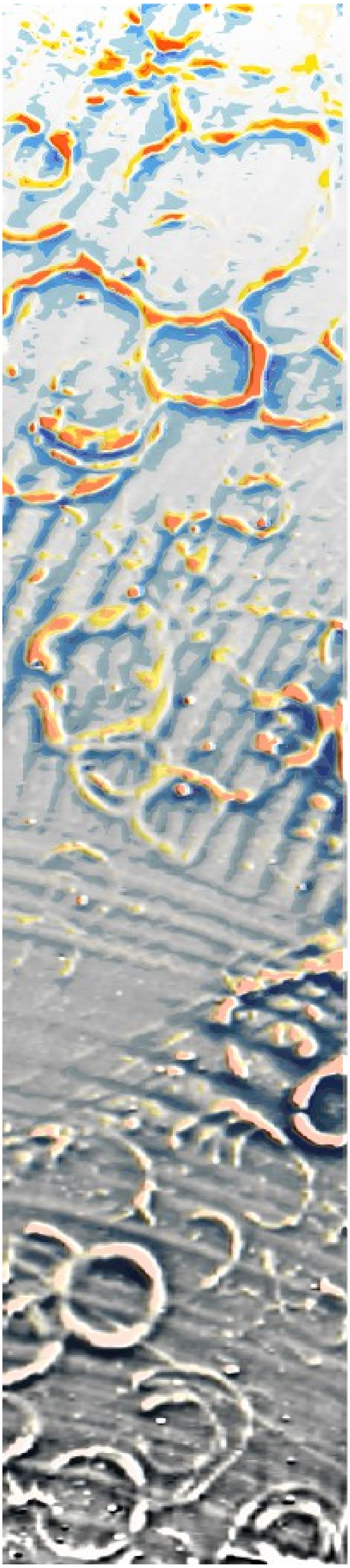

Abberley Mill Site, Worcestershire

Geophysical Survey Report

Produced for the Abberley Hills Preservation Society

Project code AMW141
OASIS archaeop1-198600

19th December 2014

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Non-Technical Summary

An earth resistance survey was commissioned by the Abberley Hills Preservation Society to prospect land at the suggested location of a mill at Glebe Field, within the medieval town of Abberley, Worcestershire.

Survey was undertaken across a low platform and surrounding slopes and an area of anomalously high resistance with well-defined edges was found. A small test pit excavated later as part of the project to sample the anomaly found deep colluvial deposits but was not sited sufficiently far into the anomaly to inform upon its origin. A linear low resistance feature was found slightly higher up slope that might have been a ditch or channel. The results fairly clearly illustrate that structures may exist below ground level at this location.

Digital Data

Item	Sent to	Sent date
Available		

Audit

Version	Author	Checked	Date
Interim			
Draft Final	MJ Roseveare	ACK Roseveare	22nd December 2014
Final			
Revision			
OASIS form started	R Fry		22nd December 2014

Table of Contents

1 Introduction

Land at Glebe Field, Abberley, was surveyed to prospect for buried structures of archaeological interest. The earth resistance survey covered an area of 1250m^2.

1.1 Location

Country	England
County	Worcestershire
Nearest Settlement	Abberley
Central Co-ordinates	375355, 267955

2 Context

2.1 Archaeology

A blog post by a member of the Abberley Hills Society steering committee has set out the evidence for a mill at Abberley ('Jo' 2014). The following has been summarised from this account:

The first mention of a mill at Abberley comes from an Inquisition Post Mortem taken on the 28th November 1309. Within this, there is mentioned:

"a certain water mill, worth yearly 10s"

Further evidence for a mill appears in Volume 4 of Victorian County History, where it is noted:

"There was a water mill in the manor of the 14th century, known in 1526-27 as Gardigasemyll"

The Tithe map of Abberley (1841) depicts, within an enclosure, two buildings in the field, known as Well Meadow. The adjoining field was known as Mill House Meadow. There is no evidence to suggest either building was related to milling.

Recent fieldwork has suggested the presence of a small earthen dam higher up the valley which has been suggested to relate to milling but in reality there is no evidence to support this and indeed the true nature of the waterworks (so associated channels, any weir, etc.) is not known. Test pits dug as part of the project by Worcestershire Archaeology found scattered traces of late post-medieval debris but much of this appears to have come from colluvial material and no structures of relevance to milling were found.

2.2 Environment

Superficial 1: 50000 BGS	None Recorded
Bedrock 1:50000 BGS	Halesowen Formation - Sandstone (HA)
Topography	Rather steeply sloping from the south down towards the stream to the north.
Hydrology	Natural – stream to the north
Current Land Use	Agricultural – mixed
Historic Land Use	Agricultural – mixed
Vegetation Cover	Grass and tall weeds (geophysical area cleared prior to survey)
Sources of Interference	None

The success of detecting anomalies of archaeological interest using earth resistance is dependant on many factors, including the prior weather conditions and the composition of the soils surveyed. It is difficult to predict the best survey time across a site which is relatively unknown in advance. The soils themselves are noted (within UKSO) as being slowly permeable seasonally wet acid loamy and clayey soils. The success of the resistance technique and of anomaly magnitude is reliant on a sufficiently detectable sub-surface contrast (based largely on moisture contrast and pedological conditions) to be present at the specific time of survey. At the time of survey, conditions were relatively wet, with surface water flowing down the slope of the field. Near surface electrical current flow would have been affected by such conditions so there may have been a tangible impact on the results.

3 Methodology

3.1 Earth Resistance Survey

3.1.1 Technical equipment

Measured Variable	Apparent electrical resistance (twin probe)
Instrument	Geoscan Research RM15A with MPX15
Configuration	Twin probe array, 0.5m AM spacing, current 1mA, gain x10
QA Procedure	Continuous observation
Resolution	0.5m x 0.5m

3.1.2 Monitoring & quality assessment

There is no dedicated quality management data available from this instrument but continuous observation throughout survey, examination of the sensitivity of the measurement to frame movement and monitoring of background resistance values between grids and days allows some measure of quality assurance.

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

3.1.3 Data Processing

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

Process	**Software**	**Parameters**
Elementary	Proprietary	3 x 3 datum median thresholding filter with the threshold set to 15 Ohm. Second pass with the threshold set to 10 Ohm.
Trend reduction	Proprietary	Not required
Interpolation	Proprietary	Bilinear interpolation (0.5m x 0.5m)
Imaging and presentation	Manifold GIS	

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.

All archived data includes process metadata.

3.2 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.

3.3 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 catalogue (ibid) in conjunction with the graphical elements of this report.

4.2 Principles – electrical resistance survey

Electrical resistance within soil is generally a measure of pore size and water content, large-pored materials having different dynamics than those with small pores. In addition, clays contribute significant electro-chemical effects through ion exchange at the surface of soil particles and tend to be significantly more conductive than silts and sands. The constant hydraulic cycle imposed by rainfall and drainage into deeper strata ensures that there is a significant temporal aspect to any survey of electrical resistance.

In general, significantly reduced electrical resistance can be associated with fills and wetter ground, although there are exceptions to this. Enhanced resistance is in general terms the converse situation, i.e. drier materials. These, however, are both relative terms and within small areas or complex archaeology the definition of 'background' may not be possible. In addition, the presence of shallow but variable geology can impart strong trends of equal or greater anomaly strength and a linear feature can produce an anomaly with strongly variable character along its length.

Detection of buried structures is seasonally dependent with the anomalies from structures changing and quite frequently disappearing as the seasons rotate. Anomaly polarity will often change alongside strength. A good season for detection of one class of structure may not be the best for another.

In addition to this, paradoxes are possible because the technique is dependent upon the strength and location of current flow in the ground, not the physical layout of structures. A very high resistance material close to the surface will force the majority of current to flow between it and the surface which produces, paradoxically, a low resistance anomaly. Similar effects can be observed where impervious materials retard the flow of soil moisture, thus the anomaly caused by a high resistance wall may be dwarfed by lower resistance next to it.

Finally, the temporal character of moisture flow in the ground has a huge effect upon electrical resistance. Surveys conducted after heavy rain will not produce the same results as ones conducted in dry weather.

4.2.1 Instrumentation

The measurement is called apparent electrical resistance because the numerical value and the shape of anomalies are dependent upon the configuration of probes in the array used. The technique, at least in this form, does not measure resistivity which is a volume and material specific measure not directly available from most planar surveys.

The twin probe array used for this survey is the archaeological norm, however, other arrays have their advantages and disadvantages. For all arrays, the relative separation of the different probes determines anomaly form. For the twin probe, increasing the separation of the mobile pair of probes increases the nominal depth of investigation by sensitising the measurement to deeper current flow.

4.3 Character & principal results

4.3.1 Overview

The data is fairly strongly variable within the small area surveyed with electrical resistance values correlating with surface variation (e.g. wet ground) in some locations but with several strong anomalies lacking obvious explanations. The site lies on a slope at the base of a steeper sided valley with the edge of a former pool at the western corner and a small platform evident within the eastern part. Test pits excavated by Worcestershire Archaeology revealed at least 0.5m depth of colluvium in various places, including within the area surveyed. Whether this applies to the whole site is unknown, however, the discovery of eighteenth century and later material with this implies that much of the colluvium could be relatively modern and hence the present form of the valley might not be the same as that potentially associated with a medieval mill.

The ability of twin probe electrical resistance survey with a probe spacing of 0.5m to detect variations to depths of between 0.5m and 0.75m means that the data will be influenced by varying water content within the colluvium. In addition, and dependent upon its thickness, variations at the base of the colluvium and potentially below this may also be detectable. It is also possible that deeper variations will alter the local drainage, e.g. a porous structure beneath the colluvium will allow preferential drainage of the material above and hence alter its electrical resistance.

In two areas, [1] and [2], low electrical resistance can be directly associated with known wet ground. At [2], water issues from the ground during rainfall and the effect upon the data, a rapid reduction in electrical resistance, was observed during survey. This also implies the colluvium was not fully hydrated during survey and therefore variations in local drainage and hence moisture should be detectable. A surrounding area [3] of relatively low resistance could thus represent partly drained ground from earlier rainfall and it is tempting to suggest that the low resistance area [1] lower down slope may be partly due to moisture from this.

Given the nature of the soils and at this site their combination with a source of water at [2], it is likely that considerable variation in the strength and location of electrical resistance anomalies will be evident over time. This of course will affect the detectability of buried structures potentially of archaeological interest.

4.3.2 Geology

At the site the depth of burial of the bedrock, geology, the Halesowen Formation sandstone, is unknown but it is likely that there is a fairly large depth of valley fill with the uppermost deposits dominated by post-medieval (and perhaps also medieval) colluvium. Whether the rock has any direct influence upon drainage of the surface soils is uncertain; topography may have a greater effect.

4.3.3 Land use

The only definite former feature known to exist within the survey data is a former field boundary shown on the 1841 Tithe Award map, its approximate location indicated on DWG 04 by a dashed line. This is very close to the location of an extant tree which might explain the latter's present isolated existence within the field. It might also form the eastern edge of anomaly [8] and western edge of [5] and this being the case there may be an association between the soil structures creating these anomalies.

A number of thin low resistance anomalies near the northern edge of the survey may relate to land drainage and the general mottling in this area seems likely to reflect the fairly boggy nature of the ground.

4.3.4 Individual anomalies

Examination of the electrical resistance data, e.g. DWG 02, reveals a number of striking anomalies and patterns, e.g., the linear low resistance structure [4] along the eastern edge of the survey and the parallel enhanced resistance area [6]. Within the latter is a rectangular area of lower resistance, sharply bounded along its northeast edge by a high resistance area [7] with again a suggestion of right angled corners and straight edges. Anomalies this well defined are rarely entirely due to natural causes and hence some sort of buried structure is suspected. This does not have to be masonry; it could be a volume of better drained soil, perhaps colluvium over a buried relative porous fill. What is particularly striking here is the orthogonal arrangements of anomalies, of both high and low resistance, frequently of potential interest to an archaeologist.

Of especial interest is the potential association between [4] and [2], the latter being where water is being channelled to the area (as seen during survey) and [4] apparently leading it away along the contour towards a body of low resistance ground [5]. Anomaly [2] therefore appears to be an artificial structure, e.g. a ditch fill, or, if the site is that of a mill, perhaps a leat supplied with water from higher up the valley. If so, the spatial relationship of this structure with [6], [7] and [8] is of interest as together they imply some sort of complex. If, for example, the site is considered to be that of a mill (this cannot be stated on the basis of this data alone) then [5] could be the site of a wheel pit and therefore a breastshot or overshot wheel. However, this is speculation without further work.

The high resistance area [8] seems unlikely, on the basis of anomaly strength and the sharpness of the anomaly's edges, to be entirely due to natural causes. A small test pit was sunk just to the southwest of this and found deep colluvium and the soil was apparently drier (*pers. comm.*), but the pit was not within the body of [8] and might therefore have sampled the edge of area [7]. Part of [6] extends into the valley bottom as a much narrower anomaly [9], although contouring the data suggests a northwards trend of higher resistance around this. Partly because of this it is not possible to label [6] as being definitely of archaeological interest, in comparison with [8]. Area [8] has much higher resistance and exceeds 105 Ohm, perhaps 30-40 Ohm greater than the background compared to perhaps only 10 Ohms greater for [6].

An area [10] of reduced resistance has an uncertain interpretation and could simply be a wetter area of ground near the valley bottom.

4.4 Conclusions

Although the Worcestershire Archaeology test pit was sunk to examine [8] it was sunk too far off the body of the anomaly to inform reliably upon it (indeed, may have been within the edge of [7]). As a consequence, the discovery of 0.6m or more of colluvial material here is of uncertain relevance and therefore the data remain the best indicator of what may exist. There is a clear association between [6] and [4] as the structures have a parallel sense but whether this is by design or due to constraint by the slope is unknown. The high lateral resistance gradients associated with [8] in particular but also parts of [6] are an indicator of strong changes in the ground that are sometimes associated with buried structures and the noticeably straight plan form of low resistance linear anomaly [4] means that this is likely to be a ditch fill.

Whether these anomalies together might suggest a location for a mill is uncertain and further work (in particular a topographic survey to link the site into the wider hydrological context) would be necessary to explore this. There is, however, sufficient evidence to suggest human intervention of some sort at this location.

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

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

Anon, 2014, "The Evidence for a Mill at Abberley", Blog Post from the Abberley Hills Preservation Society https://abberleylives.wordpress.com/2014/10/28/the-evidence-for-a-mill-at-abberley/ (accessed 18/12/14)

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

Royal Commission of the Ancient and Historical Monuments of Wales and Monmouthshire, 1914, "An inventory of the Ancient Monuments in Wales and Monmouthshire: IV County of Denbigh", London.

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

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

5 Appendices

5.1 Project metadata

Project Name	Abberley Mill Site, Worcestershire
Project Code	AMW141
Client	Abberley Hills Preservation Society
OASIS	archaeop1-198600
Fieldwork Dates	8th October 2014
Field Personnel	R Fry, ACK Roseveare
Data Processing Personnel	MJ Roseveare
Reporting Personnel	MJ Roseveare, R Fry
Draft Report Date	19th December 2014
Final Report Date	

5.2 Archiving

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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 MIfA

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 IfA GeoSIG committees in Autumn 2013.

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

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: Robert Fry, PhD MSc BA(Hons)

Rob studied Archaeology B.A.(Hons.) at the University of Reading from 2004-07. His research was heavily influenced by geophysical techniques, and he helped organise and lead the magnetic survey of Silchester Roman Town. Following university, he joined the British School at Rome, conducting surveys in Spain, Italy and Libya. After working briefly as a geophysicist at Wessex Archaeology, Rob became Project Officer of The Silchester Mapping Project at the University of Reading. Since then, he has gained an MSc in Archaeological Prospection from the University of Bradford and recently completed his Doctorate with a thesis titled "Time-lapse geophysical investigations over known archaeological features using electrical resistivity imaging and earth resistance". Rob is currently also the editor of ISAP News. At ArchaeoPhysica Rob is normally found in the field or in the office besieged by colossal quantities of survey data.

5.3.5 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.