1399

Gate Farm
Bodedern, Anglesey

Geophysical Survey

Ymddiriedolaeth Archaeolegol Gwynedd
Gwynedd Archaeological Trust

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Project No. G2535

Report No. 1399

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GATE FARM, BODEDERN, ANGLESEY: GEOPHYSICAL SURVEY (G2535)

1. INTRODUCTION

Gwynedd Archaeological Trust (GAT) has been asked by *Padog Enterprises Ltd* to undertake a geophysical survey as part of an archaeological evaluation at the proposed site of a cattle shed and associated infrastructure at Gate Farm, Bodedern, Ynys Môn (NGR SH36058096; Figure 01). The site comprises three adjoining fields, with the westernmost containing a proposed cattle shed, slurry store, collecting yard and parlour. A 564m long and 4m wide access road linking the cattle shed et al to an existing road is also proposed running through the remaining two fields alongside the current minor road.

Gwynedd Archaeological Planning Services (GAPS) requested a geophysical survey followed by a programme of trial trenching. The geophysical survey was designed to encompass the entire field containing the cattle shed, slurry, feed yard, collecting yard and parlour as indicated on Figure 01; the access road linking these buildings to the main road was not included in the geophysical survey.

The Historic Environment Record Event Primary Reference Number is 45064.

2. METHODOLOGY

2.1 Summary

The geophysical survey was carried out in a series of 20m grids, which were laid out and tied into the Ordnance Survey grid using a Trimble high precision GPS system. The grids were extrapolated from a baseline with endpoints at SH 36115.22 80996.33 and SH36001.70 80883.58. The survey was conducted using a Bartington Grad 601-2 dual fluxgate gradiometer with a 1.0m traverse interval and a 0.25m sample interval on 9/8/2017.

2.2 Instrumentation

The magnetometry survey was carried out using a Bartington Grad601-2 dual Fluxgate Gradiometer. This 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 Grad601 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. It must therefore be stressed that a lack of detectable anomalies cannot be taken to mean that that there is no extant archaeology.

The Bartington Grad601 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 mu-metal 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. 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.

The resistivity survey was carried out with a Geoscan FM15 twin electrode array. Resistivity is a survey technique that uses probes to introduce an electrical current into the soil, measuring the resistance of the soil to the passage of the current. The twin electrode array actually uses four probes; a mobile pair is mounted a fixed distance apart on a frame. One of these probes introduces a current into the ground and the other takes a voltage measurement. A pair of stationary probes connected by long trailing leads provides a return path for the current probe and reference voltage for the voltmeter. This is then used to calculate the resistivity of the soil. Resistivity quantifies how strongly a given material opposes the flow of electric current. There are many factors that influence the resistivity of buried deposits, water content being the most obvious. A wet ditch fill will have a low resistivity compared to drier soil around it, stones in a wall, or a compacted gravel surface will probably have a higher resistivity. Unlike magnetometry, this technique is sensitive to climatic factors that alter the water content of the soil.

2.3 Data Collection

Both the gradiometer and resistivity meter include on-board data-loggers. Readings in the surveys were taken along parallel traverses of one axis of a 20m x 20m grid. The traverse interval in the gradiometer survey was 1.0m and readings were logged at intervals of 0.25m along each traverse giving 1600 readings per grid. The resistivity survey used the same traverse interval but readings were taken every metre. These are the standard resolutions for general archaeological prospection. The grid was set out using a Trimble GPS system to an accuracy of +- 30mm.

2.4 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 (Fig. 3) 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 (Fig. 4) 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.

2.5 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.

In the magnetic data 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 resistivity data is often processed using a high-pass filter. This reduces large-scale variation in the data caused by natural changes in the soil making smaller anomalies more visible. Grey-scale plots are always somewhat pixelated 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 smoothed using the "graduated shade" function in ArchaeoSurveyor 2. This calculates a continuously interpolated value for every pixel. Each pixel value is calculated by generating cubic spline curves from all the data points in both the X and Y axes. This reduces the perceived effects of background noise thus making anomalies easier to see. Any further processing is noted in relation to the individual plot.

3. RESULTS

3.1 Conditions and Survey Constraints

It was found that the area specified in the project design was no longer in open fields and approximately half could not be surveyed. The following areas were not suitable for survey (see Fig. 2)

1. The topsoil in the north-eastern end of the field had removed down to bedrock in order to construct a silage store which was surrounded by an earth bund.

2. The south-western end of the field had been excavated into the bedrock and the spoil heaped into the survey area.

3. There were four patches of 2m high scrubby vegetation that had not been cut back close to the south-eastern edge of the field

4. Rubble had been heaped along the north-western boundary of the field.

The field comprised shallow topsoil, revealed by patches of erosion to be 5-10cm deep, overlying friable Ordovician shaley mudstone. Magnetic scanning in advance of the survey showed the rock to be slightly magnetic suggesting a degree of low-grade metamorphism. Aerial photographs from 2006 and 2009 (Bluesky and Getmapping coverage) show that the majority of the field was regularly ploughed apart from a 20m wide strip of scrubland along the south-eastern side separated from the rest of the field by a boundary shown on recent Ordnance survey maps. A large tank, probably masonry, is also shown on both aerial photographs and modern maps. Both the boundary and tank had been removed when the survey was carried out.

3.2 Gradiometer survey

The majority of the survey produced moderate levels of background variation that was almost certainly the result of bedrock close to the surface along with shattered shale in the thin topsoil as a result of ploughing. Several anomalies were detected by the survey; these are transcribed and numbered on the interpretation plan (Fig. 4).

Anomaly 1 appears to be a linear component of the background variation and is probably natural although it could be a feature cut into the bedrock. It is an isolated short curving feature that, if not natural, is best interpreted as being a result of modern disturbance. A linear anomaly (2) running across the field marks the line of the former field boundary shown on recent OS maps. A small area of negative anomalies (3) marks the site of the tank, probably indicating rubble fragments remaining in the topsoil. A square patch of decreased noise (4) marks a small area where the majority of the shallow topsoil had been recently stripped and piled into two low banks on either side. A series of strong anomalies along the north-western edge of the survey (5-7) are the result of ferrous material associated with the piled rubble along the boundary. The level of background noise in the eastern end of the survey (8) is much lower than elsewhere either indicating a change in the nature of the bedrock or a greater depth of topsoil.

4. CONCLUSIONS

The geophysical survey detected several recent features but did not reveal any further archaeological anomalies. Field observations indicate that the majority of the area comprises very shallow topsoil, which has been regularly ploughed, overlying friable shaley bedrock. This suggests that the survival of anything but rock-cut archaeological features is unlikely. The topsoil may be somewhat deeper in the small remaining area of undisturbed ground at the eastern end of the field.

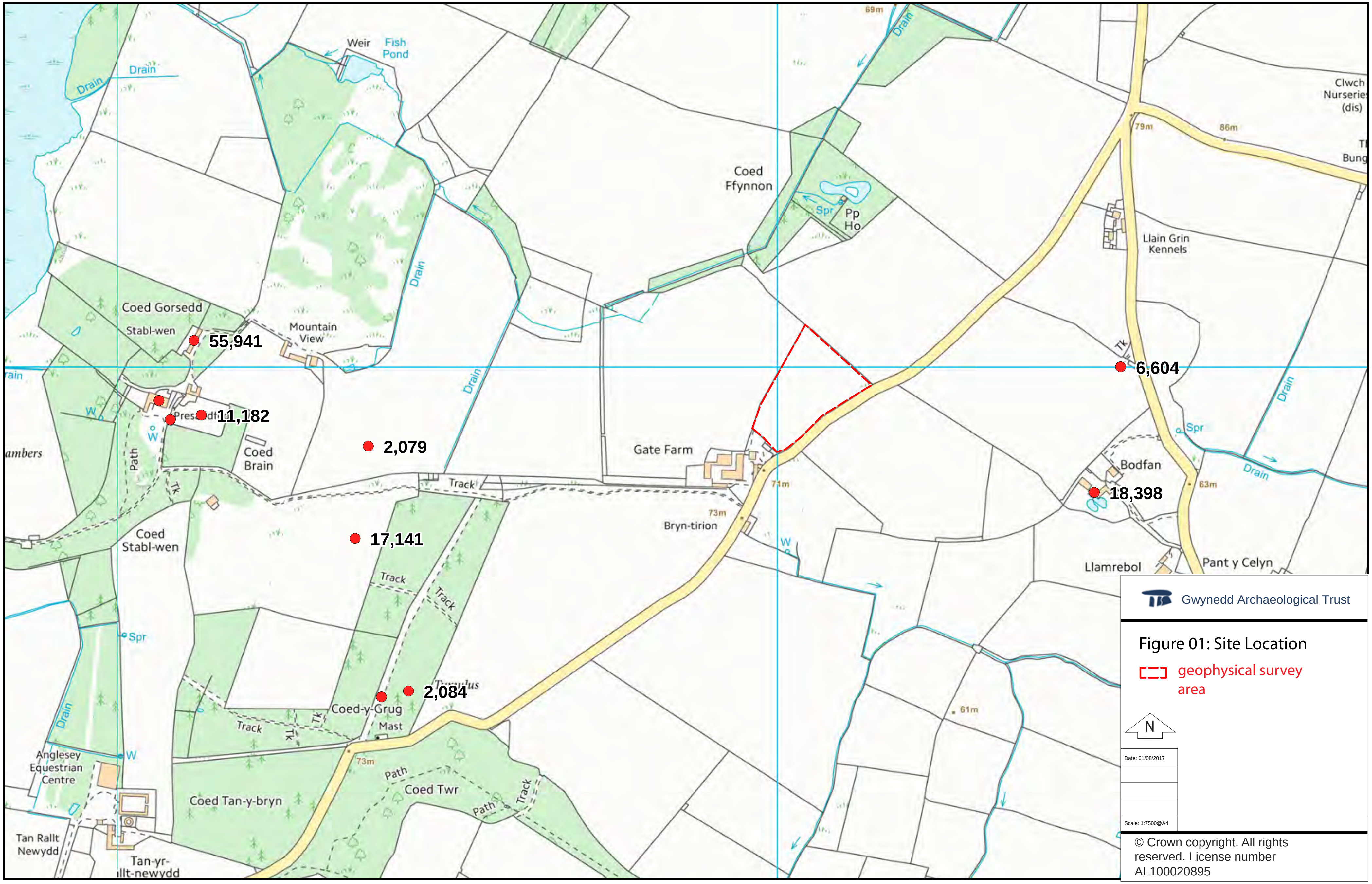

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Figure 01: Site Location

geophysical survey area

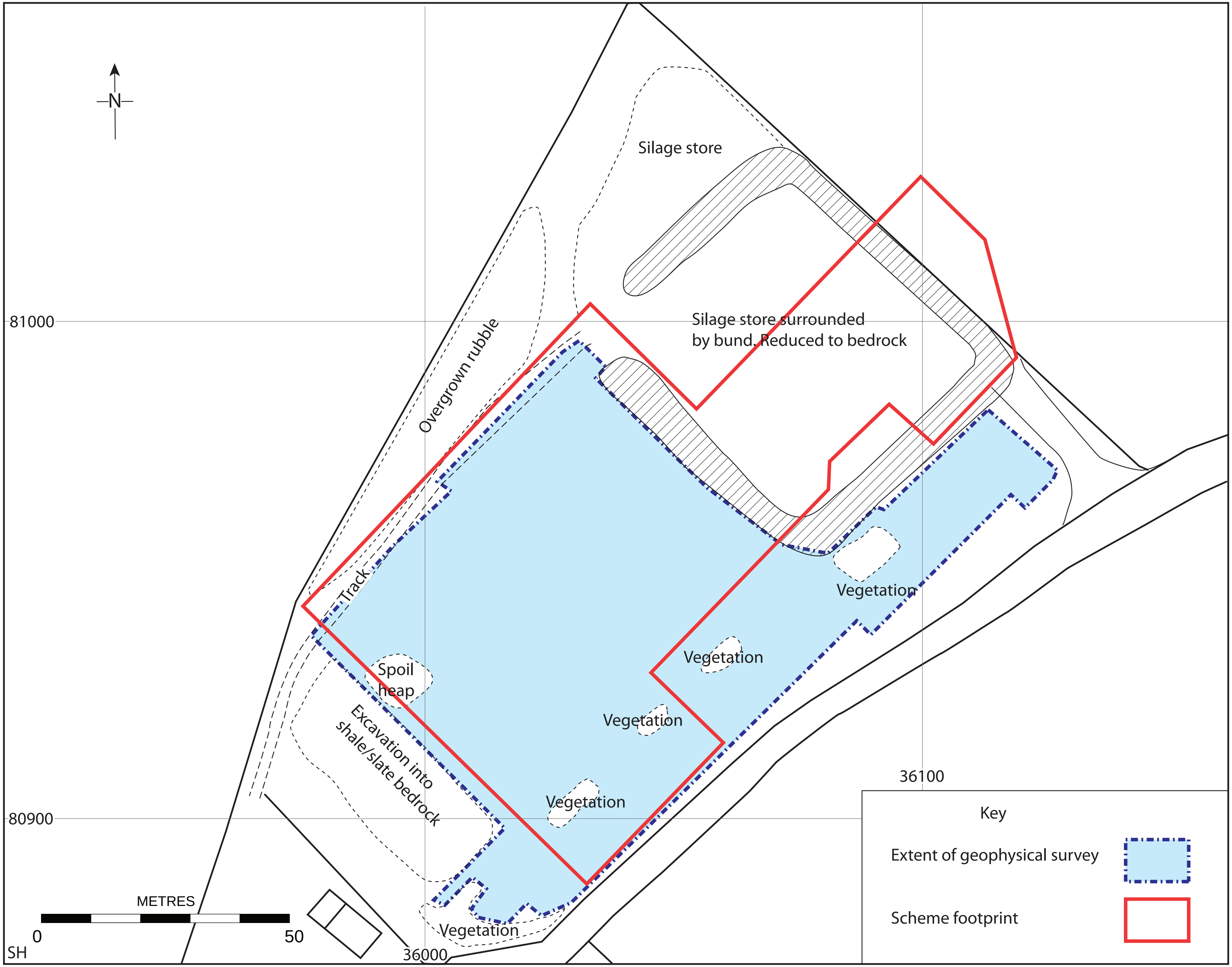

Fig. 2 Extent of geophysical survey and scheme footprint (based on *Site plan - proposed layout* Padog Enterprises Ltd 2017)

Fig. 3 Geophysical survey - grey-scale plot (base map from *Site plan - proposed layout* Padog Enterprises Ltd, 2017)

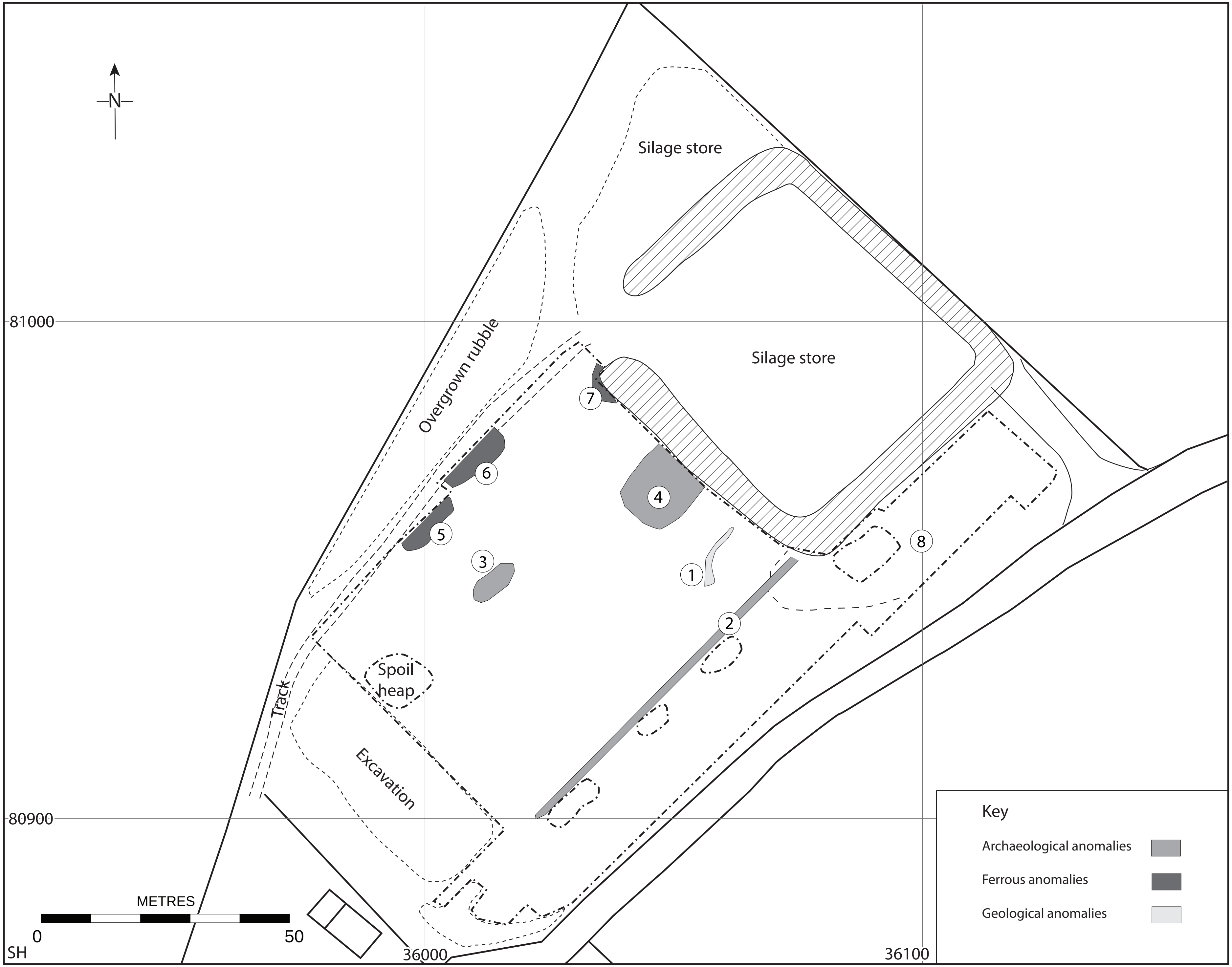

Fig. 4 Geophysical survey - Interpretation plan (base map from *Site plan - proposed layout* Padog Enterprises Ltd 2017)

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