Llanegryn, Gwynedd

Geophysical Survey Report

Produced for Castlering Archaeology

LEG121

17th February 2012

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Mapping Our Heritage

Non-Technical Summary

A magnetic survey was commissioned in advance of the proposed construction of a new school, Ysgol Bro Dysynni, southwest of Llanegryn village. Little is known about the area and the survey result is therefore of particular interest because it appears to show the line of a former road and associated settlement or similar structures alongside or at the south-western end of it. Nothing further is known about these at this stage.

Digital Data

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

Media	Sent to	Date

Audit

Version	Author	Checked	Date
Draft Final	MJR	ACKR	18.02.12
Final	MJR	MJR	28.02.12

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1 Introduction

Objective

1.1 Magnetic and electrical resistance surveys were commissioned in advance of the proposed construction of Ysgol Bro Dysynni southwest of Llanegryn village to prospect for possible buried structures of archaeological interest.

Location

Country	Wales
County	Gwynedd
Nearest Town	Llanegryn
Central Co-ordinates	259790 305100

1.2 The field has an area of approximately four hectares and the whole of it was surveyed using the magnetic technique.

Constraints and variations

1.3 The brief from the National Park Authority stipulated magnetic and electrical resistance survey were to be carried out, however, given the shortage of available time before their deadline it was agreed that magnetic survey would proceed first. A separate decision would then be made on the extent and applicability of electrical resistance survey.

2 Context

Archaeology

2.1 The site lies within the Dysynni Valley Registered Landscape of Special Historic Interest.

2.2 Nothing is known to exist within the site boundary although a scatter of prehistoric monuments in the vicinity and a medieval church on the hill above and without attached settlement might suggest there is potential for buried structures.

Environment

Superficial 1:50000 BGS	Devensian Till – south-eastern lower slopes only (TILLD)
Bedrock 1:50000 BGS	T'yr Gawen Mudstone Formation (TYGN)
Topography	Slopes down to east
Hydrology	Locally poorly drained, intensive land-drains in lowest parts
Current Land Use	Pasture (improved)
Historic Land Use	Mixed agricultural
Vegetation Cover	Grass
Sources of Interference	Adjacent buildings, fencing and traffic

2.3 The Devensian Till, a widespread mixed deposit, overlays the mudstone across the lower eastern parts of the site and is visible in the banks of the streams and clearance debris around the field margins. The T’yr Gawen formation is named after a farm 2.5 km northeast of Llanegryn and is a mudstone with subordinate siltstone and sandstone dating from immediately pre-Silurian.

3 Methodology

Objective

3.1 Both magnetic and electrical resistance survey have been requested and this report details the magnetic survey because it being the more rapid technique meant it was undertaken first. This was to ensure the externally specified schedule could be met and to provide a detailed overview of the site.

3.2 Further survey (electrical resistance) may still be needed subject to consultation with the local curatorial authority and ArchaeoPhysica.

Survey

Hardware

Measured Variable	Magnetic flux density / nT
Instrument	Array of Geometrics G858 Magmapper caesium magnetometers
Configuration	Non-gradiometric transverse array (4 sensors, ATV towed)
Sensitivity	0.03 nT @ 10 Hz (manufacturer's specification)
QA Procedure	Continuous observation
Resolution	1.0m between lines, 0.25m mean along line interval

Monitoring and quality assurance

3.3 The system continuously displays all incoming data as well as line speed and spatial data resolution per acquisition channel during survey. Rest mode system noise is therefore easy to inspect simply by pausing during survey and the continuous display makes monitoring for quality intrinsic to the process of undertaking a survey. Rest mode test results (static test) are available from the system.

3.4 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

3.5 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
Measurement and GNSS receiver data alignment	Proprietary	
Temporal reduction and regional field suppression	Proprietary	10s highpass median filter
Gridding	Surfer	Kriging, 0.25m x 0.25m
Imaging and presentation	Manifold GIS	

3.6 The initial processing uses proprietary software developed in conjunction with the multisensor acquisition system. Surfer is used for gridding and initial study before the data is ported as data surfaces (not images) into Manifold GIS for final imaging and detailed analysis. Specialist analysis is undertaken using proprietary software.

3.7 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.

3.8 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.

3.9 All archived data includes process metadata.

Interpretive framework

Resources

3.10 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

3.11 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

3.12 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.

3.13 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

3.14 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.

3.15 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 04.

Label	Anomaly Type	Feature Type	Description	Easting	Northing
1	Area enhanced magnetic field	Fill - Ditch / Deeper soil	Possibly a strip of deeper soil alongside the possible roadway defined by [2] and [4]	259860.9	305166.9
2	Linear dipolar (enhanced) magnetic field	Fill - Ditch	Roadside ditch?	259851.0	305161.8
3	Area enhanced magnetic field	Fill - Ditch / Deeper soil	Between ditch fills [2] and [4] would logically be a road surface, here associated with slightly elevated magnetic field which might suggest a soil-filled hollow	259842.3	305156.6
4	Linear dipolar (enhanced) magnetic field	Fill - Ditch	Roadside ditch?	259833.5	305151.4
5	Area enhanced magnetic field	Fill - Ditch / Deeper soil	Uphill of and partly coincident with ditch fill [4] is a band of elevated magnetic field typical of deeper soil, e.g. colluvium, perhaps here filling the bench of former road	259824.4	305146.3
6	Linear enhanced magnetic field	Fill / Natural - Ditch / Geology	One of several co-aligned features (see also [7] and perhaps [10] and [14]) that might reflect banding in the solid geology or perhaps the overlying till deposits	259822.4	305115.7
7	Linear enhanced magnetic field	Fill / Natural - Ditch / Geology	See [6]	259815.3	305095.5
8	Variable enhanced magnetic field	Fills	A sinuous set of fills correspond with a former field boundary or stream course depicted as a boundary on the 1880s edition of Ordnance Survey mapping. A seasonal stream or drain is likely	259818.9	305069.3
9	Discrete dipolar magnetic field (sample)	Debris (ferrous)	Buried debris, one of several fairly large items	259788.7	305030.8
10	Area enhanced magnetic field	Fill - Natural	Natural linear fill typical of wetland environments over till deposits	259792.7	305010.2

Label	Anomaly Type	Feature Type	Description	Easting	Northing
11	Linear dipolar (enhanced) magnetic field	Fill - Ditch	One (with [15]) of a series of rectilinear and aligned enclosures that seem to relate to the possible roadway defined by [2] and [4]. In this case, the size of the enclosure (approximately 17 x 6.5m) might suggest the presence of buildings that have not been detected magnetically. The complex appears to be overlain by former field boundary [12], removed prior to the 1880s according to the Ordnance Survey mapping and it is possible, perhaps likely, that this boundary perpetuates the line of the roadway from the northeast	259756.1	305031.6
12	Linear dipolar (enhanced) magnetic field	Fill - Ditch	Former field boundary	259732.3	305028.0
13	Area enhanced magnetic field	Fill - Deeper soil?	Possible colluvial deposit, perhaps accumulated against former field boundary [12]	259733.1	305044.3
14	Area enhanced magnetic field	Fill / Natural - Geology?	Uncertain interpretation. The structure is aligned with both artificial structures [11] and [15] and possible natural structure [6]	259764.1	305059.8
15	Linear dipolar (enhanced) magnetic field	Fill - Ditch	See [11] - this example is larger and appears overlain by possible colluvium [13] and former field boundary [12]	259742.3	305084.4
16	Area enhanced magnetic field (sample)	Natural / Fill - Geology?	Typical linear variation associated with dipping (relative to surface) mudstone	259739.9	305119.3

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.

Extant structures

5.9 A number of structures have large associated magnetic fields, including the houses at the northern end of the site. Spatially large magnetic fields were encountered here and subsequently suppressed by highpass filter to allow small scale detail to be imaged. There is an inevitable slight decrease in the stability of the magnetic data when it is collected in magnetically noisy situations like this. Passing traffic also has a similar effect, again visible in the data.

Geological and land use context

5.10 The total magnetic field data shows a clear distinction between the northwest half of the site where the magnetic character is typical of shallow soil over mudstone and the southeast half where the strong magnetic fields associated with the mudstone are absent. In this area a smooth magnetic texture typical of non-magnetic till deposits is evident.

5.11 There is no recent history of landscaping (human cause) or land-forming activity (natural) at the site so it can be reliably assumed that archaeological structures, should they exist, will be present within the uppermost parts of the profile throughout. Negative structures like pits and ditches will potentially be cut into mudstone in the western parts and therefore might be associated with relatively strong magnetic anomalies, however, those cut into the till deposits may exhibit variable contrast.

5.12 Variable soil depth is likely to create detectable variations in magnetic field strength and especially where soils are derived from the mudstone and in their vicinity. If the field has been arable at any time then some downhill migration of relatively magnetic soil may be expected.

5.13 The character of many of the anomalies is typical of long-established pasture, these tending to be slightly diffuse and generally of fairly low strength. However, anomalies from natural structure within the mudstone are relatively strong.

Possible archaeological features

5.14 There are numerous land drains extending across the site and there are different phases of drainage. There appears to be a difference each side of the possible road defined by ditch fills [2] and [4] which might suggest that some of the drains were installed while this feature was still evident in the landscape, e.g. before the 1880s.

5.15 Possible colluvium [13] and perhaps also [5] might suggest that at least the higher regions of this field have been cultivated in the past.

5.16 A possible road enters the area from the northeast and perhaps continues right across the surveyed area if it is perpetuated by the line of a former field boundary [12]. Interpretation as a road seems justifiable given the pair of parallel ditch fills and a possible fill between them up to 3.5m wide. Given the situation cut into the slope the complexity of the compound magnetic anomalies can be explained by the combination of individual fills and a colluvial (or similar) deposit sealing them.

5.17 The south-eastern road ditch [2] runs along the contour, departing from the road line at the southern end to continue this along-contour course. Why this happens is not clear, however, it may once have connected with the complex of ditches at [11] with which it is aligned.

5.18 The complex of enclosures defined by [11] and [15] is partly contained within a relatively flat area of the field above the (presumably) wetter eastern margins. This area ends where a likely former stream course [8] passes down the slope and where the complex may have connected with the possible road.

5.19 The 1889 Ordnance Survey map depicts a division dividing the field into two and the magnetic data suggests this may have been a stream rather than a bank or hedge (although neither of the latter are discounted as additional features). Its line is partly followed by a former field boundary [12] which turns away south-westwards mid field.

Conclusions

5.20 Nothing was known about the archaeological potential of this field due to there being little research conducted in the area, however, this survey seems to suggest the presence of not only a former road but also associated settlement or similar activity. This is away from both the modern centre of the village, itself apparently of no great antiquity and the medieval church which lies out of sight to the north.

5.21 What these results represent is therefore unclear and the antiquity of the buried structures is open to debate. All that is known is that they had vanished (as had later field boundary [12]) before the Ordnance Survey mapping of 1889. Their form might suggest a medieval or post-medieval origin, however, there is nothing else to justify this.

Caveats

5.22 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.

5.23 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.

5.24 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.

5.25 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.

5.26 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.

Bibliography

Batten, 2010, "*Re: Archaeological consultation – proposed school Site 1 – Llanegryn, Tywyn*", Gwynedd Archaeological Planning Service, letter dated 28.09.2010 published as part of planning application

Appendices

Survey metadata

Project information

Project Name	Llanegryn, Gwynedd
Project Code	LEG121
Client	Castlering Archaeology
Fieldwork Dates	17th February 2012
Field Personnel	ACK Roseveare, MJ Roseveare
Processing Personnel	ACK Roseveare
Reporting Personnel	MJ Roseveare
Draft Report Date	17th February 2012
Final Report Date	28th February 2012

Qualifications & experience

5.27 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.

5.28 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

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

5.30 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.

5.31 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.

5.32 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.

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

Archiving

5.34 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.

5.35 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.

5.36 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.

5.37 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.

5.38 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.