

GEOPHYSICAL SURVEY REPORT

CHERISH Ireland-Wales Project - Caerfai (Penpleidiau), Pembrokeshire

Client

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

Survey Report

14719

Date

May 2019



Comisiwn Brenhinol
Henebion Cymru
Royal Commission on the Ancient
and Historical Monuments of Wales



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Survey Report 14719: CHERISH Ireland-Wales Project - Caerfai (Penpleidiau), Pembrokeshire

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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 Grad 601-2

Traverse Interval 1.0m

Sample Interval 0.25m

3 SUMMARY OF RESULTS

- 3.1 A detailed magnetometry survey was conducted over approximately 2.5 ha of grassland and scrubland at Caerfai (Penpleidiau). No definite archaeological responses have been identified, though a large number of anomalies of uncertain origin have been mapped. These include sub-circular anomalies, perhaps reflecting enclosures or ring-ditches, a potential trackway and areas of increased response which could relate to settlement activity. A probable ploughing headland is also visible in the data.

4 INTRODUCTION

- 4.1 **SUMO Geophysics Ltd** were commissioned by the **Royal Commission on the Ancient and Historical Monuments of Wales** as part of their CHERISH – Climate Change and Coastal Heritage - project, aimed at raising awareness and understanding of the past, present and near future impacts of climate change, storminess and extreme weather events on the rich cultural heritage of the sea and coast (<http://www.cherishproject.eu>). CHERISH is a five-year Ireland-Wales project, between the Royal Commission on the Ancient and Historical Monuments of Wales, the Discovery Programme, Ireland, Aberystwyth University: Department of Geography and Earth Sciences and the Geological Survey Ireland. It began in January 2017 and will run until December 2021; the project will receive €4.1 million of EU funds through the Ireland Wales Co-operation Programme 2014-2020.

- 4.2 Scheduled Monument Consent (Section 42 licence) was granted by Louise Mees, Inspectorate of Ancient Monuments for the Welsh Government, on 21 March 2019 in order for the geophysical survey work to be undertaken.

4.3 Site details

NGR / Postcode	SM 762 240 / SA62 6QN
Location	The site is located approximately 1.5 km south-east of St. David's, Pembrokeshire. The site occupies a small clifftop headland overlooking Caerfai Bay to the west, and Caer Bwdy Bay to the east.
HER	Dyfed Archaeological Trust (DAT)
Unitary Authority	Pembrokeshire
Parish	St David's and the Cathedral Close
Topography	Mostly level with a very slight fall from north to south.
Current Land Use	Grassland / scrub
Geology (BGS 2019)	Bedrock: Solva Group - sandstone and [subequal/subordinate] argillaceous rocks, interbedded across the northern area; Menevian Group - mudstone is recorded across the south. Superficial: none recorded.
Soils (CU 2019)	Soilscape 6; freely draining slightly acid loamy soils.
Archaeology (RCAHMW 2019)	The Scheduled Monument (PE294) of Caerfai (Penpleidiau) Camp occupies the site and comprises a multivallate coastal promontory fort, naturally defended by c. 30m high sea cliffs to the west, south and east. The fort consists of a crescent of three to four lines of banks and ditches, approximately 100m in length, having what appears to be a former entrance gap on the east, blocked by two lesser banks. Emplacements for circular structures have been reported within the fort but have not been confirmed.
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	c. 2.5 ha

4.4 Aims and Objectives

To locate and characterise any anomalies of possible archaeological interest associated with the site; and hence, to inform their future management in the face of predicted loss due to coastal erosion and increased storminess.

5 RESULTS

The survey has been divided into two survey areas (Areas 1-2) and specific anomalies have been given numerical labels [1] [2] which appear in the text below, as well as on the Interpretation Figure(s).

5.1 **Uncertain**

- 5.1.1 Two sub-circular negative trends [1] have been identified in Area 1 and are of undetermined origin. The sub-annular form of the responses suggests that they could have an archaeological origin, perhaps associated with banks or potential structural remains of enclosures or platforms. Further sub-circular anomalies [2], approximately 12m in diameter, have been detected to the south-west of [1]. These could be associated with former ring-ditches or gullies; however, the interpretation of these anomalies is tentative and the high level of background disturbance across the site makes further interpretation difficult.
- 5.1.2 Two weak, parallel linear trends [3] have been identified near the south of Area 1. These may reflect a former trackway, possibly associated with settlement of the promontory fort, though similar to the anomalies described above, their exact origins remain unclear.
- 5.1.3 A series of discrete anomalies and areas of increased magnetic response [4] have been detected within the multivallate fort, though their origin is undetermined. Their location within the fort and potential rectilinear form, suggests that they could have an archaeological explanation; however, it is equally possible that they are of natural origin.
- 5.1.4 A large number of other weak linear trends and discrete anomalies are evident across the site, all of which are of uncertain origin. The straight, linear trend running approximately east-west across Area 1 could be archaeological, though its alignment suggests that it is more likely that it relates to an historic former field boundary, though no such feature is visible in the location on available historic maps. Several discrete responses could relate to pits or other settlement evidence, though it is equally feasible that they are natural and relate to variations in the underlying geology.

5.2 **Agriculture - Ploughing**

- 5.2.1 A linear band of enhanced magnetic response and an associated negative linear anomaly can be seen running along the eastern edge of Area 1. These are likely to be a result of agricultural activity, and it is thought that they are related to a ploughing headland.

5.3 **Ferrous / Magnetic Disturbance**

- 5.3.1 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 can be variable. The results from this survey indicate the presence of several linear and discrete anomalies, along with a few sub-circular features of uncertain origin. It can therefore be determined that the technique has been effective, though the level of background noise from the underlying bedrock has impacted on the survey.

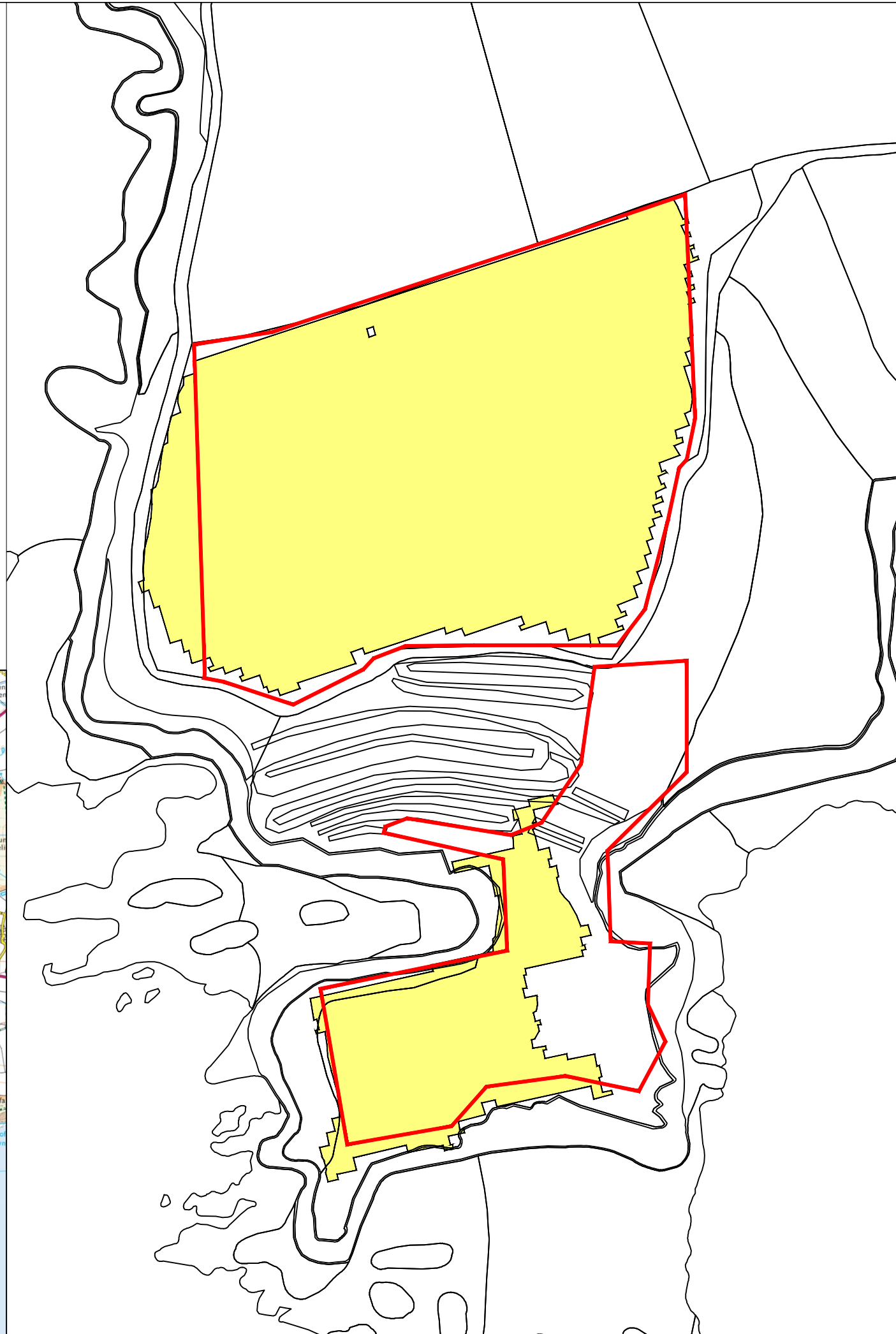
7 CONCLUSION

- 7.1 The survey at Caerfai (Penpleidiau) has identified a number of anomalies of uncertain origin. Sub-circular responses have been detected, and they may be a result of small enclosures, building platforms or ring-ditches. A possible trackway has also been mapped, along with several discrete anomalies of uncertain origin. Areas of enhanced magnetic response have been detected within the fort itself, and it is possible that these are archaeological or natural in origin. Evidence of a ploughing headland is also visible in the data, while one of the uncertain linear trends is possibly related to an historic field boundary.

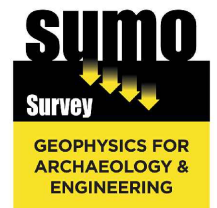
8 REFERENCES

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Survey Area



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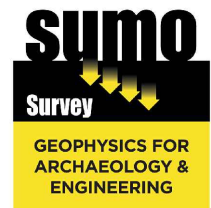
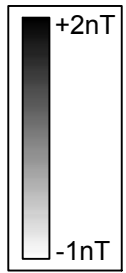


Title: Site Location

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

Project: 14719 - CHERISH Ireland-Wales Project - Caerfai (Penpleidiau), Pembrokeshire

Scale: 0 metres 75
1:1500 @ A3 Fig No: 01



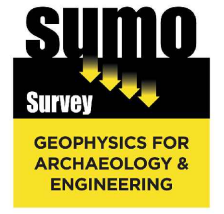
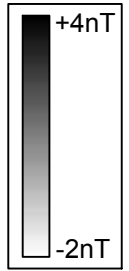
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Magnetometer Survey - Greyscale Plots

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

Project:
14719 - CHERISH Ireland-Wales Project -
Caerfai (Penpleidiau), Pembrokeshire

Scale:
0 metres 37.5
1:1250 @ A3

Fig No:
02



Title:
Magnetometer Survey - Greyscale Plots

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






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14719 - CHERISH Ireland-Wales Project -
Caerfai (Penpleidiau), Pembrokeshire

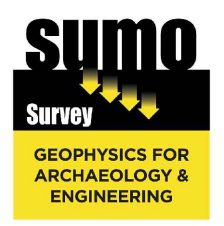
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Fig No:
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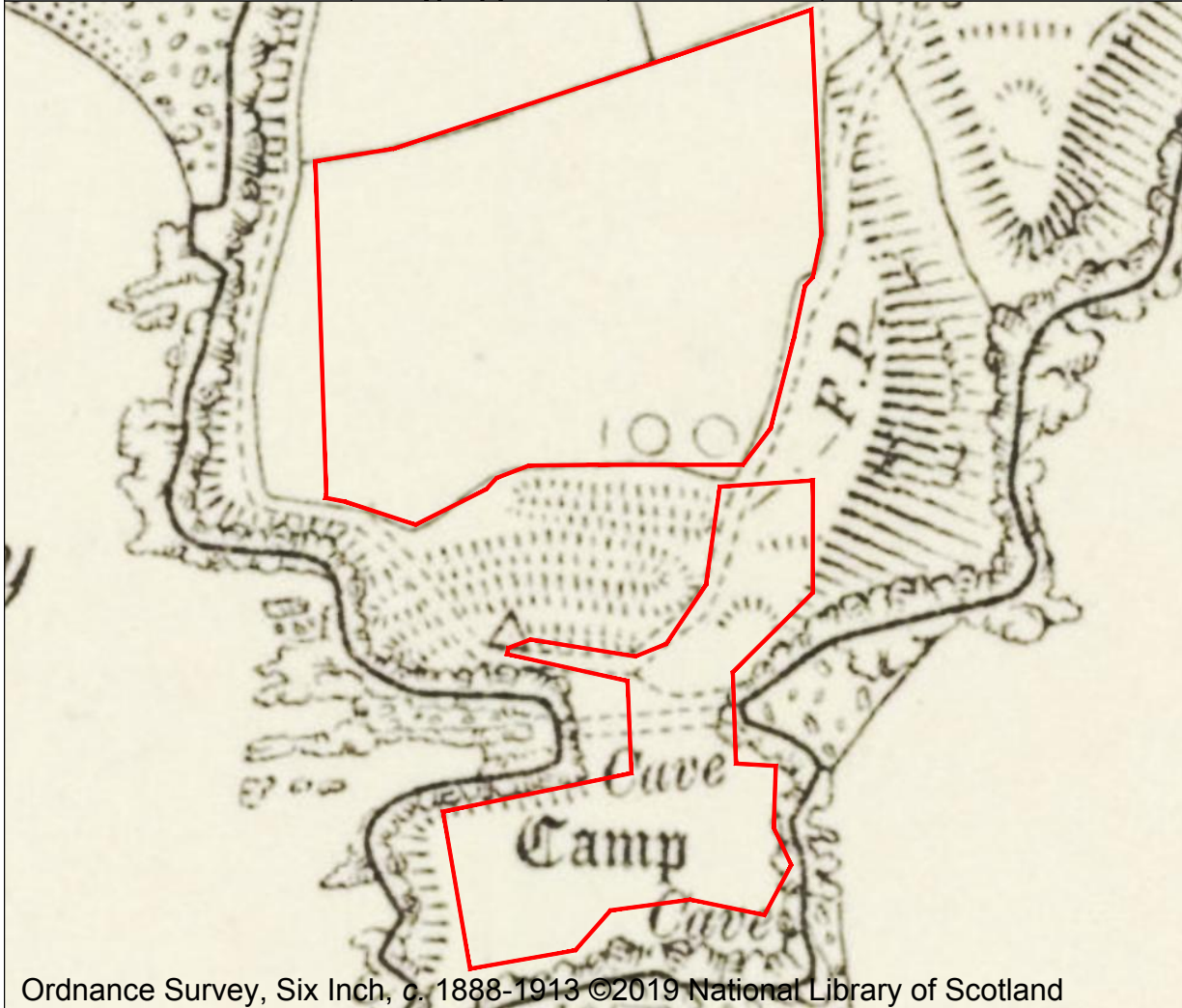
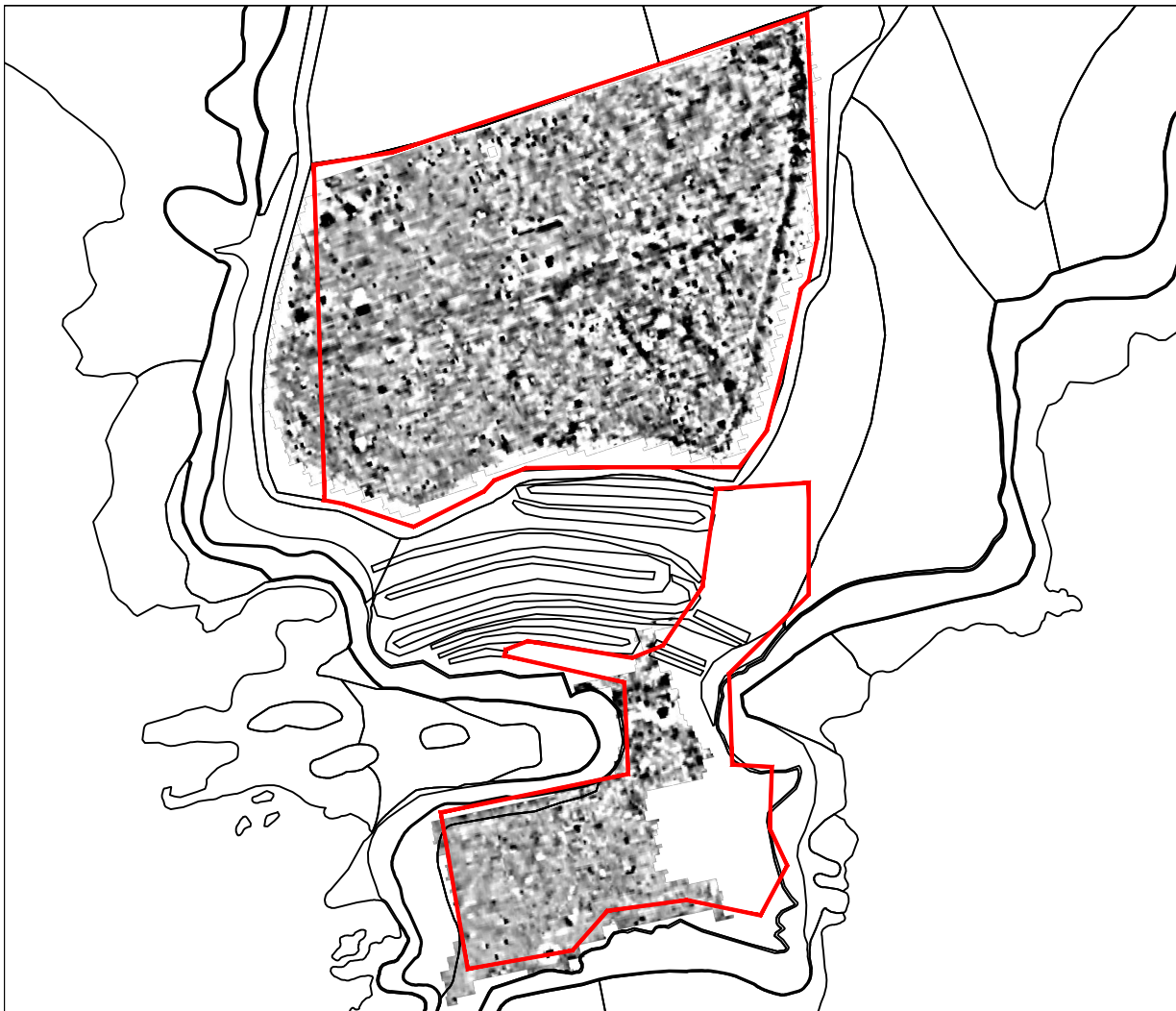


KEY

	Uncertain Origin (discrete anomaly / trend)
	Agriculture (possible ploughing headland) (discrete / negative)
	Magnetic disturbance
	Service
	Ferrous

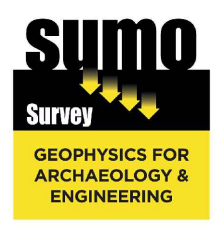


Title: Magnetometer Survey - Interpretation	
Client: Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW)	
Project: 14719 - CHERISH Ireland-Wales Project - Caerfai (Penpleidiau), Pembrokeshire	
Scale: 0 metres 37.5 1:1250 @ A3	Fig No: 04



KEY

	Uncertain Origin (discrete anomaly / trend)
	Agriculture (possible ploughing headland) (discrete / negative)
	Magnetic disturbance
	Service
	Ferrous

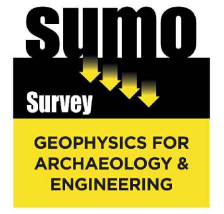
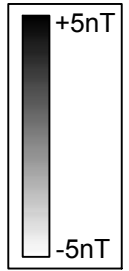


Title: Greyscale Plots, Interpretation, 1888-1913 Six Inch OS Map and 2005 Google Earth Image

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

Project: 14719 - CHERISH Ireland-Wales Project - Caerfai (Penpleidiau), Pembrokeshire

Scale: NOT TO SCALE Fig No: 05



Title:
Minimally Processed Data - Greyscale Plots

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

Project:
14719 - CHERISH Ireland-Wales Project -
Caerfai (Penpleidiau), Pembrokeshire

Scale: 0 metres 37.5
1:1250 @ A3 Fig No: 06

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	This process sets the background mean of each traverse within each grid to zero.
Traverse	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.
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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.

<i>Archaeology / Probable Archaeology</i>	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.
<i>Possible Archaeology</i>	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.
<i>Industrial / Burnt-Fired</i>	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.
<i>Former Field Boundary (probable & possible)</i>	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.
<i>Ridge & Furrow</i>	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.
<i>Agriculture (ploughing)</i>	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
<i>Land Drain</i>	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.
<i>Natural</i>	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions.
<i>Magnetic Disturbance</i>	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present.
<i>Service</i>	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.
<i>Ferrous</i>	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.
<i>Uncertain Origin</i>	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 <i>Possible Archaeology / Natural</i> or (in the case of linear responses) <i>Possible Archaeology / Agriculture</i> ; 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.

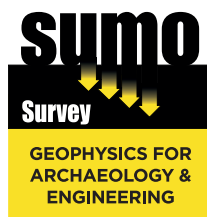
Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological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



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