GEOPHYSICAL SURVEY REPORT

Pen y Wal, Dollwen Barrow, Goginan, Ceredigion

Client

Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Survey Report

01513

Date

February 2021

Survey Report 01513: Pen y Wal, Dollwen Barrow, Goginan, Ceredigion

Survey dates	25 January 2021
Field co-ordinator	Robert Knight MA
Field Team	Stephen Weston BA
Report Date	15 February 2021
CAD Illustrations	Rebecca Fradgley BSc
Report Author	Rebecca Fradgley BSc
Project Manager	Simon Haddrell BEng AMBCS PCIfA
Report approved	Dr John Gater BSc DSc(Hon) MCIfA FSA

SUMO Geophysics Ltd
Cowburn Farm
Market Street
Thornton
Bradford
BD13 3HW

T: 01274 835016

SUMO Geophysics Ltd
Vineyard House
Upper Hook Road
Upton upon Severn
Worcestershire
WR8 0SA

T: 01684 592266

www.sumoservices.com
geophysics@sumoservices.com

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2. SURVEY TECHNIQUE

Detailed magnetic survey (magnetometry) was chosen as the most efficient and effective method of locating the type of archaeological anomalies which might be expected at this site.

Bartington Cart System Traverse Interval 0.5m Sample Interval 0.125m

3 SUMMARY OF RESULTS

3.1 A detailed magnetometer survey was conducted over approximately 1.2 hectares of land to the north of Goginan, over the site of Dollwen Barrow. The concentric circular ditches of the enclosure have been clearly mapped, along with numerous pits and potential graves to its immediate south. An additional ring ditch has been detected in the location of a large pit or depression noted on aerial photography, supporting the view that the response is indeed related to another barrow. Linear trends of uncertain origin are visible in the results, whilst the data in western and southern parts of the site are dominated by areas of amorphous natural magnetic variations.

4 INTRODUCTION

4.1 **SUMO Geophysics Ltd** were commissioned to undertake a geophysical survey of Dollwen Barrow. This survey forms part of an archaeological investigation being undertaken by the **Royal Commission on the Ancient and Historical Monuments of Wales**.

4.2 Site details

NGR / Postcode	SN 686 814 / SY23 3PA
Location	The survey area is located in the hamlet of Dollwen, to the north of the village of Goginan, which lies approximately 10km east of Aberystwyth. The Afon Melindwr river lies approximately 100m to the north-east, with an unnamed lane immediately to the north and agricultural land to the east, south and west.
HER	Dyfed Archaeological Trust
Unitary Authority	Sir Ceredigion
Parish	Melindwr
Topography	Slightly undulating
Current Land Use	Pasture / sheep grazing
Geology (BGS 2021)	Solid: Devil's Bridge Formation - mudstone and sandstone, interbedded. Superficial: River Terrace Deposits (undifferentiated) - sand and gravel.
Soils (CU 2021)	Soilscape 6: freely draining slightly acid loamy soils.
Archaeology (RCAHMW 2021)	The focal point of the Dollwen Early Bronze Age complex is a large and impressive concentric enclosure c. 43.6m in diameter (NPRN 404647), with 1.4-1.9m wide ditches (measurements were taken from the cropmark while it still showed on the ground). Only 20m to the south-east, cropmarks show a large circular depression or pit, likely to be a pond barrow. Fifteen metres to the north-east is an upstanding barrow (NPRN 404648), only discovered as a parched mound at the time of the cropmark discovery. 'Ring ditches', or further plough-levelled burial mounds, are also visible to the south of the concentric enclosure, and across the river to the north (NPRN 405448). Linear cropmarks of former boundaries could represent a contemporary field system within which the barrows were built. New aerial reconnaissance on 10th July 2018 during the record 2018 drought changed the understanding of this site. The new cropmarks showed indications of one square barrow and several grave cuts on the eastern side of the monument suggesting re-use of the site for burial in the early medieval period, as at Plas Gogerddan (301262) to the north-west. The square barrow is partly constructed over the inner ditch of the Bronze Age monument. The graves are aligned east-west suggesting Christian use of the cemetery.
Survey Methods	Magnetometer survey (fluxgate gradiometer)

Study Area *c.* 1.2 ha

4.3 Aims and Objectives

To locate and characterise any anomalies associated with Dollwen Barrow, to identify archaeological remains that may be hidden on aerial photographic sources, and to characterise the pits external to the main concentric barrow.

5 RESULTS

Specific anomalies have been given numerical labels [1] [2] *which appear in the text below, as well as on the Interpretation Figure.*

5.1 ***Probable / Possible Archaeology***

5.1.1 A large concentric circular enclosure [1] corresponds in location with the Dollwen barrow, identified through numerous aerial photographs and cropmarks. The data confirms that the outer ditch measures some 35m in diameter, with the inner ditch roughly 26m wide. Numerous pits are visible within its interior, with those at the western edge of the enclosure possibly indicative of post-pits [2a]. A discrete feature [2b] on the eastern edge of the enclosure is also indicative of a pit, and corresponds in location with a possible grave, visible on the aerial photographs of the site (Fig. 07), though no further detail is discernible.

5.1.2 A smaller circular feature [3] is noted to the south of the concentric enclosure [1], coinciding with the location of a cropmark suggestive of a large pit or depression (Fig. 07), and measuring approximately 12m across. The magnetic response of the anomaly is not suggestive of a depression *per se* but it is indicative of a ditch, supporting the view that the feature is a smaller barrow or ring ditch. A couple of small discrete responses are noted within its interior that could be related to pits.

5.1.3 Three discrete positive anomalies [4] have been mapped between the concentric enclosure [1] and the smaller barrow [2]. Each response measures between 2.0m and 3.0m in length, with the northern-most feature corresponding in location with a potential grave identified on aerial photographs (Fig. 07). The size of the anomalies suggests that they could relate to backfilled pits which might be a result of former graves, though they are not aligned east-west.

5.1.4 Further possible pits, including the one at [5], are noted to the north of the concentric enclosure. The response at [5] tallies with the location of a pit seen on aerial photographs (Fig. 07), though the additional anomalies were previously unidentified. To the south of the smaller barrow there are several other pit-like responses, but they are thought to be geological.

5.2 ***Uncertain***

5.2.1 A few tentative curvilinear and sub-circular anomalies have been mapped in the data, though their origin remains unclear. Given the archaeological context for the site it is possible that they could be indicative of additional ring ditches, however the level of naturally enhanced responses in the vicinity suggest that they could simply be a result of localised geological variations (see 5.4.1).

5.2.2 Weak linear trends have been mapped extending north, south-west and south-east from the concentric enclosure, as well as a separate linear trend on a northwest-southeast alignment. These are also of uncertain origin; they could be a result of a field system contemporary to the barrow, though such an interpretation is speculative. They are perhaps more likely to be natural or a result of agricultural effects.

5.3 ***Agricultural – Ploughing***

5.3.1 Possible evidence for modern ploughing activity is visible in the data, in the form of closely spaced, magnetically weak, parallel linear anomalies.

5.4 ***Natural / Geological / Pedological / Topographic***

5.4.1 The western and southern parts of the survey area are largely dominated by amorphous areas of magnetic enhancement. These areas are thought likely to be natural in origin, reflecting localised variations in the underlying mudstone and sandstone geology or the superficial sand and gravel deposits. It is also possible that these responses have the potential to mask weaker, more ephemeral archaeological anomalies; in places they are very difficult to differentiate with pit-like responses.

5.5 ***Ferrous / Magnetic Disturbance***

5.5.1 Ferrous responses close to boundaries are due to adjacent fences and gates. Smaller scale ferrous anomalies ("iron spikes") are present throughout the data and are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil; they are commonly assigned a modern origin. Only the most prominent of these are highlighted on the interpretation diagram.

6 DATA APPRAISAL & CONFIDENCE ASSESSMENT

6.1 Historic England guidelines (EH 2008) Table 4 states that the typical magnetic response on the local soils / geology is variable. The results from this survey indicate the presence of the clear ditch-type responses associated with former barrows, along with numerous pits. As a result, the technique is deemed to have been effective.

7 CONCLUSION

7.1 The survey at Dollwen Barrow, Goginan has confirmed the presence of the concentric circular enclosure and has also identified a second smaller ring ditch to its south. The main enclosure comprises two concentric circular ditches, measuring a total of 35m in diameter, with an internal diameter of *c.*26m. Numerous discrete anomalies within the enclosure are suggestive of pits, with some possibly indicative of post-pits; additional pits to the south of the concentric enclosure could relate to graves, as interpreted from aerial photography of the site (RCAHMW 2021). The second circular feature comprises a ring ditch some 12m in diameter, with possible small pits within its interior. Linear and curvilinear trends of uncertain origin present in the results could be of archaeological interest, given the context of the results, though they are thought most likely to have natural or agricultural explanation.

8 REFERENCES

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CU 2020 The Soils Guide. Available: www.landis.org.uk. Cranfield University, UK. [accessed 11/02/2021] *website: http://mapapps2.bgs.ac.uk/ukso/home.html*

EAC 2016 *EAC Guidelines for the Use of Geophysics in Archaeology,* European Archaeological Council, Guidelines 2.

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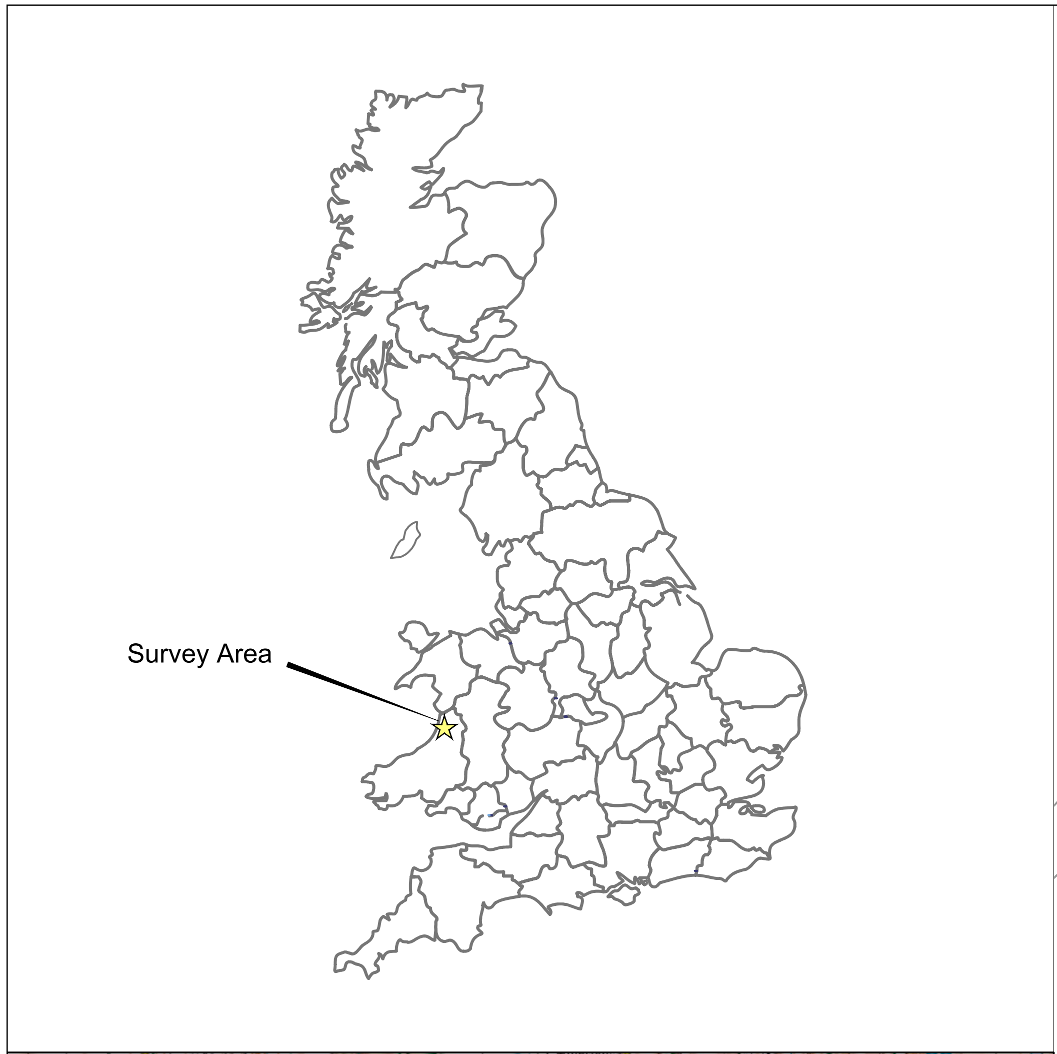
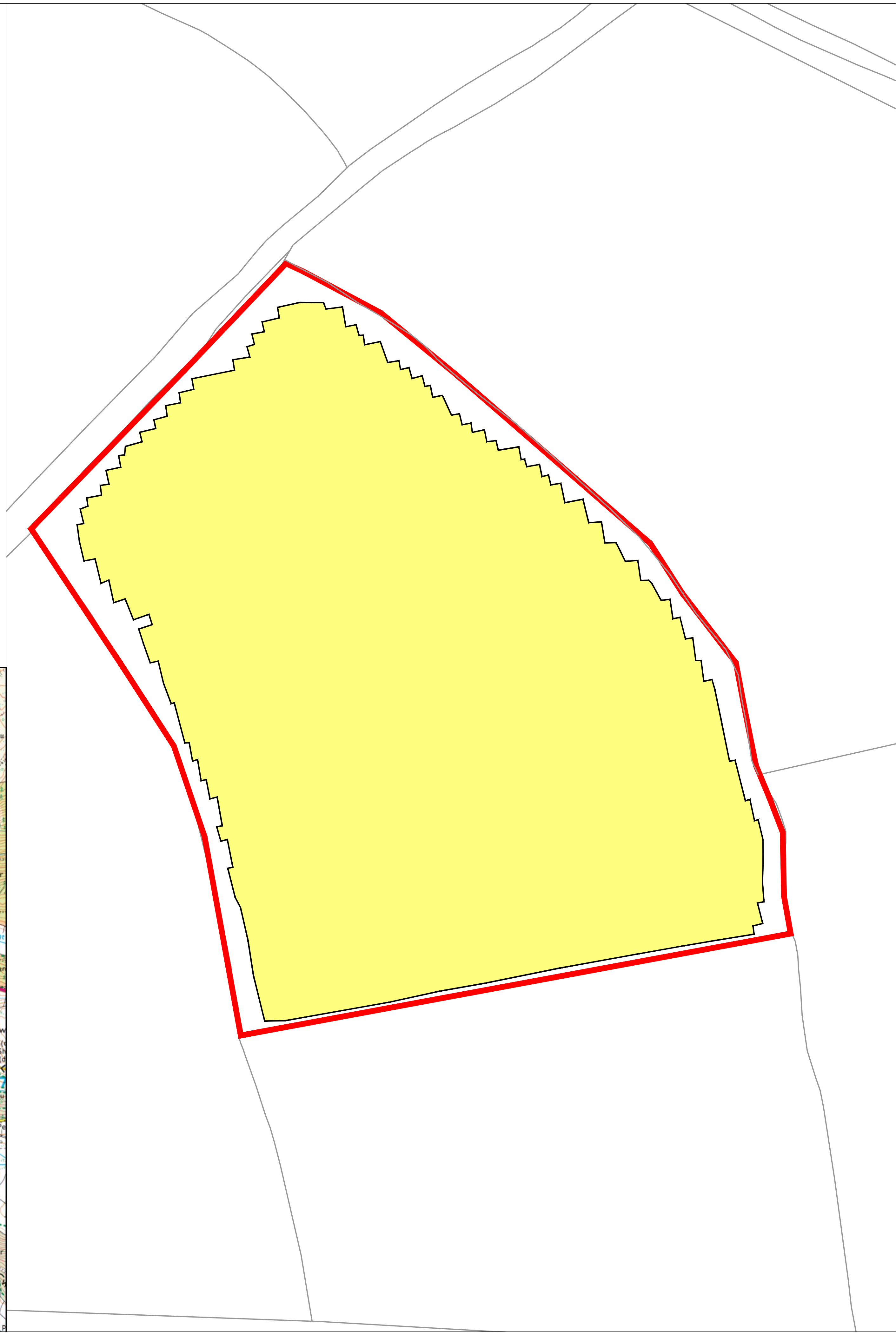
RCAHMW 2021 *Pen y Wal, Dollwen Barry, Goginan, Ceredigion: Specification for geophysical survey 2020. NGR SN 6871 8144.* Royal Commission on the Ancient and Historical Monuments of Wales; unpublished document.





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	Survey Area	N

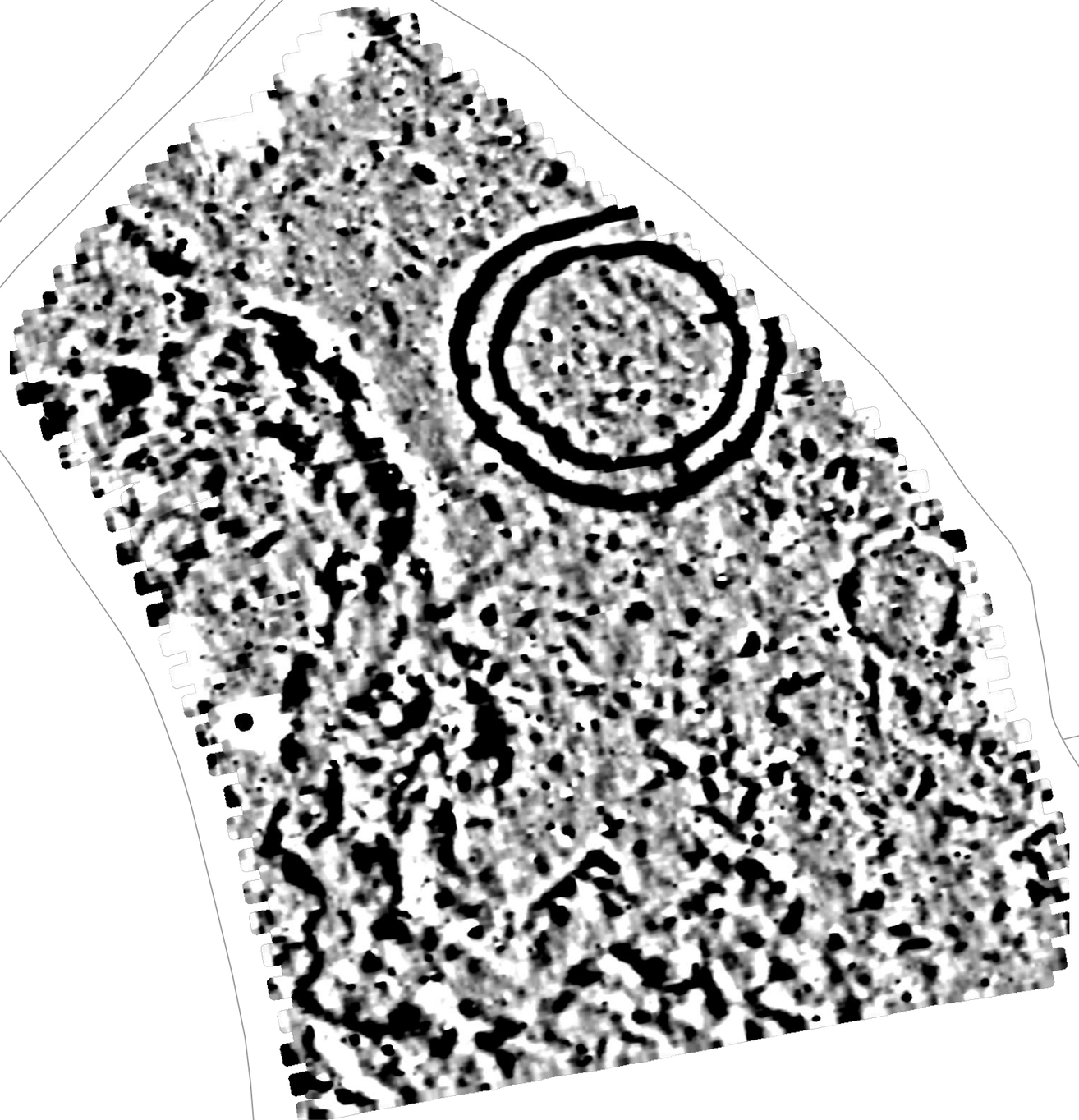
SUMO Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Site Location

Client:
Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:
01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

Scale:	Fig No:
NOT TO SCALE	01



N

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

Magnetometer Survey - Greyscale Plot

Client:

Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:

01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

Scale:

0 metres 30

1:600 @ A3

Fig No:

02

N

+4nT

-2nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

Magnetometer Survey - Greyscale Plot

Client:

Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:

01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

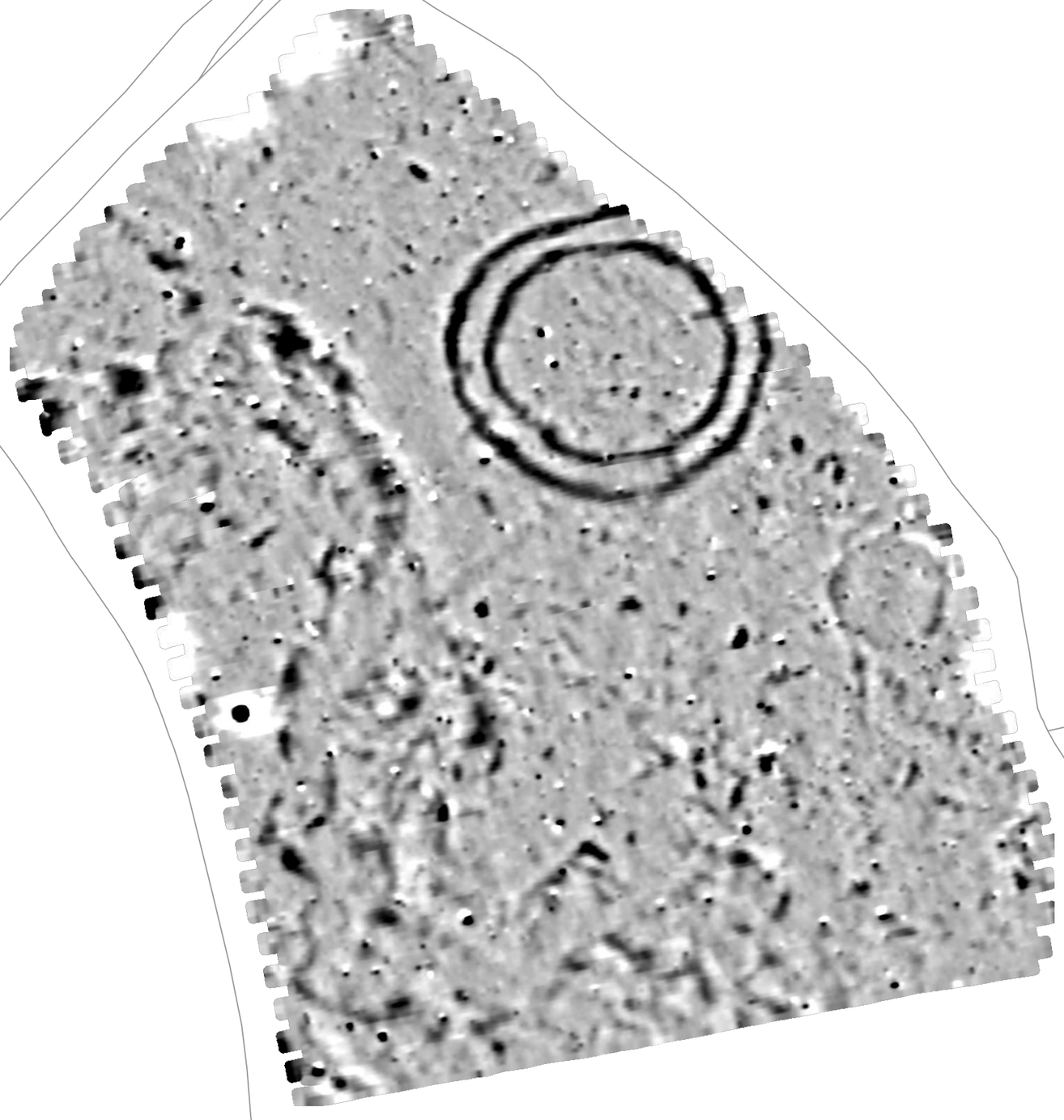
Scale:

0 metres 30

1:600 @ A3

Fig No:

03



N

+10nT

-4nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

Magnetometer Survey - Greyscale Plot

Client:

Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:

01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

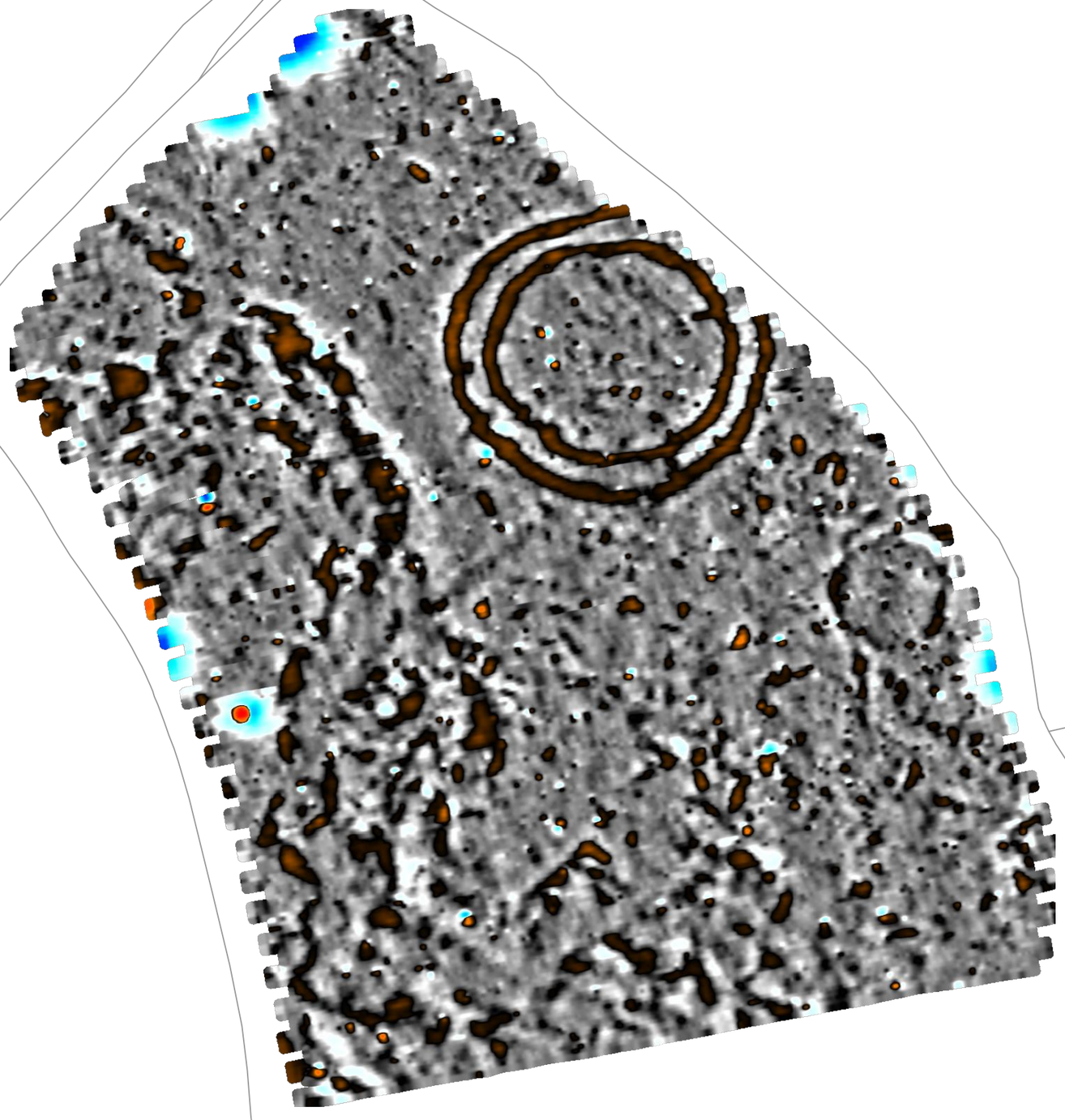
Scale:

0 metres 30

1:600 @ A3

Fig No:

04



N

+100nT

-100nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

Magnetometer Survey - Greyscale Plot

Client:

Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:

01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

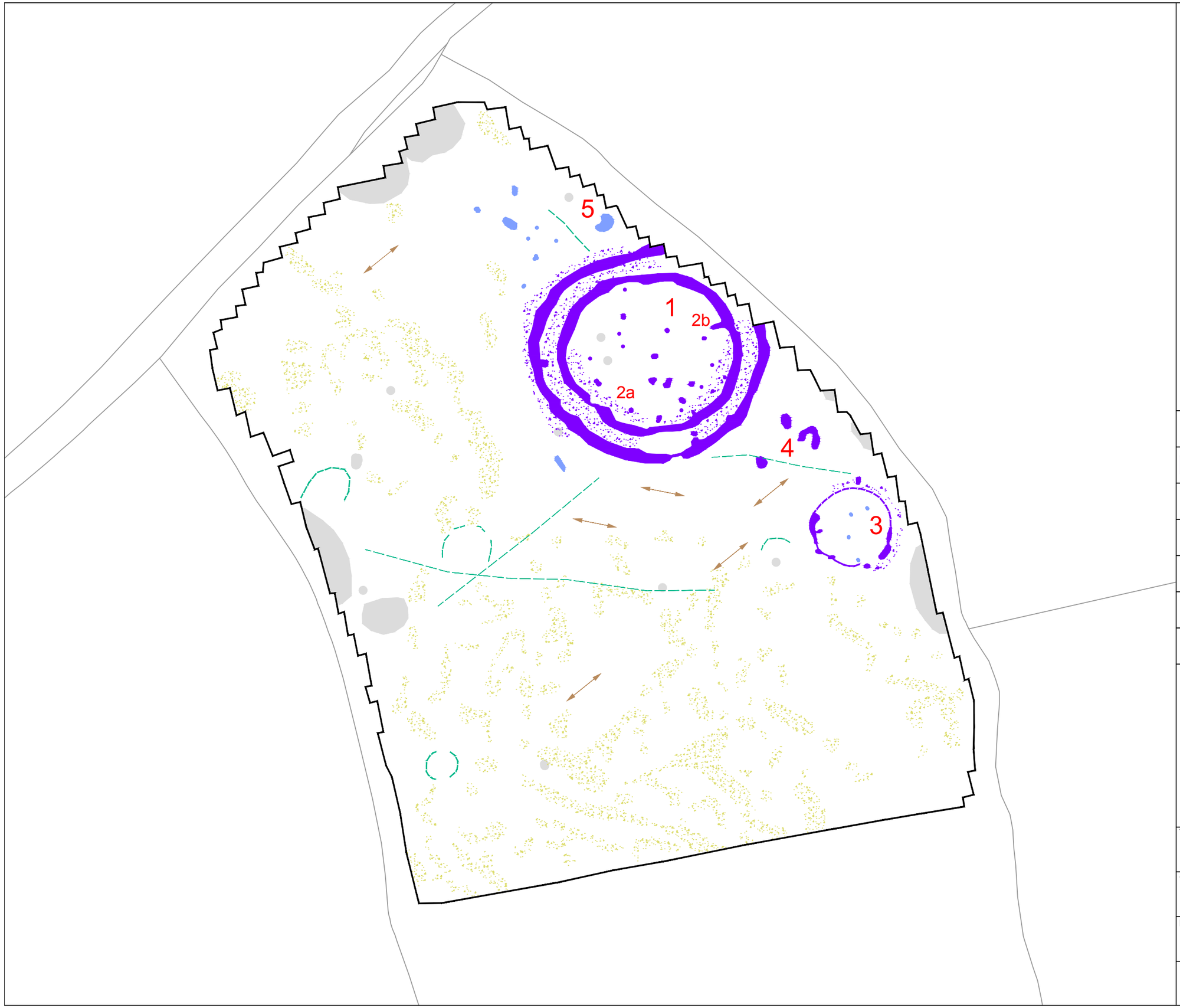
Scale:

0 metres 30

1:600 @ A3

Fig No:

05



N

KEY

	Probable archaeology (discrete anomaly / trend / enhanced response)
	Possible archaeology (discrete anomaly / trend)
	Uncertain Origin (discrete anomaly / trend)
	Agriculture (plough)
	Natural (e.g. geological / pedological)
	Ferrous

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Interpretation

Client:
Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:
01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

Scale:
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Fig No:
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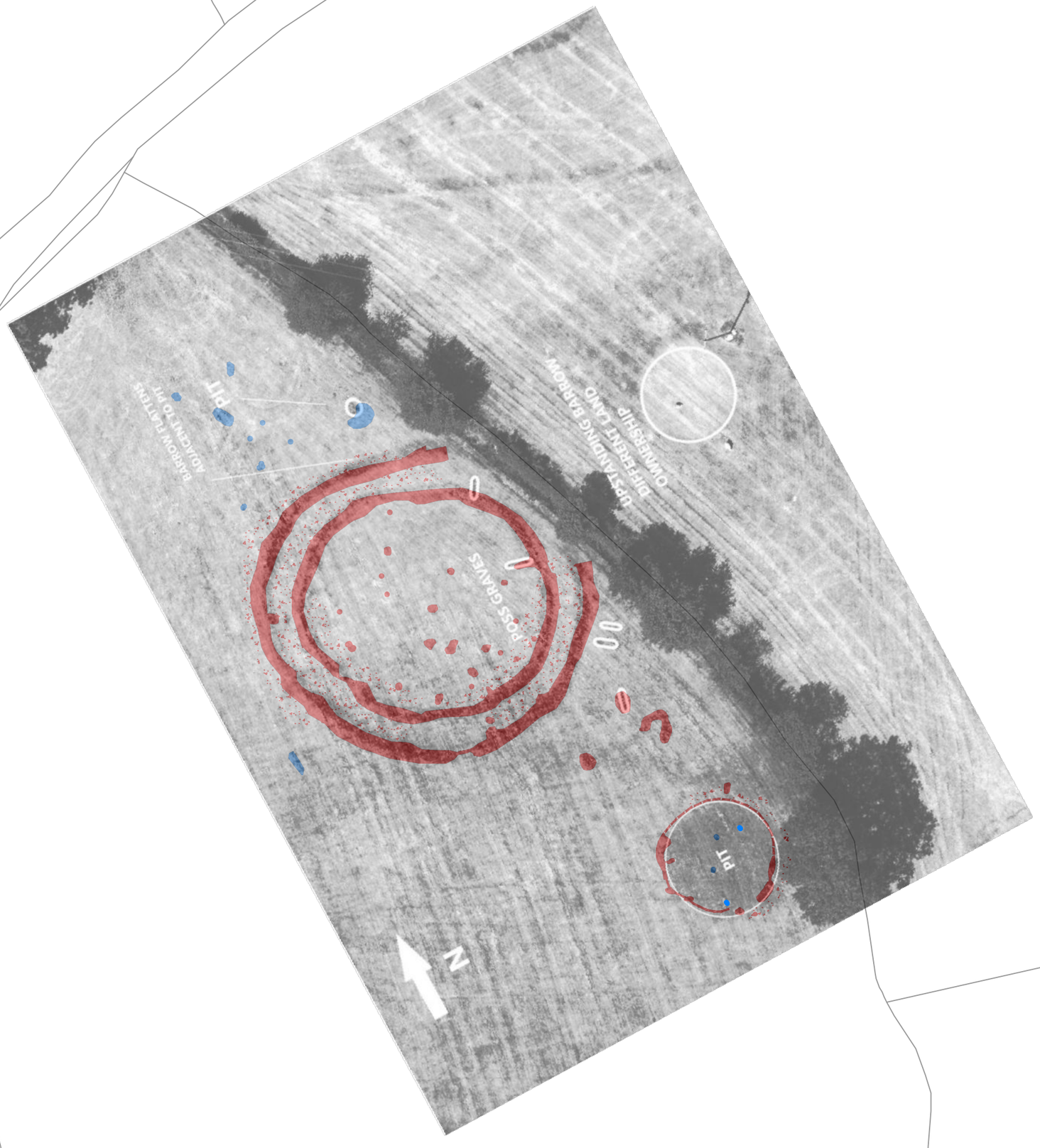

Pen y Wal, Dollwen barrow, Goginan (Crown Copyright RCAHMW AP-2018_4335)

N

KEY

	Probable archaeology (discrete anomaly / trend / enhanced response)
	Possible archaeology (discrete anomaly / trend)

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
July 2018 Aerial Photo with archaeological responses detected by survey

Client:
Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:
01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

Scale:
0 metres 25
1:500 @ A3

Fig No:
07

N

+5nT

-5nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

Minimally Processed Data - Greyscale Plot

Client:

Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:

01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

Scale:

0 metres 30

1:600 @ A3

Fig No:

08

N

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
XY Trace Plots (clipped at +/-15nT)

Client:
Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:
01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

Scale:
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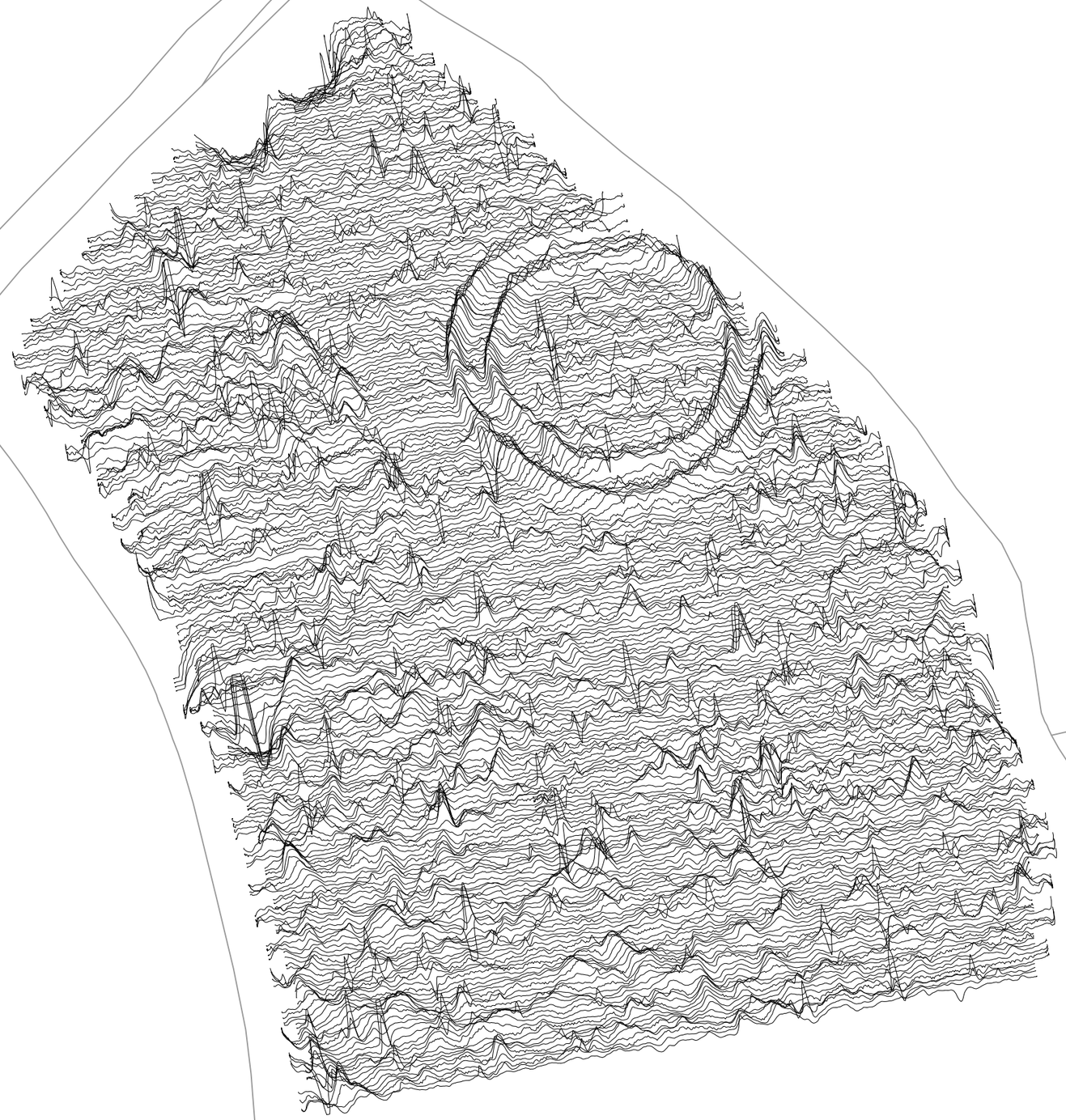
1:600 @ A3

Fig No:
09



N

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
XY Trace Plots (clipped at +/-25nT)

Client:
Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)

Project:
01513 - Pen y Wal, Dollwen Barrow, Goginan, Ceridigion

Scale:
0 metres 30
1:600 @ A3

Fig No:
10

Appendix A - Technical Information: Magnetometer Survey Method, Processing and Presentation

Standards & Guidance

This report and all fieldwork have been conducted in accordance with the latest guidance documents issued by Historic England (EH 2008) (then English Heritage), the Chartered Institute for Archaeologists (CIfA 2014) and the European Archaeological Council (EAC 2016).

Grid Positioning

For hand held gradiometers the location of the survey grids has been plotted together with the referencing information. Grids were set out using a Trimble R8 Real Time Kinematic (RTK) VRS Now GNSS GPS system.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. This results in an accuracy of around 0.01m.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	Bartington Grad 601-2	1m	0.25m

Instrumentation: Bartington *Grad* 601-2

Bartington instruments operate in a gradiometer configuration which comprises fluxgate sensors mounted vertically, set 1.0m apart. The fluxgate gradiometer suppresses any diurnal or regional effects. The instruments are carried, or cart mounted, with the bottom sensor approximately 0.1-0.3m from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT). The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0.1nT) is used. Generally, features up to 1m deep may be detected by this method, though strongly magnetic objects may be visible at greater depths. The Bartington instrument can collect two lines of data per traverse with gradiometer units mounted laterally with a separation of 1.0m. The readings are logged consecutively into the data logger which in turn is daily down-loaded into a portable computer whilst on site. At the end of each site survey, data is transferred to the office for processing and presentation.

Data Processing

Zero Mean Traverse	This process sets the background mean of each traverse within each grid to zero. The operation removes striping effects and edge discontinuities over the whole of the data set.
Step Correction (De-stagger)	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors.

Display

Greyscale/ Colourscale Plot	This format divides a given range of readings into a set number of classes. Each class is represented by a specific shade of grey, the intensity increasing with value. All values above the given range are allocated the same shade (maximum intensity); similarly, all values below the given range are represented by the minimum intensity shade. Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values. The assigned range (plotting levels) can be adjusted to emphasise different anomalies in the data-set.

Presentation of results and interpretation

The presentation of the results includes a ‘minimally processed data’ and a ‘processed data’ greyscale plot. Magnetic anomalies are identified, interpreted and plotted onto the ‘Interpretation’ drawings.

When interpreting the results, several factors are taken into consideration, including the nature of archaeological features being investigated and the local conditions at the site (geology, pedology, topography etc.). Anomalies are categorised by their potential origin. Where responses can be related to other existing evidence, the anomalies will be given specific categories, such as: Abbey Wall or Roman Road. Where the interpretation is based largely on the geophysical data, levels of confidence are implied, for example: Probable, or Possible Archaeology. The former is used for a confident interpretation, based on anomaly definition and/or other corroborative data such as cropmarks. Poor anomaly definition, a lack of clear patterns to the responses and an absence of other supporting data reduces confidence, hence the classification Possible.

Interpretation Categories

In certain circumstances (usually when there is corroborative evidence from desk-based or excavation data) very specific interpretations can be assigned to magnetic anomalies (for example, *Roman Road, Wall,* etc.) and where appropriate, such interpretations will be applied. The list below outlines the generic categories commonly used in the interpretation of the results.

Archaeology / Probable Archaeology	This term is used when the form, nature and pattern of the responses are clearly or very probably archaeological and /or if corroborative evidence is available. These anomalies, whilst considered anthropogenic, could be of any age.
Possible Archaeology	These anomalies exhibit either weak signal strength and / or poor definition, or form incomplete archaeological patterns, thereby reducing the level of confidence in the interpretation. Although the archaeological interpretation is favoured, they may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
Industrial / Burnt-Fired	Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal-working areas or hearths. It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies.
Former Field Boundary (probable & possible)	Anomalies that correspond to former boundaries indicated on historic mapping, or which are clearly a continuation of existing land divisions. Possible denotes less confidence where the anomaly may not be shown on historic mapping but nevertheless the anomaly displays all the characteristics of a field boundary.
Ridge & Furrow	Parallel linear anomalies whose broad spacing suggests ridge and furrow cultivation. In some cases, the response may be the result of more recent agricultural activity.
Agriculture (ploughing)	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
Land Drain	Weakly magnetic linear anomalies, quite often appearing in series forming parallel and herringbone patterns. Smaller drains may lead and empty into larger diameter pipes, which in turn usually lead to local streams and ponds. These are indicative of clay fired land drains.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions.
Magnetic Disturbance	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present.
Service	Magnetically strong anomalies, usually forming linear features are indicative of ferrous pipes/cables. Sometimes other materials (e.g. pvc) or the fill of the trench can cause weaker magnetic responses which can be identified from their uniform linearity.
Ferrous	This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.
Uncertain Origin	Anomalies which stand out from the background magnetic variation, yet whose form and lack of patterning gives little clue as to their origin. Often the characteristics and distribution of the responses straddle the categories of *Possible Archaeology* / *Natural* or (in the case of linear responses) *Possible Archaeology* / *Agriculture*; occasionally they are simply of an unusual form.

Where appropriate some anomalies will be further classified according to their form (positive or negative) and relative strength and coherence (trend: weak and poorly defined).

Appendix B - Technical Information: Magnetic Theory

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock. Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.1 nanoTeslas (nT) in an overall field strength of 48,000 (nT), can be accurately detected.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremanent* material.

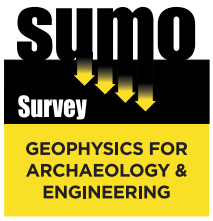
Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremanence is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremanent archaeological features can include hearths and kilns; material such as brick and tile may be magnetised through the same process.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried feature. The difference between the two sensors will relate to the strength of a magnetic field created by this feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity and disturbance from modern services.



- Archaeological
- Geophysical
- Laser Scanning
- Measured Building
- Topographic
- Utility Mapping

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