 5.13 With the exception of the anomalies above, and occasional other anomalies described below, the majority of the anomalies detected within each area are very weak, diffuse and irregular, and probably reflect natural variation with the tidal flat deposits across the area. These have not been included on the interpretation figures.
- Area 1 (Figure 3)**
- 5.14 A chain of intense magnetic anomalies has been detected aligned north-west/south-east across this area. This almost certainly reflects a service pipe, which continues to the north across Area 5.
- Area 2 (Figure 4)**
- 5.15 A narrow band of positive and dipolar magnetic anomalies has been detected across the north of this area, aligned broadly east-west. This broadly corresponds to the course of a former drain shown on early OS editions until the 1970s. The anomalies almost certainly reflect materials used in the backfill of the drain.
- Area 3 (Figure 5)**
- 5.16 A narrow band of intense dipolar magnetic anomalies has been detected across the north of this area, aligned broadly east-west. This also broadly corresponds to the course of a former drain shown on early OS editions until the 1970s. The anomalies almost certainly reflect materials used in the backfill of the drain.
- Area 4 (Figure 6)**
- 5.17 With the exception of the natural variation in the tidal deposits and a scatter of near-surface ferrous and fired litter, no other anomalies have been detected within this area.
- Area 5 (Figure 7)**
- 5.18 A chain of intense dipolar magnetic anomalies detected across this area almost certainly reflects a continuation of the ferrous pipe detected to the south in Area 1.

Areas 6 and 7 (Figures 8 & 9)

- 5.19 With the exception of the natural variation in the tidal deposits and a scatter of near-surface ferrous and fired litter, no other anomalies have been detected within these areas.

6. Conclusions

- 6.1 Geomagnetic surveys have been undertaken at seven proposed wind turbine locations at Fen Lane, near Fulstow, in Lincolnshire.
- 6.2 The probable courses of two former drainage channels have been identified in Areas 2 and 3.
- 6.3 The majority of anomalies detected in each area are very weak and irregular and almost certainly reflect natural variation within the tidal flat deposits across the study area.
- 6.4 A service pipe has been detected in the east of the study area, crossing proposed turbine Areas 1 and 5.
- 6.5 No features of likely archaeological significance have been identified in any of the survey areas.

7. Sources

- David, A, Linford, N, & Linford, P, 2008 *Geophysical Survey in Archaeological Field Evaluation*. English Heritage
- Gaffney, C, Gater, J, & Ovenden, S, 2002 *The use of geophysical techniques in archaeological evaluations*. Technical Paper 6, Institute of Field Archaeologists
- IfA 2011 *Standard and Guidance for archaeological geophysical survey*. Institute for Archaeologists
- Schmidt, A, & Ernenwein, E, 2011 *Guide to Good Practice: Geophysical Data in Archaeology*. Archaeology Data Service

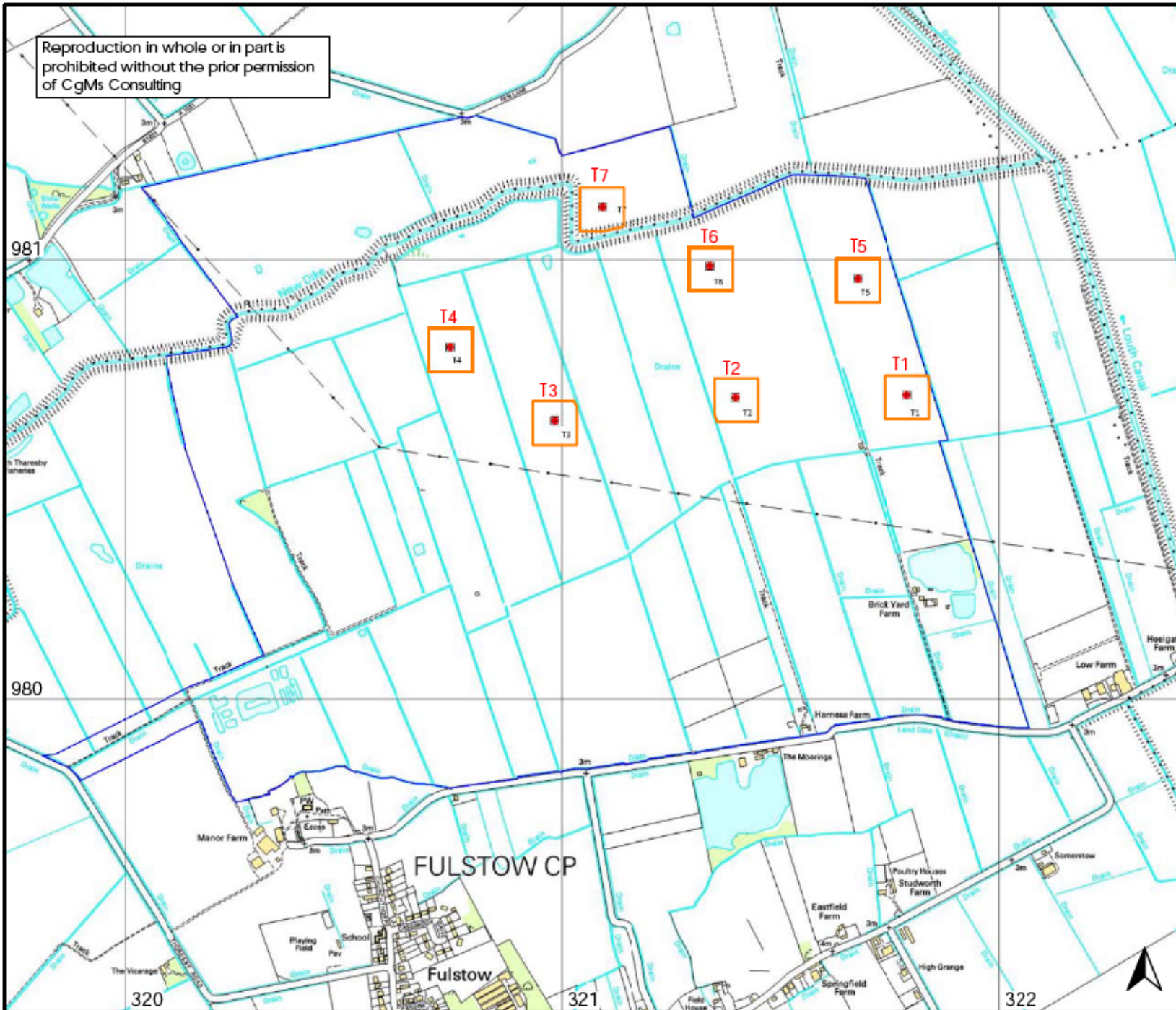
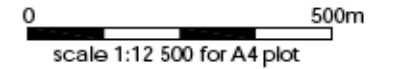
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Figure 1: Site location



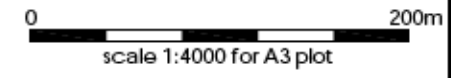
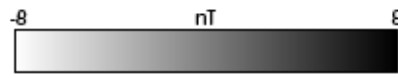
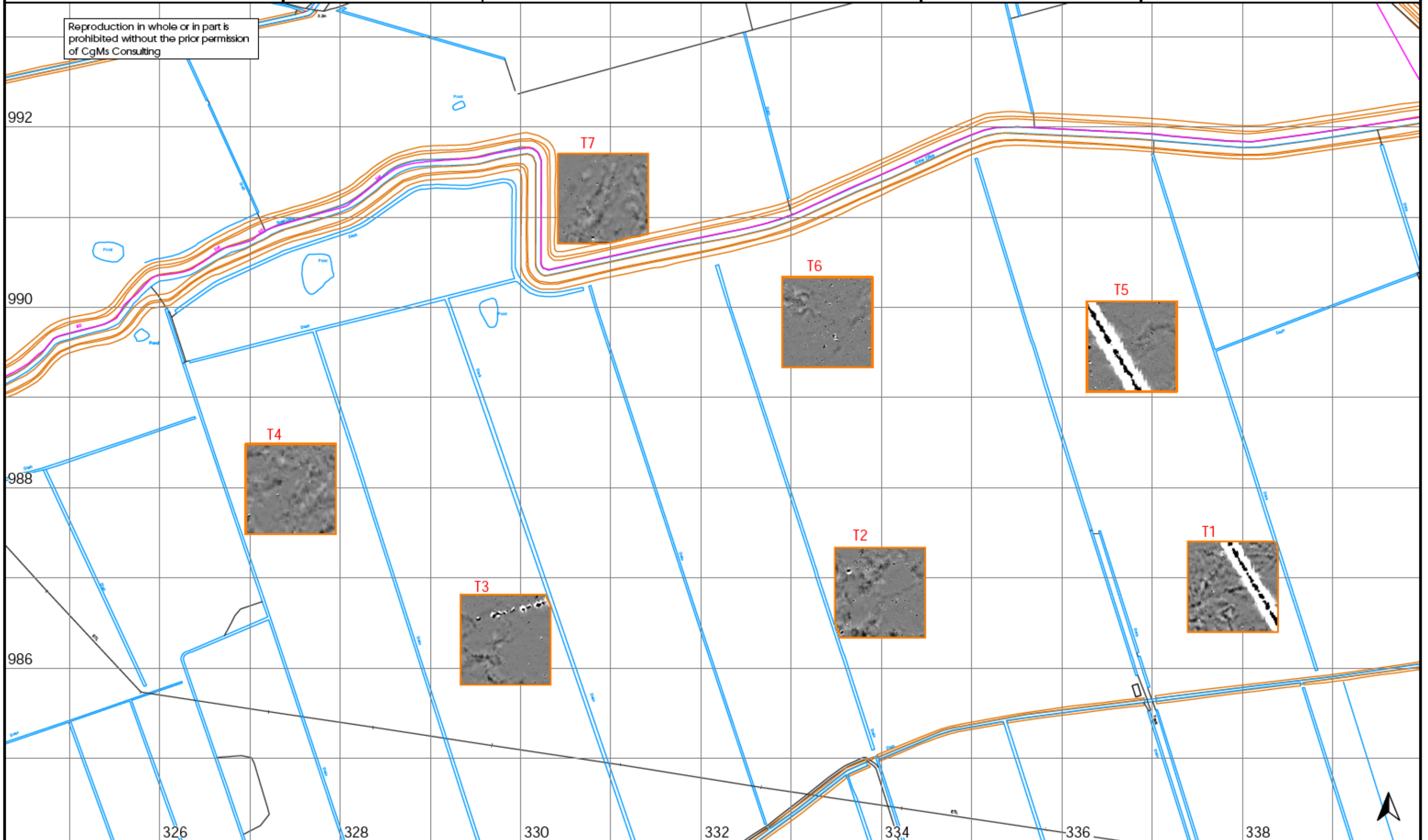


Figure 2: Geophysical survey overview

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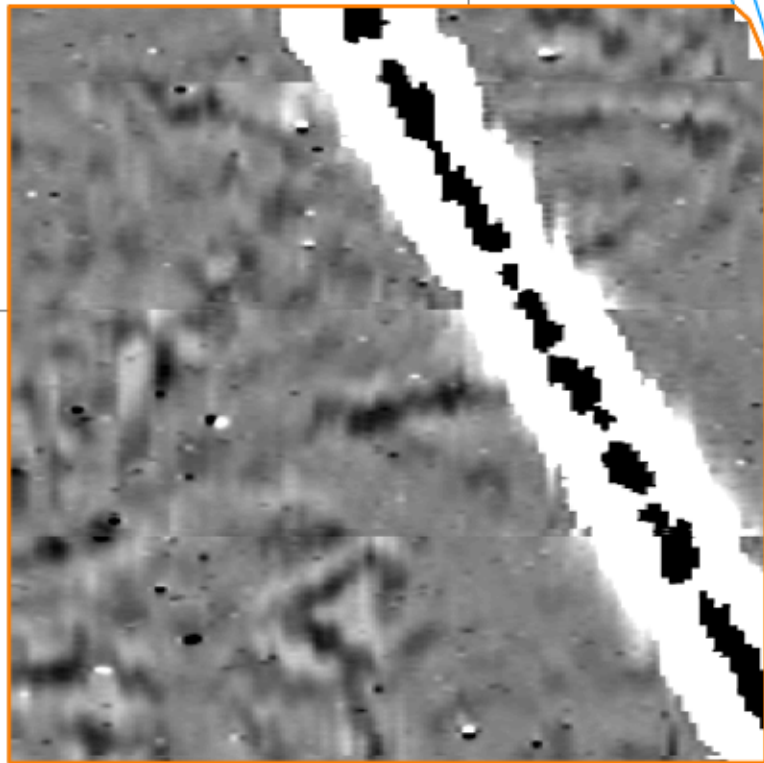
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Drain

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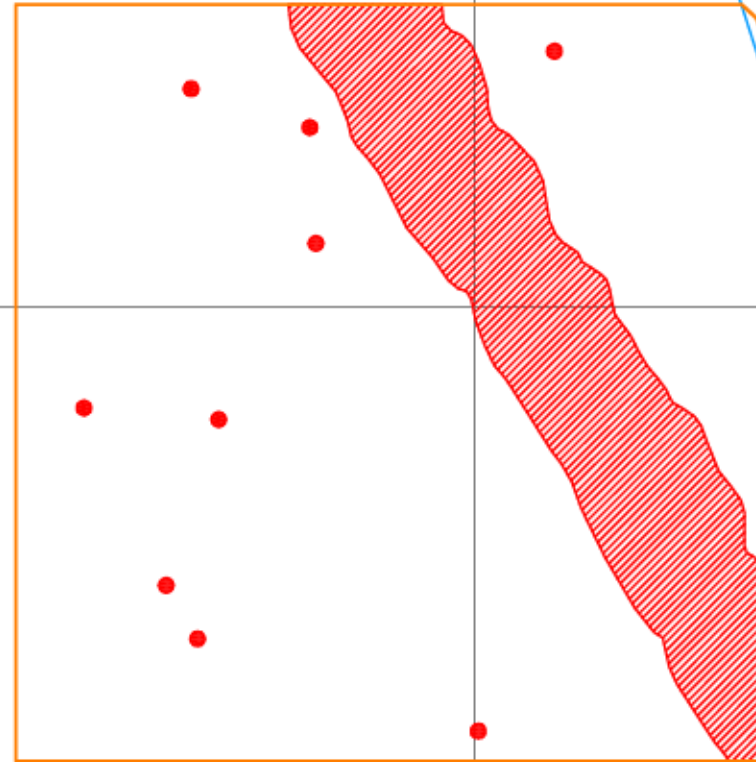
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B

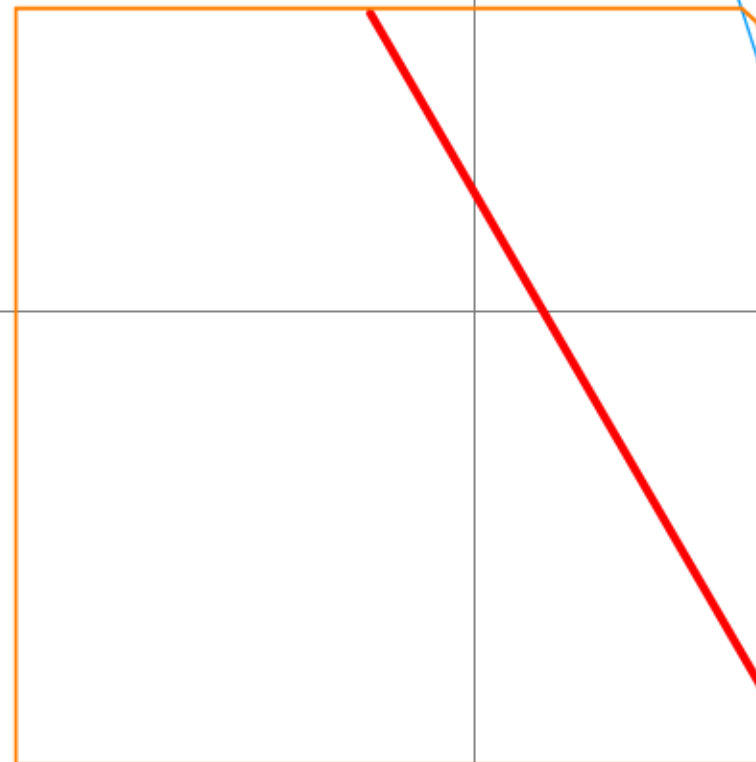
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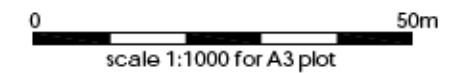
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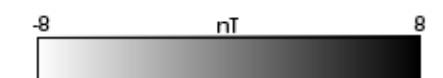
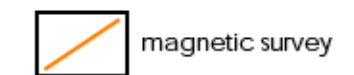
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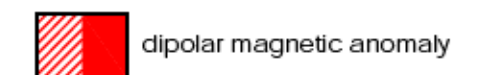
Figure 3: Area 1, geophysical survey
and interpretation



A - geophysical survey



B - geophysical interpretation



C - archaeological interpretation



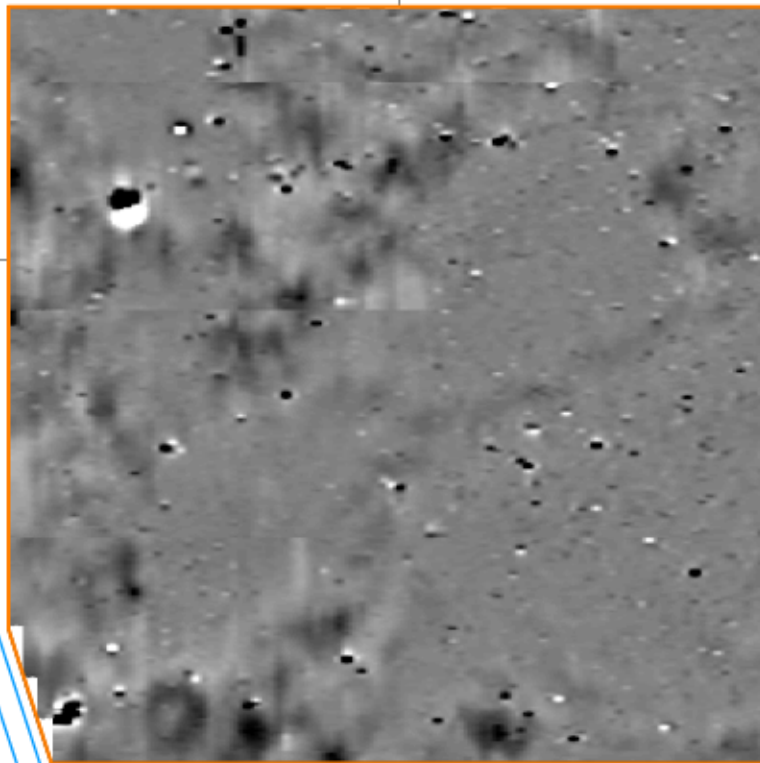
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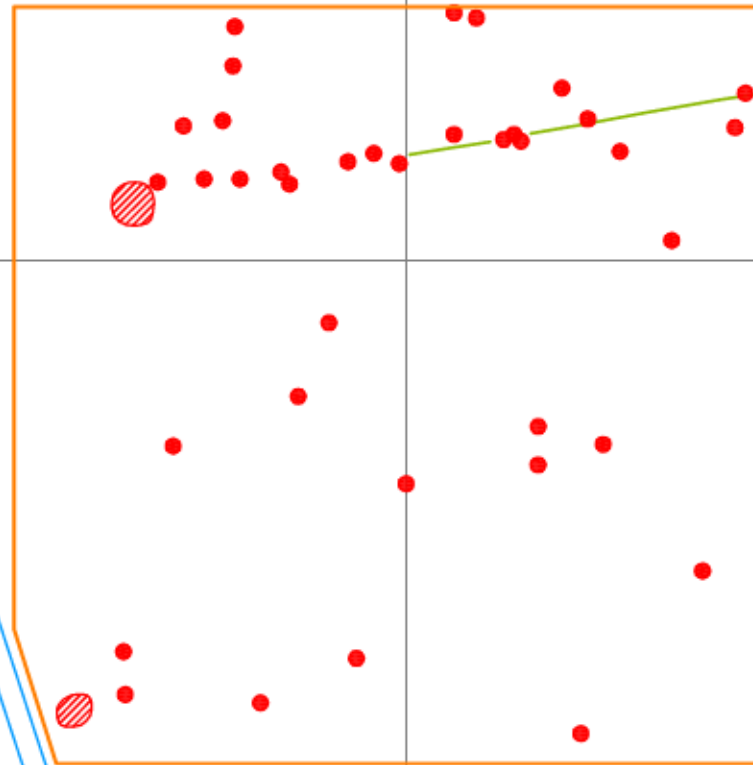


A



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T2

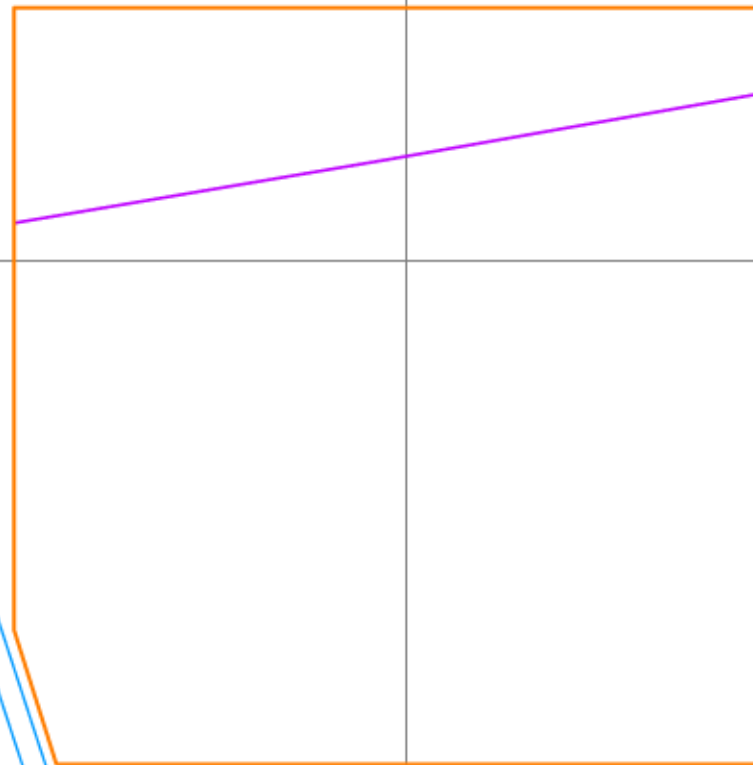


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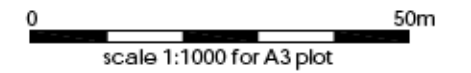
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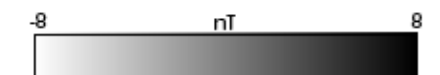
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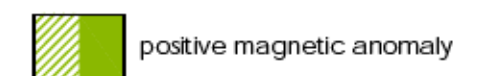
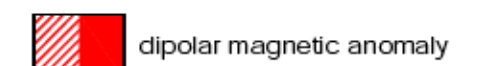
Figure 4: Area 2, geophysical survey
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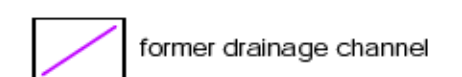
A - geophysical survey



B - geophysical interpretation



C - archaeological interpretation



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A

B

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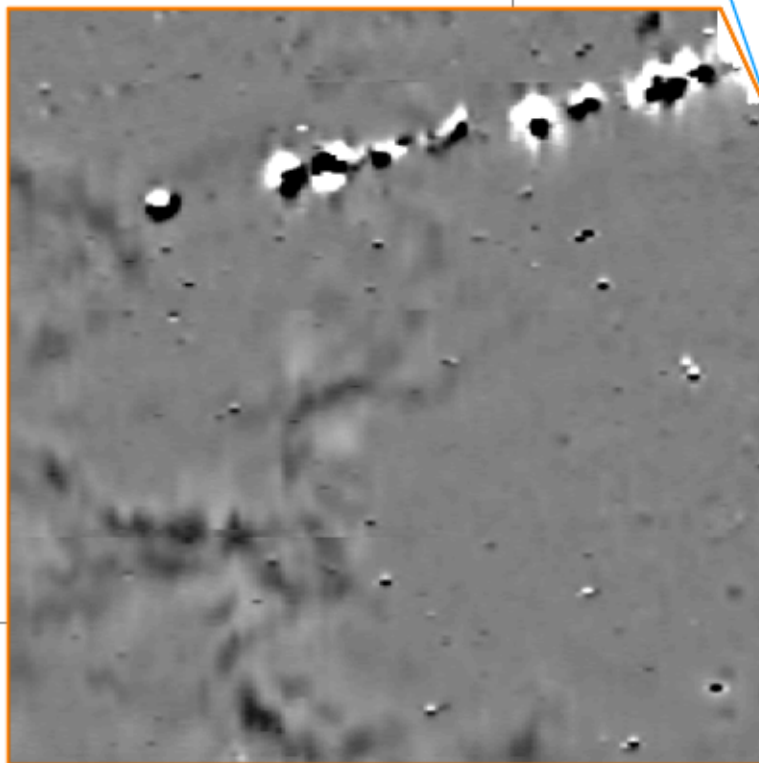
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Figure 5: Area 3, geophysical survey and interpretation

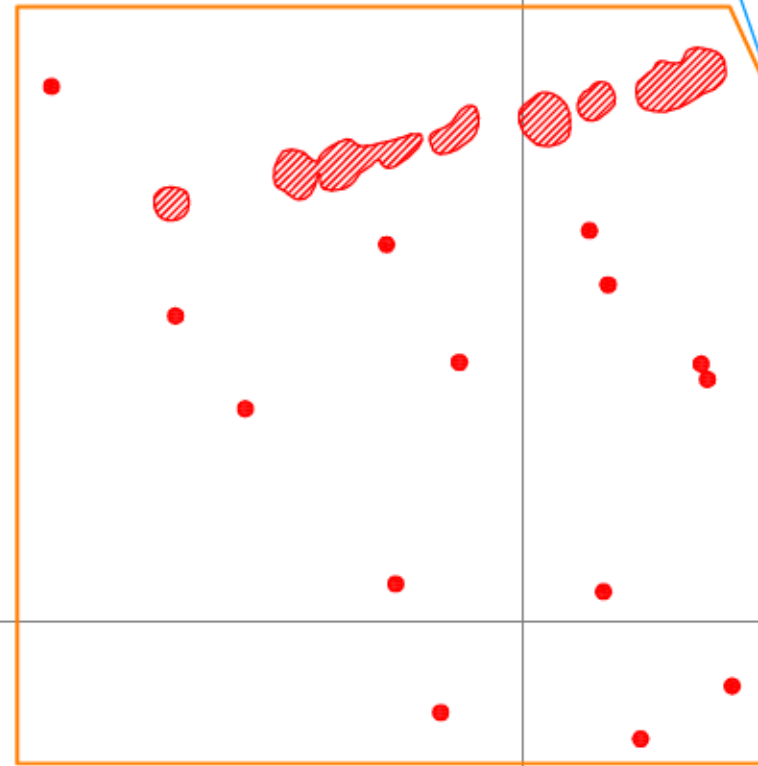
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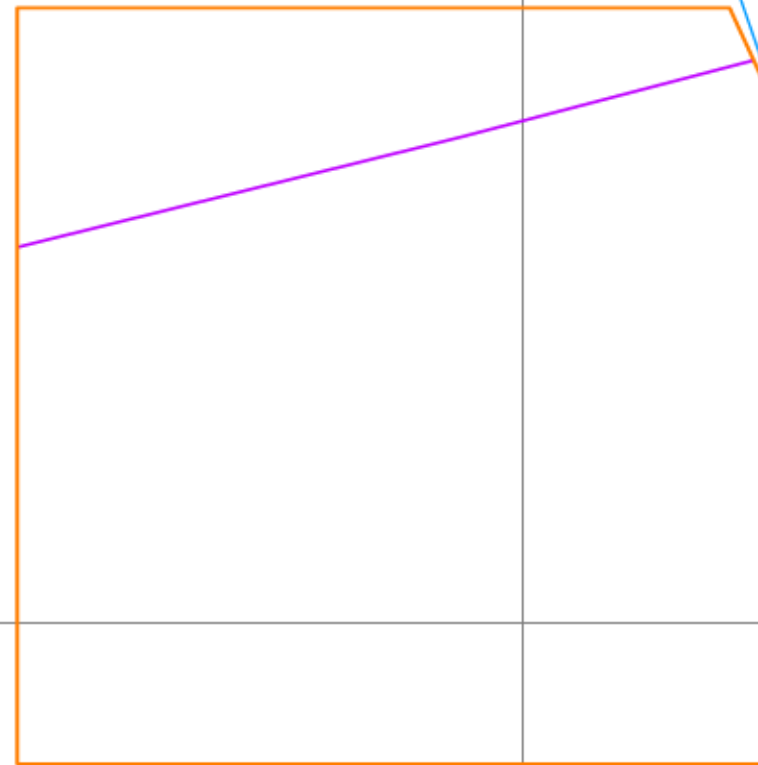


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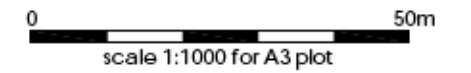


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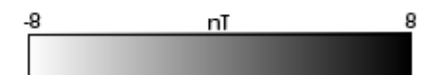
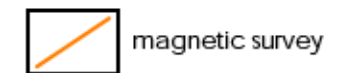
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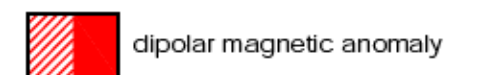
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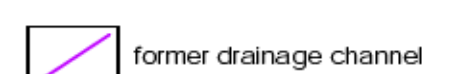
A - geophysical survey



B - geophysical interpretation



C - archaeological interpretation



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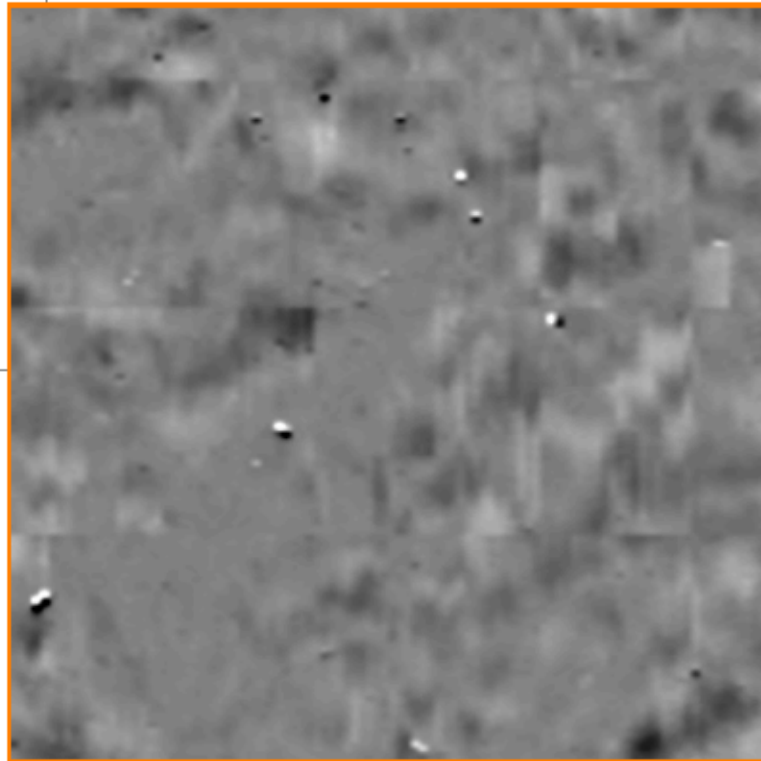
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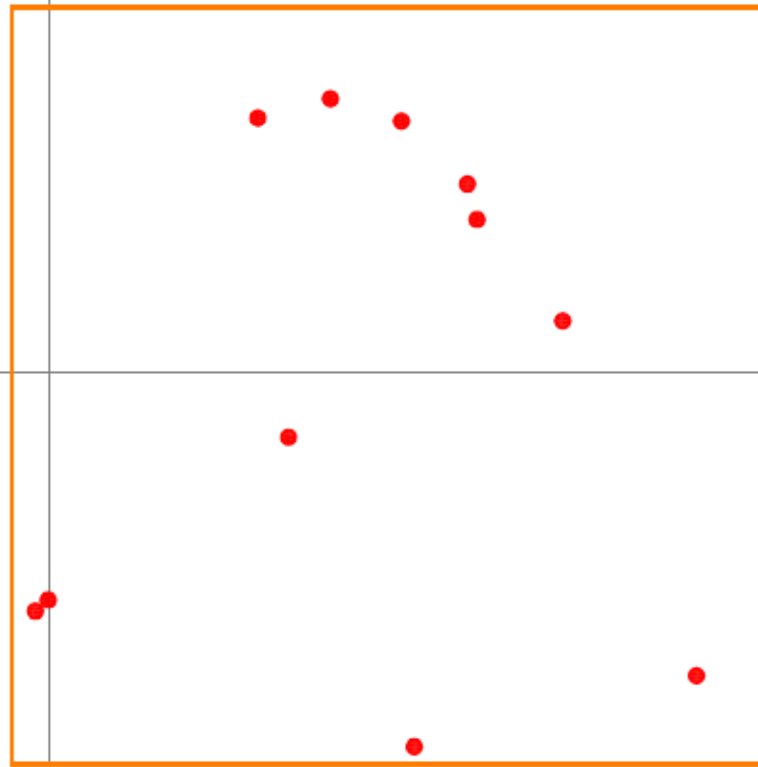
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A

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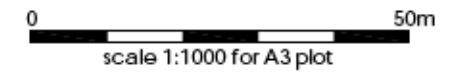
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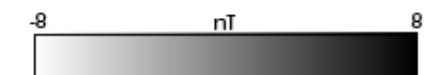
Figure 6: Area 4, geophysical survey
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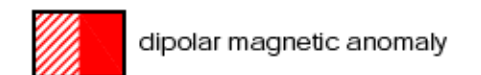
A - geophysical survey



magnetic survey



B - geophysical interpretation



dipolar magnetic anomaly

C - archaeological interpretation

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Figure 7: Area 5, geophysical survey and interpretation


0 50m
scale 1:1000 for A3 plot

A - geophysical survey

 magnetic survey

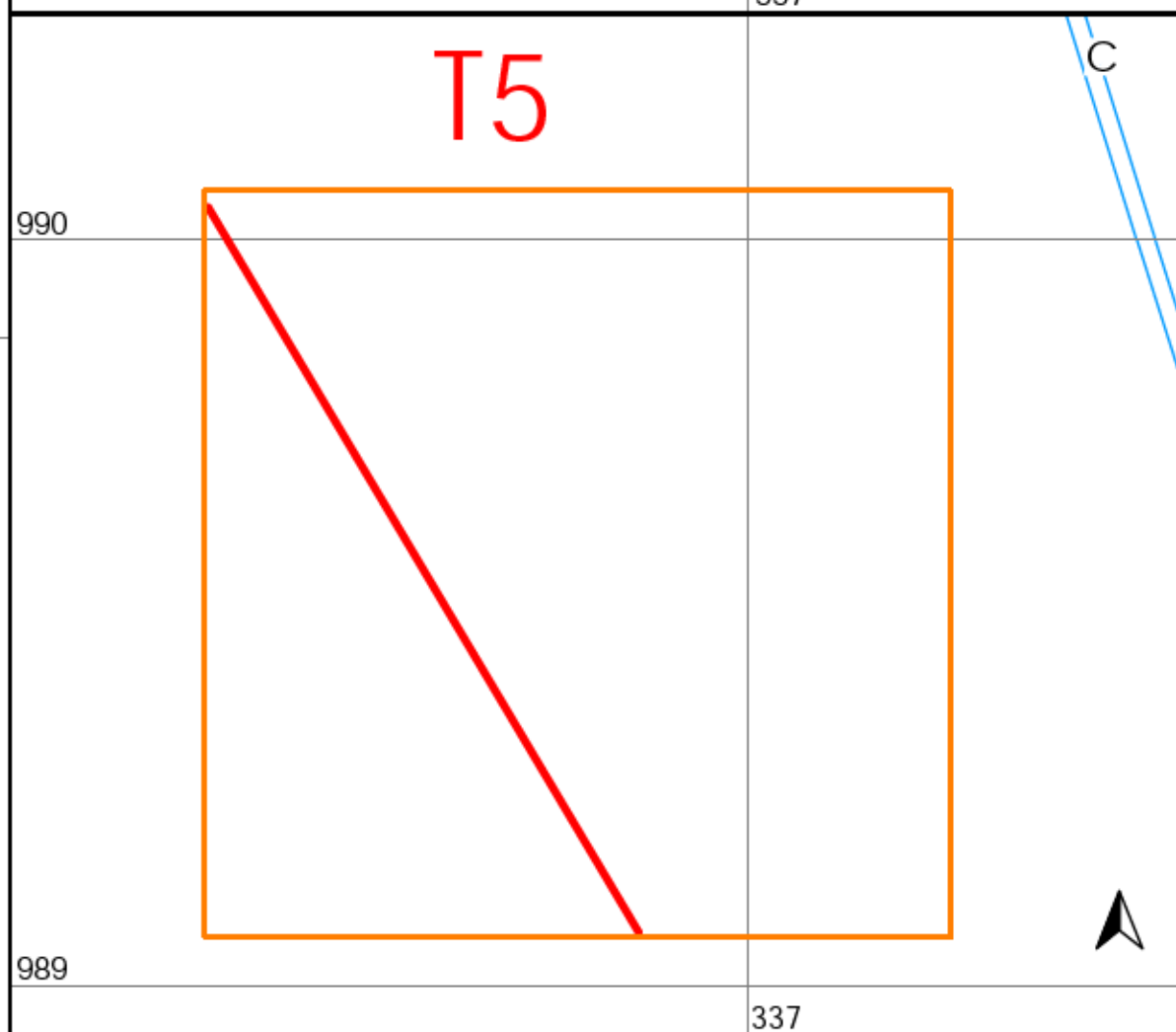
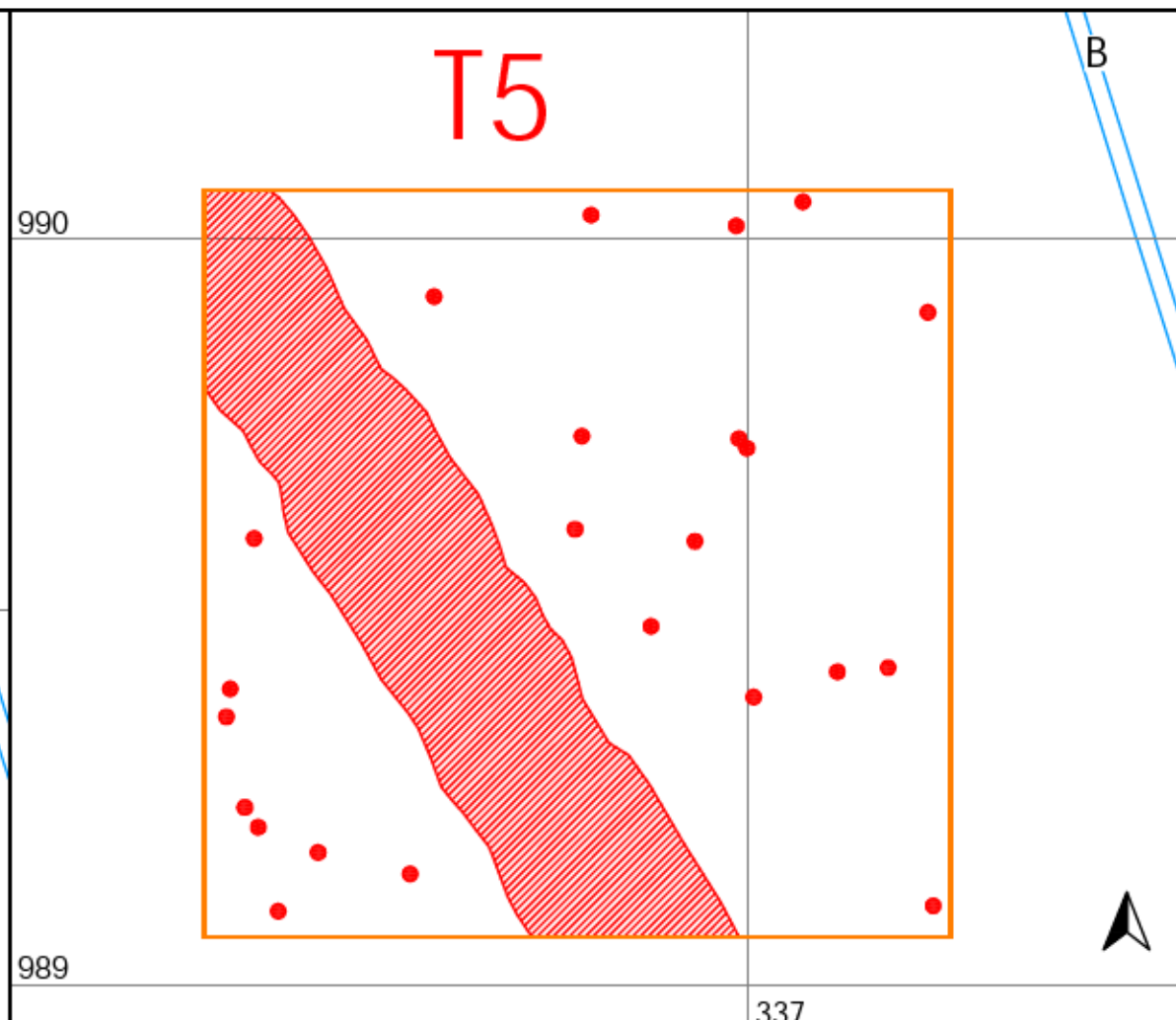
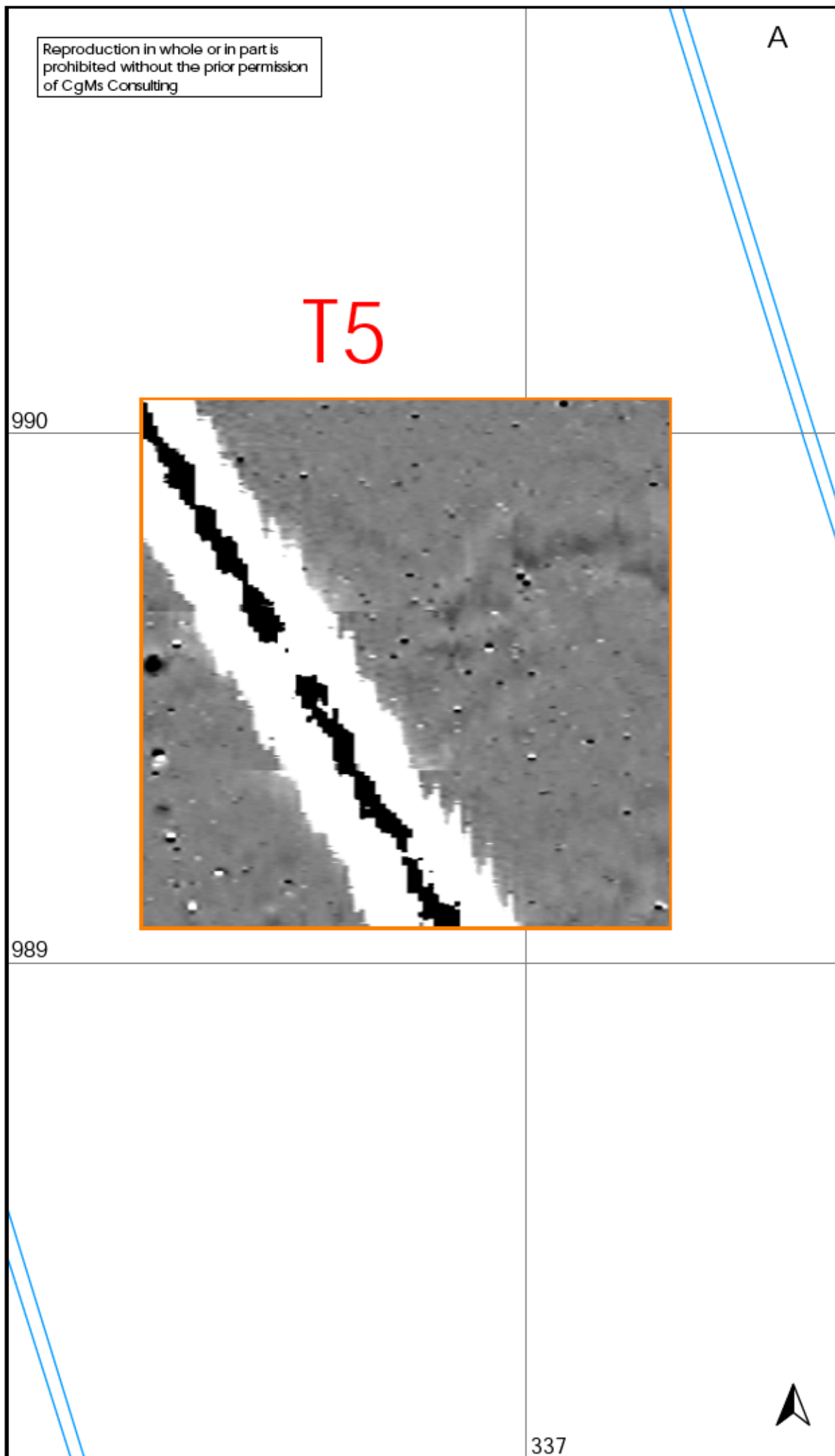
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B - geophysical interpretation

 dipolar magnetic anomaly

C - archaeological interpretation

 service pipe



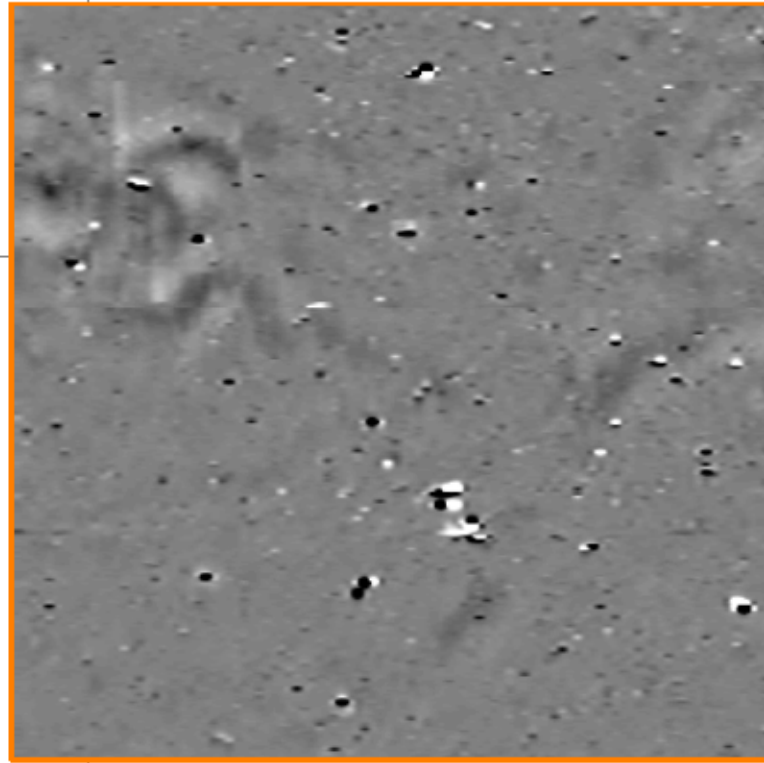
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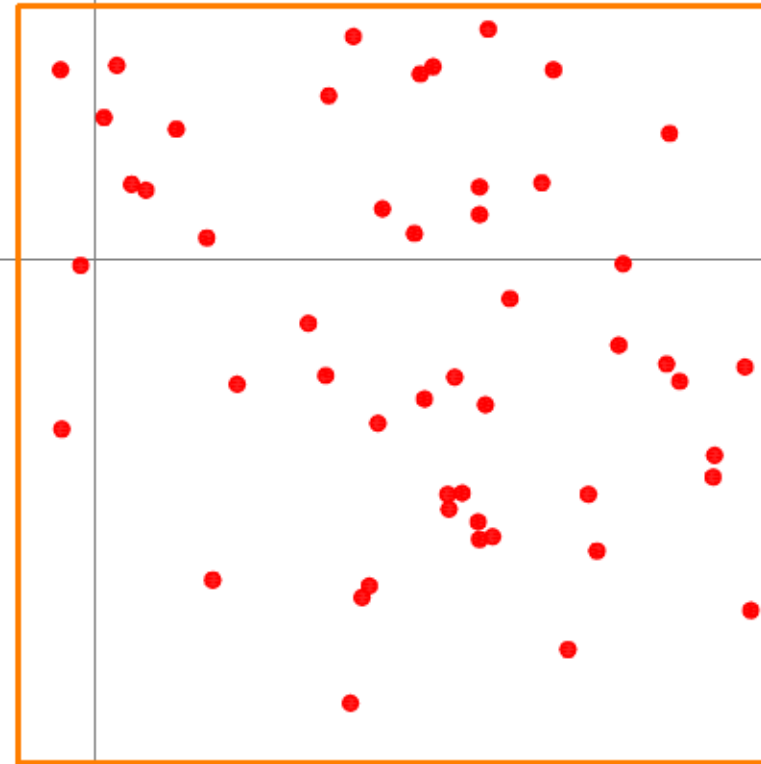
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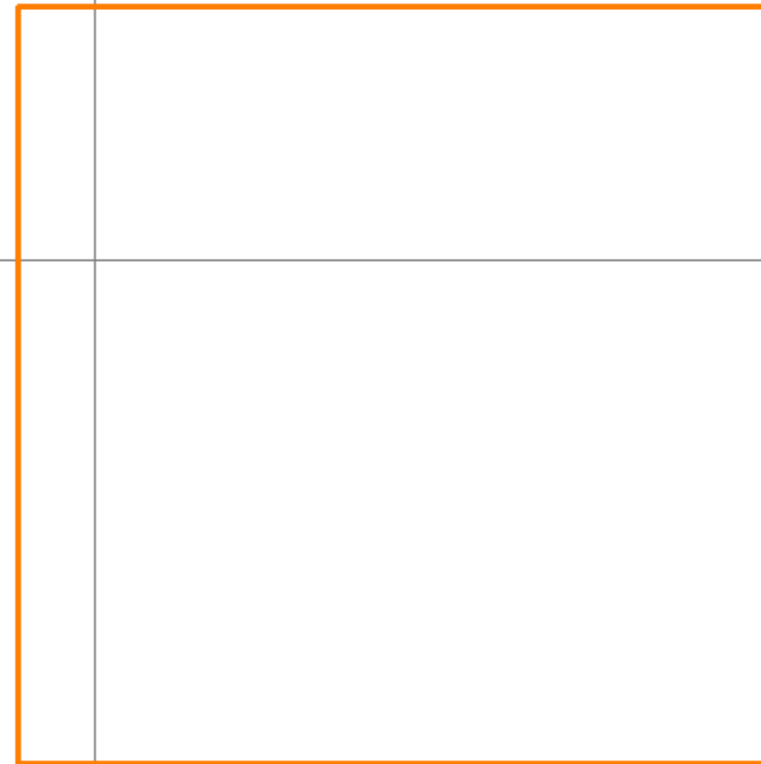
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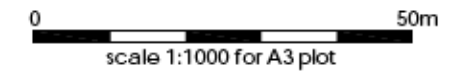
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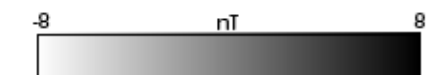
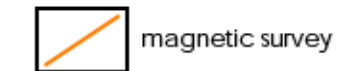
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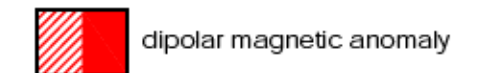
Figure 8: Area 6, geophysical survey
and interpretation



A - geophysical survey



B - geophysical interpretation



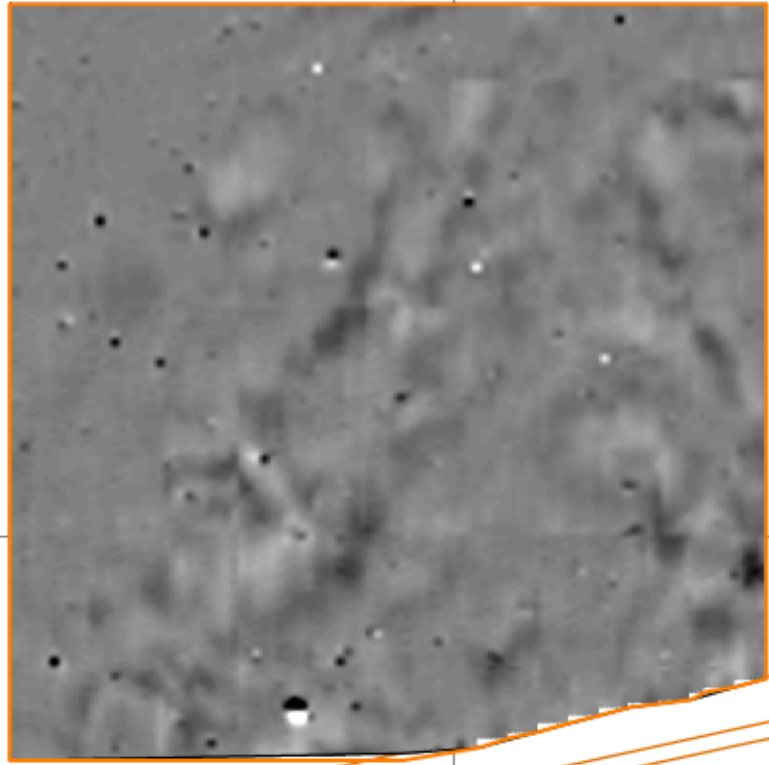
C - archaeological interpretation

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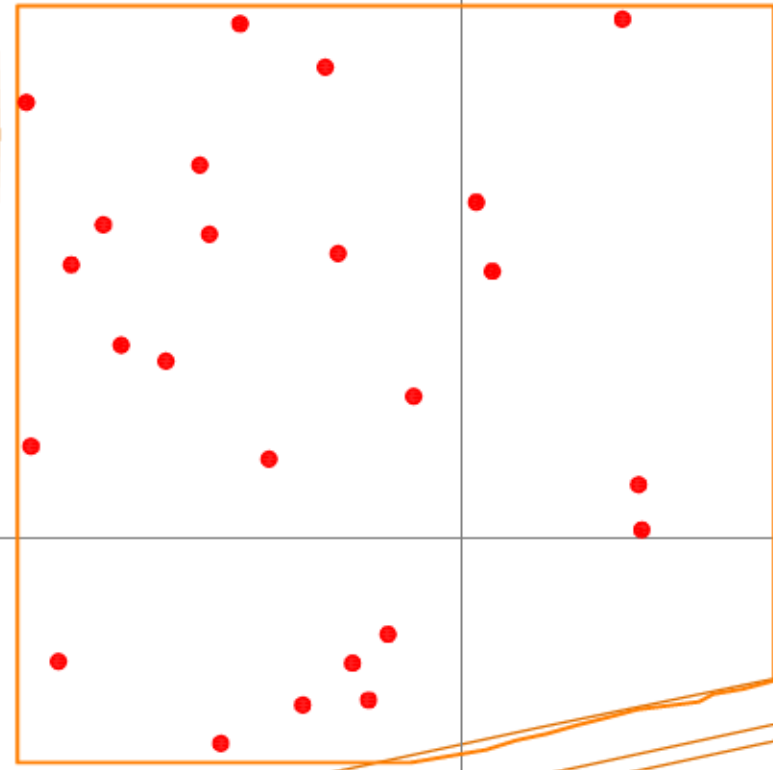


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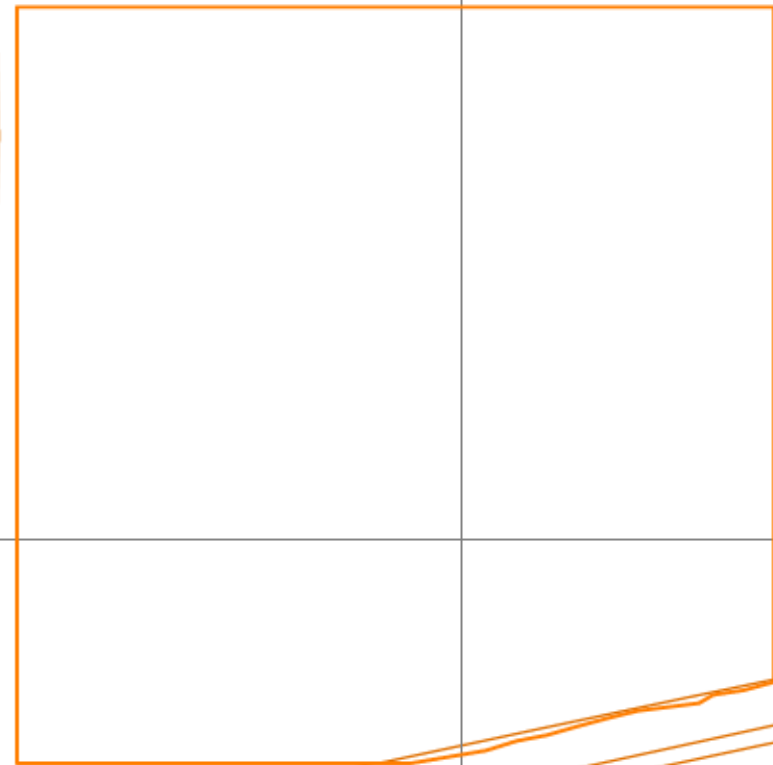


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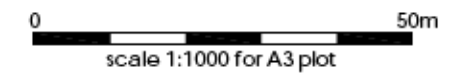
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EnergieKontor

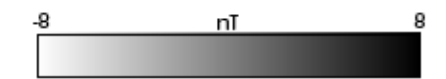
Fen Lane Wind Farm
Fulstow
Lincolnshire

geophysical survey
report 3310

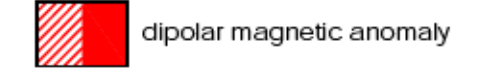
Figure 9: Area 7, geophysical survey and interpretation



A - geophysical survey

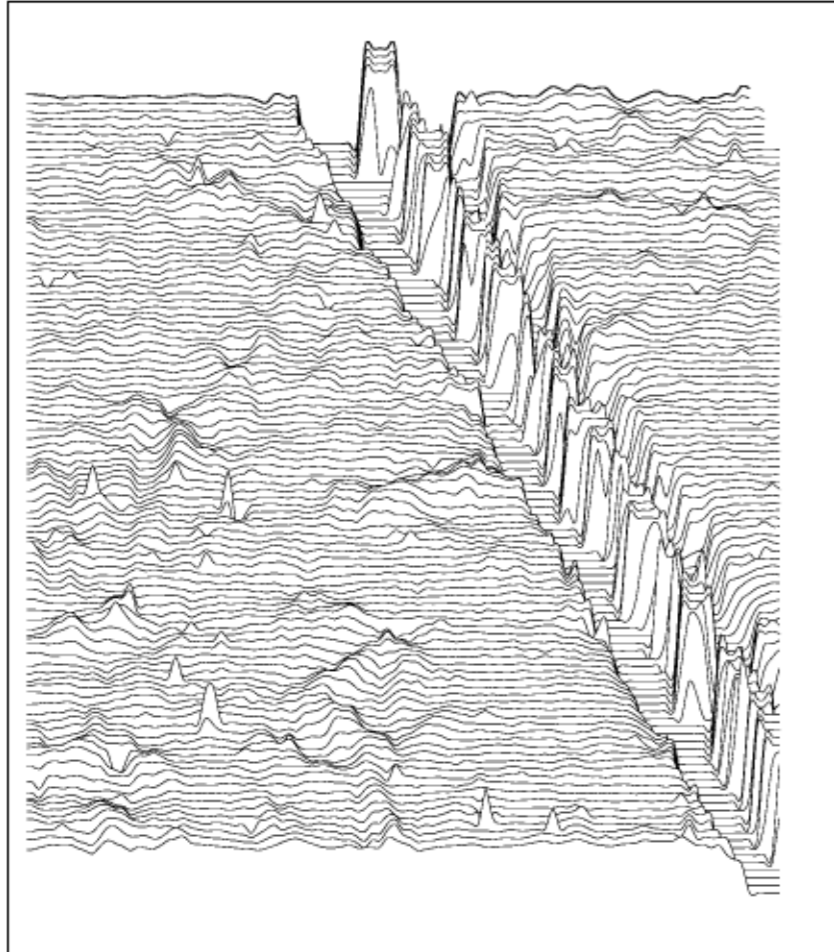


B - geophysical interpretation

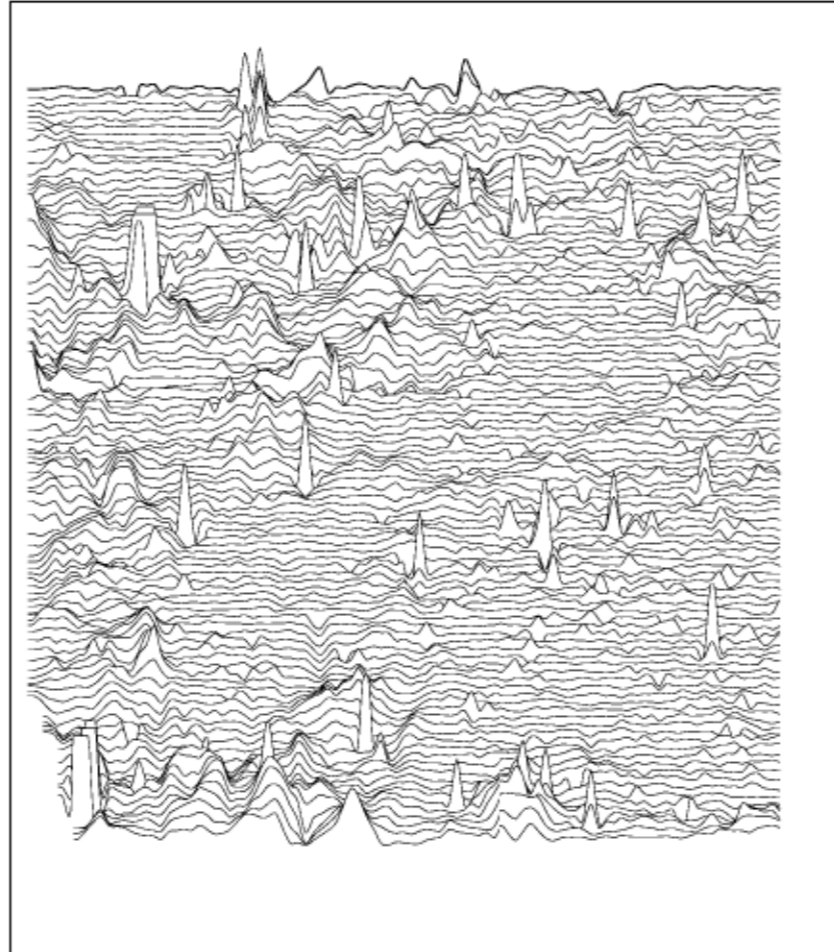


C - archaeological interpretation

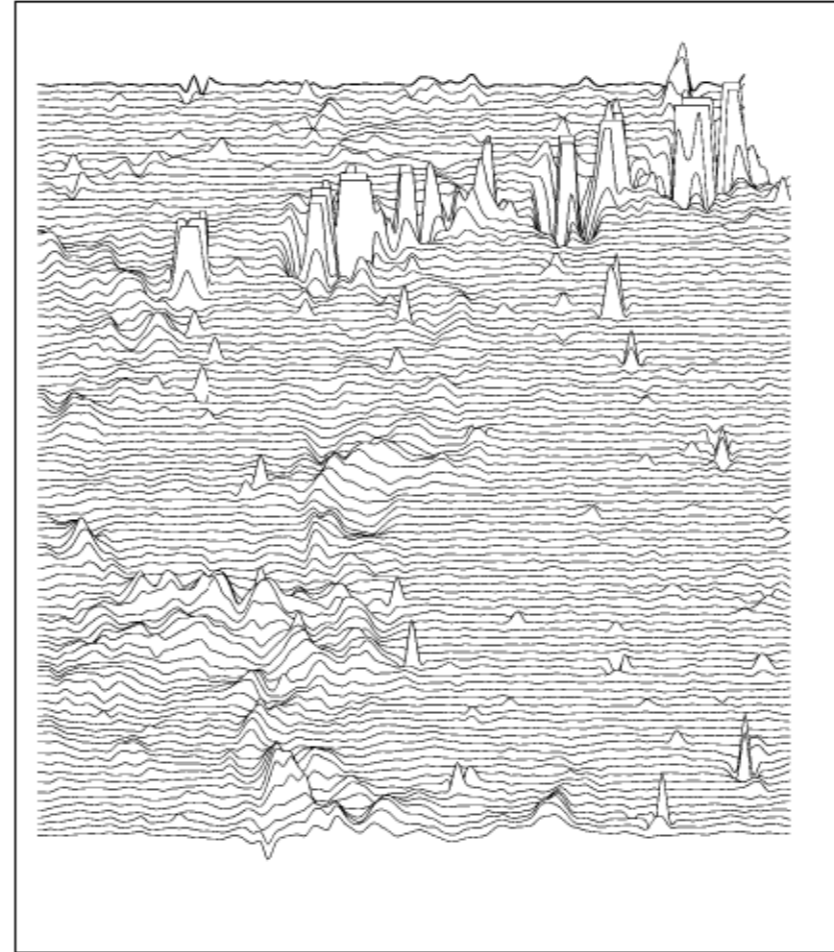
Area 1
31.70nT/cm



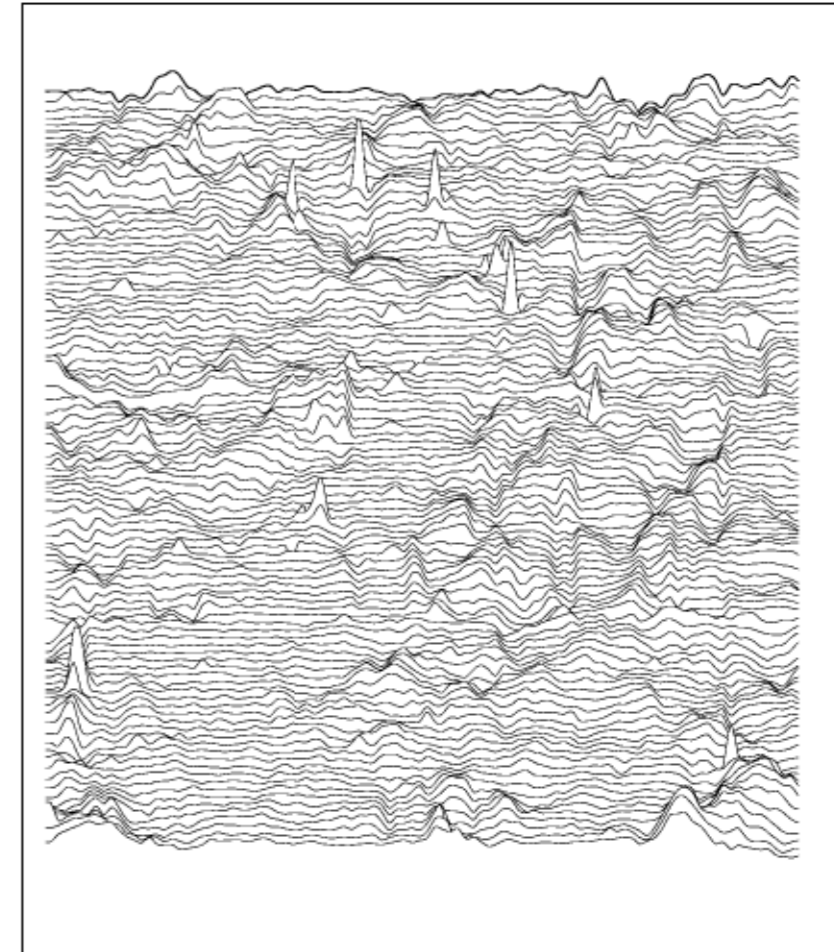
Area 2
12.00nT/cm



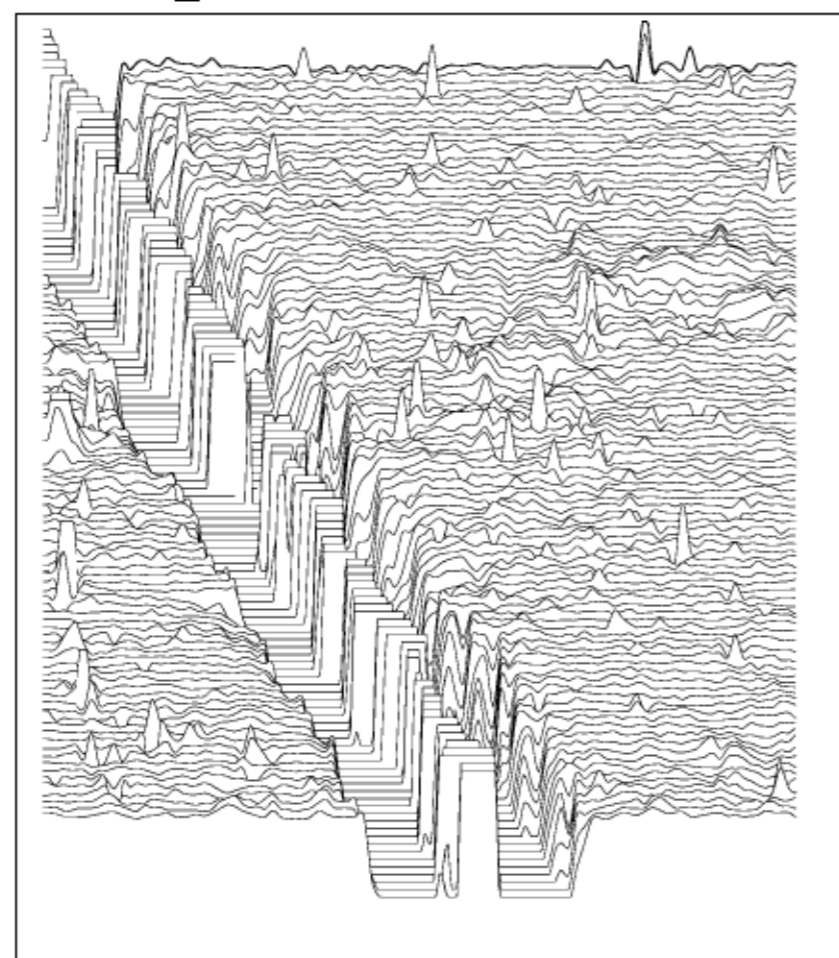
Area 3
12.00nT/cm



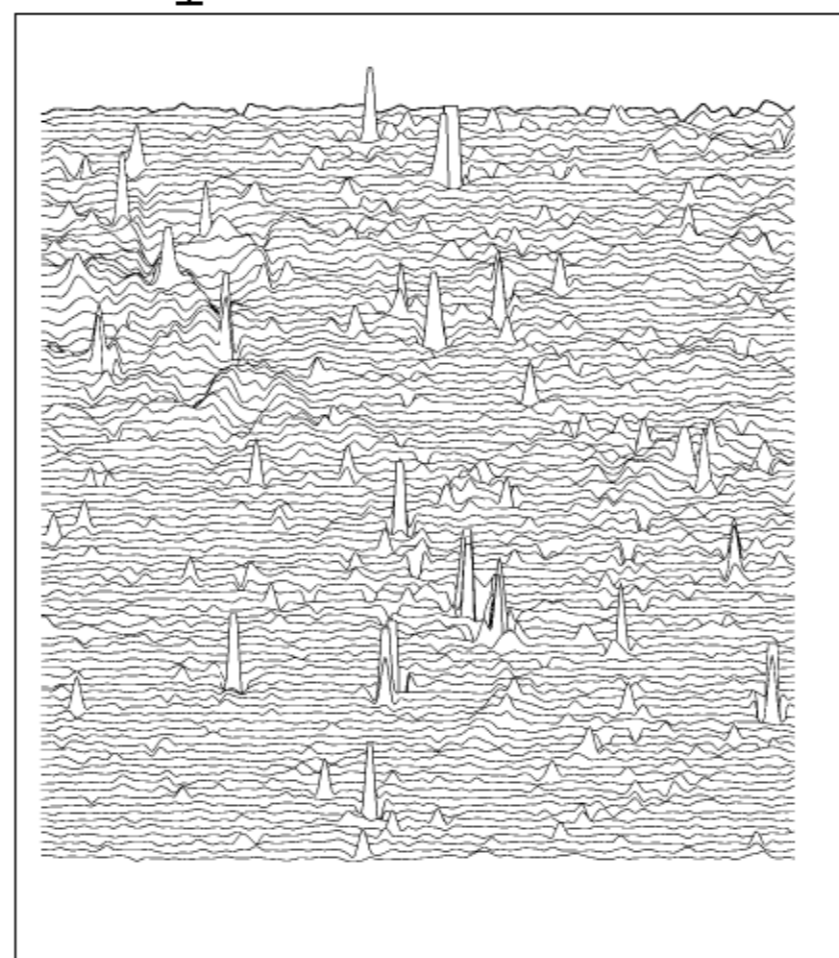
Area 4
12.00nT/cm



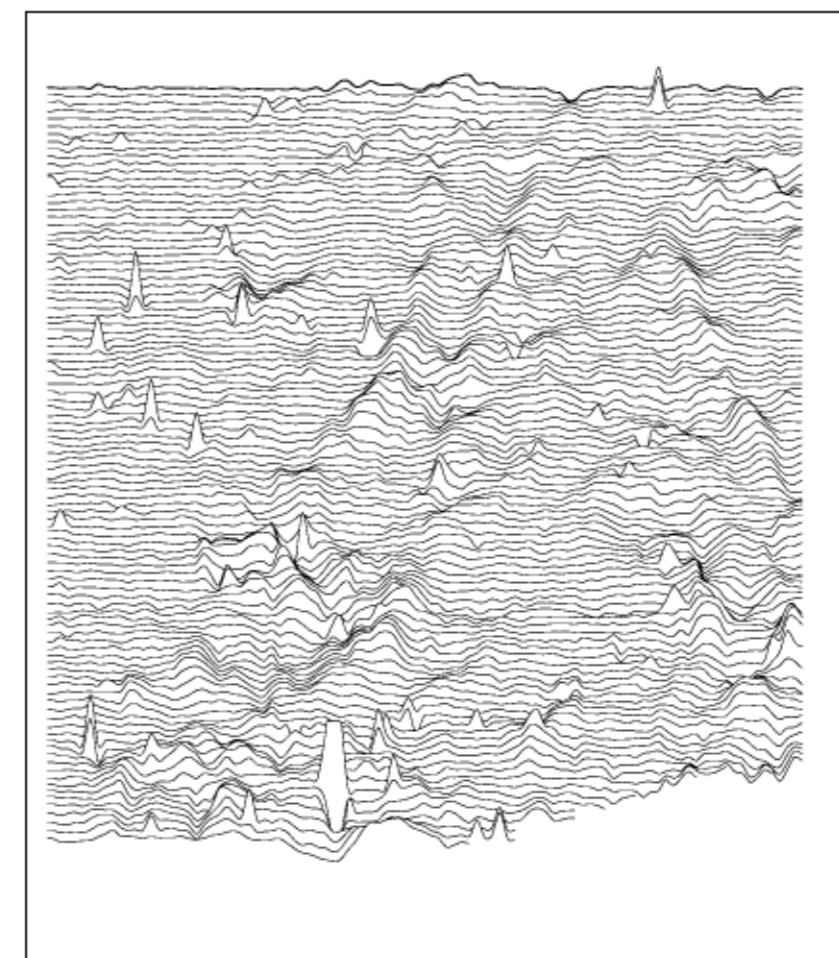
Area 5
12.00nT/cm



Area 6
12.00nT/cm



Area 7
12.00nT/cm



0 50m
scale 1:1000 for A2 plot

for
CgMs Consulting
on behalf of
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Figure 10: Trace plots of geomagnetic data