106044
Box 169A

Castell Grogwynion, Ceredigion

Geophysical Survey Report

Produced for RCAHMW

CGW121

1st June 2012

MJ Roseveare

ArchaeoPhysica Ltd

Kitchener's, Home Farm, Harewood End, Hereford HR2 8JS UK
Tel. +44 (0) 1989 730 564
Web site: www.archaeophysica.co.uk

Mapping Our Heritage

Non-Technical Summary

A high resolution magnetic survey of parts of Castell Grogwynion was undertaken to support a MPhil project by Keith Haylock at the Institute of Geography and Earth Sciences (IGES) at Aberystwyth University. XRF instrumentation revealed high levels of lead in the soil and it has been proposed that this might indicate prehistoric metal working at the site.

The magnetic survey was able to demonstrate the likely presence of at least one hearth or furnace directly below the highest levels of lead and probable associated debris. In addition, two probable roundhouses were also found where weak topographic variations suggested such structures might exist.

Digital Data

Data	Included?	Format
Survey outlines		Vector: AutoCAD R12 DXF
Interpretation		Vector: AutoCAD R12 DXF
XY Traces		Vector: AutoCAD R12 DXF
Contours		Vector: AutoCAD R12 DXF
Images		Georeferenced raster: GeoTIFF
Catalogue		Database: MS Access 2003

Media	Sent to	Date

Audit

Version	Author	Checked	Date
Draft Final	MJR	MJR	05/06/12

Table of Contents

1 Introduction

Objective

1.1 Castell Grogwynion is one of three hillforts selected as part of a MPhil project by Keith Haylock at the Institute of Geography and Earth Sciences (IGES) at Aberystwyth University. XRF instrumentation has been used to prospect for imported metal residues (specifically lead) that might indicate past metal exploitation and working in the Iron Age. Of the three, this site produced the most promising results (Haylock, *pers. comm.*).

1.2 Simon Timberlake has recommended (Driver, *pers. comm.*) that detailed magnetic survey be undertaken at the site to prospect for and map any structures that might be related to former industrial activity.

Location

Country	Wales
County	Ceredigion
Nearest Town	Aberystwyth town, Ysbyty Ystwyth lies just to the east
Central Co-ordinates	272105 272495

1.3 Two areas totalling 0.15 hectares were surveyed.

Constraints and variations

1.4 The original request was for both magnetic and magnetic susceptibility surveys but this was changed during project design to just magnetic survey, exploiting the non-gradiometric capabilities of caesium vapour instrumentation. This is based on the ability of the instruments to measure the total magnetic field without sensitisation to depth avoiding the inability of gradiometric configurations to detect horizontal laminar structures.

1.5 An instrument fault intermittently affected data during collection of the first grid but was not indentified until after the survey. Luckily, the 0.25m cross line resolution has meant that its effect upon the data and overall result has been minimal.

2 Context

Archaeology

2.1 The following is quoted verbatim from Coflein:

"Castell Grogwynion is a roughly rectangular fort in plan, nearly 170m east-west by some 100m north-south. However, the topography is so pronounced on site, falling nearly 29 metres from the summit of the western outcrop to the approaches of north-east gateway, that its shape in plan is almost irrelevant. As one approaches from the north-west or north-east towards the hillfort, only the high outcrop is really visible with the main part of the fort inconspicuous on the lower saddle of ground to the east. As one approaches closer, one is greeted by the main northern façade, comprised of a pair of terraces set about 18m apart in places, which prevents direct access up and into the fort. The overall fort is arranged in a series of steps, with the main gate positioned at the lowest point and the visitor progressing upwards through the fort, ultimately towards the high western outcrop at 289 metres O.D. One must walk to the north-east apex of the fort to gain access through the elaborate gateway, passing first a prominent bastion or slinging platform on the left (north) side, then turning through 180 degrees and passing into the lowest 'compartment' of the fort interior. Moving uphill one comes to a central part of the fort formed between a high, modified slope on the west side, by outcrops on the east, and by the inner terrace of the main façade on the north, which turns in through 90 degrees to the rear of the outcrops. A climb uphill

brings you to the last internal area below the outcrop, a steep natural terrace partly modified on the north and east sides. Climbing up further one reaches the high western outcrop, encircled with well-built low ramparts set on good foundations. As this outcrop is the only part of the fort which can be easily seen from more distant approaches, it appears that the ramparts here were designed to present an appearance of 'false multivallation' to visitors, in a statement of strength, rather than as a practical enclosure for settlement. A prominent knoll over a precipitous drop at the south-west point of the fort, overlooking the Ystwyth Valley, is also plausible as a 'lookout' point."

2.2 Given the high quantities of lead found within the soil using XRF, it seems likely that some sort of metal working activity was present at the site and therefore structures like open hearths and perhaps furnaces might survive.

2.3 On the upper (southern) platform there are two very shallow scoops that might mark the sites of hut platforms and this area is sheltered from the West by the summit outcrop of the hill. The other site of interest is within the inner ditch to the northeast of this outcrop and a slight ridge along the base of the ditch seems to broadly co-incide with the elevated levels of lead.

Environment

Superficial 1:50000 BGS	None recorded
Bedrock 1:50000 BGS	Devil's Bridge Formation (Silurian) – Interbedded Mudstone and Sandstone (DBF)
Topography	Survey conducted on approximately level platforms within the fort
Hydrology	Free draining
Current Land Use	Rough pasture
Historic Land Use	Rough pasture and hillfort
Vegetation Cover	Grassland
Sources of Interference	None

2.4 The bedrock is not expected to contribute significantly to the magnetic field at the site although variations in soil depth reflecting undulations in and discontinuities of the bedrock surface will be visible if the soil is at all magnetically susceptible.

2.5 There is not thought to be any lead vein within the rock immediately below the hillfort and therefore the elevated levels of lead are not thought to have a natural origin, e.g. through weathering of ditch side where it is cut into the base of the summit outcrop. However, this cannot be totally discounted as the rock face is hidden by soil and vegetation but the presence of elevated magnetic susceptibility co-incident with the area where the lead was found would suggest an artificial origin.

2.6 The magnetic environment at the time of survey is described by the IGRF data below:

Mag. Declination	-2.959 degrees
Mag. Inclination	67.038 degrees
Horizontal Intensity	19037 nT changing by 17.1 nT / year
North Component	19012 nT changing by 19.8 nT / year
East Component	-983 nT changing by 51.5 nT / year
Vertical Intensity	44933 nT changing by 14.2 nT / year
Total Intensity	48799 nT changing by 19.7 nT / year

2.7 To this should be added an observed variation of up to 10 nT within a hour or so caused by the natural diurnal trend coupled with a marginal effect from a solar storm.

3 Methodology

Survey

Hardware

Measured Variable	Total magnetic field intensity / nT
Instrument	Geometrics G858 (0.5m parallel configuration), 10 Hz Geometrics G858 (base station), 2 Hz
Configuration	Parallel 0.5m spaced sensors
Sensitivity	0.03 nT (G858) 0.01 nT (G858 base station)

Resolution

3.1 The line separation for the survey was 0.25m, collected in overlapping passes using sensors spaced 0.5m apart. Data collection along each line was collected at 10Hz which equates to a sample spacing of roughly 0.16m – 0.2m along each.

3.2 Temporal data was collected at 0.5s intervals using a separate base station magnetometer, necessary to reduce the effects of a magnetic storm.

3.3 Non-gradiometric data collection was used throughout so there was no compression of anomaly strength or reduction of sensitivity to horizontal structures.

Monitoring and quality assurance

3.4 Data is continually monitored during survey for unusual or obviously incorrect system behaviour or performance. Selected individual traverses are normally re-surveyed for comparison and to assess repeatability and rest-mode data is collected to assess temporal variation.

3.5 A suitably qualified Project Geophysicist was in the field at all times and fieldwork and technical considerations were guided by the Senior Geophysicist.

Processing

Procedure

3.6 All data processing is minimised and limited to what is essential for the class of data being collected, e.g. reduction of orientation effects from magnetic sensors, suppression of single point defects (drop-outs or spikes), etc. The process stream for this data is as follows:

Process	Software	Parameters
Temporal smoothing and reduction	Geometrics Magmap	N/A
Smoothing	Proprietary	Selective despike > 3 nT
Heading reduction	Geometrics Magmap	N/A
Gridding	Surfer	Cubic spline along-line to 0.25m
Potential field processing	Proprietary	Reduction to pole (not imaged)
Imaging and presentation	Manifold GIS	

3.7 Reduction to pole was carried out to investigate source body plan form and was found in this instance to have little appreciable effect upon the data set apart from an expected lateral translation of approximately 0.2m.

3.8 General information on processes commonly applied to data can be found in standard text books and also in the 2008 English Heritage Guidelines "*Geophysical Survey in Archaeological Field Evaluation*" at http://www.helm.org.uk/upload/pdf/Geophysical_LoRes.pdf.

3.9 ArchaeoPhysica uses more advanced processing for magnetic data using potential field techniques standard to near-surface geophysics. Details of these can be found in Blakely, 1996, "*Potential Theory in Gravity and Magnetic Applications*", Cambridge University Press.

3.10 All archived data includes process metadata.

Interpretive framework

Resources

3.11 Numerous sources are used in the interpretive process which takes into account shallow geological conditions, past and present land use, drainage, weather before and during survey, topography and any previous knowledge about the site and the surrounding area. Old Ordnance Survey mapping is consulted and also older sources if available.

Magnetic survey

3.12 Interpretative logic is based on structural class and examples are given below. For example a linear field or gradient enhancement defining an enclosed or semi-enclosed shape is likely to be a ditch fill, if there is no evidence for accumulation of susceptible material against a non-magnetic structure. Weakly dipolar discrete anomalies of small size are likely to have shallow non-ferrous sources and are therefore likely to be pits. Larger ones of the same class could also be pits or locally-deeper topsoil but if strongly magnetic could also be hearths. Strongly dipolar discrete anomalies are in all cases likely to be ferrous or similarly magnetic debris, although small repeatedly heated and *in-situ* hearths can produce similar anomalies. Reduced field strength (or gradient) linear anomalies without pronounced dipolar form are likely to be caused by relatively low susceptibility materials, e.g. masonry walls, stony banks or stony or sandy ditch fills.

Standards & guidance

3.13 All work was conducted in accordance with the following standards and guidance:

- David et al, "Geophysical Survey in Archaeological Field Evaluation", English Heritage 2008
- "Standard and Guidance for Archaeological Field Evaluation", Institute for Archaeologists 2008.

3.14 Archive formation is in the spirit of the following document which is, however, dated and not of direct relevance to the form and structure of data collected during non-gridded multi-sensor survey:

- Schmidt, A. et al, 2001, "Geophysical Data in Archaeology: A Guide to Good Practice", ADS

3.15 In addition, all work is undertaken in accordance with the high professional standards and technical competence expected by the Geological Society of London and the European Association of Geoscientists and Engineers.

3.16 All personnel are experienced surveyors trained to use the equipment in accordance with the manufacturer's expectations. All aspects of the work are monitored and directed by fully qualified professional geophysicists.

4 Catalogue

4.1 The numbers in square brackets in this report refer to the catalogue below and DWG 03.

Label	Anomaly Type	Feature Type	Description	Easting	Northing
1	Strong discrete dipolar	Fill / thermal - Hearth?	A very strong discrete anomaly typical of a hearth or pit filled with heated soil	272116.0	272542.6
2	Area enhanced	Fill / deposit - Debris	Spread of magnetic material associated with structure [1]. Accumulated heated soil is a likely origin, spread / braided by later cultivation	272121.5	272540.8
3	Area enhanced	Fill / deposit - Debris	Spread of magnetic material, presumably associated with structure [1] although this is not certain. Accumulated heated soil is a possibility	272130.3	272545.0
4	Non-magnetic?	Structure	Anomaly [3] has an abrupt eastern edge and if interpreted as a magnetic fill might imply the existence of a linear structure bounding it	272131.4	272542.6
5	Area enhanced	Deposit?	Material on outer face of rampart, otherwise locally deep soil?	272151.0	272531.1
6	Area reduced	Bedrock?	Very shallow soil, i.e. outcropping bedrock, might account for this anomaly, failing that, a mass of stone close under the surface	272151.1	272534.0
7	Linear enhanced	Fill - Ditch / deposit	Possible narrow ditch or hollow alongside the inner face of a low bank	272110.0	272528.5
8	Linear dipolar enhanced (sample)	Fill - Cultivation	Closely spaced cultivation furrows are aligned along the length of the platform	272104.4	272522.5
9	Area enhanced	Fill / deposit - Debris	Uncertain, perhaps a dump of heated soil or similar magnetic material within a hollow	272120.8	272519.2
10	Linear enhanced	Fill - ditch	Eaves drip or drain, alternatively the deepest region of fill over a former platform, most likely the site of a prehistoric roundhouse	272097.1	272511.4
11	Linear enhanced	Fill - ditch	See [10]	272108.5	272516.7
12	Strong discrete dipolar	Fill / thermal - Hearth?	Probable hearth or perhaps a pit with heated soil associated with likely roundhouse [10]	272101.2	272508.9
13	Strong area enhanced	Fill / Debris	Possible burnt soil within hood or eaves drip of likely roundhouse [11]	272110.6	272514.1
14	Linear enhanced	Fill? - Ditch?	A possible enclosure may be defined by a ditch or hollow up to 1.5m wide, presumably associated with the likely roundhouse sites	272117.4	272509.3

Label	Anomaly Type	Feature Type	Description	Easting	Northing
15	Variably enhanced	Fill? / Debris?	Possible midden or spread of similar material across the platform	272102.2	272499.5

5 Discussion

Introduction

5.1 The sections below first discuss the geophysical context within which the results need to be considered and then specific features or anomalies of particular interest. Not all will be discussed here and the reader is advised to consult the catalogue (*ibid*) in conjunction with the graphical elements of this report.

Principles

5.2 In general, topsoil is more magnetic than subsoil which can be slightly more magnetic than parent geology, whether sands, gravels or clays, however, there are exceptions to this. The reasons for this are natural and are due to biological processes in the topsoil that change iron between various oxidation states, each differently magnetic. Where there is an accumulation of topsoil or where topsoil has been incorporated into other features, a greater magnetic susceptibility will result.

5.3 Within landscapes soil tends to accumulate in negative features like pits and ditches and will include soil particles with thermo-remanent magnetization (TRM) through exposure to heat if there is settlement or industry nearby. In addition, particles slowly settling out of stationary water will attempt to align with the ambient magnetic field at the time, creating a deposit with depositional remanent magnetization (DRM).

5.4 As a consequence, magnetic survey is nearly always more a case of mapping accumulated magnetic soils than structures which would not be detected unless magnetic in their own right, *e.g.* built of brick or tile. As a prospecting tool it is thus indirect. Fortunately, the mechanisms outlined above are commonplace and favoured by human activity and it is nearly always the case that cut features will alter in some way the local magnetic field.

Instrumentation

5.5 The use of the magnetic sensors in non-gradiometric (vertical) configuration avoids measurement sensitisation to the shallowest region of the soil, allowing deeper structures, whether natural or otherwise to be imaged within the sensitivity of the instrumentation. However, this does remove suppression of ambient noise and temporal trends which have to be suppressed later during processing. When compared to vertical gradiometers in archaeological use, there is no significant reduction in lateral resolution when using non-gradiometric sensor arrays and the inability of gradiometers to detect laminar structures is completely avoided.

5.6 Caesium instrumentation has a greater sensitivity than fluxgate instruments, however, at the 10 Hz sampling rate used here this increase in sensitivity is limited to about one order of magnitude.

5.7 The array system is designed to be non-magnetic and to contribute virtually nothing to the magnetic measurement, whether through direct interference or through motion noise. There is, however, some limited contribution from the towing ATV.

Character & principal results

5.8 For detailed comment the reader is advised to consult the catalogue in section four, above.

5.9 The data set has some small scale problems caused by variations of sensor height and speed upon entering and leaving some small but steep slopes at the ends of survey lines. To some extent these are inevitable and though their presence would theoretically be reduced if a cart was used in practice there was insufficient room to manoeuvre a cart safely without losing useful area. Although these defects are occasionally visually distracting they have had no effect upon the interpretation of the data.

Geology

5.10 The geology undoubtedly supports magnetic susceptibility enhancement but has not directly contributed to the surface magnetic field except perhaps to slightly reduce it where the covering soil is shallowest.

5.11 What variation does exist is equally likely to be due to modification of the soil through settlement and industrial processes.

Landuse

5.12 A slightly surprising result was the discovery of cultivation strips [8] aligned along the length of the upper platform and similar to those observed as weak topographic variation on the lower platforms. The implication is that the entire interior of the monument, despite the inherent difficulties of access and exposure to weather, has been cultivated in the past, though by whom and when is unclear. It would seem that similar features also occupy the northern platform within the ditch fill.

5.13 The individual anomalies suggest narrow beds or bands of deepened soil normally no more than 1m wide with a density of roughly 1.5 per metre.

5.14 Their effect upon earlier structures is uncertain but it seems sensible to assume some disruption to structures must have occurred when cultivating a shallow soil in this manner. In addition, the anomalies from ring-ditches are most coherent where preserved beneath slopes, presumably protected by deeper soil. However, the survival of the associated probable hut platforms as weak topographic features suggests cultivation cannot have been intensive or prolonged.

Archaeology – southern (higher) area

5.15 The two possible hut platforms are both associated with partial ring ditches or drip features [10] and [11] and each has a discrete area of intense magnetisation typical of a hearth, e.g. [12]. In both cases this appears to be against the southern edge of the structure. The western structure [10] has an interior punctuated with elevated magnetic field strength and this might imply that a floor surface (with associated patches of heated ground, debris, possible pits, etc.) may survive.

5.16 There is a possible rounded enclosure defined by a band [14] of elevated magnetic field strength 1 to 2m wide. This is perhaps an accumulation of occupation (midden) material against some invisible and probably insubstantial structure or possibly an enclosure ditch.

5.17 To the south of the probable huts there is an area of elevated magnetic field strength [15] that might indicate the presence of midden material or reflect increased soil depth; the presence of strong magnetic anomalies within it could imply midden is more likely.

5.18 A probable ditch fill [7] perhaps 1.5m wide seems to exist against the base of a low bank at the northern end of this area; there is weak topographic evidence for this as well. The anomaly is likely to be caused by increased soil depth combined with occupation debris (e.g. burnt soil) from the adjacent probable settlement.

Archaeology – northern high lead content area

5.19 The most striking anomaly here is [1] which is typical of a structure either filled with burnt soil or a hearth or furnace. The anomaly suggests significant depth extent, e.g. perhaps more than a thin spread of material. This structure appears to coincide with the highest measured levels of soil lead and interpretation as a smelting hearth or casting facility seems the most likely interpretation.

5.20 Extending eastwards from this is an area of enhanced magnetic field typical of a spread of accumulated burnt soil, most likely associated with structure [1]. This apparently also coincides with a 'plume' (Haylock, *pers. comm.*) of elevated lead quantities, with a similar plan form. Debris

from whatever activity took place at [1] is the logical interpretation. The material appears to have been disturbed by subsequent cultivation along the length of the platform.

5.21 At [3] a further area of enhanced field is likely to mark an accumulation of similar material although further hearths might also be possible. It appears to be or have been bounded by a linear non-magnetic structure [4].

5.22 Anomalies [5] and [6] most likely relate to variations in soil depth associated with the defensive rampart.

Conclusions

5.23 The surveys have successfully identified two probable prehistoric round houses and a likely metal-working hearth below later cultivation. The roundhouses appear to represent a discrete complex upon the upper platform rather than elements of a larger group, although further survey would be needed to prove this either way.

5.24 There is a close association between the location and plan form of the area of elevated lead quantities and strong magnetic anomalies. Together, they provide fairly conclusive evidence for metal working at the site, either using or extracting lead or depositing it as a waste product.

Caveats

5.25 Geophysical survey is a systematic measurement of some physical property related to the earth. There are numerous sources of disturbance of this property, some due to archaeological features, some due to the measuring method, and others that relate to the environment in which the measurement is made. No disturbance, or 'anomaly', is capable of providing an unambiguous and comprehensive description of a feature, in particular in archaeological contexts where there are a myriad of factors involved.

5.26 The measured anomaly is generated by the presence or absence of certain materials within a feature, not by the feature itself. Not all archaeological features produce disturbances that can be detected by a particular instrument or methodology. For this reason, the absence of an anomaly must never be taken to mean the absence of an archaeological feature. The best surveys are those which use a variety of techniques over the same ground at resolutions adequate for the detection of a range of different features.

5.27 Where the specification is by a third party ArchaeoPhysica will always endeavour to produce the best possible result within any imposed constraints and any perceived failure of the specification remains the responsibility of that third party.

5.28 Where third party sources are used in interpretation or analysis ArchaeoPhysica will endeavour to verify their accuracy within reasonable limits but responsibility for any errors or omissions remains with the originator.

5.29 Any recommendations are made based upon the skills and experience of staff at ArchaeoPhysica and the information available to them at the time. ArchaeoPhysica is not responsible for the manner in which these may or may not be carried out, nor for any matters arising from the same.

Appendices

Survey metadata

Project information

Project Name	Castell Grogwynion, Ceredigion
Project Code	CGW121
Client	RCAHMW
Fieldwork Dates	27th March 2012
Field Personnel	ACK Roseveare MJ Roseveare
Processing Personnel	ACK Roseveare
Reporting Personnel	MJ Roseveare
Draft Report Date	1st June 2012
Final Report Date	

Qualifications & experience

5.30 All work is undertaken by qualified and experienced geophysicists who have specialised in the detection and mapping of near surface structures in archaeology and other disciplines using a wide variety of techniques. There is always a geophysicist qualified to post-graduate level on site during fieldwork and all processing and interpretation is undertaken under the direct influence of either the same individual or someone of similar qualifications and experience.

5.31 ArchaeoPhysica meets with ease the requirements of English Heritage in their 2008 Guidance "Geophysical Survey in Archaeological Field Evaluation" section 2.8 entitled "Competence of survey personnel". The company is one of the most experienced in European archaeological prospection and is a key professional player. It only employs people with recognised geoscience qualifications and capable of becoming Fellows of the Geological Society of London, the Chartered UK body for geophysicists and geologists.

Safety

5.32 Safety procedures follow the recommendations of SCAUM (now FAME) & the IAGC (International Association of Geophysical Contractors).

5.33 Principal personnel have passed the Rescue Emergency Care – Emergency First Aid course and CSCS cards are being sought for those members of staff currently without them.

5.34 All personnel are issued with appropriate PPE and receive training in its use. On all sites health and safety management is performed by the Project Geophysicist under supervision by the Operations Manager. A preliminary risk assessment will be prepared and made available to interested parties upon award of tender.

5.35 Health and safety policy documentation is reviewed every 12 months, or sooner if there is a change in UK legislation, a reported breach of such legislation, a reported Incident or Near Miss, or changes to ArchaeoPhysica's activities. Anne Roseveare, Operations Manager, has overall responsibility for conducting this review and ensuring documentation is maintained.

5.36 We are happy to confirm that ArchaeoPhysica has suffered no reportable accidents since its inception in 1998.

Archiving

5.37 ArchaeoPhysica maintains an archive for all its projects, access to which is permitted for research purposes. Copyright and intellectual property rights are retained by ArchaeoPhysica on all material it has produced, the client having full licence to use such material as benefits their project.

5.38 Access is by appointment only. Some content is restricted and not available to third parties. There is no automatic right of access to this archive by members of the public. Some material retains commercial value and a charge may be made for its use. An administrative charge may be made for some enquiries, depending upon the exact nature of the request.

5.39 The archive contains all survey and project data, communications, field notes, reports and other related material including copies of third party data (e.g. CAD mapping, etc) in digital form. Many are in proprietary formats while report components are available in PDF format.

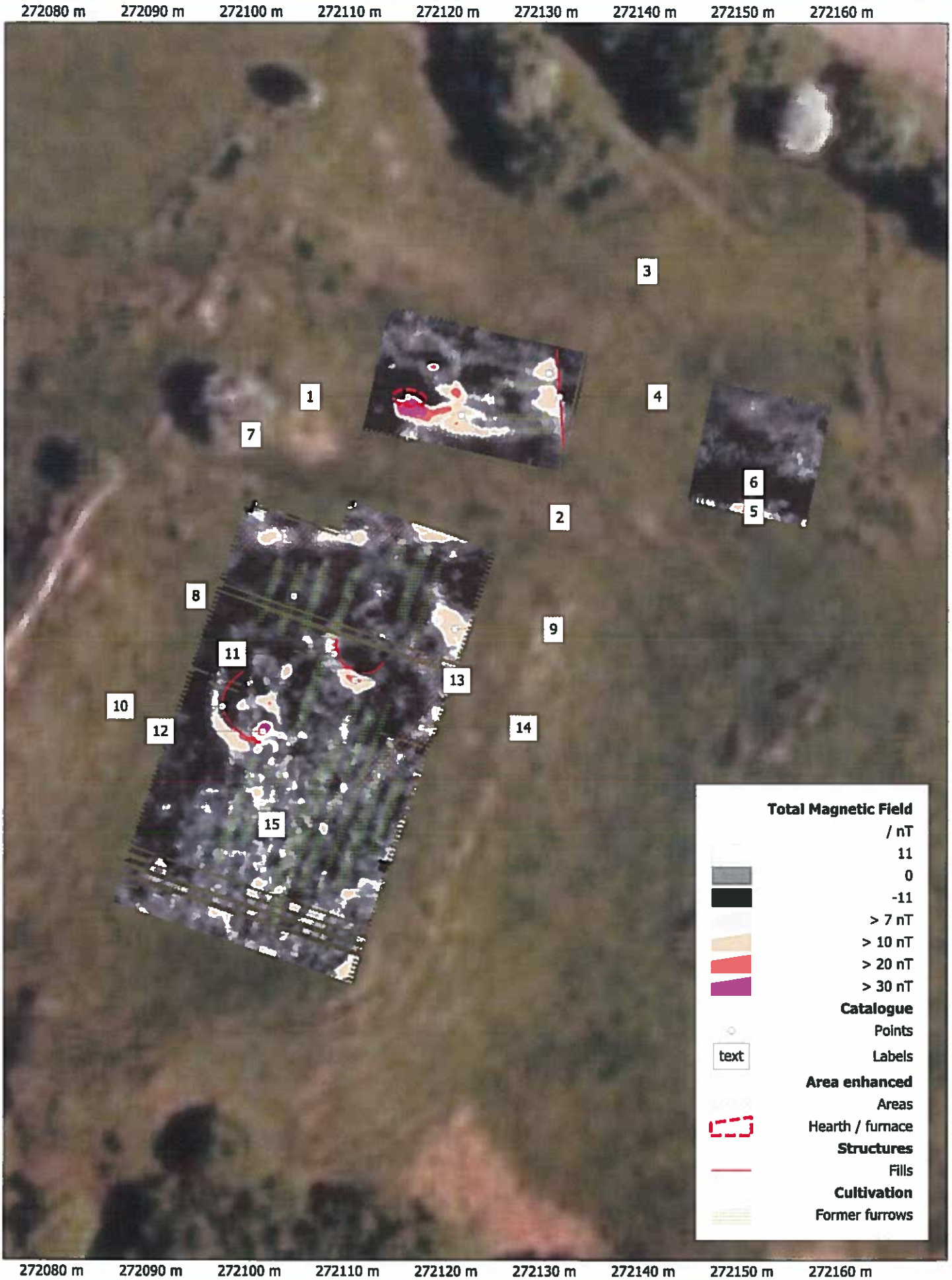
5.40 In addition, there are paper elements to some project archives, usually provided by the client. Nearly all elements of the archive that are generated by ArchaeoPhysica are digital.

5.41 It is the client's responsibility to ensure that reports are distributed to all parties with a necessary interest in the project, e.g. local government offices, including the HER where present. ArchaeoPhysica reserves the right to display data from projects on its website and in other marketing or research publications, usually with the consent of the client. Information that might locate the project is normally removed unless otherwise authorised by the client.

CGW121 Castell Grogwynion, Ceredigion, Wales
DWG 02 Magnetic Data

ArchaeoPhysica Ltd

Orthographic Centre X: 272122.98 m Centre Y: 272518.02 m Scale: 1:500 @ A4 Spatial Units: Meter. Do not scale off this drawing



CGW121 Castell Grogwynion, Ceredigion, Wales
DWG 03 Catalogue

ArchaeoPhysica Ltd

Orthographic Centre X: 272122.98 m Centre Y: 272518.02 m Scale: 1:500 @ A4 Spatial Units: Meter. Do not scale off this drawing