Proposed Nuclear Power Station Wylfa, Ynys Môn

Archaeological Evaluation: Targeted Geophysics

Ymddiriedolaeth Archaeolegol Gwynedd
Gwynedd Archaeological Trust

Proposed Nuclear Power Station Wylfa, Ynys Môn

Archaeological Evaluation: Targeted Geophysics

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Summary

Gwynedd Archaeological Trust (GAT) has completed a programme of targeted geophysical survey within the proposed location of the new nuclear power station site at Wylfa, Ynys Môn (NGR SH35459328). This survey has been completed as part of a staged programme of works by GAT for Horizon Nuclear Power and the results of the current survey will inform the future archaeological evaluation and mitigation works.

The current survey has been completed in response to the results of a multiplatform survey and geotechnical ground investigation programme completed for Horizon Nuclear Power by Fugro Aperio Ltd. within the 166.1ha development area. As part of this programme, Fugro Aperio Ltd. completed a Vertical Magnetic Gradiometry (VMD) survey using a pair of Caesium vapour magnetometers to identify below ground anomalies. The survey identified 146 anomalies (as interpreted by GAT), some of which were investigated further as part of the geotechnical ground investigation programme by Fugro Aperio Ltd, utilising test pits; these were monitored by GAT as an archaeological watching brief and possible burnt mounds were identified in two locations.

Based on the results of the VMD survey and the test pits; a programme of targeted geophysical magnetometer survey was undertaken to evaluate further the initial results, including the possible burnt mound locations as well as other anomalies suggestive of prehistoric archaeological activity. Five zones, each 1ha in size, were surveyed GAT, all located within the southern portion of the development site. The primary aim of this phase was to establish the veracity of the Fugro Aperio VMD in identifying archaeological anomalies.

Probable burnt mound activity was confirmed in GAT Zones 1 and 4 (the locations of the test pits monitored during the watching brief). Further probable prehistoric activity, originally suggested in the VMD survey results as a curvilinear anomaly, was identified in Zone 3 and shown to be a well defined ditch typical of a prehistoric enclosure. In contrast the anomaly in Zone 5, originally interpreted from the VMD survey results as a prehistoric curvilinear anomaly is now though to most likely be modern disturbance. Additional anomalies were interpreted as possible redundant post-medieval field systems.

1.0 INTRODUCTION

Gwynedd Archaeological Trust (GAT) has been commissioned by Horizon Nuclear Power (HNP) to carry out a programme of targeted archaeological evaluation (geophysics: high and standard resolution magnetometer survey) at the location of the proposed Nuclear Power Station, Wylfa, Ynys Môn.

The site of the proposed Nuclear Power Station is located adjacent to the existing Wylfa A power station and currently encompasses a 166.1 hectare area of coastline and agricultural plots, buildings and residential areas, centred on NGR **SH35459328**.

The geophysics evaluation programme targeted 5 zones located towards the southern end of the proposed development area (Fig. 1). The zones evaluated specific geophysical anomalies identified during the initial multiplatform survey stage undertaken by *Fugro Aperio Ltd* (FA), and interpreted by GAT (GAT Report **936**; results reproduced as Appendix I), as

well as two possible prehistoric burnt mound sites identified during the GAT watching brief of geotechnical test pitting (also undertaken by FA; GAT Report 994, forthcoming).

Each GAT targeted zone measured 10,000m^2 (100.0m x 100.0m):

- Zone 1 (SH 34629263): targeted the location of a suspected prehistoric burnt mound, originally identified in *Fugro Aperio Ltd* test pit TP76B during the GAT watching brief. It was intended that the high-resolution survey will enable a clearer understanding of the feature.

- Zone 2 (SH34559282): targeted *Fugro Aperio Ltd* anomalies A102, A104, 106 and A107; these anomalies were interpreted by GAT as part of a field system predating the current 18th/19th century system. It was intended that the GAT survey would enable a clearer understanding of these features.

- Zone 3 (SH 34739292): targeted *Fugro Aperio Ltd* anomaly A91. This anomaly was interpreted by GAT as a semi-circular anomaly on top of a rounded natural hill and possibly part of a circular prehistoric enclosure or settlement. It was intended that the GAT survey would enable a clearer understanding of the feature.

- Zone 4 (SH35179283): targeted the location of a suspected prehistoric burnt mound, originally identified in *Fugro Aperio Ltd* test pit TP62A during the GAT watching brief. It was intended that the GAT survey would enable a clearer understanding of the feature.

- Zone 5 (SH35579288): targeted *Fugro Aperio Ltd* anomalies A338. This feature was interpreted by GAT as either modern disturbance or a ditched enclosure of possibly prehistoric origin. It was intended that the GAT survey would enable a clearer understanding of the feature.

GAT Zones 4 and 5 were surveyed first and the high resolution results were compared with the *Fugro Aperio Ltd* magnetic data. They were also presented at standard resolution in order to provide an example of the most commonly used geophysical survey resolution for prospection and evaluation of larger areas. This showed that standard resolution survey would be the most efficient method of gathering data in the other three zones and that this produced a significant improvement to the *Fugro Aperio* data. A strategy for completing Zones 1 to 3 using standard resolution survey was agreed between HNP, GAT and Gwynedd Archaeological Planning Service (GAPS).

This phase has been completed as part of a staged programme of works; further evaluation and/or mitigation will be programmed and discussed in future project designs/reports and will be informed by the results of this survey.

1.1 Requirements

A detailed brief for archaeological works associated with the Ground Investigation Programme was not prepared by GAPS but GAPS has been involved in the specification of the archaeological works (GAPS project ref.: **D1315**).

Additionally, and in relation to the wider proposed development GAPS has indicated that “an extensive programme of evaluation will be required **prior to** determining the appropriateness of the (planning) proposals and before a suitable mitigation strategy can be

devised" (GAPS ref.: 0805ab01/**D1315**). The survey reported here forms part of a wider archaeological evaluation programme.

As requested by GAPS, one of the main aims of this stage of geophysical survey was to evaluate the initial *Fugro Aperio Ltd* survey results within a number of targeted areas to help assess whether a similar approach could be taken in the proposed development area to the south: i.e., a geophysical contractor appointed by HNP to undertake a large-scale VMD survey, with the data being interpreted by GAT and specific anomalies then surveyed in more detail.

2.0 BACKGROUND

2.1 Horizon Nuclear Power multiplatform survey/ground investigation programme

The current targeted evaluation was preceded by a scheme wide multiplatform survey/ground investigation programme undertaken by HNP. As part of this programme *Fugro Aperio Ltd* completed a Vertical Magnetic Gradiometry (VMD) survey using a pair of Caesium vapour magnetometers with a 1m traverse interval (Fig.1); which was used as a none intrusive survey to identify below ground anomalies.

A total of 146 anomalies were identified by the VMD survey; which were subsequently interpreted by GAT (Fig. 1 and GAT Report **936**, see Appendix I). Specific anomalies were then targeted by FA via test pitting; a total of 36 test pits were targeted by FA (primarily for buried services) and GAT was commissioned by Horizon/FA to supervise 9 of these pits (TP-61A, TP-62A, TP-76A, TP-16A, TP-15B, TP-22A, TP-22B, TP-62B, TP-78B and subsequently TP-76B). Suspected prehistoric burnt mound activity was identified in two of these test pits (**TP62A** and **TP76B**; see Fig. 1) by GAT as part of a watching brief phase (report on watching brief is currently in development; GAT Report 994, forthcoming).

2.2.1 TP62A

This test pit was located at NGR **SH35189282** on a hillside sloping down to the SE and measured 0.5m in depth, and 0.03m x 0.37m in diameter. The test pit included a compact, black deposit of clay-silt-charcoal matrix surrounding fire cracked and reddened stones <0.05m in diameter, interpreted as burnt mound material. The feature was preserved in situ and not excavated within the confines of the test pit.

2.2.2 TP76B

This test pit was located at NGR **SH34629264**, located on ground which slopes down to a boggy area to the south. The test pit included a 0.8m thick deposit of friable black, clay-silt-/charcoal matrix surrounding fire cracked and reddened stones <0.1m in diameter. A sample was taken of the burnt material, and a written and photograph record was made of the exposed section. The rest of the feature survives *in situ.*

3.0 METHODOLOGY

3.1 Gwynedd Archaeological Trust High & Standard Resolution Magnetometer Geophysical Survey

The survey was carried out in a series of 20m grids, which were tied into the Ordnance Survey grid using a Trimble GPS system to an accuracy of 20mm. The survey was conducted using a Bartington Grad 601-2 Dual Sensor fluxgate gradiometer. The surveys in zones 4 and 5 were carried out at high resolution (0.5m traverse interval x 0.25m sample interval) and in zones 1, 2 and 3 at standard resolution (1.0 m traverse interval x 0.25m sample interval)

3.1.1 Instrumentation

The Bartington Grad 601-2 dual Fluxgate Gradiometer uses a pair of Grad-01-100 sensors. These are high stability fluxgate gradient sensors with a 1.0m separation between the sensing elements, giving a strong response to deeper anomalies.

The instrument detects variations in the earth's magnetic field caused by the presence of iron in the soil. This is usually in the form of weakly magnetised iron oxides which tend to be concentrated in the topsoil. Features cut into the subsoil and backfilled or silted with topsoil therefore contain greater amounts of iron and can therefore be detected with the gradiometer. This is a simplified description as there are other processes and materials which can produce detectable anomalies. The most obvious is the presence of pieces of iron in the soil or immediate environs which usually produce very high readings and can mask the relatively weak readings produced by variations in the soil. Strong readings are also produced by archaeological features such as hearths or kilns because fired clay acquires a permanent thermo-remnant magnetic field upon cooling. This material can also get spread into the soil leading to a more generalised magnetic enhancement around settlement sites.

Not all surveys can produce good results as anomalies can be masked by large magnetic variations in the bedrock or soil or high levels of natural background "noise" (interference consisting of random signals produced by material within the soil). In some cases, there may be little variation between the topsoil and subsoil resulting in undetectable features.

The Bartington Grad 601 is a hand held instrument and readings can be taken automatically as the operator walks at a constant speed along a series of fixed length traverses. The sensor consists of two vertically aligned fluxgates set 1.0m apart.

Their Mumetal cores are driven in and out of magnetic saturation by an alternating current passing through two opposing driver coils. As the cores come out of saturation, the external magnetic field can enter them producing an electrical pulse proportional to the field strength in a sensor coil. The high frequency of the detection cycle produces what is in effect a continuous output.

The gradiometer can detect anomalies down to a depth of approximately one metre. In agricultural land (as opposed to the deeper deposits of urban sites) archaeological features are usually detected at levels between the base of the topsoil and the top of cuts into the natural subsoil. This zone usually falls within the one metre range of the gradiometer. Substantial depths of windblown sand, soil added during landscaping or other recent accumulations of material can, however, mask archaeological responses.

The magnetic variations are measured in nanoTeslas (nT). The earth's magnetic field strength is about 48,000 nT, typical archaeological features produce readings of below 15nT although burnt features and iron objects can result in changes of several hundred nT. The instrument is capable of detecting changes as low as 0.1nT.

3.1.2 Data Collection

The gradiometer includes an on-board data-logger. Readings in the surveys are taken along parallel traverses of one axis of a 20m x 20m grid. The traverse interval is 0.5m. Readings are logged at intervals of 0.25m along each traverse.

3.1.3 Data presentation

The data is transferred from the data-logger to a computer where it is compiled and

processed using ArchaeoSurveyor 2 software. The data is presented as a grey-scale plot where data values are represented by modulation of the intensity of a grey scale within a rectangular area corresponding to the data collection point within the grid. This produces a plan view of the survey and allows subtle changes in the data to be displayed. This is supplemented by an interpretation diagram showing the main features of the survey with reference numbers linking the anomalies to descriptions in the written report. It should be noted that the interpretation is based on the examination of the shape, scale and intensity of the anomaly and comparison to features found in previous surveys and excavations etc. In some cases the shape of an anomaly is sufficient to allow a definite interpretation e.g. a Roman fort. In other cases all that can be provided is the most likely interpretation. The survey will often detect several overlying phases of archaeological remains and it is not usually possible to distinguish between them. Weak and poorly defined anomalies are most susceptible to misinterpretation due to the propensity for the human brain to define shapes and patterns in random background 'noise'. An assessment of the confidence of the interpretation is given in the text.

3.1.4 Data Processing

The data is presented with a minimum of processing although corrections are made to compensate for instrument drift and other data collection inconsistencies. High readings caused by stray pieces of iron, fences, etc are usually modified on the grey scale plot as they have a tendency to compress the rest of the data. The data is however carefully examined before this procedure is carried out as kilns and other burnt features can produce similar readings. The data on some noisy or very complex sites can benefit from 'smoothing'. Grey-scale plots are always somewhat pixellated due to the resolution of the survey. This at times makes it difficult to see less obvious anomalies. The readings in the plots can therefore be interpolated thus producing more but smaller pixels and a small amount of low pass filtering can be applied. This reduces the perceived effects of background noise thus making anomalies easier to see. Any further processing would be noted in relation to the individual plot.

4.0 RESULTS

Two 1 ha zones were initially surveyed and the results compared with the results from the previous multiplatform survey carried out by FA (See Appendix 1 - *GAT report 936, Targeted Geophysics (G2096) interim report: Assessment of techniques*). In addition the high resolution survey results are presented at standard resolution (1.0m x 0.25m) in order to demonstrate the quality of results that could be expected from a large-scale specialist archaeological survey. As would be expected, both the high resolution and standard resolution surveys showed greatly increased levels of detail compared to the multi-platform results. There was however, only a slight increase in clarity in the high resolution survey when compared with standard resolution data. After consultation with *HNP* and GAPS; email correspondence dated 06 September 2011 it was decided to survey the remaining three zones at standard resolution. Smaller areas could be re-surveyed at high resolution if finer detail was required.

The individual zone results are presented below, along with a comparison to the VMD survey results. Figures 2 to 11 present the greyscale survey results along with the GAT interpretations. Figures 12 to 16 provide comparisons within the individual zones between the GAT survey and the VMD survey interpretations.

4.1 Zone 1

Zone 1 (SH 34629263): targeted the location of suspected prehistoric burnt mound, originally identified in *Fugro Aperio Ltd* test pit TP76B. The south of the survey area was level and very wet with sloping ground to the north and a large mound, probably bedrock, at the western limit. It was bisected by a field boundary.

4.1.1 Survey results (Figs 2 and 3)

The suspected burnt mound produced a strong anomaly (1) consistent with a thermoremnant feature suggesting that the interpretation was correct. A second area of possible thermoremnant anomalies (2) was detected on the end of the raised bedrock mound and is also best interpreted as a burnt mound. The edge of a further area of strong anomalies (3) was detected in the north-west corner of the survey. This appears to be a little more diffuse and given its position on a slope is best interpreted as being of geological origin. The south-west corner of the survey is dominated by a large irregular anomaly (4) that corresponds to a wet area in the fields. This appears to be the remains of a drained and possibly infilled pond. This area is drained by a substantial stone-lined 18th or 19th century drainage ditch and the pond would therefore predate the current field system. A former field boundary shown on 1889 and 1924 Ordnance Survey County Series maps produced a faint linear anomaly (5). A wide and diffuse linear anomaly (6) interpreted as a former boundary from the *Fugro Aperio Ltd* data appears to be of geological origin.

4.1.2 Comparison with VMD survey results (Fig. 12)

The GAT fluxgate gradiometer survey detected smaller anomalies (1, 2 and 3, described above) that could not be distinguished from background variations on the VMD data. Anomaly 1 was identified as a burnt mound in a test pit. A possible former pond (GAT anomaly 4/*Fugro* anomaly A-125) and two former boundaries (GAT anomaly 5/*Fugro* anomaly A-121 and GAT anomaly 6/*Fugro* anomaly A120) were detected by both surveys. GAT anomaly 5/*Fugro* anomaly A-121 was weak and diffuse and the wider context revealed by the larger survey area of the VDM produced the most accurate interpretation.

4.2 Zone 2

Zone 2 (SH34559282): targeted *Fugro Aperio Ltd* anomalies A102, A104, A106 and A107 (see Figure 1); these anomalies had been interpreted by GAT as part of a field system predating the current 18th / 19th century system. The survey area consisted of an area of pasture sloping from the east down to the edge of an area of mounds that are presumed to be grassed-over bedrock.

4.2.1 Survey results (Figs 4 and 5)

The survey detected a series of well-defined linear anomalies best interpreted as field boundaries (7-11). Anomalies 7 and 8 correspond to *Fugro Aperio Ltd* anomalies A104 and A106. These along with anomalies 9 and 10 appear to be part of a former field system predating those shown on the 1820 and 1889 OS maps (Figures 17 and 18 respectively). Anomaly 11 respects these field boundaries and is probably part of the same system. These fields appear to be typical smaller enclosures that predate the larger fields produced during estate improvements in the 18th century.

Three wider, diffuse, positive anomalies (12, 13 and 14) are most likely to be the result of the underlying geology but could alternatively be interpreted as the ploughed-down remains of lynchets from a prehistoric or medieval field system.

Part of a curvilinear feature was detected close to the north-west corner of the survey. This was not detected by the to *Fugro Aperio Ltd* survey. The anomaly does not correspond to any of the mounds at the base of the slope. This anomaly could be interpreted in several ways depending on its overall outline, but could be either a prehistoric enclosure or more recent disturbance. A further narrow, linear anomaly is probably agricultural in origin, possibly a drain. The entire survey is criss-crossed with narrow linear anomalies (shown as dashed lines on the interpretation plan) which do not respect the earlier field boundaries and are therefore the result of modern ploughing. Several faint circular anomalies also dashed lines on the plan also appear to be natural or agricultural subsoil features.

4.2.2 Comparison with VMD survey results (Fig. 13)

The Fluxgate gradiometer survey revealed a lot of fine detail. This was, however, mostly agricultural activity and modern disturbance. The major relict field boundaries were, however, clearly identified on both surveys.

4.3 Zone 3

Zone 3 (SH 34739292) targeted *Fugro Aperio Ltd* anomaly A91. This anomaly has been interpreted as a semi-circular anomaly on top of a rounded natural hill, possibly part of a circular prehistoric enclosure or settlement.

4.3.1 Survey results (Figs 6 and 7)

This area contained further former field boundaries predating those shown on the 1820 and 1889 OS maps (17, 18 and 19). Feature 19 is a parallel double anomaly perhaps indicating a former trackway. These are presumably part of the same field system as anomalies 7-11.

A curvilinear anomaly (20, Fugro Aperio A91) intersects anomaly 19. This appears to be a ditch, possibly with a gap in the eastern side. It is not possible to determine the phasing of the two features from the geophysical survey data but if the ditch predates the boundary a prehistoric origin seems likely. Given its elevated situation one possible interpretation for this feature is that it forms part of the enclosure of a prehistoric defended settlement / site of some form. The incomplete nature of the ditch could point to the enclosure never being completed or to later disturbance. It may also indicate that a different interpretation is required; however there are comparable sites within the wider area around the proposed development site and many prehistoric defended settlements in similar locations on Anglesey. No features apart from a strong, probably recent, ferrous anomaly (21) and a small area of disturbance (22) could be seen in the interior.

4.3.2 Comparison with VMD survey results (Fig. 14)

There were several weak anomalies in this zone, identified as relict field boundaries, that were only identified by the GAT fluxgate gradiometer survey. The anomaly with the greatest archaeological potential GAT anomaly 20/*Fugro* anomaly A-91, interpreted as a possible prehistoric ditched enclosure, was clearly visible on both surveys.

4.4 Zone 4

Zone 4 (SH35179283): targeted the location of a suspected prehistoric burnt mound, originally identified in *Fugro Aperio Ltd* test pit TP62A. The survey area was in a field sloping to the east.

4.4.1 Survey results (Figs 8 and 9)

The survey detected a strong magnetic anomaly (23) interpreted as the burnt mound discovered in *Fugro Aperio Ltd* test pit TP62A The anomaly is consistent with a thermoremnant feature. It appears to be principally produced by in-situ burning with a fairly consistent positive and negative response across the feature. Burnt mounds sometimes produce mass of randomly orientated responses due to the presence of randomly orientated magnetically enhanced heat-affected stones. This affect depends, however, on the iron content of stones used in the mound.

A second possible thermoremnant (24) anomaly that could be another burnt mound was detected 12 metres to the south-east.

Both anomalies lie on the line of a linear anomaly (25) that indicates the line of a former field boundary. This could suggest an alternative, later, origin for features A and B such as large bonfires dating from the removal of the hedgerow.

Two further linear positive anomalies, 26 and 27, are probably the result of drains or ditches and a similar negative anomaly 28 is probably a further drainage feature.

Less well-defined linear anomalies 29 and 30 are probably a result of ploughing.

4.4.2 Comparison with VMD survey results (Fig. 15)

The strongest anomaly, a relict field boundary GAT anomaly 25/*Fugro* anomaly A96 was revealed by both surveys. Smaller and weaker anomalies including two possible burnt mounds (GAT anomalies 23 and 24) were not readily distinguishable on the VMD survey.

4.5 Zone 5

Zone 5 (SH35579288): targeted *Fugro Aperio Ltd* anomaly A338. This feature has been interpreted as either modern disturbance or a ditched enclosure possibly Prehistoric in origin. The survey area was in level slightly uneven pasture.

4.5.1 Survey results (Figs 10 and 11)

The survey revealed a complex series of anomalies. The irregular character of anomalies 31 to 34, one of which is *Fugro Aperio Ltd* anomaly A338, suggest that they are not archaeological in origin and are a result of landscaping or other subsoil changes. The field has clearly been heavily cultivated and possibly landscaped and is criss-crossed with fine linear anomalies (shown as dotted lines on the interpretation) consistent with several phases of deep ploughing. There are also numerous linear anomalies (35-40) best interpreted as drains or service trenches on the eastern side of the survey.

4.5.2 Comparison with VMD survey results (Fig. 16)

Most of the major anomalies were identified by both surveys. The greater level of detail from the fluxgate gradiometer survey allowed the large circular feature GAT anomaly 31/*Fugro* anomaly A-38 to be interpreted as modern disturbance as opposed to more significant archaeology.

5. CONCLUSIONS

5.1 Effectiveness of VMD Survey

The VMD survey carried out by *Fugro Aperio Ltd* allowed a very large area to be assessed quickly and efficiently in a manner that provides data suitable for a range of purposes. In terms of identifying archaeological features the VMD survey has revealed numerous large-scale archaeological anomalies seemingly from several periods of history. It has also identified areas of modern disturbance / activity and areas where large-scale cut features are not present. It is therefore clearly an effective method for identifying potential "hot-spots" of archaeological potential and for identifying areas that are unlikely to contain large--scale features. However, the relatively low resolution results are not suitable for detailed archaeological assessment. For these purposes standard resolution Bartington surveys provide a good balance between speed and resolution and have been shown to deliver adequate results on this site in comparison with high resolution surveys.

5.2 Results of the detailed surveys

The results from the five 1 ha sample areas allowed the features detected in the *Fugro Aperio Ltd* survey to be assessed in greater detail. Several additional features were also discovered giving a more detailed understanding of the archaeological resource in certain locations.

Four potential burnt mound sites were detected (1, 2, 23, and 24). Features 1 and two are in on the edge of an area of wetland, a typical location for burnt mounds. Features 23 and 24 are in a sloping field away from water and alternative interpretations of these may be valid..

The curvilinear anomaly in zone 3 (20) was shown to be a well defined ditch typical of a prehistoric enclosure. In contrast the curvilinear anomaly in zone 5 (31) was shown to have a very different character and is most likely to be modern disturbance.

The *Fugro Aperio Ltd* survey revealed a series of somewhat disconnected linear features across the three fields containing Zones 1, 2 and 3. The clearer results from the targeted survey show that these were part of an extensive system of small fields dating from the 18th century or before that were superseded by the current larger fields that are a typical product of 18th and 19th century agricultural improvements, usually by large estates.

5.3 Implications for the archaeolgical evaluation of the development site

The majority of the larger-scale anomalies were identified by both surveys. The large area of the VMD survey allowed archaeological features to be seen in the context of the wider landscape, thus allowing good interpretation of larger features. This survey successfully identified large-scale anomalies and provided a general assessment of the levels of archaeological activity across the development area.

The fluxgate gradiometer survey produced a greater level of detail and also allowed a better estimation of the intensity of anomalies. This was useful in the case of the possible burnt mounds which were faintly visible on the VMD survey but could not be distinguished from background geological variation. This technique was shown to be useful for detecting both large and smaller-scale archaeological features.

As discussed in Appendix 1, geophysical survey techniques do not always identify all types of remains. It is therefore important that further investigation of the results is undertaken to provide greater certainty regarding the origin of features identified and to ascertain whether areas of null results are in fact free of significant archaeolgical features or whether the VMD methodology fails to identify particular types of remains and whether other survey methodologies would be more effective in certain areas of the site.

To achieve this further intrusive and non-intrusive archaeolgical works in key areas of the site are required to test the VMD and detailed survey results. The methodology, scope and focus of these works will be developed in consultation with GAPS and implemented as part of the required wider evaluation programme.

6. SOURCES CONSULTED

Davidson, A., 2010. Gwynedd Archaeological Trust Report **842**. Proposed Nuclear Power Station at Wylfa, Anglesey, North Wales: *Archaeological & Cultural Heritage Baseline Assessment Report***.** May 2010

Hopewell, D. 2011 Gwynedd Archaeological Trust Report **936**. *Preliminary outline interpretation of potential archaeological magnetic gradient anomalies in Phase 1 area, Wylfa* March 2010 (not published: reproduced as Appendix I)

Horizon Nuclear Power drawings TQHOWA/001 & TQHOWA/003

Fugro Aperio Ltd drawing 3652-11B

Wylfa New Build: Intermediate Ground Investigation Scope data

APPENDIX I

PROPOSED NUCLEAR POWER STATION, WYLFA YNYS MÔN

GAT report 936: Preliminary outline interpretation of potential archaeological magnetic gradient anomalies in Phase 1 area, Wylfa

INTRODUCTION

This document lists and interprets non-ferrous and non-geological magnetic gradient anomalies from Wylfa Phase 1 area. The individual anomalies are presented on a drawing overlaid on magnetic gradient data and a background map provided by *Fugro Aperio Limited*. Each anomaly is interpreted and the level of confidence of the interpretation and the potential importance of the archaeological resource are recorded. The interpretation of archaeological anomalies depends on recognising the morphology of a feature in plan and there are often several possible interpretations. Alternative interpretations are therefore noted in the table along with level of confidence.

A Vertical Magnetic Gradiometry (VMD) survey undertaken by *Fugro Aperio Ltd* as part of the multiplatform survey/ground investigation programme. The VMD survey was completed using a Caesium vapour magnetometer positioned at 1.0m traverses

Gradiometer surveys can detect a wide range of buried archaeological features such as linear ditches, thermoremnant anomalies such as kilns and hearths, buildings, walls and pits. It should, however, be stressed that it can not be assumed that geophysical survey will detect all archaeological features. Some features such as Neolithic settlement may only survive as small discrete postholes that are too small to be detected by most surveys, graves may be filled with the same soil as the surroundings and thus be undetectable and sometimes there is no magnetic difference between the archaeology and natural subsoil.

Note: this report has been produced to provide an interpretation of all identifiable anomalies recovered from the Fugro Aperio Limited Vertical Magnetic Gradiometry (VMD) survey. So-called "blank areas", where no anomalies were identified, do not necessarily equate to areas of non-archaeological activity and/or areas of "reduced risk"..

Key

Anomaly Number – Recorded on associated interpretation plan

Interpretation – Interpretation of the anomaly based on its shape in plan and the strength of the magnetic gradient when compared to known archaeological site types

Confidence- The level of confidence of the interpretation. Some archaeological anomalies can be identified with a high degree of confidence, e.g. the distinctive outline of a Roman fort. Most anomalies cannot however be interpreted with a high level of certainty. Linear ditches could be assigned to many periods and functions and very weak anomalies, for example those produced by prehistoric settlement and cemeteries can be difficult to distinguish from natural subsoil variations and periglacial features.

Confidence is scored as:

H – High, the anomaly can be recognized from its shape or form as a recognizable site type.
M- Medium, the anomaly can be provisionally allocated to a site type or more general category.
L- Low- Amorphous and weak anomalies that can be provisionally allocated to a site type.

Table 1 – Interpretation of magnetic gradient anomalies

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A-01	Former field boundary, unclear as aligned with traverse direction	M	D	Modern disturbance, possibly a track or even a data gathering artefact	M
A-02	Modern disturbance associated with pipeline	M	F	Former field boundary or enclosure bank.	L
A-03	Minor feature, probably agriculture or fragments of former field boundaries shown on 1889/1924 OS County Series maps	M	C-D		
A-04	Minor features, probably agriculture or fragments of former field boundaries shown on 1889/1924 OS County Series maps	M	C-D		
A-05	Roughly concentric circular anomalies. Modem disturbance associated with Wylfa A construction	H	F	Multivallate prehistoric enclosure or settlement	L
A-06	Modern surface track/footpath	H	F		
A-07	Minor feature, probably agricultural	M	F		
A-08	Narrow trench, probably modern carrying a pipe or cable	H	F		
A-09	Narrow trench, probably modern carrying a pipe or cable	H	F	Possibly a narrow ditch forming an enclosure with A-13	L
A10	Double parallel anomaly, probably former field boundary shown on 1889/1924 OS County Series maps	H	C-D	Narrow double feature, probably modern trench carrying a pipe or cable.	L
A-11	Meandering feature, probably agricultural or pipe trench	M	F	Possibly a narrow ditch, former boundary or enclosure	L
A-12	Meandering feature, probably agricultural or pipe trench, continuation of A-11	M	F	Possibly a narrow ditch, former boundary or enclosure	L
A-13	Narrow curvilinear trench, possibly modern carrying a pipe or cable	M	F	Possibly a narrow ditch forming an enclosure with A-09	L

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A14	Faint curvilinear features with some additional associated noise. Either natural subsoil variation or agricultural / modern disturbance	H	F	Possibly slight remains of prehistoric settlement, pits and enclosures. Fairly unlikely however	L
A-15	Small discrete circular anomaly, either natural or a processing artefact	M	F	Small round barrow, prehistoric or Roman. Possible but unlikely	L
A-16	Parallel anomalies, modern ploughing as opposed to medieval ridge and furrow	H	D	The central (NW – SE) wider anomaly could be a former field boundary shown on 1889/1924 OS County Series maps	M
A-17	?Modern surface track/footpath, continuation of A-06	H	F		
A-18	Former field boundary shown on 1889 OS map	H	C-D		
A-19	Long curvilinear feature, possibly a former trackway	M	B-C	Modern disturbance	M
A-20	Mound visible on 1948 aerial photograph, natural feature	M	F	Prehistoric barrow	L
A-21	Mound visible on 1948 aerial photograph, natural feature	M	F	Prehistoric barrow	L
A-22	Widely spaced parallel linear anomalies, poss. former field boundary	M	C-D	Agriculture or modern disturbance	M
A-23	Parallel linear anomalies, former field boundary	M	C-D	Agriculture or modern disturbance	M
A-24	Faint linear anomaly, drainage or former boundary	M	C-D		
A-25	Strong roughly circular anomaly 20m diam, central feature. Possibly prehistoric settlement or funerary monument. Requires further evaluation	M	A-B (E)	Modern disturbance	L
A-26	Faint linear anomaly, drainage or former boundary	M	C-D		
A-27	Two linear anomalies with right angle turn. Agriculture or modern disturbance	M	D	Enclosure or boundary ditches	L

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A-28	Linear anomaly. Agriculture or modern disturbance	M	D		
A-29	Linear anomaly. Agriculture or modern disturbance	M	D		
A-30	Former boundary and footpath shown on 1889 OS map	H	C-D		
A-31	Former track from Tyddyn Du	H	C		
A-32	Former boundary and drain shown on 1889 OS map	H	C-D	Modern disturbance	M
A-33	Linear anomaly possibly former boundary or drainage	M	C-D		
A-34	Narrow linear anomaly, possibly a drain	L	D	Agriculture or modern disturbance	M
A-35	Narrow linear anomaly, possibly a drain	L	D	Agriculture or modern disturbance	M
A-36	Oval anomaly, recent disturbance	M	F	Unknown archaeological feature	L
A-37	Linear anomaly possibly former boundary	M	C-D	Modern disturbance	M
A-38	Modern disturbance	M	F	Ditched enclosure poss. prehistoric	L
A-39	Linear anomaly, possibly former boundary or drainage	M	C-D	Modern feature	L
A-40	Large oval anomaly, quarry pit	M	C-D	Modern disturbance	M
A-41	Modern disturbance poss. former access track	M	F	Curvilinear anomaly possibly part of former boundary or enclosure	M
A-42	Modern disturbance	M	F	Curvilinear anomaly possibly part of former boundary or enclosure	M
A-43	Modern disturbance poss. former access track	M	F		

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A-44	Linear anomaly, possibly former boundary or drainage	M	C-D		
A-45	Former boundary shown on 1889 and 1924 Ordnance Survey County Series maps	H	C-D		
A-46	Two linear anomalies, probably modern drainage or agriculture	H	F		
A-47	Linear anomaly, crosses modern boundaries, post-medieval field boundary	M	C-D		
A-48	Former field boundary shown on 1889 and 1924 Ordnance Survey County Series maps	H	C-D		
A-49	Former field boundary shown on 1889 and 1924 Ordnance Survey County Series maps	H	C-D		
A-50	Former field boundary possible continuation of A-49	H	C-D		
A-51	Weak linear anomaly, possible former field boundary	M	C-D		
A-52	Double parallel linear anomaly, former trackway	M	C-D	Linear anomaly, possibly former double ditched boundary	M
A-53	Linear anomaly crosses current field system possibly former early boundary	M	C-D		
A-54	Ferrous and linear anomaly modern services	H	F		
A-55	Former field boundary shown on 1889 and 1924 Ordnance Survey County Series maps	H	C-D		
A-56	Former field boundary shown on 1889 and 1924 Ordnance Survey County Series maps	H	C-D		
A-57	Linear anomaly possibly former boundary or drain	M	C-D		

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A-58	Former field boundary shown on 1889 and 1924 Ordnance Survey County Series maps	H	C-D		
A-59	Curvilinear anomaly, drainage channel	M	D		
A-60	Curvilinear anomaly, drainage channel, continuation of A-59	M	D		
A-61	Linear anomaly, former boundary or drain	M	C-D		
A-62	Plough scarring, prob. modern	H	F		
A-63	Field drains	H	F		
A-64	Field drains	H	F		
A-65	Linear anomaly, former boundary or drain	M	C-D		
A-66	Linear anomaly, former boundary	M	C-D		
A-67	Circular anomaly, 40m diameter. Prehistoric enclosure or settlement	H	A-B		
A-68	Area of noise, possible activity associated with A-67	M	E	Modern disturbance or landscaping	L
A-69	Linear anomaly, former boundary or enclosure	M	C-D		
A-70	Modern dumping	H	F		
A-71	Weak circular anomaly, 40m diameter. Prehistoric enclosure or settlement	M	A-B	Modern disturbance	L
A-72	Linear anomaly, former boundary	M	C-D		

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A-73	Parallel anomalies, modern drainage or ploughing	H	F		
A-74	Parallel anomalies, modern drainage or ploughing	H	F		
A-75	Linear anomaly, former boundary, part of current field system	M	C-D		
A-76	Group of linear anomalies and increased noise. Early boundaries and settlement (medieval or post-medieval)	M	B-C (E)	Modern disturbance	L
A-77	Linear anomaly, former boundary	M	C-D		
A-78	Circular anomaly, modern disturbance	M	F	Circular anomaly, 40m diameter. Prehistoric enclosure or settlement	L
A-79	Broken and forking linear, former trackway, age unknown	M	B-D	Modern disturbance	L
A-80	A series of linear anomalies at approx right-angles. Medieval or post-medieval field system	M	B-D	Modern drainage	L
A-81	Faint linear anomalies, probably ploughing or drainage	L	D		
A-82	Data artefact?	M	F	Modern services / drain	L
A-83	Fragmentary double linear anomaly, former trackway	M	D	Modern erosion	L
A-84	Former field boundary shown on 1889 and 1924 Ordnance Survey County Series maps	H	C-D		
A-85	Two curvilinear anomalies, former boundaries, poss. prehistoric or medieval	M	B-C	Modern disturbance	L
A-86	Linear and rectangular anomalies. Medieval or post- medieval settlement/buildings	M	A-C (E)	Geology or modern disturbance	L

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A-87	Curvilinear anomaly, modern disturbance	M	F	Circular anomaly, prehistoric enclosure or settlement	L
A-88	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D		
A-89	Footpath shown on 1889 and 1924 Ordnance Survey County Series maps				
A-90	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-91	Curvilinear anomaly, prehistoric enclosure or settlement	L	A-B		
A-92	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-93	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-94	Possible terracing, medieval or prehistoric field system	M	B-C	Modern drainage or agricultural features	M
A-95	Former field boundary shown on 1889 and 1924 Ordnance Survey County Series maps	H	C-D		
A-96	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-97	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-98	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-99	Rectangular and ferrous or thermo-remnant anomaly, Enclosure and building unknown date	M	A-D (E)	Modern disturbance	L
A-100	Area of increased noise, post medieval or modern landscaping	M	D	Geology	L

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A-101	Area of increased noise, post medieval or modern landscaping	M	D	Geology	L
A-102	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-103	Area of increased noise, post medieval or modern landscaping	M	D	Geology	L
A-104	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-105	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-106	Weak linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-107	Linear anomaly, part of a field system predating current 18th/19th century system	L-M	C-D	Geology	L
A-108	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-109	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-110	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-111	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-112	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-113	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A-114	Modern drainage	M	F		
A-115	Two linear anomalies, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-116	Modern disturbance or land drains down W side of fields	M	F		
A-117	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-118	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-119	Palaeochannel or other natural sub-soil feature	M	F	Linear anomaly, part of a field system predating current 18th/19th century system	M
A-120	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-121	Former field boundary shown on 1889 and 1924 Ordnance Survey County Series maps	H	C-D		
A-122	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-123	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-124	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-125	Area of increased noise, post medieval or modern landscaping	M	D	Geology	L
A-126	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L
A-127	Linear anomaly, part of a field system predating current 18th/19th century system	M	C-D	Modern agricultural features or disturbance	L

Anomaly Number	Interpretation	Confidence	Importance	Alternative Interpretation	Confidence
A-128	Linear anomaly, former field boundary	M	C-D		
A-129	Parallel anomalies, modern drainage or ploughing	H	F		

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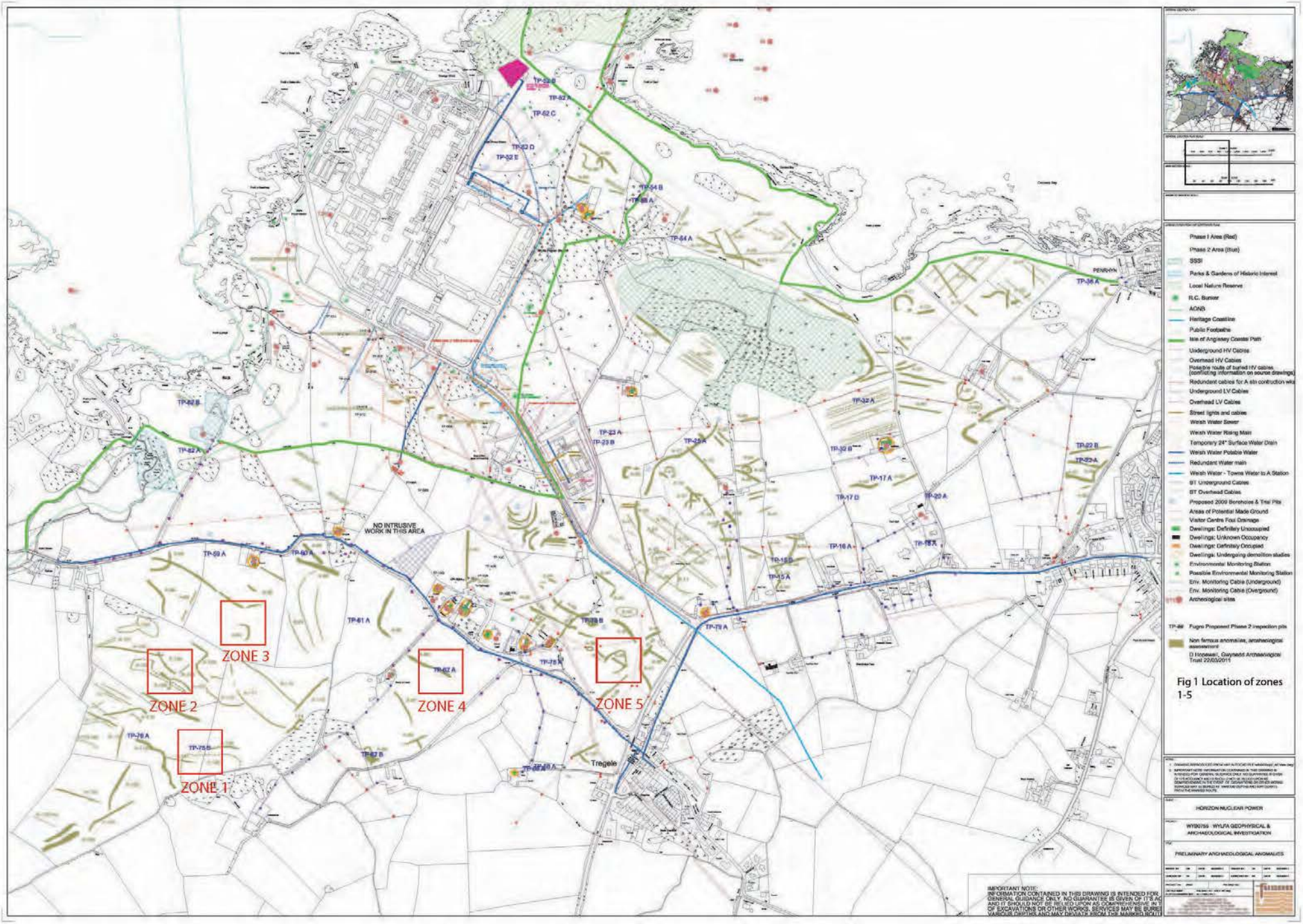

ZONE 1
ZONE 2
ZONE 3
ZONE 4
ZONE 5
NO INTRUSIVE WORK IN THIS AREA
Tregele
PENRHYN
Phase 1 Area (Red)
Phase 2 Area (Blue)
SSSI
Parks & Gardens of Historic Interest
Local Nature Reserve
R.C. Bunker
AONB
Heritage Coastline
Public Footpaths
Isle of Anglesey Coastal Path
Underground HV Cables
Overhead HV Cables
Possible route of buried HV cables (conflicting information on source drawings)
Redundant cables for A sta contruction wks
Underground LV Cables
Overhead LV Cables
Street lights and cables
Welsh Water Sewer
Welsh Water Rising Main
Temporary 24" Surface Water Drain
Welsh Water Potable Water
Redundant Water main
Welsh Water - Towns Water to A Station
BT Underground Cables
BT Overhead Cables
Proposed 2009 Boreholes & Trial Pits
Areas of Potential Made Ground
Visitor Centre Foul Drainage
Dwellings: Definitely Unoccupied
Dwellings: Unknown Occupancy
Dwellings: Definitely Occupied
Dwellings: Undergoing demolition studies
Environmental Monitoring Station
Possible Environmental Monitoring Station
Env. Monitoring Cable (Underground)
Env. Monitoring Cable (Overground)
Archeological sites
Fugro Pinpoint Phase 2 inspection pits
Non ferrous anomalies, archaeological assessment
D Hopewell, Gwynedd Archaeological Trust 22/03/2011
Fig 1 Location of zones 1-5
HORIZON NUCLEAR POWER
WYB0755 WYLFA GEOPHYSICAL & ARCHAEOLOGICAL INVESTIGATION
PRELIMINARY ARCHAEOLOGICAL ANOMALIES
IMPORTANT NOTE:
INFORMATION CONTAINED IN THIS DRAWING IS INTENDED FOR
GENERAL GUIDANCE ONLY. NO GUARANTEE IS GIVEN OF IT'S AC
AND IT SHOULD NOT BE RELIED UPON AS COMPREHENSIVE IN T
OF EXCAVATIONS OR OTHER WORKS. SERVICES MAY BE BURIE
VARIOUS DEPTHS AND MAY DEVIATE FROM THE MARKED ROUTE

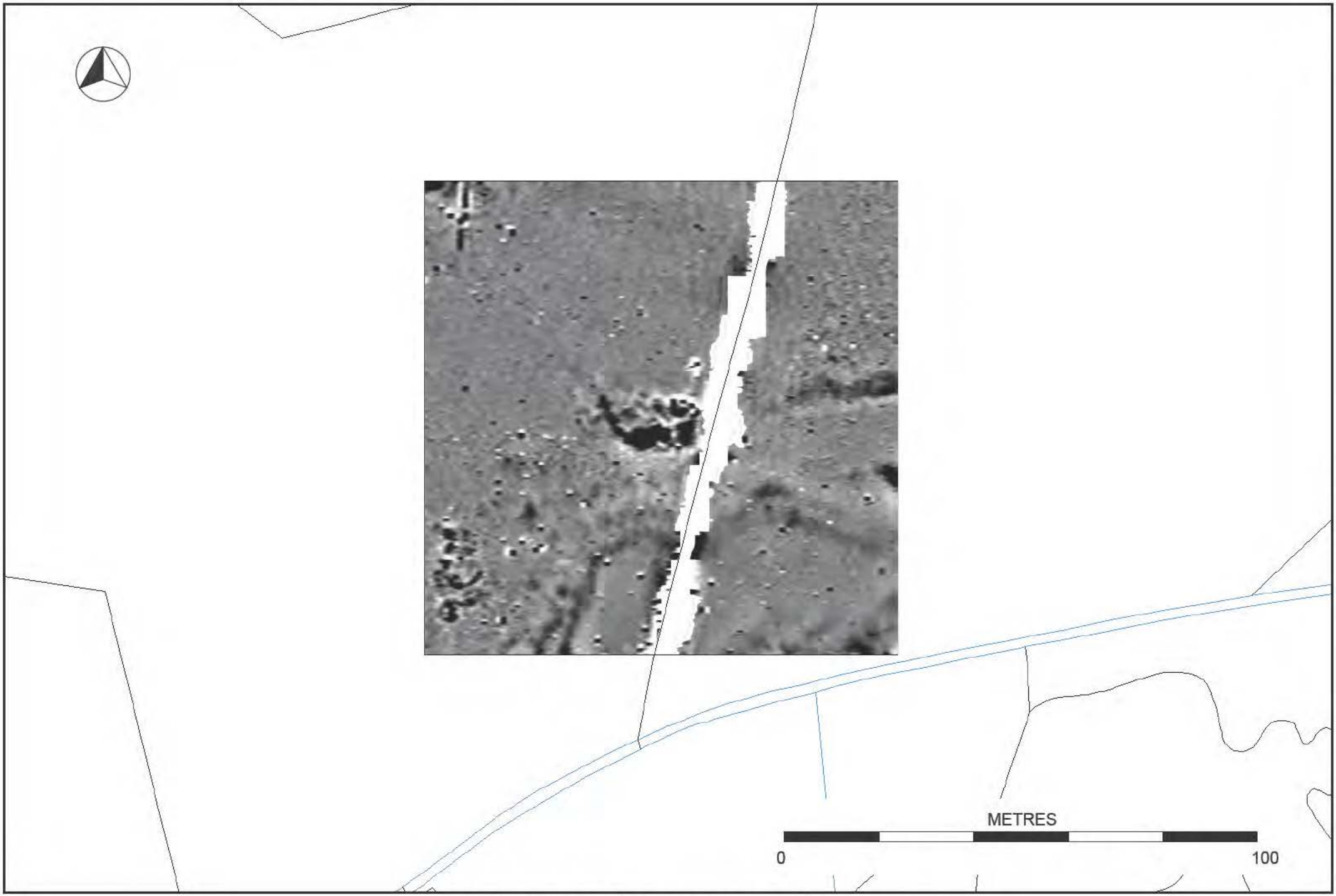


Fig. 2 Standard resolution gradiometer survey of Zone 1

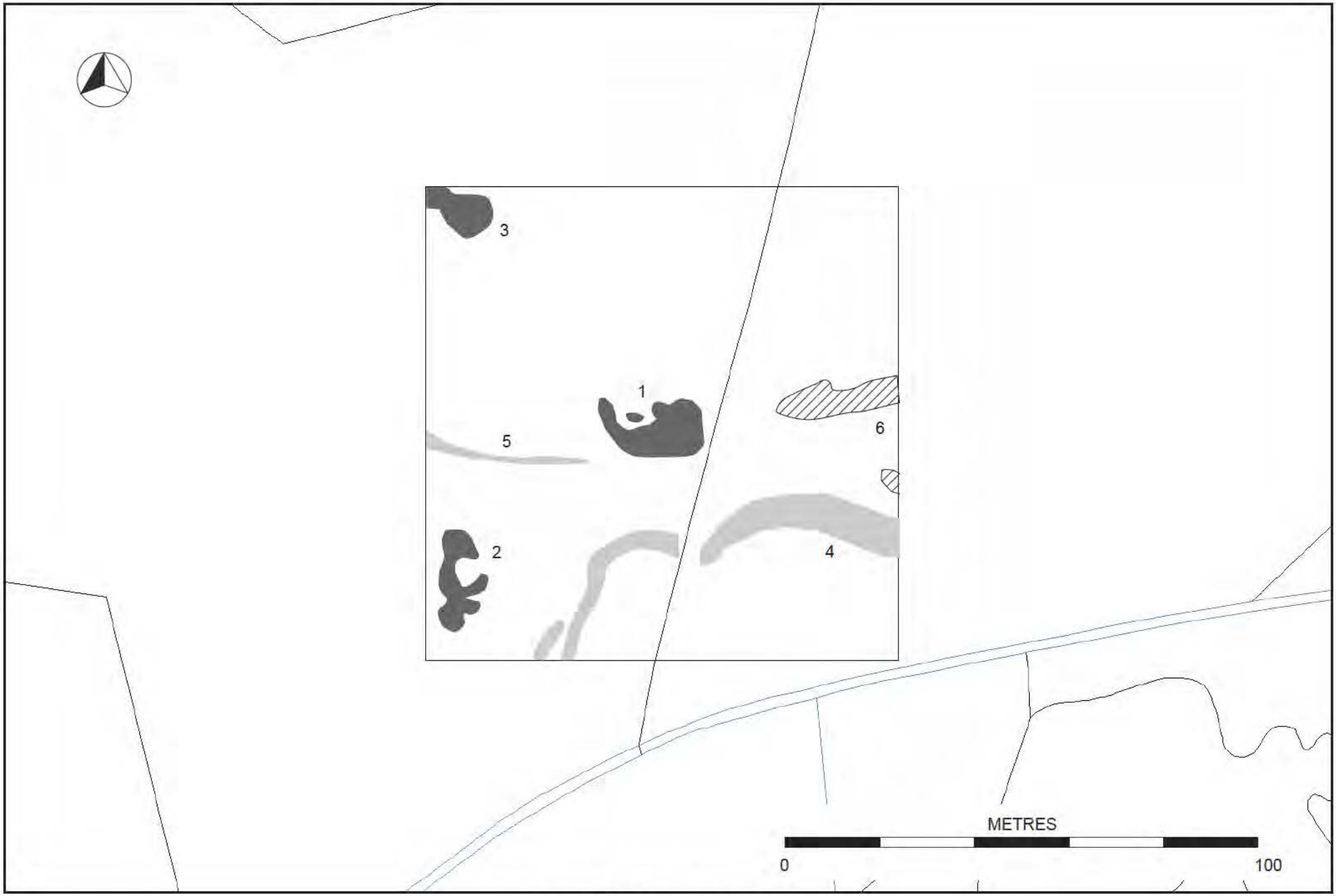


Fig. 3 Zone 1, interpretation

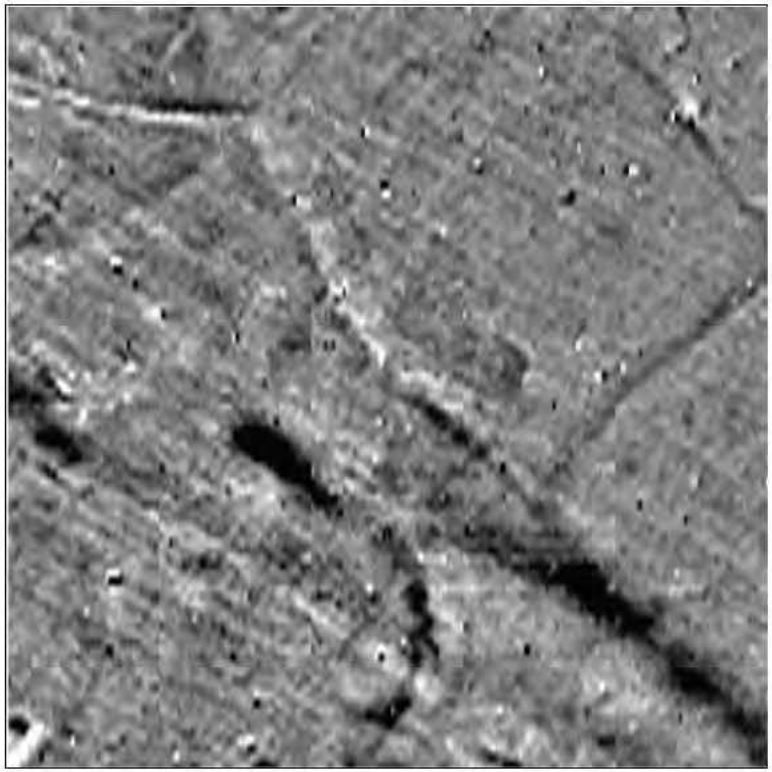
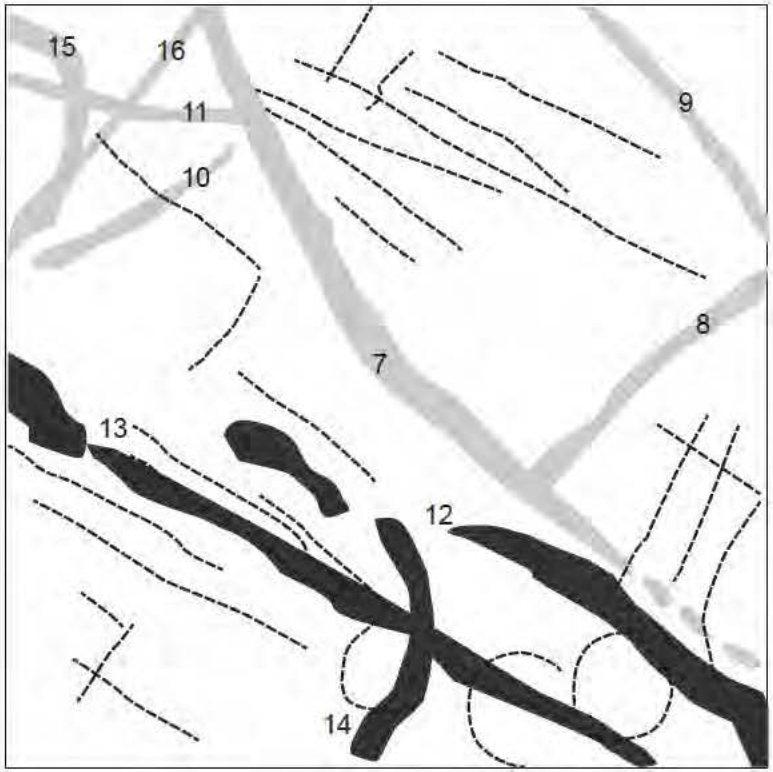


Fig. 4 Standard resolution gradiometer survey of Zone 2



METRES

0 100

Fig. 5 Zone 2, interpretation

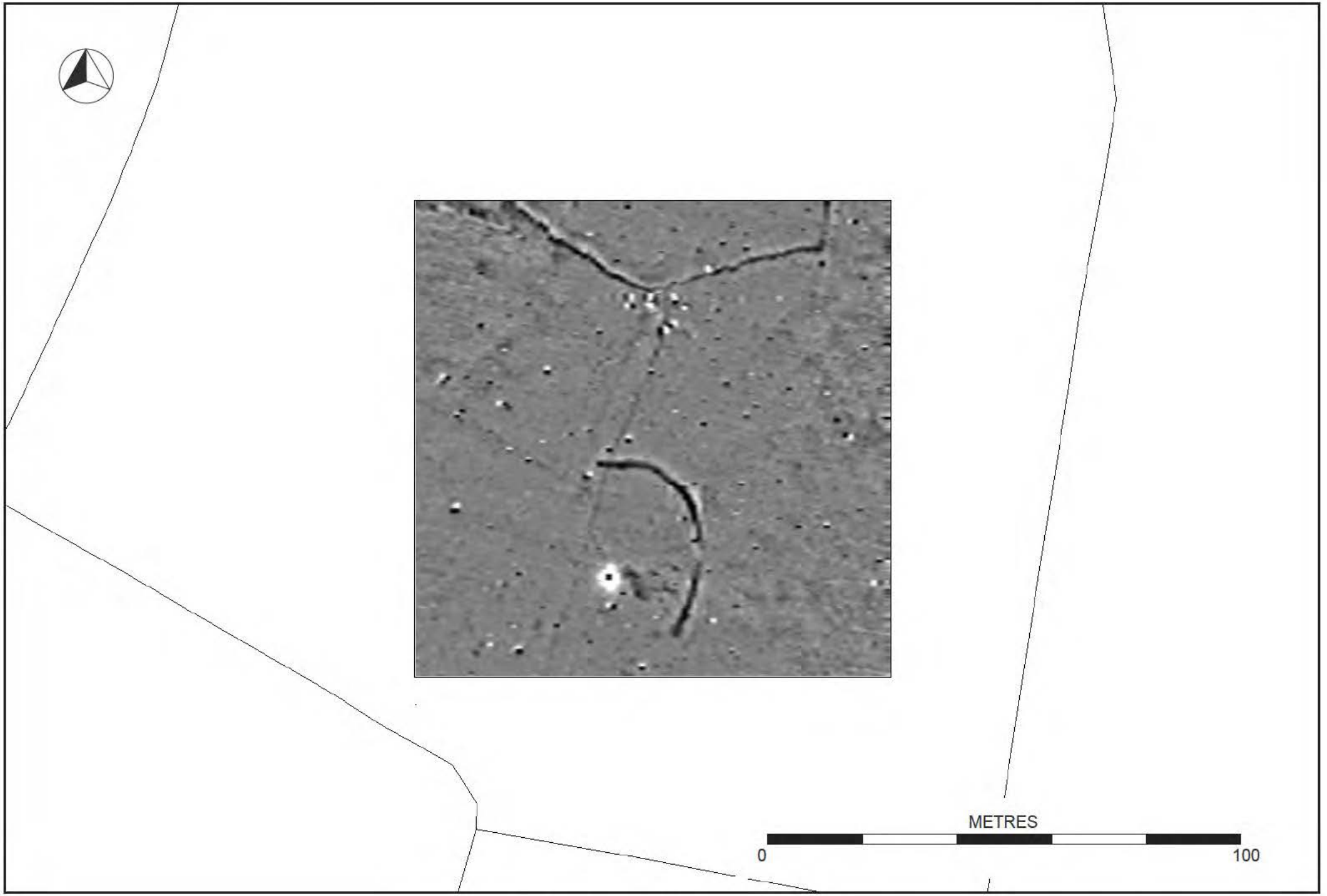


Fig. 6 Standard resolution gradiometer survey of Zone 3

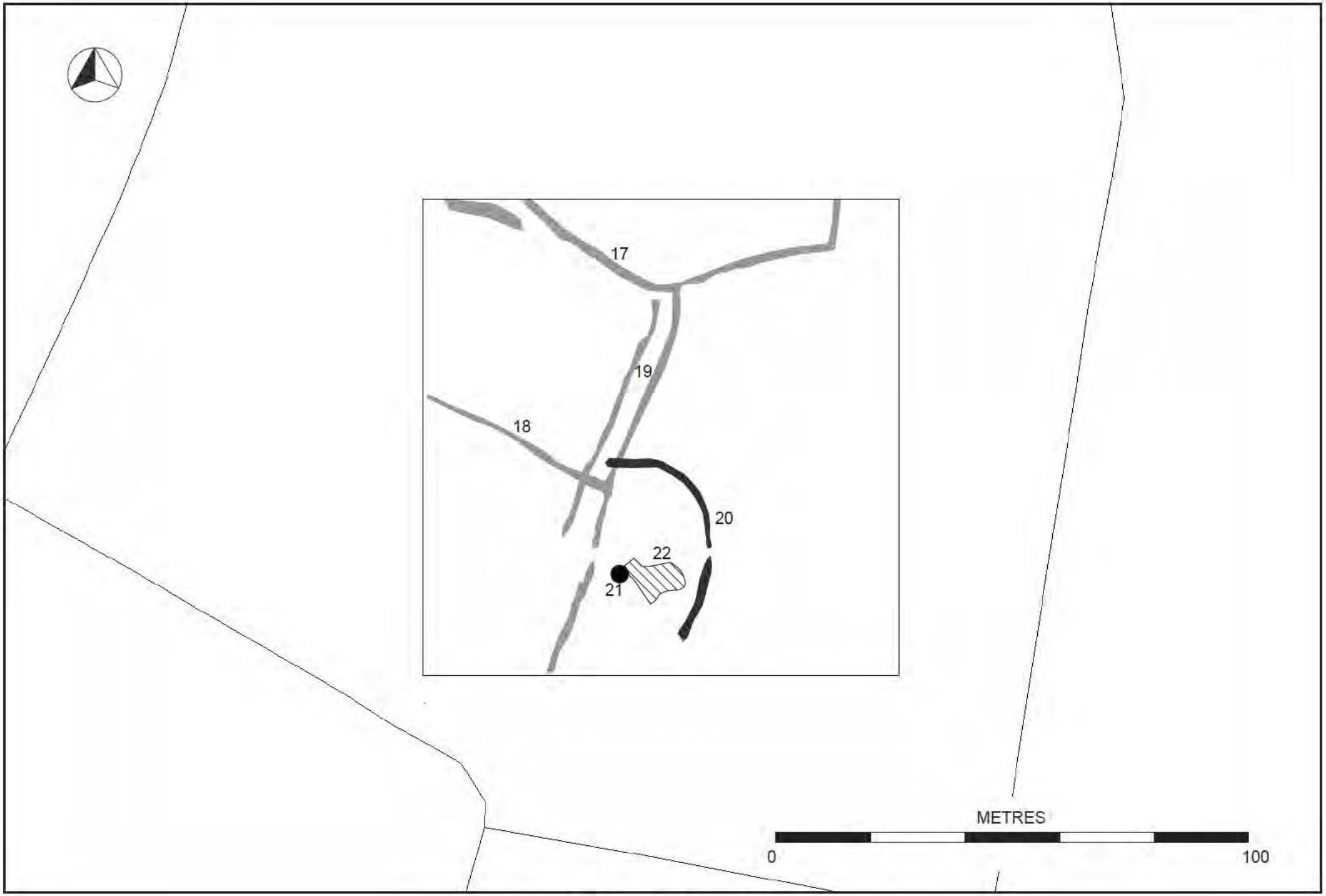


Fig. 7 Zone 3, interpretation

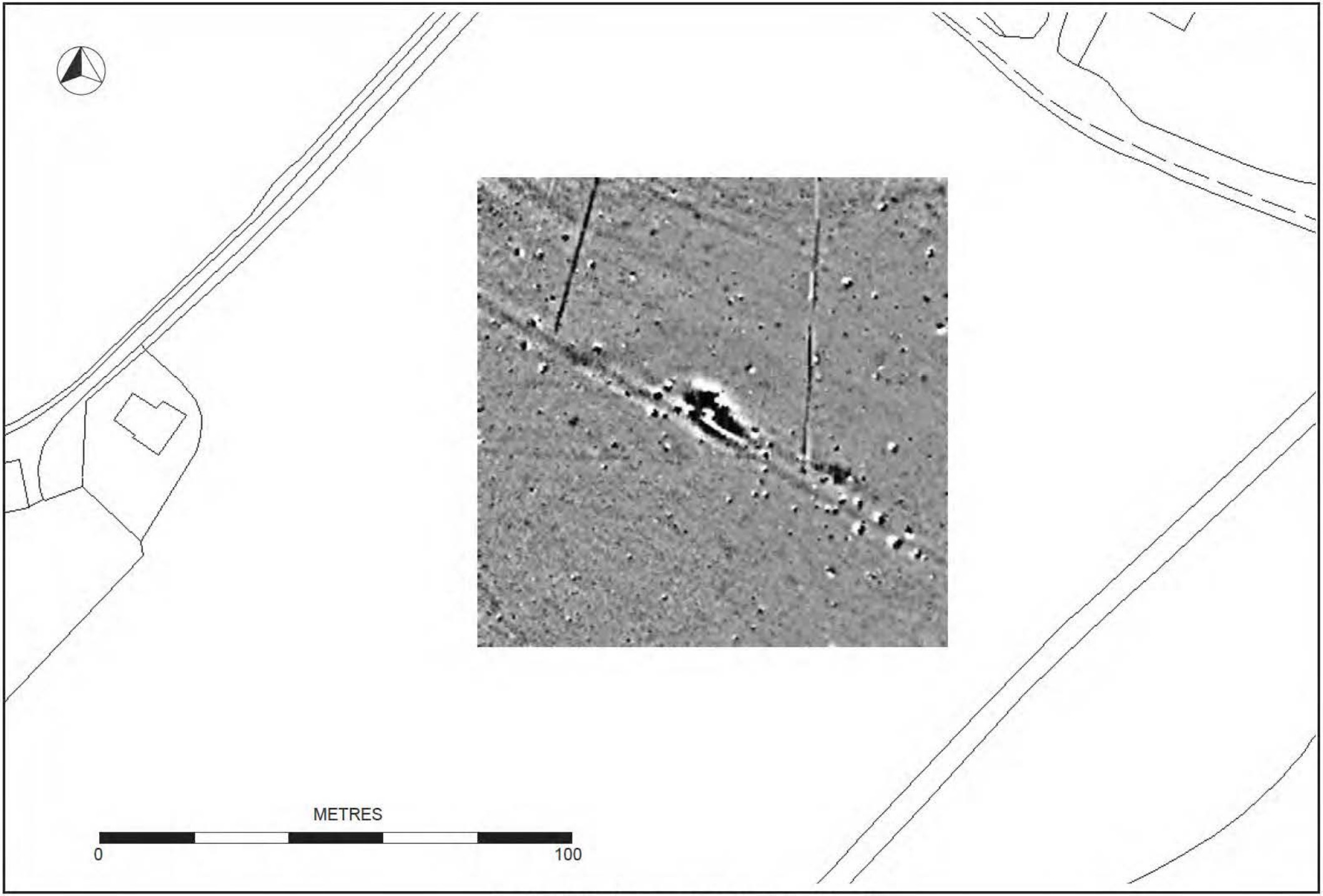


Fig. 8 High resolution gradiometer survey of Zone 4

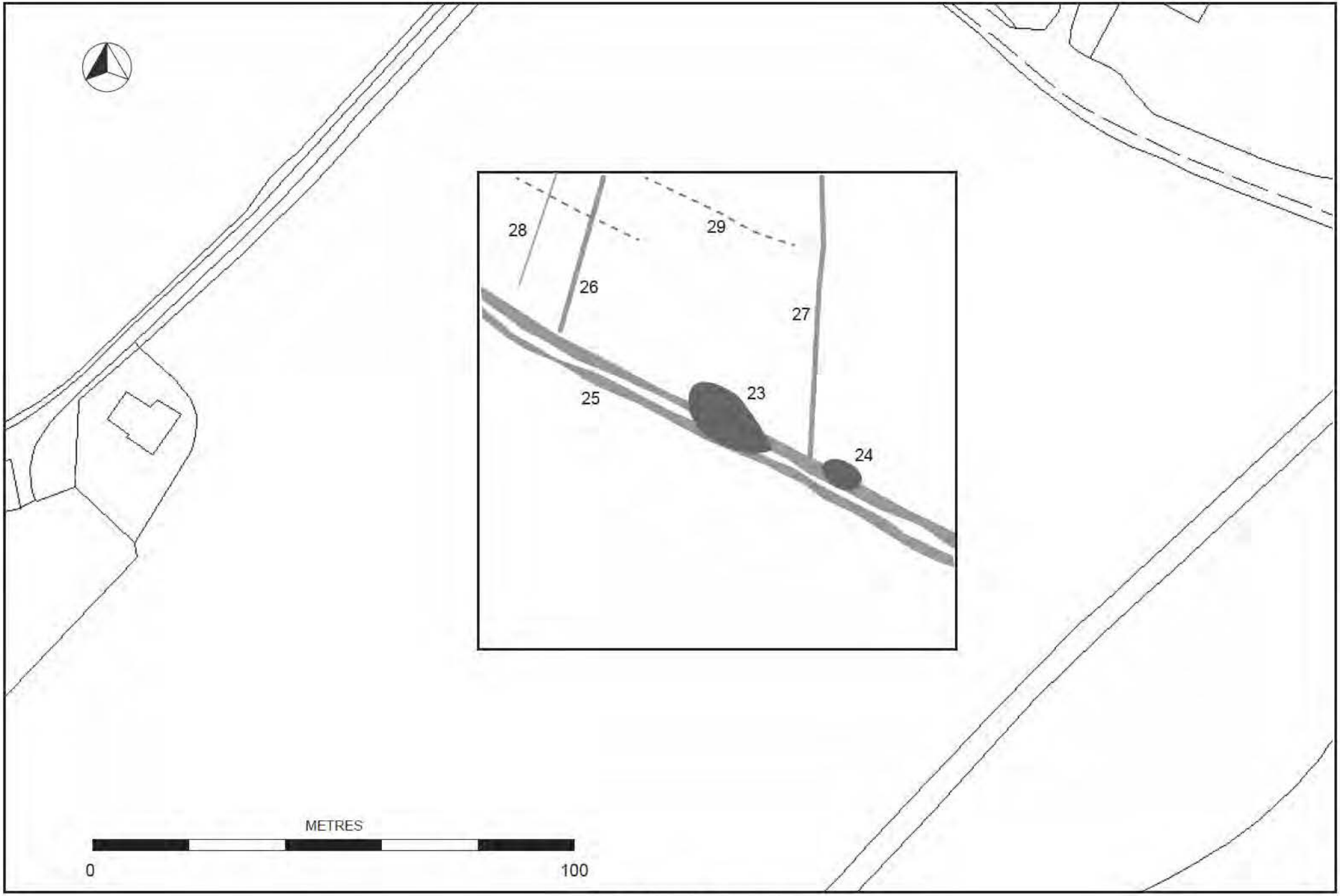


Fig. 9 Zone 4, interpretation

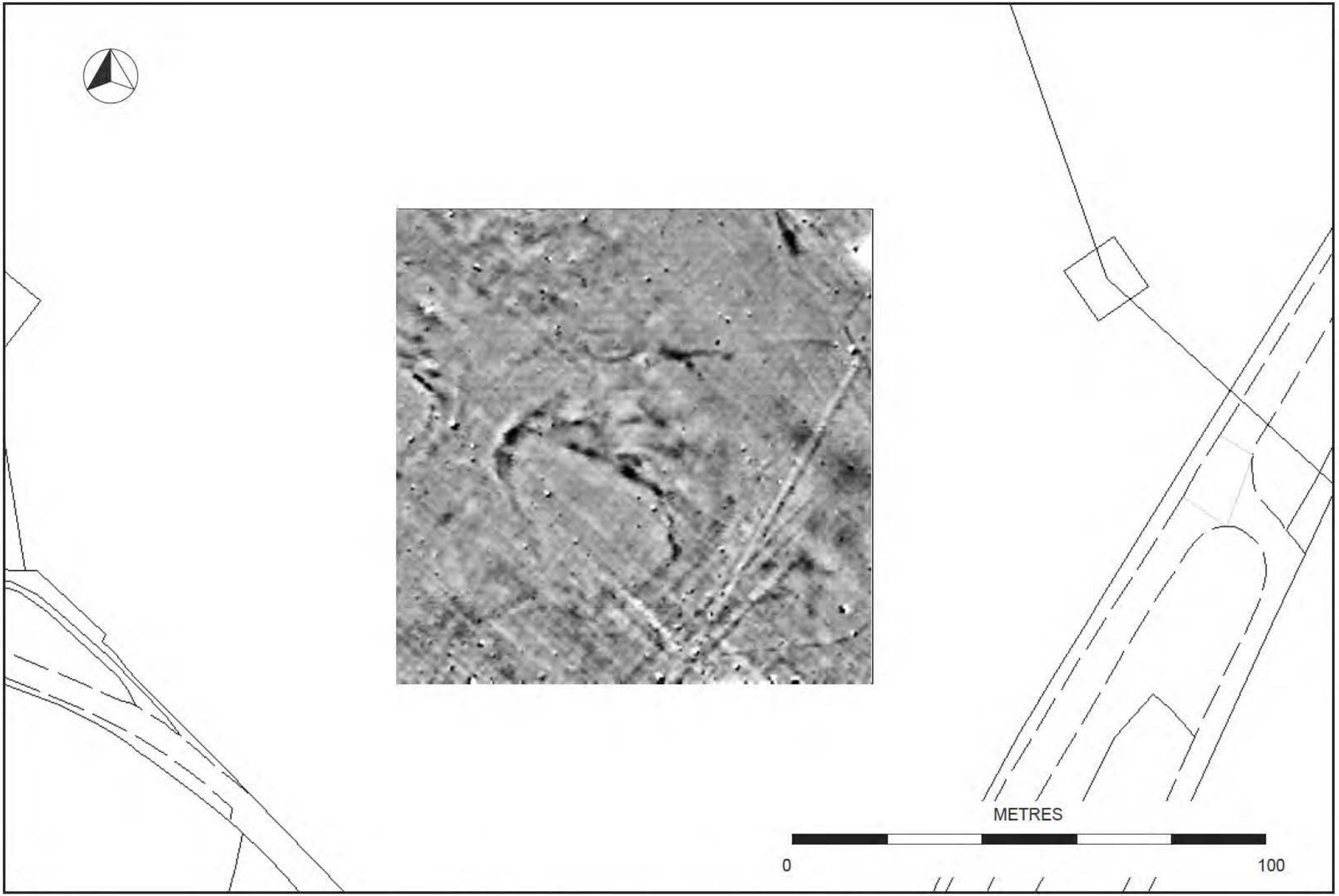


Fig. 10 High resolution gradiometer survey of Zone 5

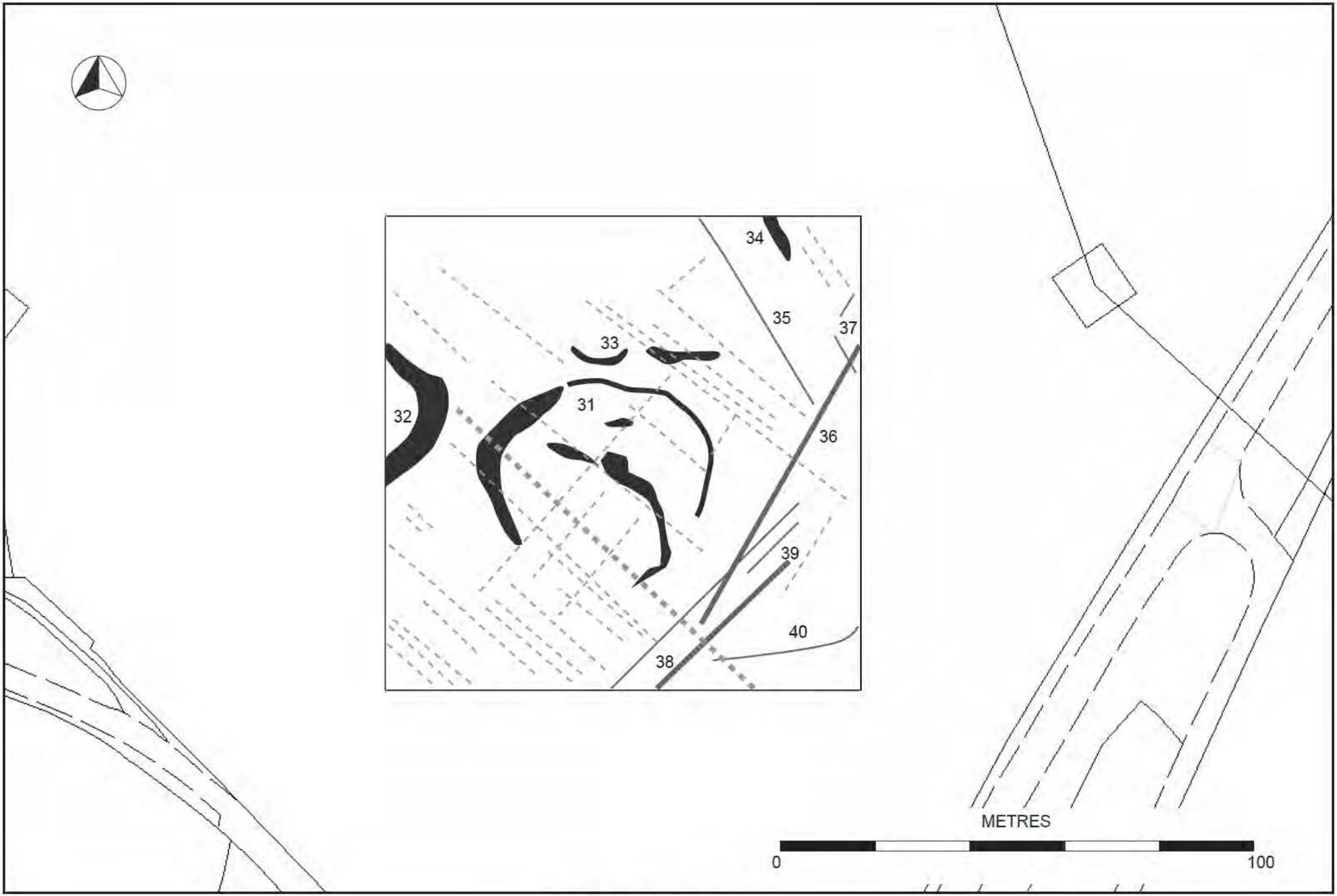


Fig. 11 Zone 5, interpretation

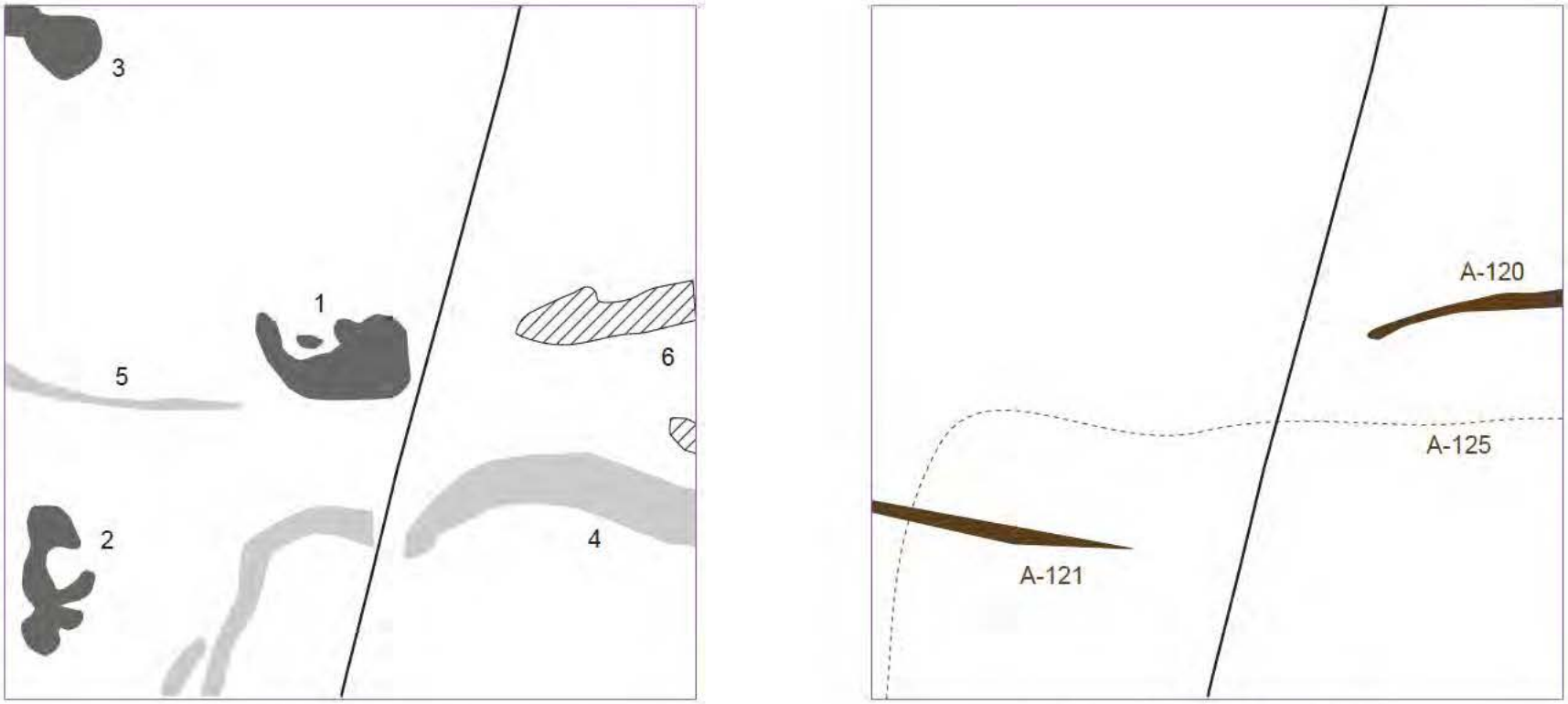


Fig. 12 Interpretation of fluxgate gradiometer data (*Gwynedd Archaeological Trust*) and vertical magnetic gradiometry data (*Fugro Aperio Ltd*) for Zone 1

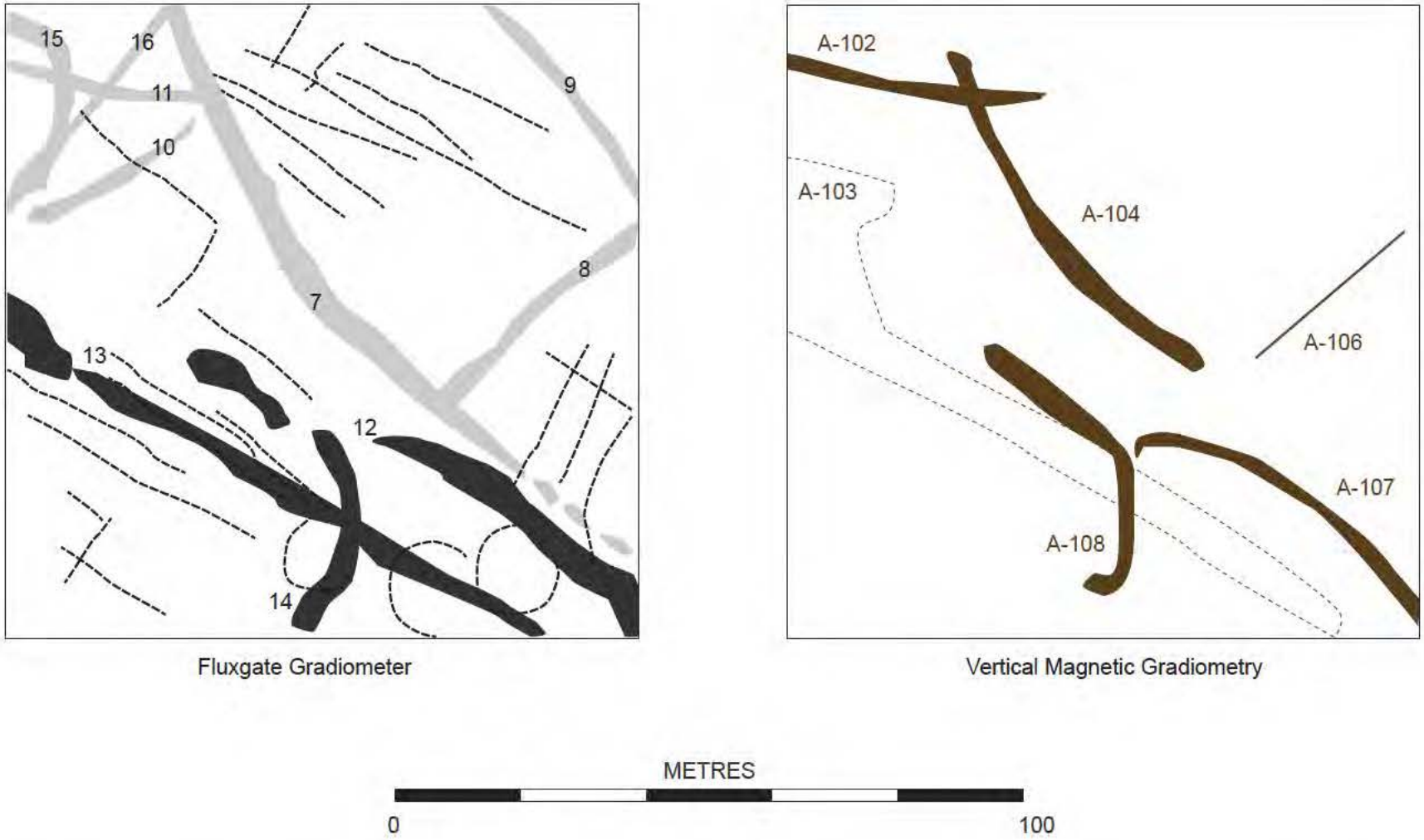
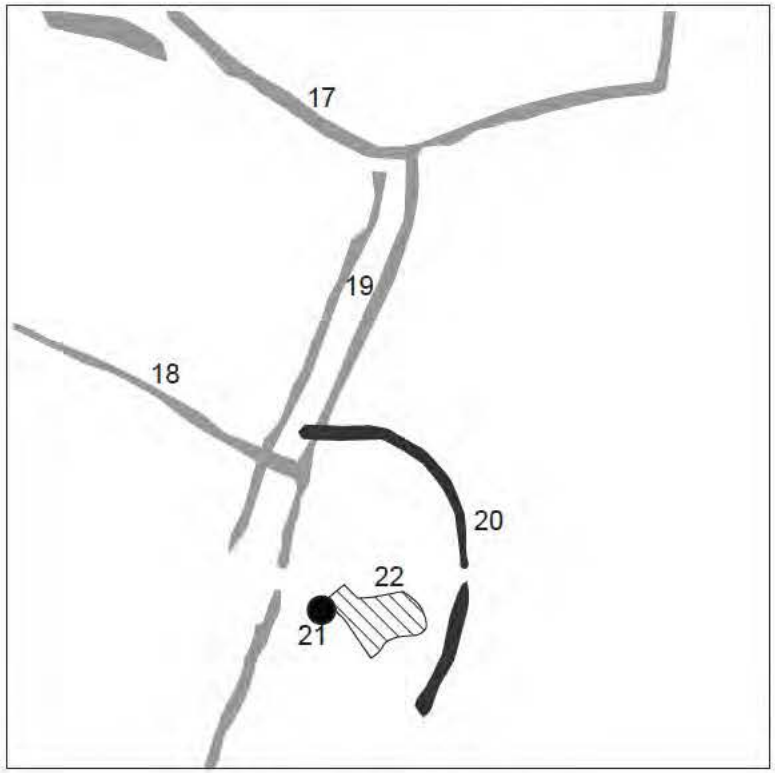
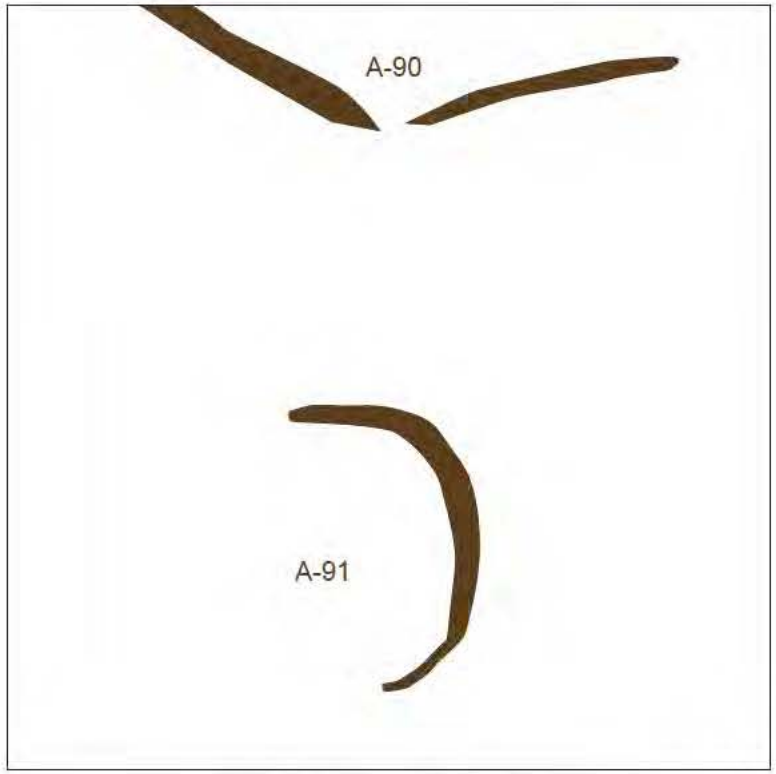


Fig. 13 Interpretation of fluxgate gradiometer data (*Gwynedd Archaeological Trust*) and vertical magnetic gradiometry data (*Fugro Aperio Ltd*) for Zone 2



Fluxgate Gradiometer

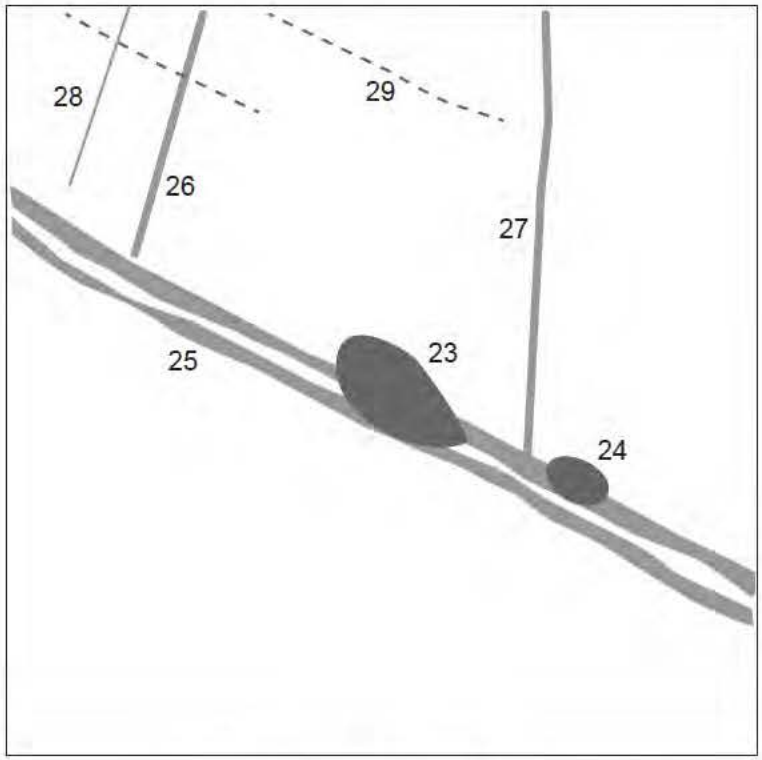


Vertical Magnetic Gradiometry

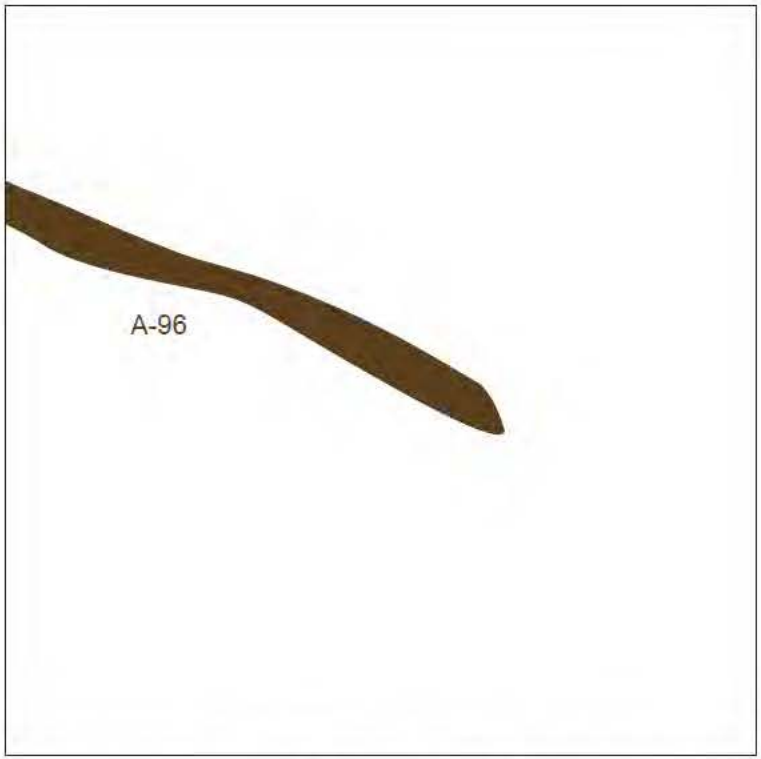
METRES

0 100

Fig. 14 Interpretation of fluxgate gradiometer data (*Gwynedd Archaeological Trust*) and vertical magnetic gradiometry data (*Fugro Aperio Ltd*) for Zone 3



Fluxgate Gradiometer

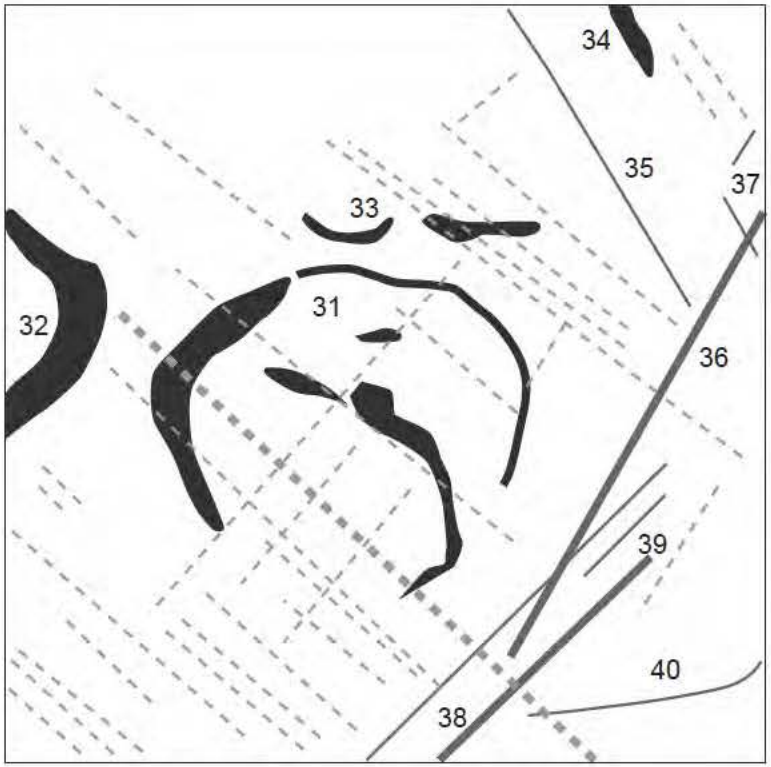


Vertical Magnetic Gradiometry

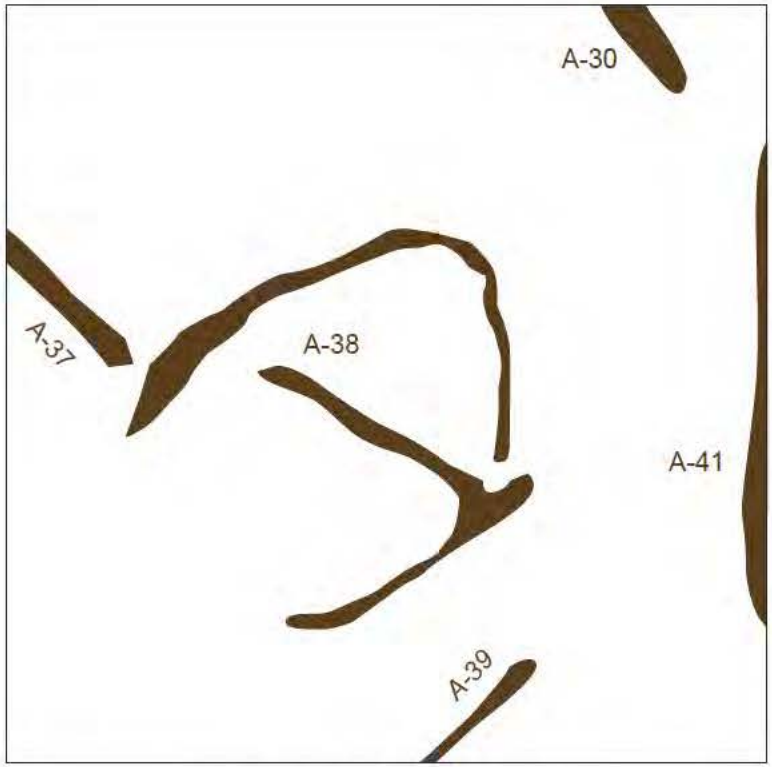
METRES

0 100

Fig. 15 Interpretation of fluxgate gradiometer data (*Gwynedd Archaeological Trust*) and vertical magnetic gradiometry data (*Fugro Aperio Ltd*) for Zone 4



Fluxgate Gradiometer



Vertical Magnetic Gradiometry

METRES

0 100

Fig. 16 Interpretation of fluxgate gradiometer data (*Gwynedd Archaeological Trust*) and vertical magnetic gradiometry data (*Fugro Aperio Ltd*) for Zone 5

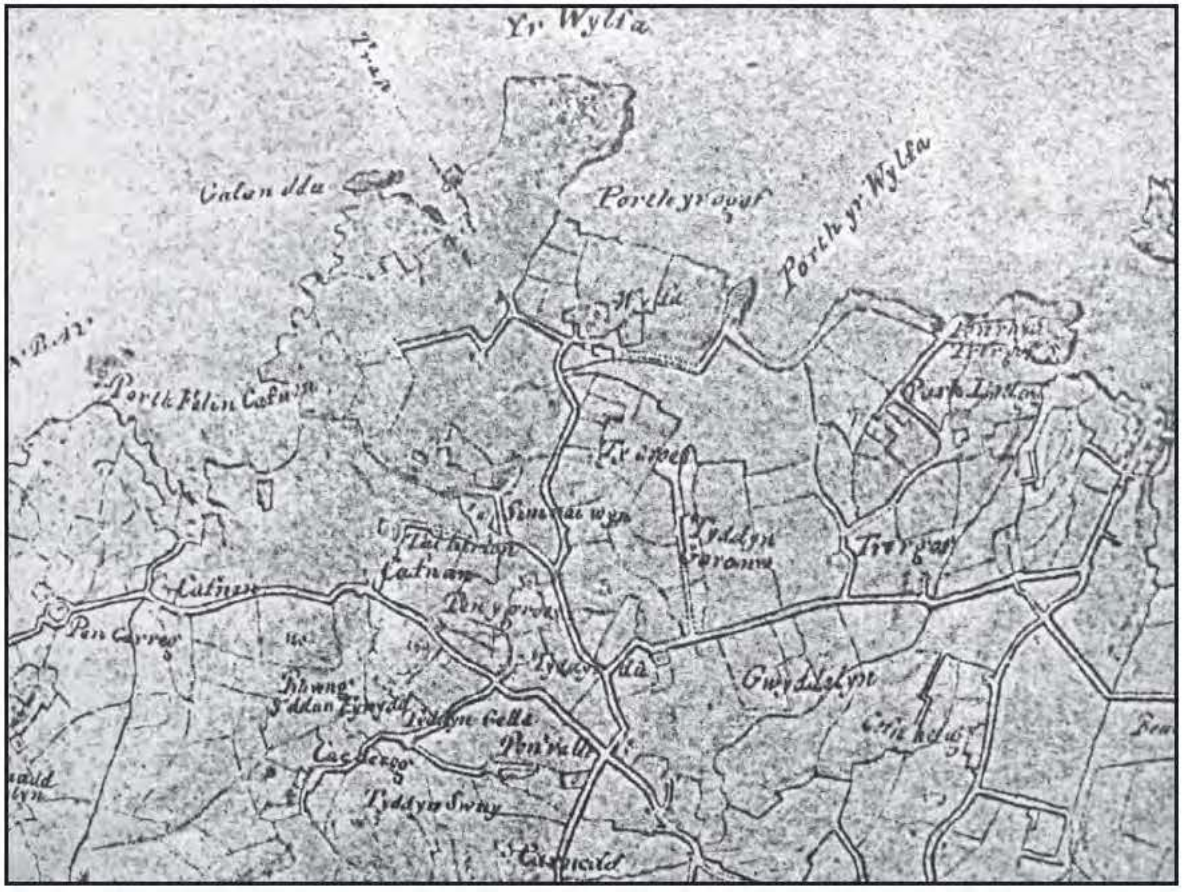


Fig. 17 Ordnance Survey 2 inch manuscript *c.* 1820's

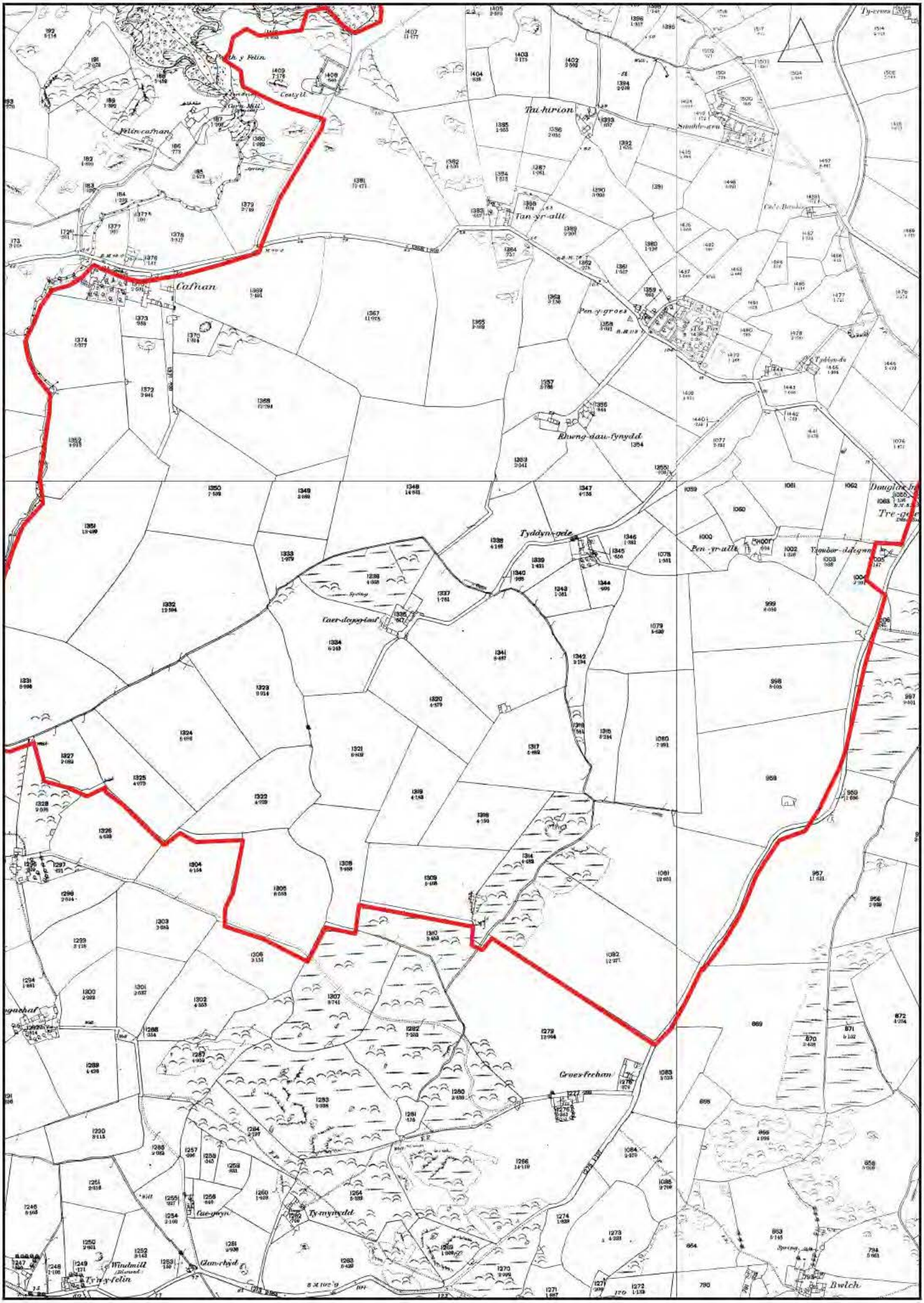


Fig. 18 Wylfa south 1889. Ordnance Survey, Anglesey County Series, Scale 1:8,000

Ymddiriedolaeth Archaeolegol Gwynedd
Gwynedd Archaeological Trust

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