WYAS Archaeological Services

Land at Kirkefield Stables

Hart Village

Teesside

Geophysical Survey

Report no. 3022
July 2016

Client: Mr Peter Jenkins

CIfA Registered Organisation

West Yorkshire Joint Services

Land at Kirkefield Stables, Hart Village, Teesside

Geophysical Survey

Summary

A geophysical (magnetometer and earth resistance) survey was carried out on land behind Kirkefield stables, Hart, prior to the proposed development of the site. The survey area comprised of an enclosed area of around 0.2 hectares, currently under pasture. The magnetometer survey was able to detect areas of disturbance, geology and an area of possible archaeology towards the southern boundary of the site. The categorisation of these magnetic anomalies, were further enhanced with data from the earth resistance survey, indicating the possible remnants of a former structure. Therefore the overall archaeological potential of the site is deemed to be moderate.

WYAS Archaeological Services

Report Information

Client:	Mr Peter Jenkins
Address:	The Barn, Brewery Farm, Front Street, Hart Village, TS27 3AJ
Report Type:	Geophysical Survey
Location:	Hart Village
County:	Teesside
Grid Reference:	NZ 4737 3494
Period(s) of activity:	Modern
Report Number:	3022
Project Number:	6445
Site Code:	MBC16
OASIS ID:	archaeol11-297668
Date of fieldwork:	June 2016
Date of report:	July 2016
Project Management:	Christopher Sykes BA MSc
Fieldwork:	Christopher Sykes
Report:	Christopher Sykes
Illustrations:	Christopher Sykes
Photography:	Christopher Sykes
Research:	Christopher Sykes

Authorisation for distribution: ---

Nepshaw Lane South, Morley, Leeds LS27 7JQ
Telephone: 0113 383 7500.
Email: admin@aswyas.com

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1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by AAG Archaeology (the Client) on behalf of Mr Peter Jenkins (their client) to undertake a geophysical (magnetometer and resistance) survey of land at Kirkefield Stables, Hart village ahead of a future proposed planning application. Guidance contained within the National Planning Policy Framework (DCLG 2012) was followed, in line with current best practice (CIfA 2014; David *et al*. 2008) as detailed in the project design (Sykes 2016). The survey was carried out on the 30th June 2016 to provide additional information on the archaeological resource of the Proposed Development Area (PDA).

Site location, topography and land-use

The PDA lies within a self-contained field, at the eastern end of Hart village. The site sits between Hart Road to the north (the former A1049) and the south by the bypass of A1049 created in the 1980's. The site is located approximately 4km to the northwest of the town centre of Hartlepool (see Fig. 1). The survey area is centred at NZ 4737 3494 at a height above Ordnance Datum (aOD) of approximately 67m.

Soils and geology

The proposed development overlies bedrock deposits of the Roker Formation, overlain by superficial deposits of Devensian Till (BGS 2016). The soils of the PDA are identified as being of the Dunkeswick formation, characterised as as slowly permeable fine loams over clay (Soil Survey of England and Wales 1983).

2 Archaeological Background

The PDA lies to the east of an Anglo-Saxon and medieval settlement, the core of which lies to the northwest of the site. Stray finds have been discovered, which have included a number of Anglo-Scandanavian carved stones, and a cross base, found in Kirk Field, in an areas which now sits to the south of the A1049. These stray finds are now within the Church of St Mary Magdelene (AAG, 2016).

A local metal detectorist has found a 14th century silver brooch, a medieval pin and a medieval strap end. A decorative stone, which may have formed part of a stone sculpture may have been identified by the same individual (AAG, 2016).

To the immediate northeast of the PDA, finds of an Anglo-Saxon and medieval nature have been identified (AAG, 2016).

3 Aims and Methodology

The main aim of the geophysical survey was to provide sufficient information to enable an assessment to be made of the impact of the development on potential sub-surface archaeological remains and for further evaluation or mitigation proposals, if appropriate, to be recommended. To achieve this aim, a magnetometer and resistance survey covering all amenable parts of the PDA was undertaken (see Fig. 2).

The general objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

Magnetometer survey

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The survey was undertaken using Bartington Grad601 magnetic gradiometers. These were employed taking readings at 0.25m intervals on zig-zag traverses 1.0m apart within 30m by 30m grids, so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

Resistance survey

The survey was undertaken using a Geoscan RM15 resistance meter. These were employed taking readings at 1m intervals on zig-zag traverses 1.0m apart within 30m by 30m grids. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey (OS) mapping, is shown in Figure 1. Figure 2 displays the survey location showing greyscale magnetometer data at scale 1:1000 @A4. Figure 3 displays the processed magnetometer data at a scale of 1:1000, with Figure 4 showing an XY trace plot of the data. Figure 5 the interpretation of this data at the same scale. Figure 6 depicts the processed resistivity data at 1:1000 and Figure 7 the interpretation of this data also at the same scale of 1:1000.

Technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and 2. Technical information on locating the survey area is provided in Appendix 3. Appendix 4 describes the composition and location of the archive. A copy of the completed OASIS form is included in Appendix 5.

The survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the Chartered Institute for Archaeologists (CIfA 2014). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty's Stationery Office (© Crown copyright).

The figures in this report have been produced following analysis of the data in processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.

4 Results and Discussion (see Figures 3 to 7)

Magnetometer survey

Ferrous anomalies

Ferrous anomalies, as individual 'spikes', or as large discrete areas are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. There is no obvious pattern or clustering to their distribution in this survey to suggest anything other than a random background scatter of ferrous debris probably caused by structural demolition.

Two overwhelming areas of magnetic disturbance have been identified with the PDA. The area to the west is likely to have been caused by the land disturbance caused during the erection of the stable building on the site. The second lies within the middle of the survey area, is caused by the location of an "obstacle" in the form of upturned metal bath tub. Discrete pockets have been detected across the site.

Geological anomalies

Numerous anomalies within the dataset are typical of responses associated with geology and are thought to be caused by variations in the depth and composition of the soils and the superficial deposits from which they derive. It is likely that the majority are associated with the topography of the site.

A number of small discrete anomalies have been identified as geological in origin across the site. The magnetic responses, identified through the XY trace plot are markedly different from those of magnetic disturbance.

Possible archaeology

A group of anomalies (**P1**) have been identified via analysis of the magnetic response characteristics, which differ to those of other identified anomalies. Furthermore these results have been re-enforced with anomalies detected in the earth resistance survey, detailed below. A definitive interpretation cannot be assigned however, because of the inference from the overbearing high magnitude anomaly and the isolated nature of the responses.

Resistance survey

Within the PDA zones of very high and very low resistance have been recorded. There are no obvious topographic or visual explanations for these variations. The high resistance features (**R1**) which are associated with P1 suggest a feature which could be wall like in nature. Similarly a collection of low resistance features have been identified (**R2**), in contrast to the background readings in the PDA. They could create possible linear qualities which may be the result of wall material being removed, but this is a tentative interpretation.

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.

Conclusions

A number of anomalies have been identified as possibly archaeological in origin. The magnetic anomaly P1 coupled with R1 (a high magnetism, high resistance) is suggestive of material which could be a wall, based on the location of the responses, and their characteristics. In addition, low resistance features (R2), in contrast to the background readings could be ditch-like features indicative of removed walls which have been subsequently infilled with material which does not impede the electrical current. Based on these results, the archaeological potential of the PDA is moderate.

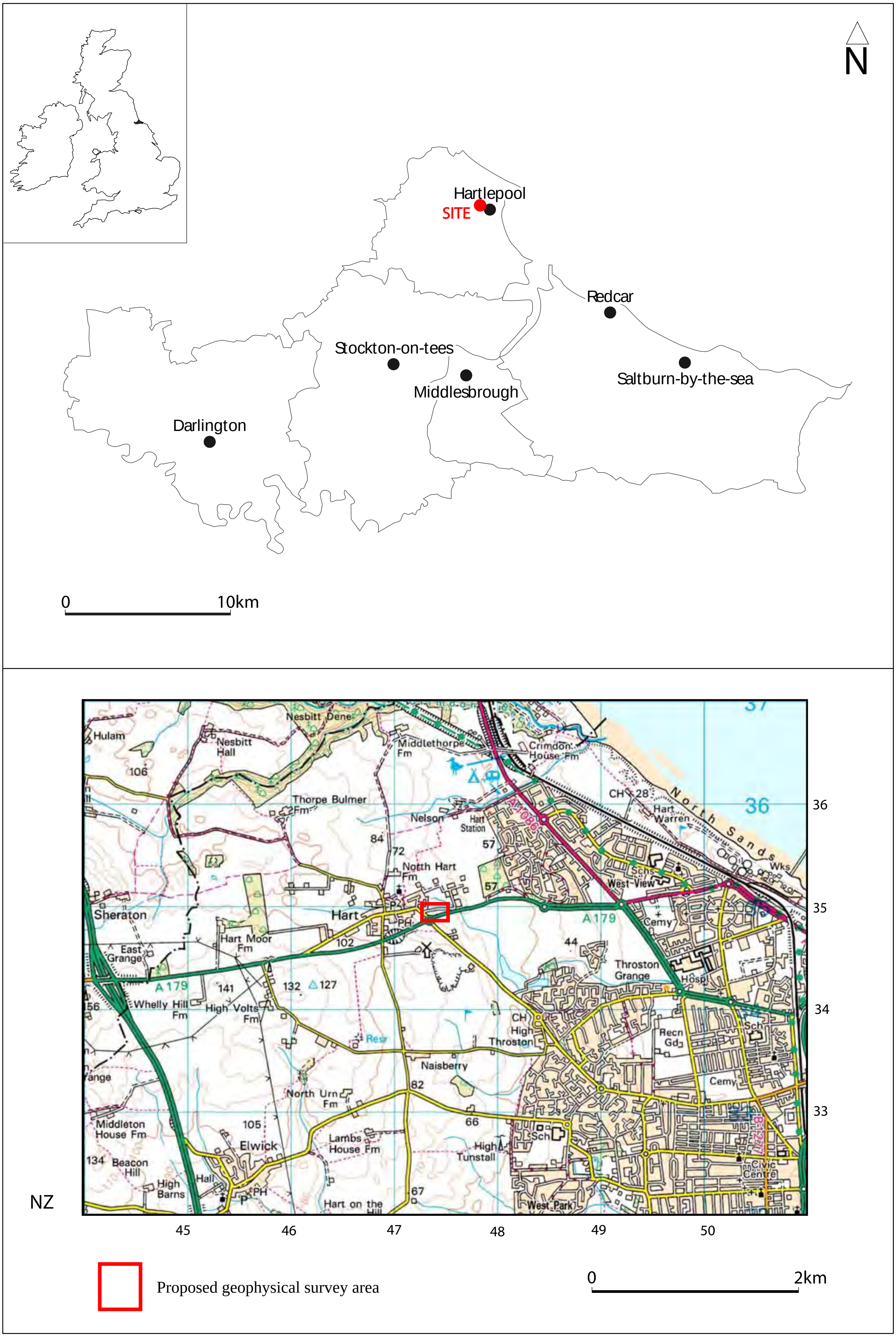


Fig. 1. Site location

Fig. 2. Survey location showing greyscale magnetometer data (1:1000 @ A3)

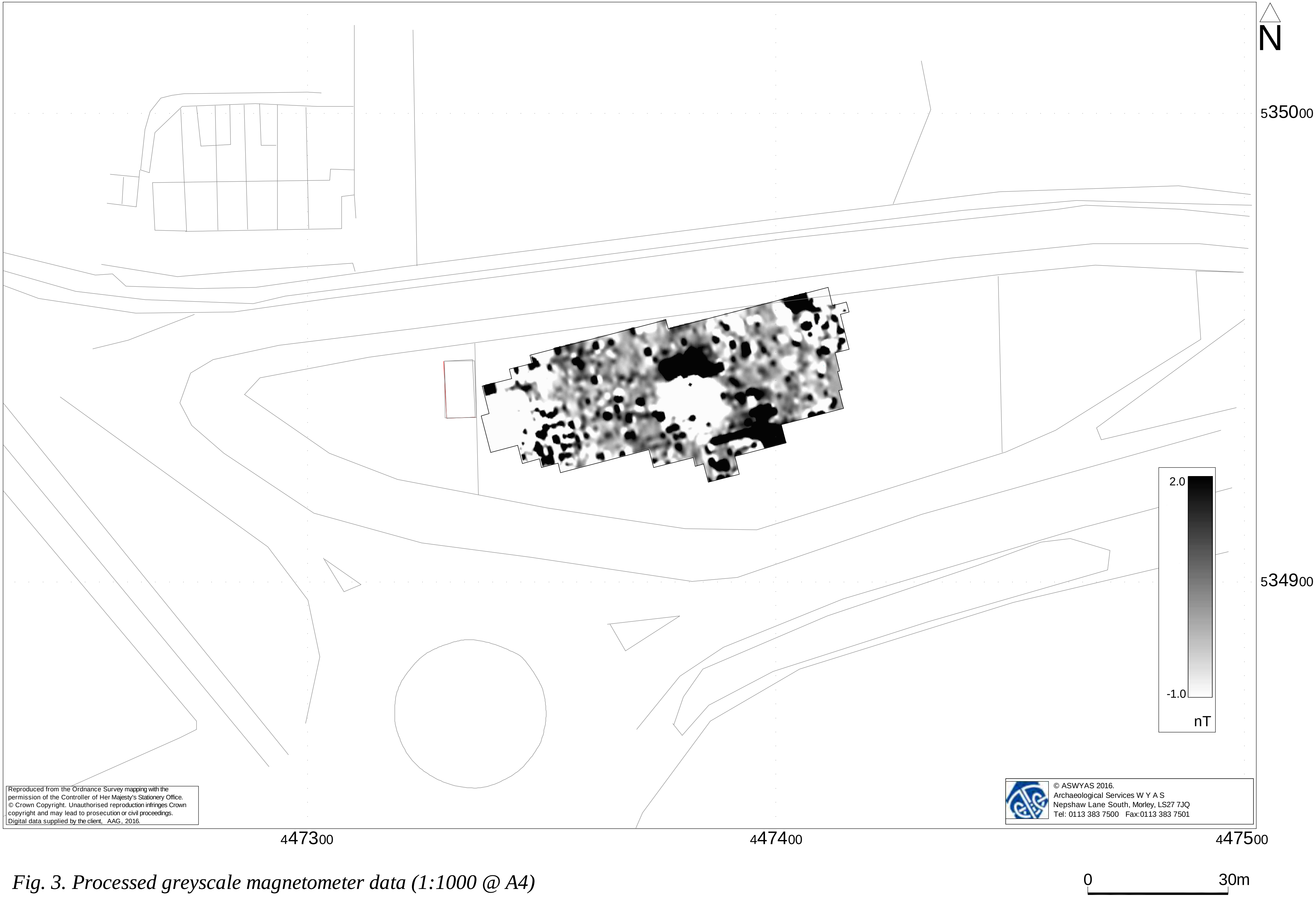
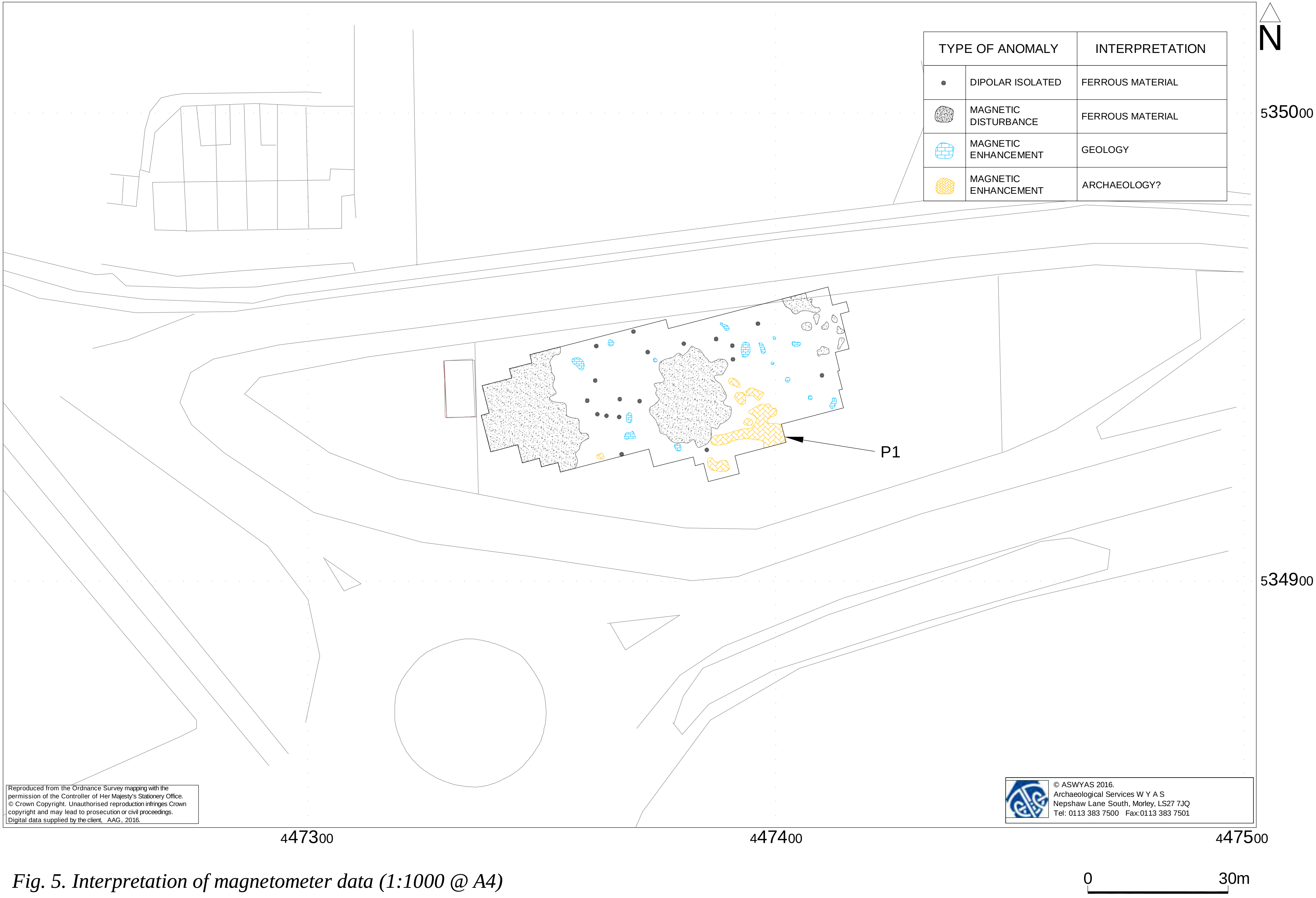


Fig. 3. Processed greyscale magnetometer data (1:1000 @ A4)

Fig. 4. XY trace plot of minimally processed magnetometer data (1:1000 @ A4)

0 30m



Archaeological Services W Y A S
Nepshaw Lane South, Morley, LS27 7JQ
Tel: 0113 383 7500 Fax:0113 383 7501

Fig. 5. Interpretation of magnetometer data (1:1000 @ A4)

Fig. 6. Processed earth resistance data (1:1000 @ A4)

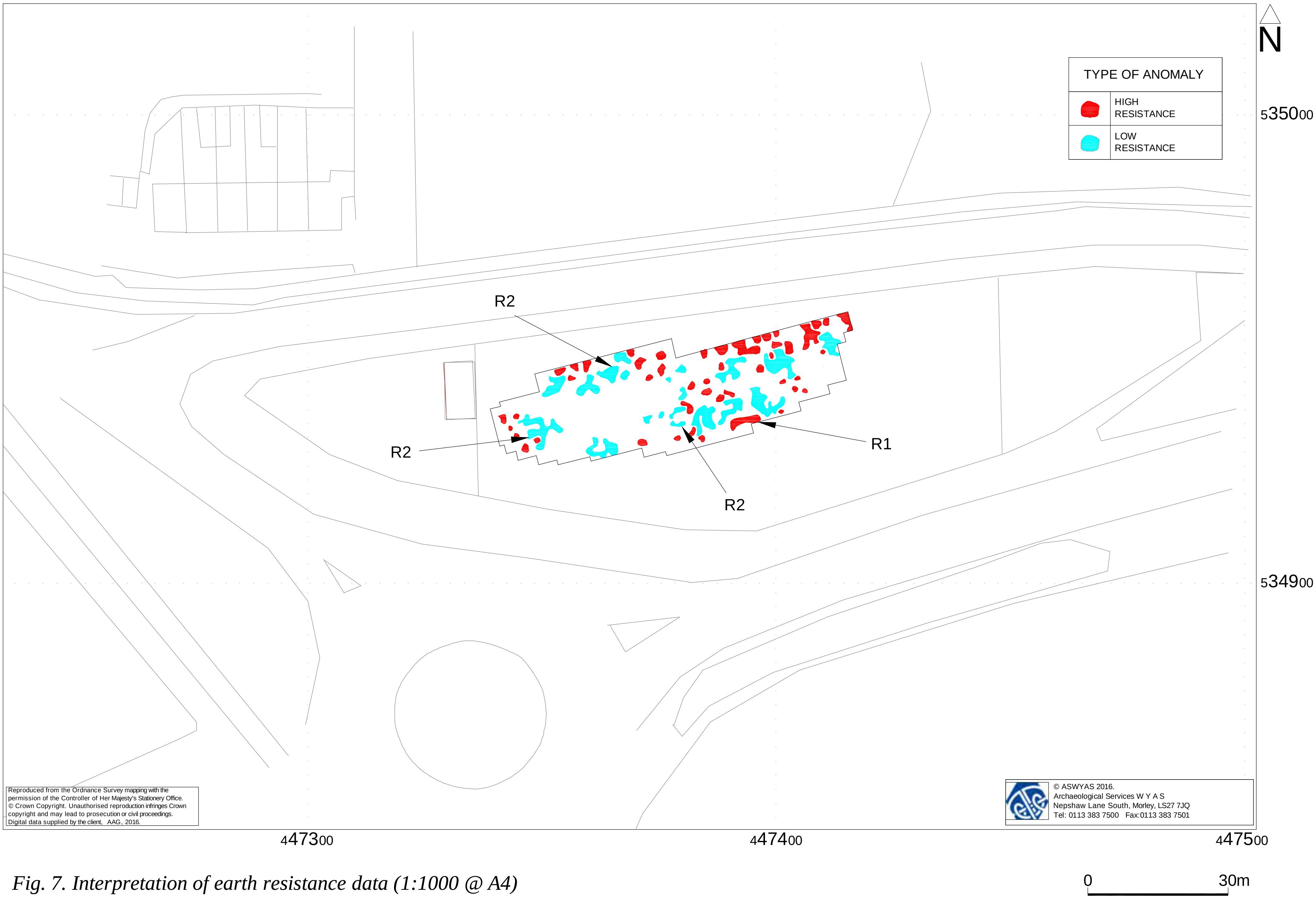


Fig. 7. Interpretation of earth resistance data (1:1000 @ A4)


Plate 1. Area unsuitable for survey, facing east


Plate 2. General overview of survey area, facing east


Plate 3. General overview of survey area, facing west


Plate 4. Area unsuitable for survey, facing east

Appendix 1: Magnetic survey - technical information

Magnetic Susceptibility and Soil Magnetism

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms. Areas of human occupation or settlement can then be identified by measuring the magnetic susceptibility of the topsoil because of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough.

Types of Magnetic Anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes)

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Linear trend

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

Methodology: Gradiometer Survey

The main method of using the fluxgate gradiometer for commercial evaluations is referred to as ***detailed survey*** and requires the surveyor to walk at an even pace carrying the instrument within a grid system. A sample trigger automatically takes readings at predetermined points, typically at 0.25m intervals, on traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 0.5m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

The gradiometer data have been presented in this report in processed greyscale format. The data in the greyscale images have been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.

Appendix 2: Earth resistance survey - technical information

Soil Resistance

The electrical resistance of the upper soil horizons is predominantly dependant on the amount and distribution of water within the soil matrix. Buried archaeological features, such as walls or infilled ditches, by their differing capacity to retain moisture, will impact on the distribution of sub-surface moisture and hence affect electrical resistance. In this way there may be a measurable contrast between the resistance of archaeological features and that of the surrounding deposits. This contrast is needed in order for sub-surface features to be detected by a resistance survey.

The most striking contrast will usually occur between a solid structure, such as a wall, and water-retentive subsoil. This shows as a resistive high. A weak contrast can often be measured between the infill of a ditch feature and the subsoil. If the infill material is soil it is likely to be less compact and hence more water retentive than the subsoil and so the feature will show as a resistive low. If the infill is stone the feature may retain less water than the subsoil and so will show as a resistive high.

The method of measuring variations in ground resistance involves passing a small electric current (1mA) into the ground via a pair of electrodes (current electrodes) and then measuring changes in current flow (the potential gradient) using a second pair of electrodes (potential electrodes). In this way, if a structural feature, such as a wall, lies buried in a soil of uniform resistance much of the current will flow around the feature following the path of least resistance. This reduces the current density in the vicinity of the feature, which in turn increases the potential gradient. It is this potential gradient that is measured to determine the resistance. In this case, the gradient would be increased around the wall giving a positive or high resistance anomaly.

In contrast a feature such as an infilled ditch may have a moisture retentive fill that is comparatively less resistive to current flow. This will increase the current density and decrease the potential gradient over the feature giving a negative or low resistance anomaly.

Survey Methodology

The most widely used archaeological technique for earth resistance surveys uses a twin probe configuration. One current and one potential electrode (the remote or static probes) are fixed firmly in the ground a set distance away from the area being surveyed. The other current and potential electrodes (the mobile probes) are mounted on a frame and are moved from one survey point to the next. Each time the mobile probes make contact with the ground an electrical circuit is formed between the current electrodes and the potential gradient between the mobile and remote probes is measured and stored in the memory of the instrument.

A Geoscan RM15 resistance meter was used during this survey, with the instrument logging each reading automatically at 1m intervals on traverses 1m apart. The mobile probe spacing was 0.5m with the remote probes 15m apart and at least 15m away from the grid under survey. This mobile probe spacing of 0.5m gives an approximate depth of penetration of 1m for most archaeological features. Consequently a soil cover in excess of 1m may mask, or significantly attenuate, a geophysical response.

Appendix 3: Survey location information

An initial survey station was established using a Trimble VRS differential Global Positioning System (Trimble R6 model). The cart data was geo-referenced using the geo-referenced survey station with a Trimble RTK differential Global Positioning System (Trimble R6 model). The accuracy of this equipment is better than 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.

Appendix 4: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the Teesside Environment Record).

Appendix 5: Oasis form

OASIS DATA COLLECTION FORM: England

List of Projects | Manage Projects | Search Projects | New project | Change your details | HER coverage | Change country | Log out

Printable version

OASIS ID: archaeol11-297668

Project details

Project name	Millbank Close, Hart
Short description of the project	A geophysical (magnetometer and earth resistance) survey was carried out on land behind Kirkefield stables, Hart, prior to the proposed development of the site. The survey area comprised of an enclosed area of around 0.2 hectares, currently under pasture. The magnetometer survey was able to detect areas of disturbance, geology and an area of possible archaeology towards the southern boundary of the site. The categorisation of these magnetic anomalies, were further enhanced with data from the earth resistance survey, indicating the possible remnants of a former structure. Therefore the overall archaeological potential of the site is deemed to be moderate.
Project dates	Start: 30-06-2016 End: 30-06-2016
Previous/future work	Not known / Not known
Any associated project reference codes	MBC16 - Sitecode
Any associated project reference codes	MBC16 - Sitecode
Type of project	Field evaluation
Site status	None
Current Land use	Grassland Heathland 5 - Character undetermined
Monument type	N/A None
Monument type	N/A None
Significant Finds	N/A None
Significant Finds	N/A None
Methods & techniques	"Geophysical Survey"
Development type	Small-scale (e.g. single house, etc.)
Prompt	Research
Position in the planning process	Not known / Not recorded
Solid geology	DEVONIAN UNDIFFERENTIATED

Drift geology	ALLUVIUM
Techniques	Magnetometry

Project location

Country	England
Site location	CLEVELAND HARTLEPOOL HART Land at Millbank Close
Postcode	TS27 3BT
Study area	0.2 Hectares
Site coordinates	NZ 47370 34943 54.707164701814 -1.26474643417 54 42 25 N 001 15 53 W Point
Height OD / Depth	Min: 67m Max: 67m

Project creators

Name of Organisation	Archaeological Services WYAS
Project brief originator	Self (i.e. landowner, developer, etc.)
Project design originator	ASWYAS
Project director/manager	C. Sykes
Project supervisor	C. Sykes
Type of sponsor/funding body	Landowner

Project archives

Physical Archive Exists?	No
Digital Archive recipient	ASWYAS
Digital Contents	"none"
Digital Media available	"Geophysics","Images raster / digital photography","Survey"
Paper Archive Exists?	No

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Land at Millbank Close
Author(s)/Editor(s)	Sykes, C.
Other bibliographic details	n/a
Date	2016
Issuer or publisher	ASWYAS

Place of issue or publication	Leeds
Description	Grey Literature
Entered by	Christopher Sykes (christopher.sykes@aswyas.com)
Entered on	6 October 2017

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