WYAS Archaeological Services

Carl Wark

Peak District National Park

South Yorkshire/Derbyshire

Geophysical Survey

Report no. 2875
June 2016

Client: Jeremy Freeston

West Yorkshire Joint Services

Carl Wark,
Peak District National Park,
Derbyshire

Geophysical Survey

Summary

A geophysical survey using a magnetometer, a magnetic susceptibility meter and an electromagnetic survey using a CMD Explorer, covering approximately 0.5 hectares, was carried out on land around the Scheduled Ancient Monument known as Carl Wark. The survey was undertaken as part of a research project on the hillfort. No anomalies of archaeological interest have been detected by any of the survey methods employed.

WYAS
Archaeological
Services

Report Information

Client:	Jeremy Freeston
Address:	Dragonshead Productions Limited, 2 Surprise Villas, Sheffield Road, Hathersage, Hope Valley, S32 1DA
Report Type:	Geophysical Survey
Location:	Carl Wark
County:	Derbyshire/South Yorkshire border
Grid Reference:	SK 25915 81468
Period(s) of activity:	Prehistory
Report Number:	2875
Project Number:	6227
Site Code:	CWA15
OASIS ID:	archaeol11-253644
Date of fieldwork:	February 2016
Date of report:	June 2016
Project Management:	Chris Sykes BA MSc
Fieldwork:	Emma Brunning BSc MCIfA
	Chris Sykes
Report:	Chris Sykes and Emma Brunning
Illustrations:	Emma Brunning
Photography:	Emma Brunning
Research:	Emma Brunning

Authorisation for distribution: ----------

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Contents

List of Figures

List of Plates

1 Introduction

Archaeological Services WYAS (ASWYAS) was commissioned by Jeremy Freeston, on behalf of Dragonshead Productions (the Client), to undertake a geophysical (magnetometer, magnetic susceptibility and electromagnetic) survey of the Scheduled Ancient Monument known as Carl Wark. The work was undertaken in accordance with a Project Design (Brunning 2016). Guidance contained within the National Planning Policy Framework (DCLG 2012) was followed, in line with current best practice (CIfA 2014; David *et al*. 2008). The survey was carried out between the 4th and 5th of February 2016, to provide additional information on the archaeological resource of the site.

Site location, topography and land-use

Carl Wark is located on Hathersage Moor, within the Peak District National Park. The area of investigation (AOI) is located approximately 2km east of Hathersage, approximately 0.5km south of Higger Tor and 0.5km north of an area known as Toad's Mouth centred at SK 25915 81468 (see Fig. 1). The AOI is an elevated area within the moor and heathlands of the Peak District National Park. The AOI totals approximately 0.5ha consisting of a discrete area on rocky outcrops and boulders. The site is at an elevation of 369m above Ordnance Datum (aOD).

Soils and geology

The underlying bedrock geology comprises of Chatsworth Grit – sandstone. No superficial deposits have been recorded (BGS 2016). Soils of the survey area belong to the Anglezarke (631a) association; well drained very acid coarse loamy soils over sandstone, with a bleached subsurface horizon. Some shallow soils with a peaty or humose surface horizon. Rocks and boulders locally (SSEW 1983).

2 Archaeological Background

An unrecorded excavation in the 1950s was undertaken by Mr F. Simpson. The results were inconclusive. Simpson concluded that this was an Iron Age hillfort, but the morphology of the site is in contrast to other sites of the same period.

In 2014, ArcHeritage was commissioned by the National Trust to undertake a Conservation Management Plan for the site. It documented the possible origins of the site, and a précis of the history including use of the survey area as a Second World War training ground (Badcock 2014).

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 research potential for archaeological remains and for further evaluation or mitigation proposals, if appropriate, to be recommended. To achieve this aim, a magnetometer, electromagnetic and magnetic susceptibility survey covering all amenable parts of the AOI 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.

Electromagnetic survey

On this site a GF Instruments CMD Explorer – multidepth electromagnetic conductivity meter was used. This system has five probes, interlocked together to make an instrument that measures over 2 metres in width. The electromagnetic conductivity meter is a contactless geophysical survey instrument that allows for multiple depth ranges. The instrument was attached to an external GPS system which recorded measurements onto the data logger. Real Time Kinetic (RTK) differential Global Positioning System (dGPS) allows for the geo-referencing of all measurement points within ±1cm accuracy These readings were then transferred from the data logger and brought into our processing software.

Data processing

The data have been presented in this report in colour formats. The data in the 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. TerraSurveyor V3.0.25.0 software was used to process and present the data recorded by the CMD Explorer.

Magnetic susceptibility survey

Magnetic survey methods rely on the ability of a variety of instruments to measure very small magnetic fields associated with buried archaeological remains. Features such as a ditch, pit or kiln can act like a small magnet, or series of magnets, that produce distortions (anomalies) in the earth's magnetic field. In mapping these slight variations, detailed plans of sites can be obtained as buried features often produce reasonably characteristic anomaly shapes and strengths (Gaffney and Gater 2003). Further information on the types of anomalies is provided in Appendix 1.

On this site, a grid was established, in two areas of interest. Measurements were taken at 5m intervals and were manually recorded onto a table, before being converted digitally pre-processing.

Data processing

Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

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.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey (OS) mapping, is shown in Figure 1. Figure 2 displays an overview of the survey area at 1:2500. Figure 3 shows a processed greyscale of magnetometer data with Figure 4 displaying an interpretation, both at a scale 1:1000. Figure 5 shows a colour representation of the electromagnetic conductivity data at a scale of 1:1000. Finally Figure 6 shows the magnetic susceptibility data at a scale of 1:1000.

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

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).

The figures in this report have been produced following analysis of the data in 'raw' and 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 2-6)

What follows will be a breakdown of the various techniques employed, and how they complement and support each other.

The gradiometer survey has detected geological anomalies but has not detected any evidence of burning or clustering of ferrous activity which would be an indicator of continuous human activity. The magnetometer has been able to delimit the band of geological and boulder anomalies within the centre of the monument. A scattering of small scale ferrous responses can be seen throughout the area, whilst these are likely to be of a modern date it is possible that they relate to mortar shells and bullet casing from the military training which took place during the 1940's.

Similarly the results from the CMD Explorer show that the area of high resistance corresponds with the location of a boulder in the landscape. However the electromagnetic survey has detected an area of low resistance, circular in shape, with possible high resistance anomalies demarcating an area. Whilst there is no clear indication that there is human activity here, the survey has indicated that this could be an area of future investigation.

The results from the magnetic susceptibility, in two areas, one within an area supposed to form a possible structure, and at the top and bottom of the entrance to the Scheduled Monument have proved inconclusive. An area of high responses within the "building" may be a sign of activity.

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.

5 Conclusions

Carl Wark is a poorly understood monument which has been scheduled. Whilst an excavation took place in the 1950s, and focused on a small aspect of the site, little has been done within the interior of the monument. This survey allowed a variety of techniques to be employed and for the results to be analysed objectively.

The landscape of the monument is dominated by the geology and this has certainly had an influence on the results of the techniques used. However the lack of evidence of purposeful, constant human activity is in itself useful information in helping to understand the form and function of this monument. As it lies within an area of identified prehistoric field systems, enclosures and cairns, it is likely to have been used for sanctuary, or infrequent use, rather than an area of permanent occupation.

The electromagnetic results have been perhaps the most useful in identifying an area of low conductivity, which may benefit from future investigation to determine the cause of the anomaly. This may in turn help to answer the ongoing research questions of this site.

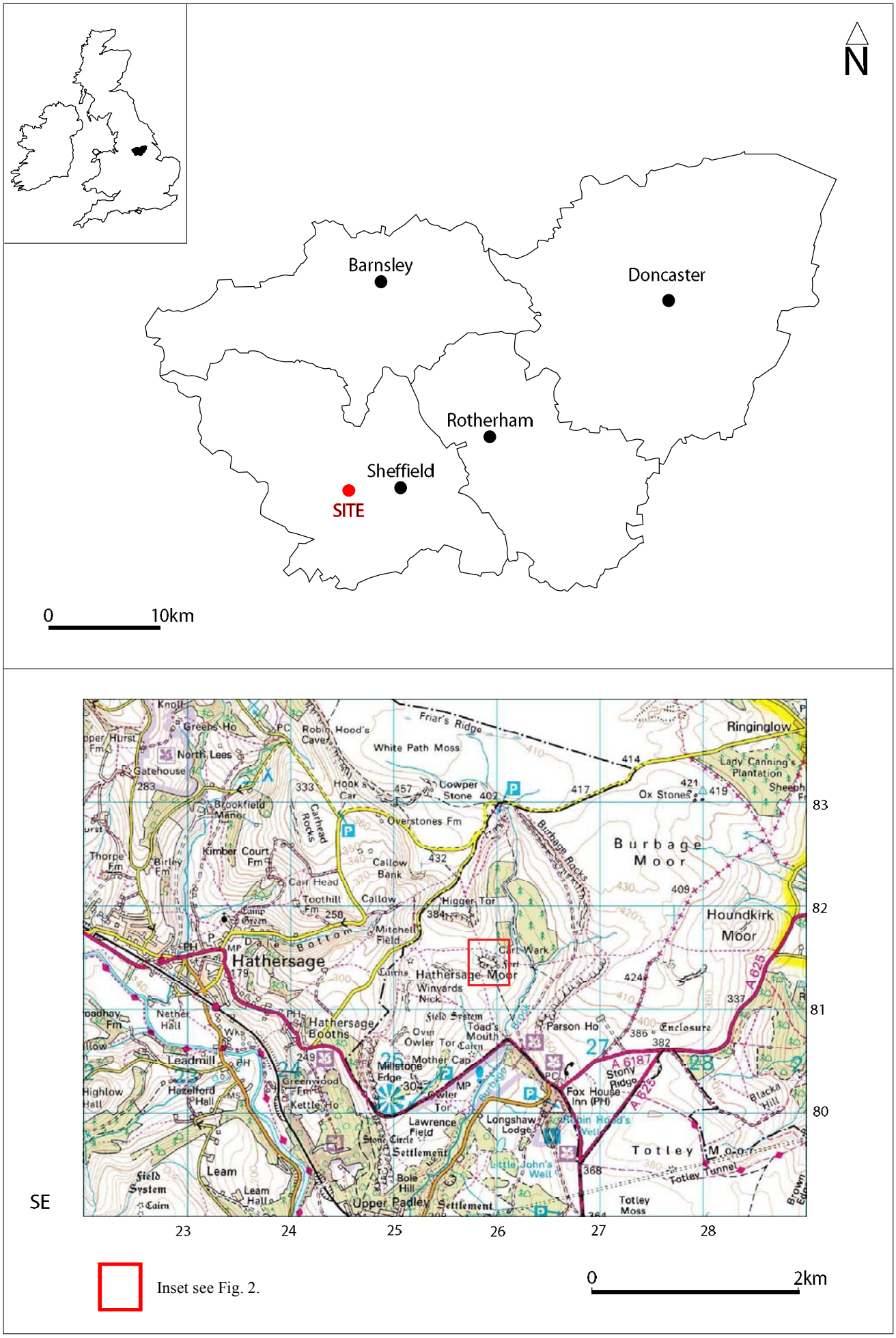

Fig. 1. Site location

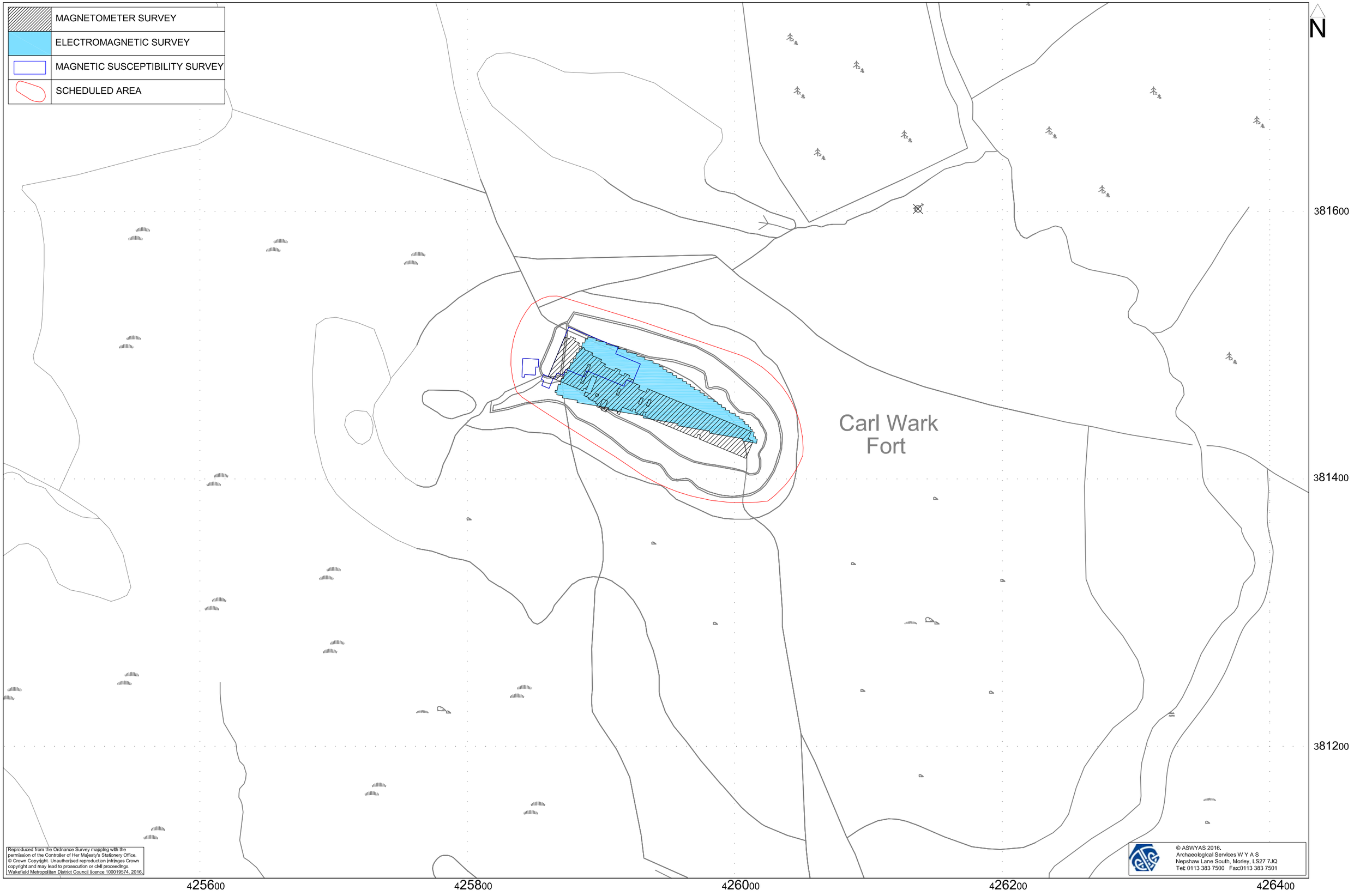

Fig. 2. Location of survey areas (1:2500 @ A3)

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

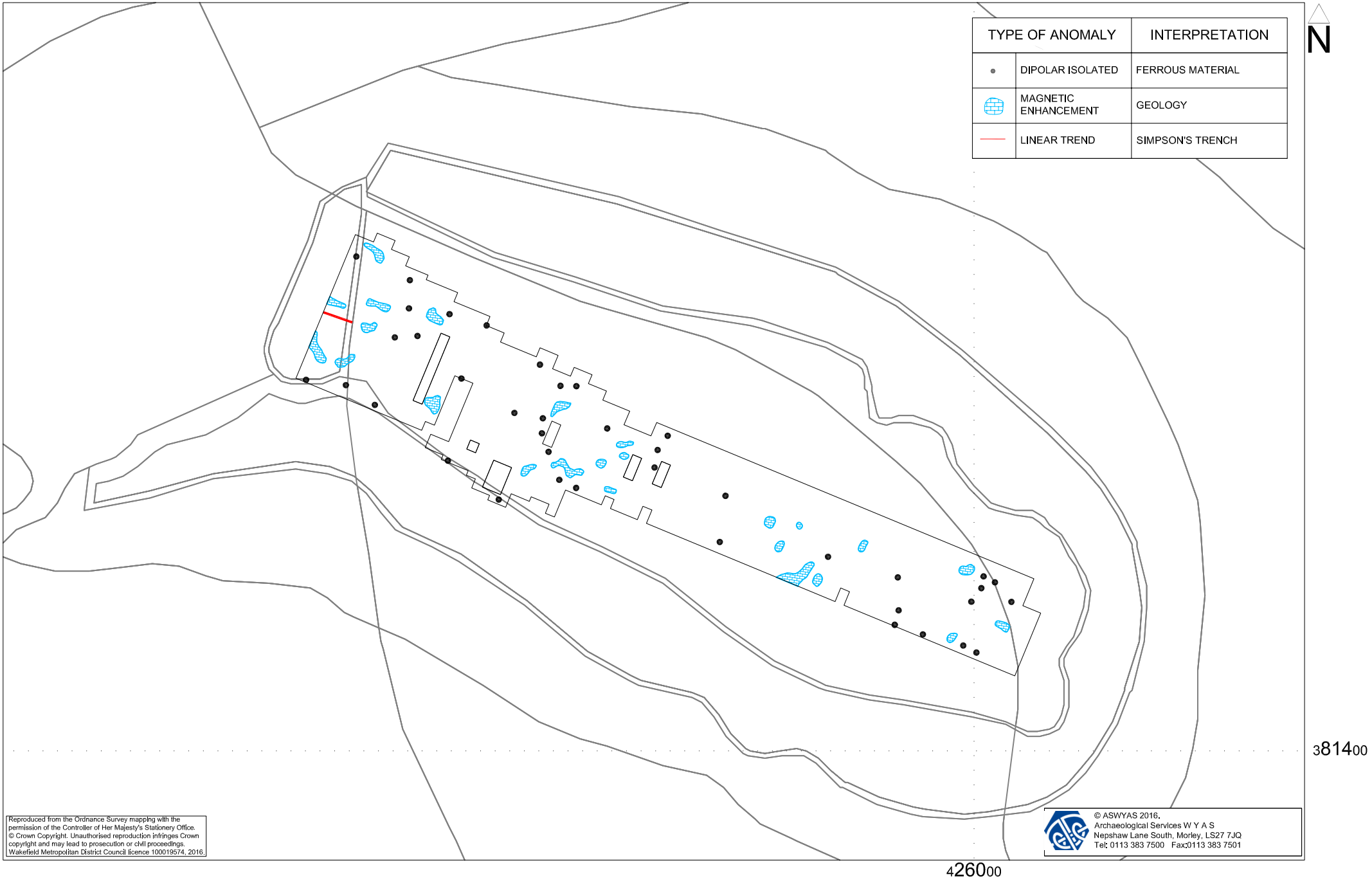

Fig. 4. Interpretation of magnetometer data (1:1000 @ A4)

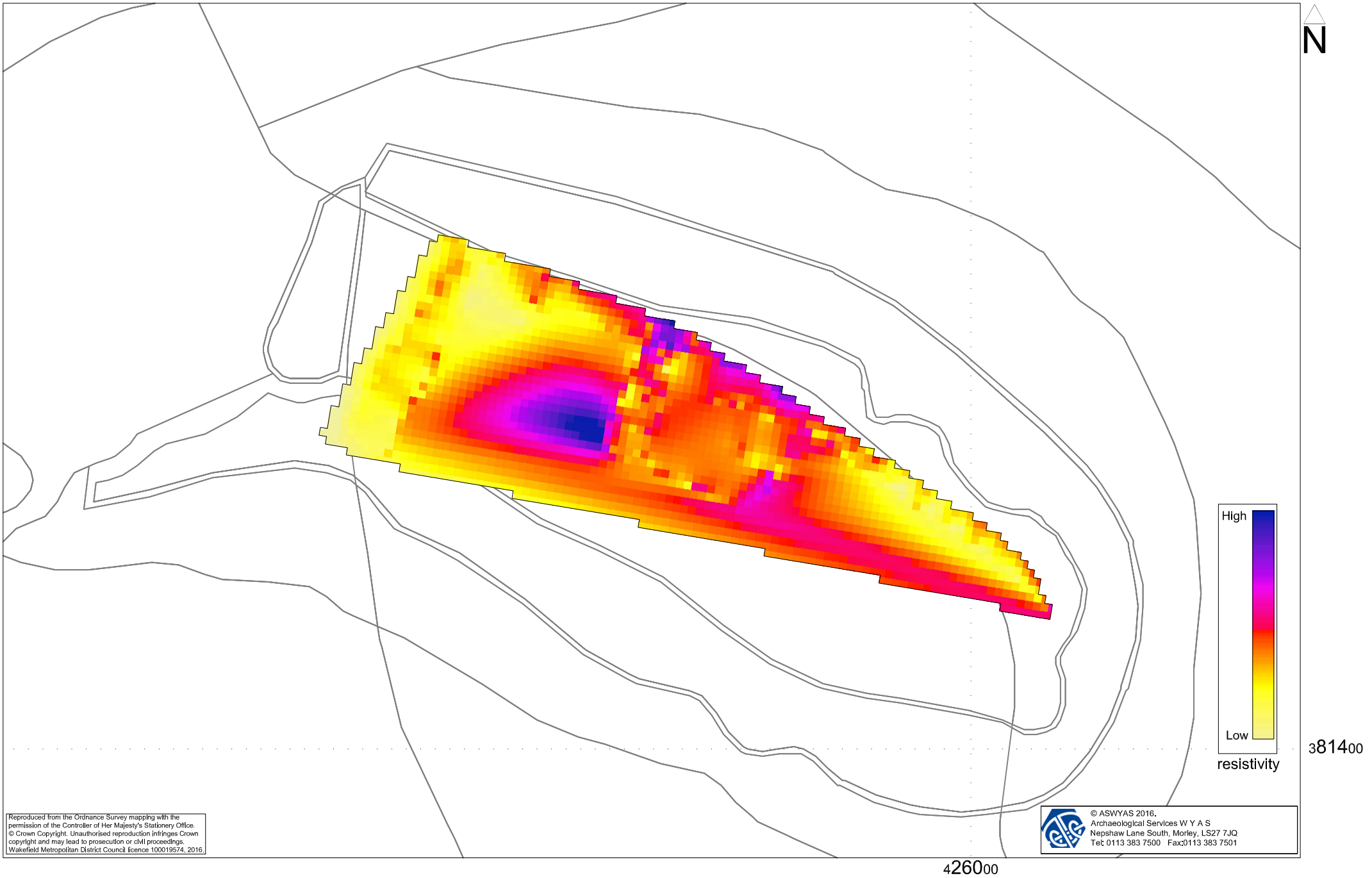

Fig. 5. Electromagnetic conductivity data (1:1000 @ A4)

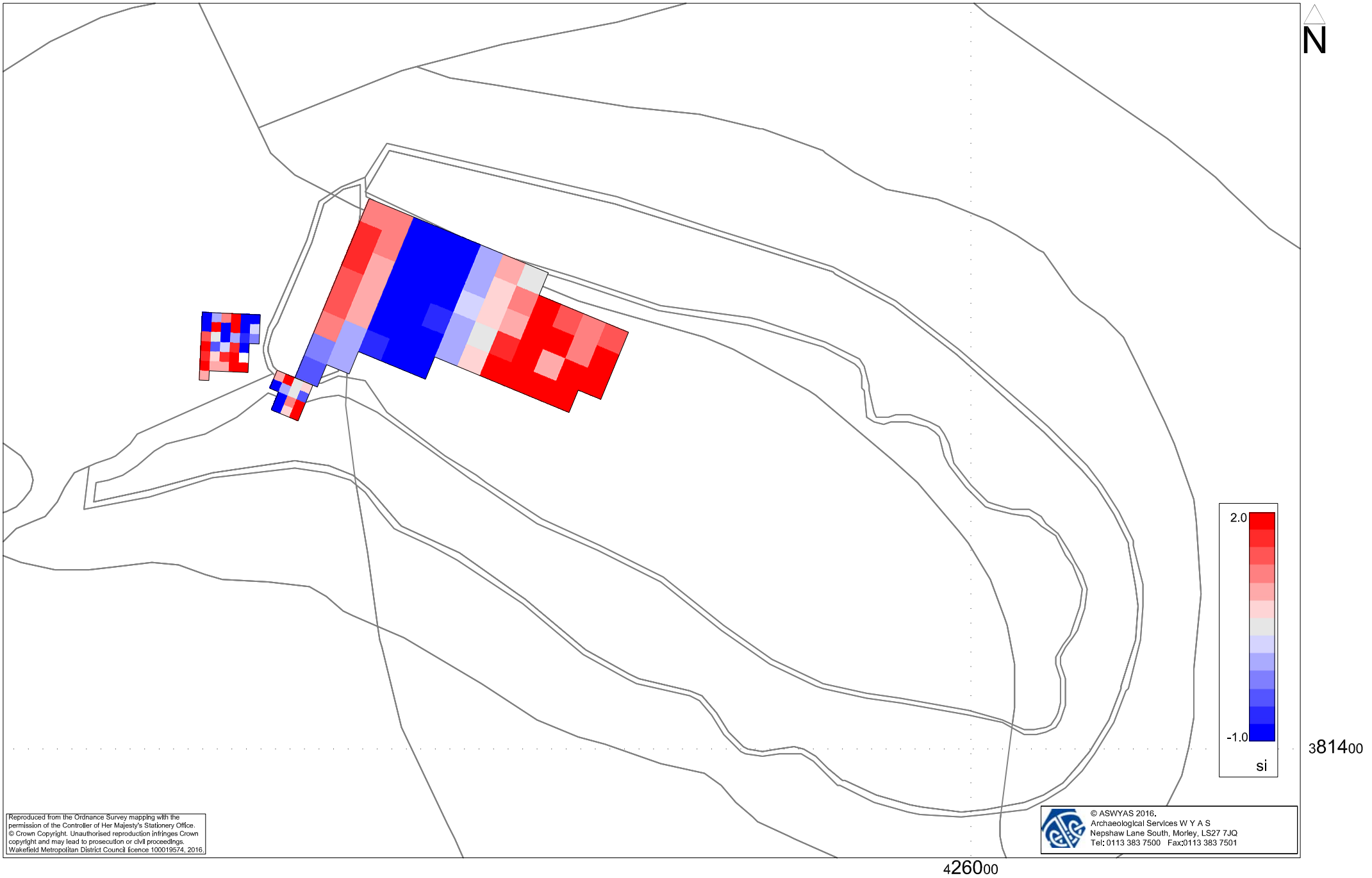

Fig. 6. Magnetic susceptibility data (1:1000 @ A4)

Plate 1. General working shot facing south-east

Plate 2. General working shot facing south

Plate 3. General working shot facing south

Plate 4. General working shot facing north-west

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.

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: Survey location information

An initial survey station was established using a Trimble VRS differential Global Positioning System (Trimble R6 model). The data were 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 then 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 3: 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 Derbyshire Historic Environment Record).

Appendix 4: OASIS form

OASIS DATA COLLECTION FORM: England

OASIS ID: archaeol11-253667

Project details

Project name	Carl Wark
Short description of the project	A geophysical survey using a magnetometer, a magnetic susceptibility meter and an electromagnetic survey using a CMD Explorer, covering approximately 0.5 hectares, was carried out on land around the Scheduled Ancient Monument known as Carl Wark. The survey was undertaken as part of a research project on the hillfort. No anomalies of archaeological interest have been detected by any of the survey methods employed.
Project dates	Start: 04-02-2016 End: 05-02-2016
Previous/future work	Yes / No
Any associated project reference codes	6227 - Sitecode
Any associated project reference codes	1017504 - SM No.
Type of project	Research project
Site status	Scheduled Monument (SM)
Current Land use	Grassland Heathland 1 - Heathland
Monument type	HILLFORT Late Prehistoric
Significant Finds	NONE None
Investigation type	"Geophysical Survey"
Prompt	Research
Solid geology (other)	Chatsworth Grit
Drift geology	PEAT
Techniques	Magnetometry
Techniques	Electromagnetic
Techniques	Magnetic susceptibility

Project location

Country	England

Site location	SOUTH YORKSHIRE SHEFFIELD SHEFFIELD Carl Wark
Study area	0.5 Hectares
Site coordinates	SK 25915 81468 53.329222223951 -1.61084033976 53 19 45 N 001 36 39 W Point
Height OD / Depth	Min: 368m Max: 370m

Project creators

Name of Organisation	Archaeological Services WYAS
Project brief originator	Jeremy Freeston
Project design originator	Jeremy Freeston
Project director/manager	C. Sykes
Project supervisor	C. Sykes

Project archives

Physical Archive Exists?	No
Digital Archive recipient	Jeremy Freeston
Digital Contents	"Survey"
Digital Media available	"Images vector","Text","Geophysics","Images raster / digital photography"
Paper Archive Exists?	No

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	Carl Wark, Peak District National Park
Author(s)/Editor(s)	Sykes, C
Date	2016
Issuer or publisher	ASWYAS
Place of issue or publication	Morley, Leeds
Description	A4 report with A3 figures

Entered by	Emma Brunning (emma.brunning@aswyas.com)
Entered on	2 June 2016

Appendix 5: Historic England geophysical survey database questionnaire

Historic England

Historic England Geophysical Survey Summary Questionnaire

Survey Details

Name of Site: Carl Wark Slight Univallate Hillfort

County: South Yorkshire/Derbyshire

NGR Grid Reference (Centre of survey to nearest 100m): **SK 25915 81468**

Start Date: 04/02/16 **End Date: 05/02/16**

Geology at site (Drift and Solid): **Bedrock geology = Chatsworth Grit – sandstone**

Drift = loamy soils over sandstone, peat

Known archaeological Sites/Monuments covered by the survey
(Scheduled Monument No. or National Archaeological Record No. if known)

Carl Wark slight univallate hillfort – SM 1017504

Archaeological Sites/Monument types detected by survey
(Type and Period if known. "?" where any doubt).

none

Surveyor (Organisation, if applicable, otherwise individual responsible for the survey):

Archaeological Services WYAS

Name of Client, if any:

Jeremy Freeston, Dragonshead Productions

Historic England

Purpose of Survey:

Research – to locate any anomalies of archaeological interest

Location of:

a) Primary archive, i.e. raw data, electronic archive etc:

ASWYAS, Nepshaw Lane South, Morley, Leeds LS27 7JQ

b) Full Report:

ASWYAS

Historic England

Technical Details

(Please fill out a separate sheet for each survey technique used)

Type of Survey (Use term from attached list or specify other): **Magnetometer**

Area Surveyed, if applicable (In hectares to one decimal place): **0.5**

Traverse Separation, if regular: 1m **Reading/Sample Interval: 0.25m**

Type, Make and model of Instrumentation:

Bartington Grad 601-2

For Resistivity Survey:

Probe configuration:

Probe Spacing:

Land use at the time of the survey (Use term/terms from the attached list or specify other):

Moorland

Historic England

Technical Details

(Please fill out a separate sheet for each survey technique used)

Type of Survey (Use term from attached list or specify other):

Magnetic Susceptibility

Area Surveyed, if applicable (In hectares to one decimal place): **0.2**

Traverse Separation, if regular: 2 **Reading/Sample Interval:2**

Type, Make and model of Instrumentation:

Bartington MS2

For Resistivity Survey:

Probe configuration:

Probe Spacing:

Land use at the time of the survey (Use term/terms from the attached list or specify other):

Moorland

Historic England

Technical Details

(Please fill out a separate sheet for each survey technique used)

Type of Survey (Use term from attached list or specify other):

Electro-magnetic survey

Area Surveyed, if applicable (In hectares to one decimal place): **0.5**

Traverse Separation, if regular: 1m **Reading/Sample Interval: 0.1m**

Type, Make and model of Instrumentation:

CMD explorer

For Resistivity Survey:

Probe configuration:

Probe Spacing:

Land use at the time of the survey (Use term/terms from the attached list or specify other):

Moorland

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