GEOPHYSICAL SURVEY REPORT

CHERISH Ireland-Wales Project - Castell Bach, Cwmtydu, Ceredigion

Client

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

Survey Report

14719

Date

May 2019

Survey Report 14719: CHERISH Ireland-Wales Project - Castell Bach, Cwmtydu, Ceridigion

Survey dates	28 March 2019
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Report Date	8 May 2019
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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 1.5 ha of rough pasture land at Castell Bach, Cwmtydu. Remains associated with the promontory fort have been identified, including the ramparts of the inner and outer defences. Possible archaeological anomalies have been mapped inside the inner enclosure, though the exact origin of these remains undecided. Several responses of uncertain origin are visible across the area, and these could be archaeological or natural.

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	SN 363 597 / SA44 6LH
Location	The site is located approximately 3.5km south-west of New Quay, Ceredigion, and is situated on the cliff top above Castell Bach Bay.
HER	Dyfed Archaeological Trust (DAT)
Unitary Authority	Ceredigion
Parish	Llandysiliogogo
Topography	Sloping down from east to west
Current Land Use	Rough pasture / heathland
Geology (BGS 2019)	Bedrock: Mynedd Bach Formation - sandstone and mudstone. Superficial: Till, Devensian (Irish Sea Ice) - diamicton.
Soils (CU 2019)	Soilscape 6; freely draining slightly acid loamy soils.
Archaeology (RCAHMW 2019)	The Scheduled Monument (CD068) of a promontory coastal fort occupies the site. The monument comprises the remains of two earthworks, cutting off a small headland, which is being eroded by the sea. The bivallate inner fort currently encloses 0.25 ha, defined by two close-set ramparts, each with an outer ditch; a third rampart and outer ditch are widely spaced some 100m to the east. The whole site currently encloses 1.48 ha but may have enclosed nearly 2 ha before coastal erosion cut away the west side (RCAHMW 2019).
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	*c.* 1.5 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 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 ***Known / Possible Archaeology***

5.1.1 A series of curving positive and negative anomalies [1] are visible in the west of the area, and correspond with the defences of the inner, bivallate enclosure. Approximately 100m to the north-east, additional bank and ditch features [2] have been detected; these also correspond with extant earthworks on the site. The responses reflect the defensive banks and ditches and have been characterised as being 'known' archaeology given that they are directly associated with the earthworks of the Scheduled Monument (CD068).

5.1.2 A series of further ditch-like responses and areas of enhanced magnetic response [3] have been identified within the inner enclosure. Their location suggests that they could have an archaeological explanation and they may reflect settlement evidence; especially the anomaly which has a rectilinear shape. However, most of the responses lack any clear form and it is also feasible that they are a result of natural magnetic variations.

5.2 ***Uncertain***

5.2.1 A moderately strong discrete anomaly [4] and similar, weaker discrete response [5] have been identified to the east of the inner enclosure. These are of uncertain origin, though it is possible that they could be archaeological, given their location within the outer defences of the fort.

5.2.2 Several moderate strength discrete responses and areas of enhanced magnetic response [6, 7] have been detected. These could be archaeological, perhaps related to former ditches, settlement evidence or other features associated with the promontory fort, though it is also equally possible that they are of natural origin. Linear responses [8] in the north-east of the area are ditch-type in their appearance, though their relationship with the inner and outer enclosures is not clear; as such, they have been categorised as 'uncertain'.

5.3 ***Natural / Geological / Pedological / Topographic***

5.3.1 A few weak bands of increased magnetic response can be seen in the data, these are thought to be of natural origin, i.e. related to localised variations in the underlying geology or superficial deposits.

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 clearly reflect natural bedrock. While small features, such as gullies and post-holes may be 'missed', larger ditches and pits should have been detected. The earthworks are very prominent, and the anomalies detected are largely a result of topographic effects.

7 CONCLUSION

7.1 The survey at Castell Bach, Cwmtydu has recorded anomalies which reflect the inner and outer ramparts of the Scheduled promontory fort, which survive as extant earthworks. A small cluster of discrete anomalies and areas of enhanced magnetic response have been detected within the inner enclosure, and it is possible that these are a result of settlement activity. A large number of discrete, linear and amorphous areas of increased response are present in the data, all of which are of uncertain origin.

8 REFERENCES

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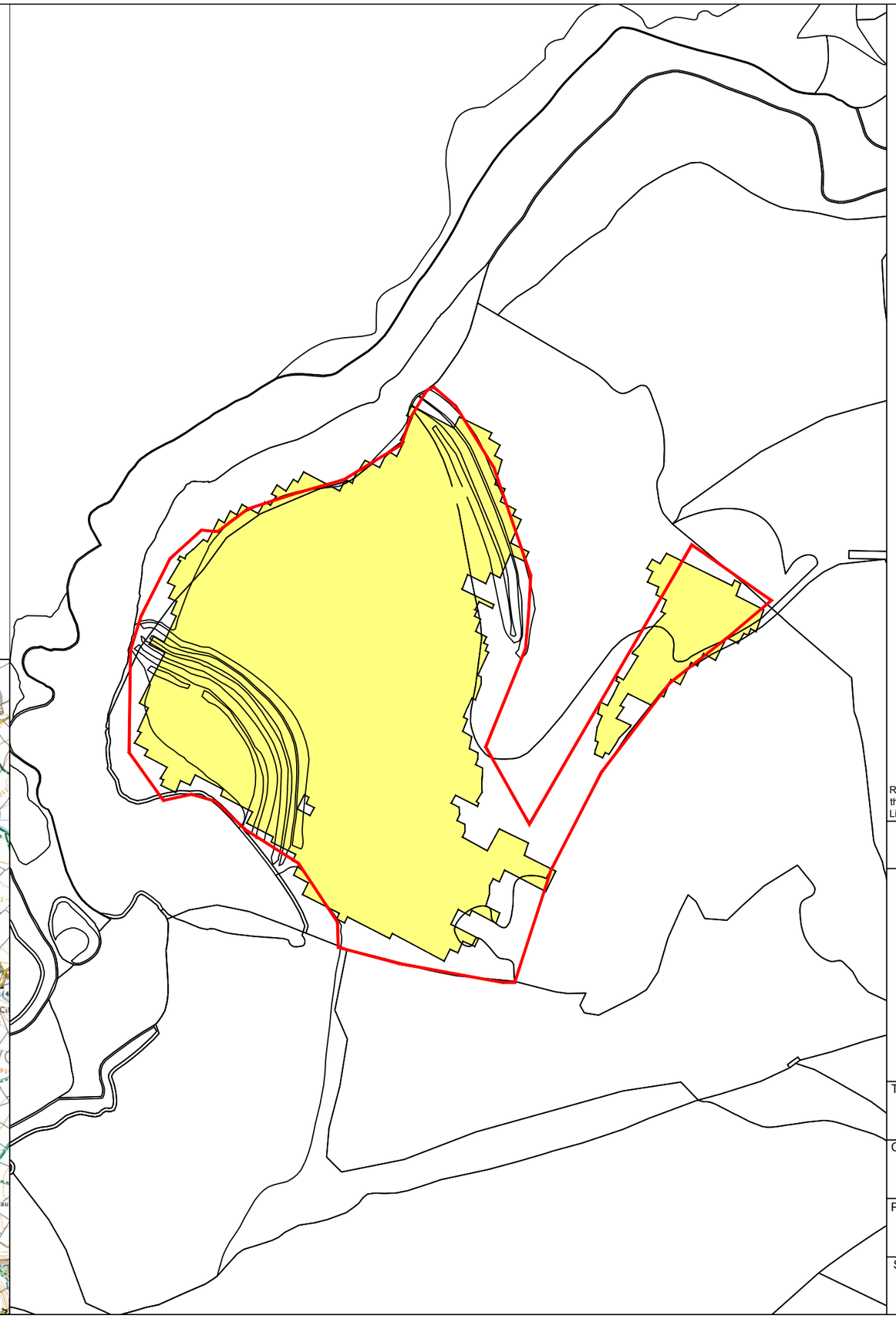

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Survey Areas

N

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Site Location

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

Project:
14719 - CHERISH Ireland-Wales Project - Castell Bach, Cwmtydu

Scale:
NOT TO SCALE

Fig No:
01

N

+1nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:

Magnetometer Survey - Greyscale Plots

Client:

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

Project:

14719 - CHERISH Ireland-Wales Project - Castell Bach, Cwmtydu

Scale:

0 metres 50

1:1000 @ A3

Fig No:

02

N

+2nT

-1nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Greyscale Plots

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

Project:
14719 - CHERISH Ireland-Wales Project - Castell Bach, Cwmtydu

Scale:
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Fig No:
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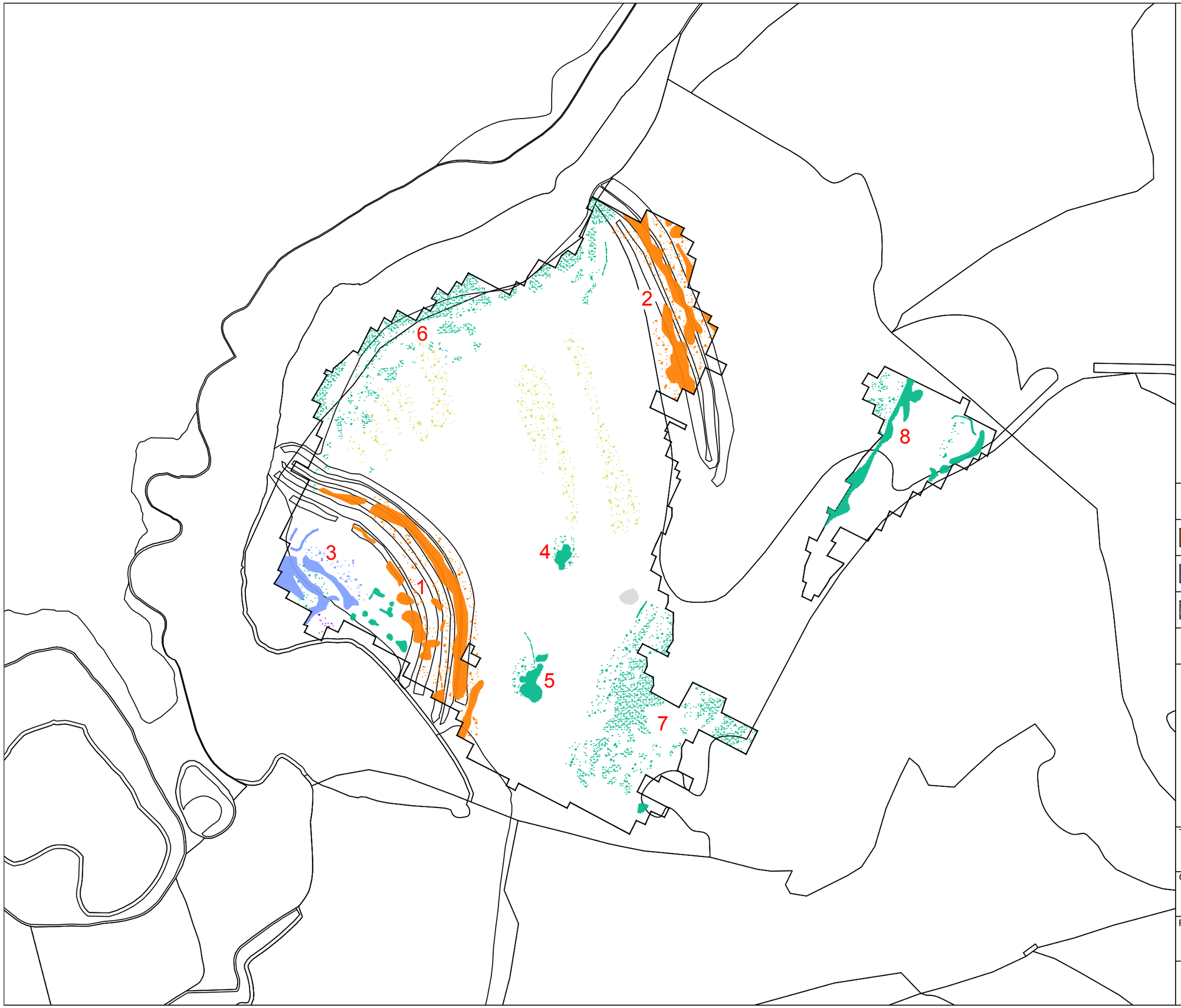

KEY

- Known (corroborated) archaeology (discrete anomaly / trend / negative)
- Possible archaeology (discrete anomaly / trend / area of increased response)
- Uncertain Origin (discrete anomaly / area of increased response / trend)
- Natural (e.g. geological / pedological)

sumo Survey
GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Magnetometer Survey - Interpretation

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

Project:
14719 - CHERISH Ireland-Wales Project - Castell Bach, Cwmtydu

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Fig No:
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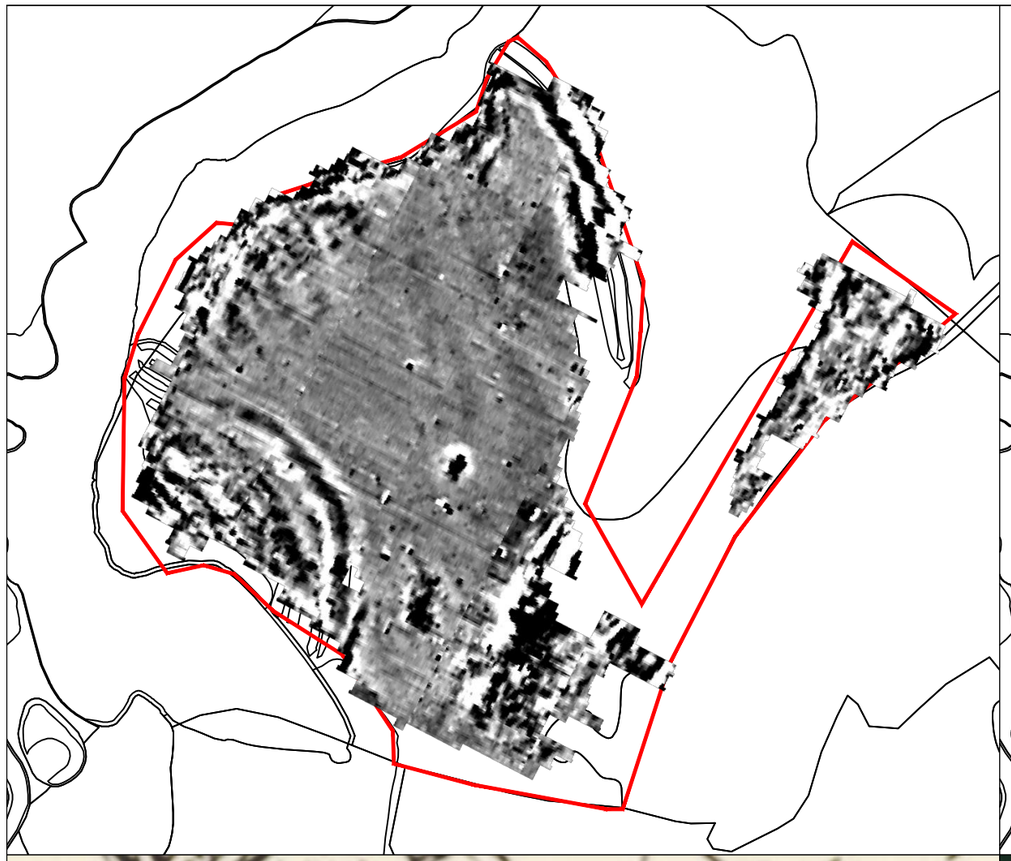
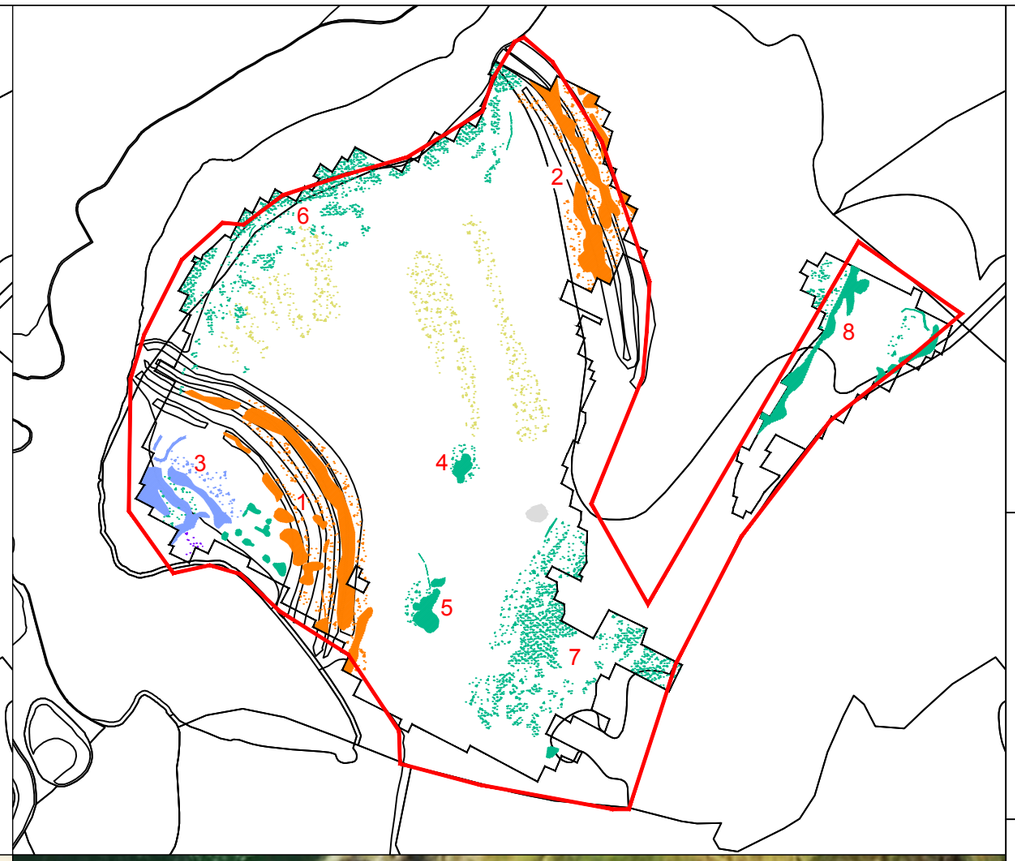




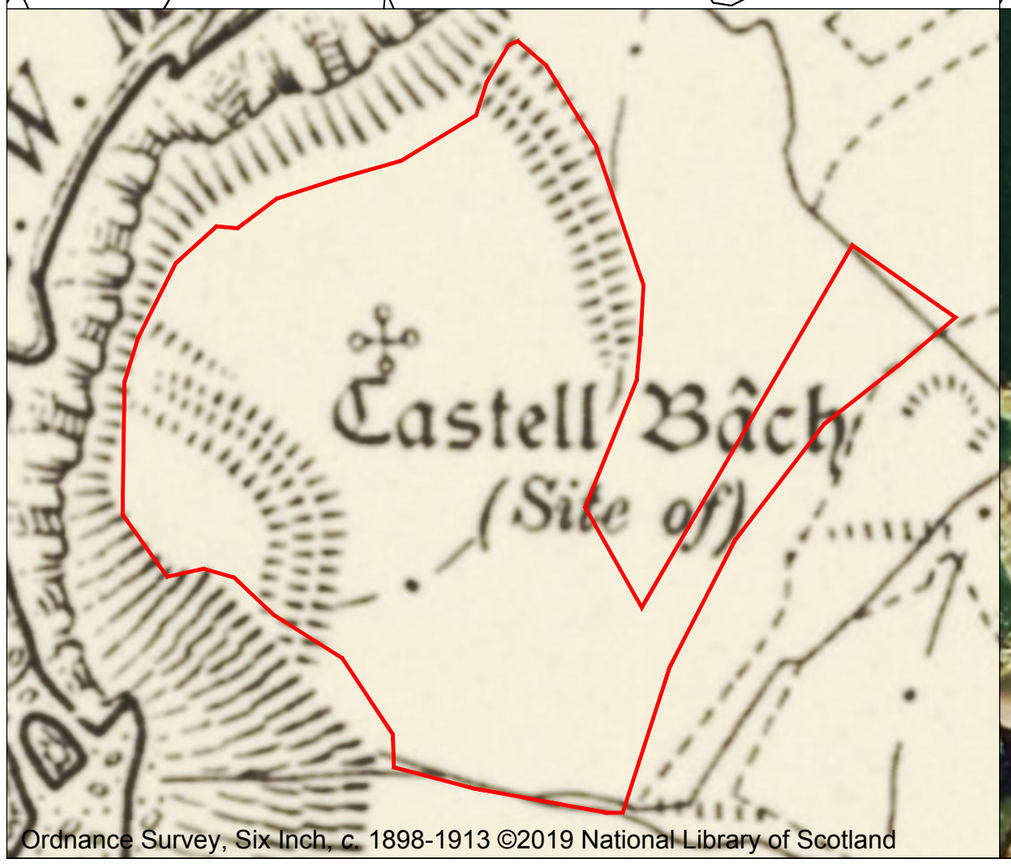
N

+1nT

-1nT

KEY

	Known (corroborated) archaeology (discrete anomaly / trend / negative)
	Probable archaeology (discrete anomaly / trend / negative)
	Uncertain Origin (discrete anomaly / trend / area of increased response)
	Natural (e.g. geological / pedological)



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GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Greyscale Plot, Interpretation, *c.*1888-1913 OS Map and 2006 Google Earth Image

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

Project:
14719 - CHERISH Ireland-Wales Project - Castell Bach, Cwmtydu

Scale:
0 metres 75
1:1500 @ A3

Fig No:
05

N

+5nT

-5nT

sumo Survey

GEOPHYSICS FOR ARCHAEOLOGY & ENGINEERING

Title:
Minimally Processed Data - Greyscale Plots

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

Project:
14719 - CHERISH Ireland-Wales Project - Castell Bach, Cwmtydu

Scale:
0 metres 50
1:1000 @ A3

Fig No:
06

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.

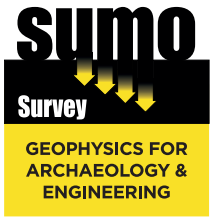
Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological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