Chesters Hill Site

Geophysical Survey Report

Produced for Abbotsbury Heritage Research Project

ABB20051

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Mapping Our Heritage

Non-Technical Summary

The geophysical survey was undertaken for the Abbotsbury Heritage Research Project to provide non-invasive information about potential archaeological remains on the site. An aerial photograph showed linear marks in the grass that could have been caused by archaeological remains.

A caesium magnetometer survey was carried out on the slope of the hill above the West Fleet, covering an area of the marks that were thought to define a possible enclosure.

The recorded magnetic variation was particularly small and no archaeological features were identified.

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1 Introduction

Location

1.1 The survey was on the southern flank of Chesters Hill, near Abbotsbury, Dorset at NGR 358100 083350. The field is immediately adjacent to the West Fleet and to the west is the inlet with the Abbotsbury Swannery.

Parties involved

1.2 The Abbotsbury Heritage Research Project (AHRP) commissioned the survey as part of their investigation of a number of sites in the area.

1.3 Acknowledgements are due to various members of the AHRP for their assistance and to the Ilchester Estate for access.

Summary of methodology

Rationale

1.4 The project specification was discussed with Peter Laurie of the AHRP, who oversaw commissioning the survey. The primary objective was to establish what archaeological remains might be associated with a set of rectangular cropmarks, using non-invasive methods.

Instruments & survey resolution

1.5 A block of data 60m x 60m was collected over an area of the most prominent marks.

1.6 The magnetic survey used a Geometrics Magmapper G858 caesium vapour magnetometer in dual channel configuration on a wheeled cart. They were operated with a line separation of 1.0m with samples at 10Hz providing measurements with an along-line interval of about 0.15m. This usually provides an efficient overview with sufficient detail to identify most potential archaeological features.

Constraints & variations

1.7 The area covered was smaller than that originally agreed, as during the course of the survey it became apparent there was such little magnetic variation that it was unlikely that further survey would be useful.

2 Archaeological context

Known features

2.1 The name of the hill suggests some kind of fortification. A WWII pillbox is sited on top of the hill at the western end and there are low earthworks on the summit.

2.2 Aerial photographs showed linear marks, possibly forming rectangular structures, on the flank of the hill.

2.3 The wreck site of the Dorothea, a coaster from Rotterdam carrying iron ore (magnetite) is thought to be almost opposite the site on Chesil Beach. A patch of magnetite pebbles now forms part of Chesil Beach at that location but details of how the cargo was unloaded before she was refloated are unclear.

Cartographic sources

2.4 No further cartographic sources were consulted for this survey.

Documentary sources

2.5 No further documentary sources were consulted for this survey.

Field observations

2.6 No visible traces of archaeological features were identified on or around the site.

3 Landscape context

Topography

3.1 The site lies just above sea level on the southern flank of a rounded hill rising to 30m, overlooking the West Fleet.

Hydrology

3.2 The land is relatively free draining, though some land drains were visible.

Geology

3.3 The solid geology forms part of the Lower Oolite Series; the Upper, Middle and Lower Series are exposed in bands between the chalk and the coast. The soils are sandy and no more than two metres thick at the foreshore.

4 Results

Environmental Data

Geological & pedological influences

4.1 The magnetic background was particularly quiet, probably due to relatively non-magnetic limestone geology overlaid with soil containing a significant proportion of wind-blown sand.

Palaeoenvironmental evidence

4.2 There is no evidence for past environments within the data.

Archaeology

4.3 No anomalies of archaeological interest were found although there was the normal thin scatter of intense dipolar anomalies typical of buried brick, tile and ferrous debris. This is usually associated with cultivated fields and relates to the import of materials for agricultural improvement.

4.4 It is possible that they may include small pieces of magnetite from the Dorothea but none of this material was observed on the foreshore or in exposed soil in the field so this interpretation is perhaps unlikely.

Caveats

4.5 Geophysical survey is literally that, 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, others that relate to 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.

4.6 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.

4.7 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.

4.8 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.

4.9 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.

5 Conclusion

Significant results

5.1 The survey found no geophysical evidence for archaeological structures or activity relating to the grounding of the Dorothea.

Recommendations

5.2 There are no recommendations to be made, except perhaps to explore further the history of the Dorothea's grounding in case the location and removal of cargo impacts upon subsequent survey in the area.

6 Appendices

Survey metadata

Project information

Project Name	Chesters Hill Site
Project Code	ABB20051
Client	Abbotsbury Heritage Research Project
Fieldwork Dates	4-5 April 2006
Personnel	Martin Roseveare, Anne Roseveare, Assunta Trapanese
Final Report Date	August 2006

Location

Country	England
County	Dorset
Nearest Town	Abbotsbury
Landholding	Ilchester Estate
Central Co-ordinates	358100 083350
Co-ordinate System	UK OS National Grid

Environmental data

Geology – Soil	Sandy soils
Geology – Parent	Lower Oolite Series
Topography	Broad slope of rounded hill 30m above sea level
Hydrology	Free draining
Current Land Use	Pasture
Historic Land Use	Pasture
Vegetation Cover	Short grass
Sources of Interference	None

Geodetic data

Projection	Orthographic
Co-ordinate System	OSTN02
Bearing	Zero
Precision	0.05m
Instrument Used	Seres DGPS
Reference Points	Autonomous DGPS
References Definition	ArchaeoPhysica

Process documentation

Caesium magnetometer

Measured Variable	Total magnetic field intensity, nano Tesla (nT)
Instrument	Geometrics G858 Magmapper
Configuration	Dual-channel on ArchaeoPhysica cart, sensors 0.3m above surface
QA Procedure	Static test
QA Result	Normal
Data Source Format	Geometrics proprietary binary

6.1 Single point spike reduction, manual stagger correction and automatic heading correction in Geometrics MagMap2000.

6.2 Post-MagMap, the data was cubic interpolated along lines to 0.15m and interpolated across lines to 0.5m using an ArchaeoPhysica proprietary algorithm based on potential field behaviour.

6.3 This was the last stage of processing of the total field vertical gradient data. The separate total field data streams from the two sensors were then subjected to standard potential-field-based processing after subtraction of the base station data. Processing was as follows.

6.4 Regional field approximation by third order Butterworth low-pass filter with regional minimum wavelength set at 200m. Subtracted from the total field data to leave the residual field which was then split into two streams.

6.5 The first was used to simulate 1.0m vertical gradient data by upward continuation. The second was split into depth components by an upward continuation-based filter and the shallow component retained for analysis. Details of these processes can be found in most good geophysical textbooks.

Base station magnetometer

Measured Variable	Total magnetic field intensity, nano Tesla (nT)
Instrument	Scintrex EnviMag
Configuration	2m from surface
QA Procedure	Static test
QA Result	Visual assessment
Data Source Format	ASCII

6.6 The base station magnetometer data was subjected to spike reduction followed by polynomial smoothing in MagMap2000.

Archive data

Introduction

6.7 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.

6.8 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.

General description

6.9 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.

6.10 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.

File types

Extension	Associated Software or Format Information	Example Content
.bin	Geometrics MagMap2000 (version specific)	Magnetometer downloads
.csv	ASCII comma-separated data	Various data files
.dat	Generic ASCII data (may not be human readable)	Magnetometer downloads
.doc	Microsoft Word document (Office 97 and newer)	Report documents
.dwg	Autodesk AutoCAD format (version specific)	Plans & digitised maps
.dxf	ASCII Drawing eXchange format	Plans & digitised maps
.grd	Golden Software Surfer 7 binary or ASCII grid	Survey data
.html	ASCII HyperText Markup Language file	Report files, web pages
.man	Manifold GIS 6.5 (version specific)	Project data
.mdb	Microsoft Access document (Office 97 and newer)	Database files
.pdf	Adobe Acrobat Format (version 6 and newer)	Report files
.r15	Geoscan Research RM15 download (sequential ASCII)	Data files
.srf	Golden Software Surfer document (version 8)	Project data
.stn	Geometrics MagMap2000 ASCII data	Processed magnetic data
.txt	Generic human readable ASCII data	Notes etc.
.xls	Microsoft Excel document (Office 97 and newer)	Spreadsheet files
.xml	AP System or Manifold GIS	Logs, palettes, MS .NET files

6.11 The files listed above represent the usual content of digital archives held by ArchaeoPhysica.

Dissemination

6.12 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.

Background information

Introduction to geophysics

6.13 Geophysics is the application of measurements of the physical properties of materials to further our understanding of the Earth. As such it is a broad and diverse discipline with specialisms ranging from deep core and mantle studies through petroleum exploration to "shallow earth" environmental geophysics of which archaeological survey is just one example. The diversity and complexity of many archaeological features makes it one of the most difficult, and arguably least well understood, branches of geophysics.

The role of the geophysical contractor

6.14 Within archaeology, there is a tendency for a narrow range of instrumentation to be used on a routine basis, to the possible detriment of the archaeological resource. Every site has its own physical and archaeological micro-environment and to maximise returns and cost-effectiveness every survey needs to be designed from the ground up. In some cases, this may call for the use of so-called 'novel' technologies, in other cases the old favourites may suffice. Whatever the scenario, the choice of instrumentation, configuration, survey resolution and sampling need to be assessed against the agreed project objectives.

6.15 This needs to be done by, or under the direct supervision of, a qualified and experienced geophysicist due to the wide range of parameters to be considered, not least, cost-effectiveness. It is probably fair to say that there are very few circumstances where geophysics is unable to contribute something of benefit, but the means may not be immediately obvious. All surveys by ArchaeoPhysica are tailor-made, even where working to a third party brief. This is because we feel our experience and knowledge must be brought to bear upon the survey design to avoid unnecessary failure later. In many cases, this is simply to fulfil an educational role.

6.16 For similar reasons as already outlined, it is essential that interpretation of the geophysical data be undertaken by an experienced geophysicist rather than an archaeologist. Geophysical data is, as discussed in an earlier section, an indirect indicator of archaeological features and to correctly process, analyse and image such data requires specialist knowledge that is not usually available to an archaeologist. In the simplest terms, geophysics is not archaeology and therefore requires the attention of specialist understanding in its own right, in the same manner as analysis of botanical or faunal assemblages.

7 Technical Information

Introduction

7.1 The following information is intended to provide some background on the various physical properties and the techniques used to measure them.

Magnetic Field Survey

Geomagnetism

7.2 The geomagnetic field is at any location the four-dimensional (space and time) vector sum of several discrete components. The temporal component has categories separated by the time over which any variation in their intensity becomes noticeable. Archaeological surveys are concerned with the two most rapidly changing categories, micropulsations and the diurnal field. The former may only last a few seconds and have amplitudes comparable with anomalies from archaeological sources, e.g., 2-5nT. The second is the daily fluctuation in the regional field that is broadly predictable and varies by some 30-40nT per day. This can be complicated by magnetic storms, which can contribute field variations of well over 100nT, frequently associated with intense bursts of magnetic noise within the spread of amplitudes associated with archaeological sources. A third temporal variation is due to variations in the distribution of magnetic sources within the Earth's core. Unlike the other two, these occur over years, influencing both the amplitude and direction of the regional field and for archaeological purposes can be safely ignored.

7.3 The stationary (non-temporal) component of the magnetic field is the sum of the myriad of magnetic sources within the Earth's crust. These range from deeply buried magnetic minerals through to changes in soil structure and properties due to environmental, agricultural and of course archaeological sources. To provide a sense of scale, the deeply buried sources can contribute anomalies of a few thousand nT across many kilometres of landscape, though visible as changes of only a few nT across the sizes of areas associated with many archaeological projects. In contrast, the environmental and archaeological sources may contribute just 10nT or so, detectable at distances of no more than perhaps 3m for the larger anomalies.

7.4 Where anomalies exist of a larger spatial extent than the survey area they form part of the regional field and are caused by the deepest magnetic components of the ground. The remaining field is called the residual and represents roughly the sum of the magnetic sources present within the survey area, whatever their depth of burial. In basic terms, the more sensitive the instrument used to generate this data and the less cluttered the soil, the deeper the source that can be imaged magnetically, perhaps ditch fills or settlement sites concealed beneath marginal peat for example. A branch of geophysical processing called potential field analysis allows the geophysicist to further subdivide these sources, allowing the very shallowest ones, indicative of archaeological sources, to dominate the deeper.

The burial environment

7.5 Topsoil is usually magnetic relative to other soils and hence is important for magnetic survey. If topsoil is exceptionally deep it can mask more weakly magnetic features beneath it. Alternatively, regions where the topsoil is locally deeper than elsewhere are usually associated with enhanced magnetic field strength. Archaeological features that incorporate relict topsoil tend to enhance the magnetic field around them.

7.6 In some cases, features may exist magnetically that cannot be detected during excavation. This is normal, as some soils with enhanced magnetic properties do not exhibit any visible difference from their surroundings. In addition, some features survive as shadows in the topsoil after they have been physically removed by ploughing. The converse scenario is of course also true: there are many archaeological features that have no detectable magnetic component. Finally, sometimes it will be the case that the archaeological feature itself is not magnetic but some secondary characteristic still allows its detection by magnetic survey. An example is where a ditch has been filled, perhaps soon after excavation, with the same material as its surroundings and therefore lacks magnetic contrast with the surrounding material. As this fill settles, deeper topsoil (whether contemporary or modern) can accumulate in the resulting hollow, creating a local slightly positive magnetic anomaly. An example of this is a grave site where the grave itself is usually nonmagnetic but can occasionally be located by the disturbance of the contemporary surface. Of course if the top of the feature has been truncated by ploughing this effect will disappear.

7.7 Hearths, burnt or fired soil and clay, and similar contexts involving the application of heat to soil, tend to become strongly magnetic due to chemical changes in the soil, in particular the conversion of iron oxides to maghaemite and magnetite. Assuming there is adequate iron in the soil initially, the process results in a particularly strong enhancement that is effectively permanent (the degradation that does occur can be regarded as negligible over usual archaeological time scales). This means that hearths can usually be detected with confidence. In addition, the presence of domestic fires at settlement sites tends to lead to an accumulation of magnetic soil throughout the settled area and for a distance beyond. It is possible therefore, that features that are undetectable away from a settlement will become more detectable the closer survey proceeds to the inhabited area, an effect that has been observed in large surveys.

7.8 A secondary effect of the same process is that the presence of non-magnetic features may become detectable if magnetic material has accumulated in or around them. A common example is wall footings against which magnetic soil has accumulated, even in trace quantities.

Configuration & measurement

7.9 The magnetic field has a direction and intensity and hence it is possible to measure either the intensity of a directional component or the total intensity. The total intensity is measured using a total field magnetometer, e.g., a caesium magnetometer but it is common in UK archaeological surveys to measure just the vertical component, using a fluxgate gradiometer.

7.10 In addition, magnetometers can be configured in different ways, usually as single sensor magnetometers or as gradiometers. For this discussion it is assumed that the gradiometer is vertical. A single magnetic sensor measures all components of the ambient field, including the temporal which is not desired and hence needs to be removed from the data during processing. This is usually achieved either through reduction using software or by using a base station magnetometer, one that does not move and simply records the temporal variations so that they can be subtracted from the field data later.

7.11 A gradiometer avoids this by having two sensors measuring simultaneously, one sensor being mounted higher than the other. By subtracting the data from the upper sensor from the lower, the temporal component, common to both sensors, is removed. This has a disadvantage in that unless the upper sensor is quite high above the ground, e.g., 3m, the data from it can contain a large component due to shallow and hence archaeological sources. When the data is subtracted this reduces the anomaly strength from shallow sources as well as deep. For gradiometers using widely spaced sensors, e.g., the Bartington Grad601-2 (1m) or the ArchaeoPhysica wheeled instrument (1.2m), this is much less of a problem than for shorter ones, e.g., the Geoscan Research FM36 (0.5m).

7.12 One advantage of vertical gradiometers is that they provide slightly better defined edges of anomalies due to magnetic sources close to them, e.g., magnetic fills in the tops of pits and ditches. A magnetometer, however, will quite often provide slightly larger anomaly strength and the calculated vertical gradient is nearly always a good model of the measured gradient.

7.13 Conversely, magnetometers are better at imaging laminar structures and can hence differentiate between soils at the same depth but with different magnetic susceptibility. This is of particular benefit when imaging small areas or sites with complex magnetic properties, e.g., settlement remains.