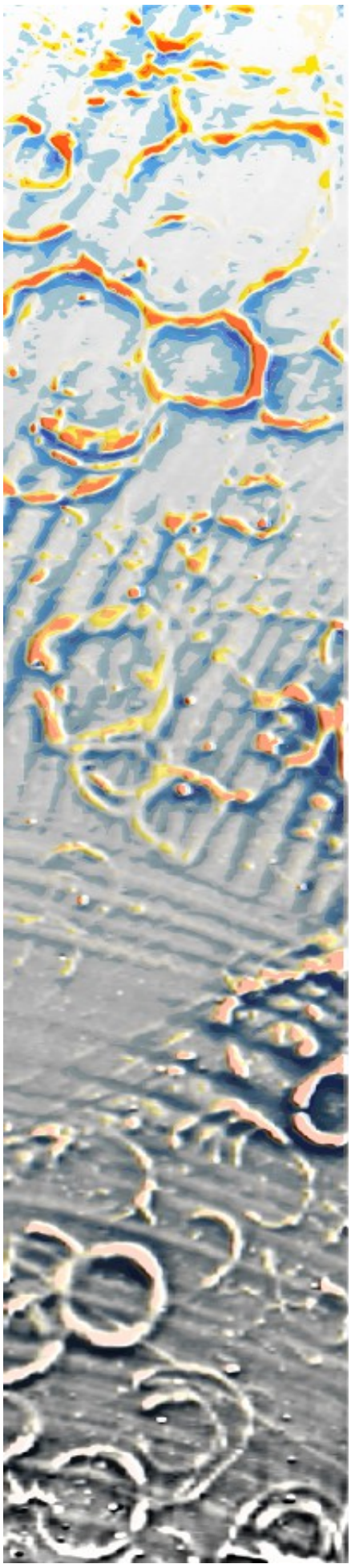

Coed-y-Dinas, Welshpool, Powys

Geophysical Survey Report

Produced for Clwyd-Powys Archaeological Trust

Project code SSW151

5th May 2015

MJ Roseveare, Senior Geophysicist
BSc(Hons) MSc MEAGE FGS MCIfA

ArchaeoPhysica Ltd
Kitchener's, Home Farm, Harewood End, Hereford HR2 8JS
Tel. +44 (0) 1989 730 564 www.archaeophysica.com

Non-Technical Summary

A magnetic survey was commissioned by the Clwyd-Powys Archaeological Trust on behalf of their end client to prospect land at Coed-y-Dinas for buried structures of archaeological interest.

The survey revealed a series of likely enclosure ditches across the southern part of the field although these are not continuous and do not form a single coherent layout. There may also be weak signs of former ridge and furrow cultivation and perhaps also drains. Overlaid across the site are bands of magnetic debris that seem likely to be derived from occasional use of the field as a car park.

Digital Data

Item	Sent to	Sent date
CAD – Vector Elements	Nigel Jones	1st May 2015

Audit

Version	Author	Checked	Date
Interim			
Draft Final	MJ Roseveare	ACK Roseveare	5th May 2015
Final			
Revision			
OASIS			

Table of Contents

1 Introduction....1
1.1 Location....1
2 Context....1
2.1 Archaeology....1
2.2 Environment....1
3 Methodology....2
3.1 Survey....2
3.1.1 Technical equipment....2
3.1.2 Monitoring & quality assessment....2
3.2 Data processing....2
3.2.1 Procedure....2
3.3 Interpretation resources....2
3.4 Interpretive classes....3
3.4.1 Introduction....3
3.4.2 Agriculture – boundaries....3
3.4.3 Agriculture – cultivation....3
3.4.4 Agriculture – drains....3
3.4.5 Archaeology – fills....3
3.4.6 Archaeology – other discrete....4
3.4.7 Archaeology – structures....4
3.4.8 Archaeology – zones....4
3.4.9 Geology – discrete....4
3.4.10 Geology – zones....4
3.4.11 Services....4
3.4.12 Texture....4
3.5 Standards & guidance....5
4 Discussion....6
4.1 Introduction....6
4.2 Principles....6
4.2.1 Instrumentation....6
4.3 Character & principal results....6
4.3.1 Geology....6
4.3.2 Land use....7
4.3.3 Archaeology....7
4.4 Conclusions....7
4.5 Caveats....7
4.6 Bibliography & selected reference....8
5 Appendices....9
5.1 Project metadata....9
5.2 Archiving....9
5.3 ArchaeoPhysica....9
5.3.1 The company....9
5.3.2 Senior Geophysicist: Martin J Roseveare, MSc BSc(Hons) MEAGE FGS MCIfA....10
5.3.3 Operations Manager: Anne CK Roseveare, BEng(Hons) DIS MISoilSci....10
5.3.4 Geophysicist: Samuel Purvis, MSc BSc(Hons) 10

1 Introduction

Land at Coed-y-Dinas was surveyed to inform a future planning application for development. The survey was required to prospect for buried structures of archaeological interest. The survey was undertaken across a single field under pastoral management and encompassed approximately 2.6 hectares.

1.1 Location

Country	Wales
County	Powys
Nearest Settlement	Welshpool
Central Co-ordinates	322300, 305775

2 Context

2.1 Archaeology

The below paragraphs are derived from online sources, in particular the Royal Commission on the Ancient and Historical Resources of Wales (Coflein).

To the north of the survey area is a possible Bronze Age round barrow (MG 281) designated as a scheduled monument, it is approximately 17 metres in diameter and stands to a height of approximately 0.5 metres. Within the survey area itself, a circular ring ditch has been identified as a cropmark on aerial photographs and seems to be NPRN 306956. Although undated, it may be contemporary with the Bronze Age Barrow to the north.

The remaining Coflein records in the immediate survey area relate to post-medieval buildings associated with Coed-y-Dinas Farm. The 'industrial' area of the farm is to the west of the survey area while the farmhouse lies to the south. The land in-between (the survey area) is depicted as agricultural fields on the 1886-7 first edition Ordnance Survey mapping.

2.2 Environment

Soilscape (UKSO)	Freely draining slightly acid loamy soils (6)
Superficial 1: 50000 BGS	Glaciofluvial Fan Deposits, Devensian – Sand and Gravel (GFNQD)
Bedrock 1:50000 BGS	Nant-ysgollon Mudstone Formation (NYG)
Topography	Flat
Hydrology	Natural floodplain
Current Land Use	Pastoral
Historic Land Use	Pastoral
Vegetation Cover	Grass
Sources of Interference	Various expected, from passing vehicles to small ferrous items in litter (the area is used as a car park) and potentially over and underground services

The Devensian sand and gravel deposits are likely to present a variable magnetic texture with pockets within the material associated with fairly strong anomalies in comparison with those from sources of archaeological interest. There might also be contributions from individual elements within the gravel, depending upon it's source. Given that the site is upon a flood plain, there is the potential for alluvial deposits and former channels, as well as seasonally wet areas that may exhibit a different magnetic character.

The site is used as car park and over time such sites tend to accumulate small items of ferrous litter that may be apparent in the data as small discrete anomalies.

3 Methodology

3.1 Survey

3.1.1 Technical equipment

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
Spatial resolution	0.5m between lines, 0.3m mean along line interval

3.1.2 Monitoring & quality assessment

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.

3.2 Data processing

3.2.1 Procedure

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

Process	**Software**	**Parameters**
Measurement & GNSS receiver data alignment	Proprietary	
Temporal reduction, regional field suppression	Proprietary	Bandpassed 0.3 – 5.0 s
Gridding	Surfer	Kriging, 0.25m x 0.25m
Smoothing	Surfer	Gaussian lowpass 3x3 data
Imaging and presentation	Manifold GIS	

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

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.

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.

All archived data includes process metadata.

3.3 Interpretation resources

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. Geological information is sourced only from British Geological Survey resources and aerial imagery from online sources. Topographic data is usually sourced from the Environment Agency (LiDAR) unless derived from original ArchaeoPhysica survey.

Information from nearby ArchaeoPhysica surveys is consulted to inform upon local data character, variations across soils and near-surface geological contexts. Published data from other contractors may also be used if accompanied by adequate metadata.

3.4 Interpretive classes

3.4.1 Introduction

Key to interpretation is separation of each anomaly into broad classes, namely whether caused by agricultural processes (e.g. ploughing, composting, drainage etc.), geological factors or whether a structure of archaeological interest is likely. Within these anomalies are in turn classified by whether they most likely represent a fill or a drain, or a region of differing data texture, etc. More detailed descriptions are included below.

The actual means of classification is based upon geophysical understanding of anomaly formation, the behaviour of soils, landscape context and structural form. For example, to consider just one form of anomaly: weakly dipolar discrete magnetic 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.

3.4.2 Agriculture – boundaries

Coherent linear dipolar enhancement of magnetic field strength marking ditch fills, narrow bands of more variable magnetic field or changes in apparent magnetic susceptibility, are all included within this category if they correlate with boundaries depicted on the Tithe Map or early Ordnance Survey maps. If there is no correlation then these anomaly types are not categorised as field boundaries.

3.4.3 Agriculture – cultivation

Banded variations in apparent magnetic susceptibility caused by a variable thickness of topsoil, depositional remanent magnetisation of sediments in furrows or susceptibility enhancement through heating (a by product of burning organic matter like seaweed) tend to indicate past cultivation, whether ridge-based techniques, medieval ridge and furrow or post medieval 'lazy beds'. Modern cultivation, e.g. recent ploughing, is not included.

3.4.4 Agriculture – drains

In some cases it is possible to identify drainage networks either as ditch-fill type anomalies (typically 'Roman' drains), noisy or repeating dipolar anomalies from terracotta pipes or reduced magnetic field strength anomalies from culverts, plastic or non-reinforced concrete pipes. In all cases identification of a herring bone pattern to these is sufficient for inclusion within this category.

3.4.5 Archaeology – fills

Any linear or discrete enhancement of magnetic field strength, usually with a dipolar character of variable strength, that cannot be categorised as a field boundary, cultivation or as having a geological origin, is classified as a fill potentially being of archaeological interest. Fills are normally earthen and include an often invisible proportion of heated soil or topsoil that augments local magnetic field strength. Inverted anomalies are possible over non-earthen fills, e.g. those that comprise peat, sand or gravel within soil. This category is

subject to the 'habitation effect' where, in the absence of other sources of magnetic material, anomaly strength will decrease away from sources of heated soil and sometimes to the extent of non-detectability.

Former enclosure ditches that contained standing water can promote enhanced volumetric magnetic susceptibility through depositional remanence and remain detectable regardless of the presence of other sources of magnetic material.

3.4.6 Archaeology – other discrete

This category is secondary to fills and includes anomalies that by virtue of their character are likely to be of archaeological interest but cannot be adequately described as fills. Examples include strongly magnetic bodies lacking ferrous character that might indicate hearths or kilns. In some cases anomalies of ferrous character may be included.

3.4.7 Archaeology – structures

On some sites the combination of plan form and anomaly character, e.g. rectilinear reduced magnetic field strength anomalies, might indicate the likely presence of masonry, robber trenches or rubble foundations. Other types of structure are only included if the evidence is unequivocal, e.g. small ring ditches with doorways and hearths. In some circumstances a less definite category may be assigned to the individual anomalies instead.

3.4.8 Archaeology – zones

On some sites it is possible to define different areas of activity on the basis of magnetic character, e.g. texture and anomaly strength. These might indicate the presence of middens or foci within larger complexes. This category does not indicate a presence or absence of anomalies possibly of archaeological interest.

3.4.9 Geology – discrete

On some sites, e.g. some gravels and alluvial contexts, there will be anomalies that can obscure those potentially of archaeological interest. They may have a strength equal to or greater than that associated with more relevant sources, e.g. ditch fills, but can normally be differentiated on the basis of anomaly form coupled with geological understanding. Where there is ambiguity, or relevance to the study, these anomalies will be included in this category.

3.4.10 Geology – zones

Not all changes in geology can be detected at the surface, directly or indirectly, but sometimes there will be a difference evident in the geological data that can be attributed to a change, e.g. from alluvium to tidal flat deposits, or bedrock to alluvium. In some cases the geophysical difference will not exactly coincide with the geological contact and this is especially the case across transitions in soil type.

3.4.11 Services

All overheard (OH) and underground (UG) services are depicted where these are detectable in the data or may influence aspects of the interpretation.

3.4.12 Texture

Geophysical data varies in character across areas, due to a range of factors including soil chemistry, near surface geology, hydrology and land use past and present. Where these variations are of interest or relevance to the study they are included in this category.

3.5 Standards & guidance

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.

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.

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 Discussion

4.1 Introduction

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 graphical elements of this report.

4.2 Principles

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.

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).

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.

4.2.1 Instrumentation

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.

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.

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.

4.3 Character & principal results

4.3.1 Geology

As expected there is a strong geological element within the magnetic data, with numerous strong anomalies of small spatial extent (e.g. within group [17]) and also linear structures that could equally well be of archaeological interest, being generically fills. Examples of these include [11] and [12] and perhaps also [15] and [16]. Sinuous anomalies [3] and [4] seem more obviously natural from their geophysical character and seem likely to mark former channels, perhaps of a stream.

4.3.2 Land use

Two discrete anomalies [1] and [2] seem to mark fairly large buried items of ferrous character, probably modern and perhaps related to the use of the land although nothing was seen during survey.

Some east to west striation [5] in the western part of the site hints at former ridge and furrow cultivation but this is only visible within a small area where background magnetic susceptibility appears to be slightly higher. A natural origin is also possible.

A linear very weak reduced field anomaly [6] suggests that relatively non-magnetic structure might exist although it is unclear what this could be or whether there are further examples, perhaps obscured by the background texture. There could be a spatial correlation with possible ditch fill [8], the latter anomaly apparently ending in line with [6], which could be a drain rather than anything of archaeological interest.

Two approximately north to south broad bands of debris [18] and [20] are probably related to use of the land as a car park and seem to be debris in the topsoil, perhaps materially deliberately introduced, although their actual function is not known.

Two other accumulations of magnetic debris [21] and [22] are perhaps discrete spreads relating to land improvement or landscaping.

4.3.3 Archaeology

The primary anomalies of archaeological interest are [7], [8], [9], [10] and possibly [14] which all appear to represent fairly narrow ditch fills of variable anomaly strength and definition. They seem to form enclosures though none are known from any published Ordnance Survey map so interpretation as former field boundaries is not immediately possible. None link together and it seems likely that their variable anomaly strength belies differences in their fills and possibly survival.

A short linear anomaly [13] may also be a ditch fill, in which case the possible association of [11] and [12] may be of interest.

4.4 Conclusions

Overall the survey has successfully mapped what appear to be a series of enclosure boundaries of variable contrast against the naturally fairly strongly magnetic texture of the background. As expected, the superficial geology has a definite presence in the data, against which small discrete anomalies of archaeological interest are not easily detected. There is a hint of former ridge and furrow cultivation and there is an overprint from the modern use of the land as a car park and pasture field. Anomalies of archaeological interest are concentrated in the southern half of the site.

4.5 Caveats

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.

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.

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.

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.

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.

4.6 Bibliography & selected reference

Aspinall *et al*, 2008. "Magnetometry for Archaeologists", Geophysical Methods for Archaeology, Altamira Press

Blakely, 1996, "Potential Theory in Gravity and Magnetic Applications", Cambridge University Press

David *et al*, 2008, "Geophysical Survey in Archaeological Field Evaluation", English Heritage

Gaffney *et al*, 2002, "Technical Note 6: The use of geophysical techniques in archaeological evaluations", Institute for Archaeologists

Milsom, 2003, "Field Geophysics", 3rd edition, The Geological Field Guide Series, Wiley

Schmidt, A., 2013, "Geophysical Data in Archaeology: A Guide to Good Practice", ADS

Scollar, 1990, "Archaeological Prospecting and Remote Sensing", Topics in Remote Sensing 2, Cambridge University Press

Tarling *et al* (ed.), 1999, "Palaeomagnetism and Diagenesis in Sediments", Geological Society, London, Special Publications, 151

Telford *et al*, 1990, "Applied Geophysics", 2nd Edition, Cambridge University Press

5 Appendices

5.1 Project metadata

Project Name	Coed-y-Dinas, Welshpool, Powys
Project Code	SSW151
Client	Clwyd-Powys Archaeological Trust
Fieldwork Dates	20th April 2015
Field Personnel	S. Purvis, A. Gerea, A. Mihai
Data Processing Personnel	R. Fry
Reporting Personnel	M.J. Roseveare
Draft Report Date	5th May 2015
Final Report Date	

5.2 Archiving

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. Access is by appointment only and some content is restricted and not available to third parties

Archive formation is in the spirit of Schmidt, A., 2013, "Geophysical Data in Archaeology: A Guide to Good Practice", ADS.

ArchaeoPhysica has a policy of contributing in time to the ADS Grey Literature library, usually after about six months post-dating release of the report. In addition, extracts of data images may be used, without reference to their source, in marketing and similar material. In these cases anything that might identify the project or client is removed.

5.3 ArchaeoPhysica

5.3.1 The company

ArchaeoPhysica has provided geophysical survey to archaeologists since 1998 and is consequently one of the oldest specialist companies in the sector. It has become one of the most capable operations in the UK, undertaking 1000 hectares of magnetic survey per annum. In addition 2D & 3D electrical, low frequency electromagnetic and radar surveys are regularly undertaken across the UK, also overseas. ArchaeoPhysica is the most established provider of caesium vapour magnetic survey in Europe, and holds probably the largest archaeological archive of total field magnetic data in the world. Unusually for the archaeological sector, key staff are acknowledged qualified geophysical specialists in their own right and regularly contribute to in-house and other research projects. For a number of years the company taught applied geophysics to Birkbeck College (London) undergraduate and post-graduate archaeology students, and developed a new and comprehensive course for the College.

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.

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.

5.3.2 Senior Geophysicist: Martin J Roseveare, MSc BSc(Hons) MEAGE FGS MCIfA

Martin specialised (MSc) in geophysical prospection for shallow applications at the University of Bradford in 1997 and has worked in commercial geophysics since then. He was elected a Fellow of the Geological Society of London in 2009 and is also a full member of the Institute of Archaeologists. He has taught applied geophysics for Birkbeck College's archaeological degree students for a number of years. Professional interests outside archaeology include the application of geophysics to agriculture, also geohazard monitoring and prediction. He also has considerable practical experience of the improvement and integration of geophysical hardware and software. At ArchaeoPhysica Martin carries overall responsibility for all things geophysical and is often found writing reports or buried in obscure software and circuit diagrams. He was elected onto the EuroGPR and CIfA GeoSIG committees in Autumn 2013.

5.3.3 Operations Manager: Anne CK Roseveare, BEng(Hons) DIS MISoilSci

On looking beyond engineering, Anne turned her attention to environmental monitoring and geophysics and has since been applying specialist knowledge of chemistry & fluid flow to soils. She is member of the British Society of Soil Science and is interested in the use of agricultural applications of geophysics. Anne was the founding editor of the International Society for Archaeological Prospection (ISAP) and has spent many years walking fields in parallel lines. Much of her time now is spent managing complicated scheduling and logistics for ArchaeoPhysica, overseeing safety procedures and data handling, while dreaming of interesting places around the world to undertake surveys, including researching the urban archaeology of Asia.

5.3.4 Geophysicist: Samuel Purvis, MSc BSc(Hons)

Sam studied Archaeology at The University of Bradford before progressing to a Masters in Archaeological Prospection. His primary research focus is on electromagnetic methods of shallow survey and is an expert with the newest multicoil electromagnetic instrumentation. Sam's main role at ArchaeoPhysica is technical, collecting high quality data, maintaining systems and keeping the show on the road.