ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

on behalf of
Tees Archaeology

Land at Kirkfield
Hart Village
Hartlepool
County Durham

geophysical survey

report 2871
April 2012

Durham University

Contents

Figures

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1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted on behalf of Tees Archaeology at Kirkfield, Hart. The works comprised approximately 7ha of geomagnetic survey and 1ha of electrical resistance survey.

1.2 The works were commissioned by Tees Archaeology at Hartlepool Borough Council and conducted by Archaeological Services Durham University.

Results

1.3 Probable former ditches and field boundaries have been detected in the north of the study area, together with a possible former streambed.

1.4 Further possible ditch features have been tentatively identified in the south of the area, though these did not produce corresponding anomalies in a resistance survey.

1.5 Other resistance surveys targeted clusters of small magnetic anomalies which could potentially have reflected small pits, graves or large postholes. However, no such features were confirmed by the resistance surveys.

1.6 The remains of timber buildings and graves may still be present within the study area, however, they have not been identified in these surveys and interpretations.

1.7 Former ploughing, disturbed areas, land drains and recent services have been identified.

1.8 An illustrated talk on archaeological geophysical survey was presented to Hart History Group on 14th March 2012, together with the preliminary results from the surveys reported here.

2. Project background

Location (Figure 1)

2.1 The study area comprised land at Kirkfield, to the south-east of Hart Village, near Hartlepool, County Durham (NGR centre: NZ 4754 3478). The site was centred on Keepers Cottage. A small copse stood in the centre of the east side of the site, to the north was the A179 road, to the east and south was open farmland and to the west was a local road.

2.2 Seven geomagnetic surveys totalling approximately 7ha were undertaken in seven land parcels, and five electrical resistance surveys totalling approximately 1ha were undertaken in four land parcels.

Research proposal

2.3 Tees Archaeology and Hart History Group are conducting a research project at Kirkfield, of which these surveys form a part.

Objective

2.4 Part of an Anglo-Saxon crosshead and some pagan Saxon material has previously been recovered from the study area. The remains of timber buildings, including possibly an early church, and burial sites were anticipated.

2.5 The principal aim of the surveys therefore was to assess the nature and extent of any sub-surface features of potential archaeological significance within the study area. A second objective was to engage the local community with this aspect of the research.

Methods statement

2.6 The surveys have been undertaken in accordance with a methods statement prepared by Archaeological Services Durham University and approved by Robin Daniels of Tees Archaeology, and with national standards and guidance (below, para. 5.1).

Dates

2.7 Fieldwork was undertaken between 5th and 7th March 2012. This report was prepared for 20th April 2012.

Personnel

2.8 Fieldwork was conducted by Jamie Armstrong, Jonny Dye and Richie Villis (Supervisor). The geophysical data were processed by Richie Villis. This report was prepared by Duncan Hale, the Project Manager, with illustrations by Tony Liddell.

Archive/OASIS

2.9 The site code is **HKF12**, for **H**art **K**irk**F**ield 20**12**. The survey archive will be supplied on CD to the client for deposition with the project archive in due course. Archaeological Services Durham University is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (**OASIS**). The OASIS ID number for this project is **archaeol3-123943**.

Acknowledgements

2.10 Archaeological Services Durham University is grateful to Tees Archaeology, Hartlepool Borough Council and the farmer for facilitating this work.

3. Historical and archaeological background

3.1 The area is of interest because of the name 'Kirkfield' and the find of a large piece of Anglo-Saxon crosshead in the field. It is considered likely therefore that there may be remains of a possible early timber church with associated buildings and burials near the findspot.

3.2 Also, pagan Saxon material has been recovered from land just north of the A1049 road by a metal detector. It is possible there may be timber buildings and a pagan Saxon cemetery in that area, currently excluded from the survey.

4. Landuse, topography and geology

4.1 At the time of survey the study area comprised sheep pasture, divided into several fields by wire fences and hedgerows. Several metal feeding troughs and two old ploughs were present within the site.

4.2 The study area occupied gently sloping, east-facing, land with an elevation of approximately 75m OD in the west and 60m OD in the east.

4.3 The underlying solid geology of the area comprises Late Permian dolostone of the Roker Formation, which for the most part is overlain by Devensian till.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation* (David, Linford & Linford 2008); the Institute for Archaeologists (IfA) *Standard and Guidance for archaeological geophysical survey* (2011); the IfA Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Guide to Good Practice: Geophysical Data in Archaeology* (Schmidt & Ernenwein 2011).

Technique selection

5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a suite of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar, electromagnetic survey and topsoil magnetic susceptibility survey. Some techniques are more suitable than others in particular situations, depending on site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

5.3 In this instance, based on previous finds from the site, it was considered likely that cut features such as ditches, graves and pits might be present on the site, and that

evidence for other types of feature such as timber buildings, trackways, wall foundations and fired structures (such as kilns and hearths) might also be present.

5.4 Given the anticipated depth of targets and the non-igneous geological environment of the study area a geomagnetic technique, fluxgate gradiometry, was considered appropriate for detecting the types of feature mentioned above. This technique involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

5.5 Given the possible presence of structural remains an electrical resistance survey was also considered appropriate for targeting smaller areas based on the results of the geomagnetic survey. This technique is complementary to a geomagnetic survey. Earth electrical resistance survey can be particularly useful for mapping stone and brick features. When a small electrical current is injected through the earth it encounters resistance which can be measured. Since resistance is linked to moisture content and porosity, stone and brick features will give relatively high resistance values while soil-filled features, which retain more moisture, will provide relatively low resistance values.

Field methods

5.6 A 20m grid was established across each survey area and related to known, mapped Ordnance Survey points using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections typically providing 10mm accuracy.

5.7 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad601-2 dual fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was nominally 0.03nT, the sample interval was 0.25m and the traverse interval was 1m, thus providing 1,600 sample measurements per 20m grid unit.

5.8 Measurements of earth electrical resistance were determined using Geoscan RM15D Advanced resistance meters and MPX15 multiplexers with a mobile twin probe separation of 0.5m. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was 0.1ohm, the sample interval was 1m and the traverse interval was 1m, thus providing 400 sample measurements per 20m grid unit.

5.9 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.10 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (minimally processed) data. The greyscale images and interpretations are presented in Figures 2-8; the trace plots are provided in Figure 9. In the greyscale images, positive magnetic and high resistance anomalies are displayed as dark grey, while negative magnetic and low resistance anomalies are displayed as light grey. Palette bars relate the greyscale intensities to anomaly values in nanoTesla/ohm as appropriate.

5.11 The following basic processing functions have been applied to the geomagnetic data:

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities
destagger	corrects for displacement of geomagnetic anomalies caused by alternate zig-zag traverses
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m by 0.25m intervals

5.12 The following basic processing functions have been applied to the resistance data:

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
add	adds or subtracts a positive or negative constant value to defined blocks of data; used to reduce discontinuity at grid edges
despike	locates and suppresses spikes in data due to poor contact resistance
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m by 0.25m intervals

Interpretation: anomaly types

5.13 Colour-coded geophysical interpretation plans are provided. Three types of geomagnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches
negative magnetic	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths

5.14 Two types of resistance anomaly have been distinguished in the data:

high resistance	regions of anomalously high resistance, which may reflect foundations, tracks, paths and other concentrations of stone or brick rubble
low resistance	regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches

Interpretation: features

General comments

5.15 Colour-coded archaeological interpretation plans are provided.

5.16 Except where stated otherwise in the text below, positive magnetic anomalies are taken to reflect relatively high magnetic susceptibility materials, typically sediments in cut archaeological features (such as ditches or pits) whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning.

5.17 Series of parallel positive magnetic anomalies have been detected across most of the study area. Those in Area 4 in the south are slightly arcuate and almost certainly reflect traces of medieval ridge and furrow cultivation. In most other areas the anomalies are relatively straight and may reflect later ploughing and/or drainage.

5.18 A scatter of small, discrete dipolar magnetic anomalies has been detected in each survey area. These anomalies almost certainly reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plans, however, they have been omitted from the archaeological interpretation plans and the following discussion.

Area 1

5.19 A concentration of small dipolar magnetic anomalies has been detected in the northern part of this area. These anomalies almost certainly reflect the presence of rubble or similar materials.

5.20 A few positive magnetic anomalies have been detected here, in addition to those associated with ploughing and drainage. One linear anomaly aligned east-west and curving round to the north almost certainly reflects a soil-filled feature, possibly a former field boundary. A similar anomaly aligned north-south in the southern part of this field may also reflect a former field boundary or headland; this feature is also evident in the resistance data as a high resistance anomaly. These features are not shown on early Ordnance Survey (OS) maps.

5.21 The resistance survey in this field was located to target the above linear feature and also a cluster of small anomalies which could possibly have reflected small pits, graves or large postholes. Since no such features were detected in the resistance survey the magnetic anomalies are interpreted as small, near-surface, ferrous and fired items.

5.22 A more irregular positive magnetic anomaly which starts in this field and continues east through Area 2 could possibly reflect a former spring and stream channel.

Area 2

5.23 Traces of a post-medieval field boundary have been detected in this field, as indicated on early OS editions.

5.24 A curvilinear positive magnetic anomaly in the southern half of the field may reflect a former stream, as above. A second anomaly, to the east, could also possibly reflect a former course of this stream.

5.25 Three very weak and diffuse positive magnetic anomalies in the west of the field, which appear to form concentric arcs, reflect slight increases in the magnetic susceptibility of the soil and could reflect the remains of soil-filled features, possibly ploughed-out ditches.

5.26 The resistance survey in this field was located to target the above arcs, a relatively strong linear anomaly (the possible streambed) and another cluster of small anomalies, which, as in Area 1, could possibly have reflected small pits, graves or large postholes. Again, since no such features were detected in the resistance survey these magnetic anomalies are interpreted as small, near-surface, ferrous and fired items.

5.27 The resistance survey did again confirm the presence of ploughing or drainage features and a broad band of relatively high resistance which is interpreted as a former streambed. A small low resistance anomaly corresponds to a relatively large dipolar magnetic anomaly, both of which are interpreted as reflecting a relatively large ferrous item.

Area 3

5.28 Several intense dipolar magnetic anomalies were detected in this small field. A chain of anomalies aligned broadly east-west almost certainly reflects a ferrous service pipe. The larger anomalies here reflect two old ploughs, steel sheep feeders, and adjacent buildings and gates. One small dipolar anomaly corresponds to a telegraph pole. A broad band of small, intense anomalies along the southern side of the field reflects hardcore for an existing track.

5.29 Some possible former plough features may be present in the data.

Area 4

5.30 In addition to the broad ridge and furrow anomalies here, several other positive and dipolar anomalies were detected. These are concentrated in the north and east of the field. It was considered that some of the cluster of small anomalies in the north could reflect small pits, graves or large postholes, and so were targeted with resistance survey. However, no such features were detected in the resistance survey and the magnetic anomalies are interpreted as small, near-surface, ferrous and fired items.

5.31 The curvilinear positive magnetic anomalies in the east of this field are very weak but could possibly reflect the remains of former ditches. Resistance survey did not confirm the presence of ditches but one curvilinear high resistance anomaly was detected, which could indicate the presence of stone or brick. The anomaly is relatively well defined, in the shape of a rounded corner, immediately north of where a ditch was tentatively identified.

5.32 Three narrow high resistance anomalies aligned north-west/south-east could reflect land drains.

Areas 5, 6 and 7

5.33 No features of likely archaeological origin have been identified in these areas, excluding former ploughing.

5.34 A concentration of small intense dipolar anomalies in the west of Area 5 corresponds to a recent, made-ground platform constructed for siting a marquee. Sheep feeders and troughs were present in each area, giving rise to large dipolar magnetic anomalies.

5.35 Resistance survey was undertaken in Area 6 due to its proximity to the 'Kirkfield' and to a cluster of small anomalies in the north of Area 4.

5.36 Two discrete low resistance anomalies were detected in the west of Area 6. Such anomalies often reflect the increased water retention of soil-filled features, however, in this case there are no corresponding positive magnetic anomalies. Similarly, large ferrous items can produce low resistance anomalies but there are no corresponding dipolar magnetic anomalies here. In this instance these anomalies are simply interpreted as particularly wet areas.

6. Conclusions

6.1 Geomagnetic and electrical resistance surveys have been undertaken at Kirkfield, south-east of Hart Village in County Durham.

6.2 Probable former ditches and field boundaries have been detected in the north of the study area, together with a possible former streambed.

6.3 Further possible ditch features have been tentatively identified in the south of the area, though these did not produce corresponding anomalies in a resistance survey.

6.4 Other resistance surveys targeted clusters of small magnetic anomalies which could potentially have reflected small pits, graves or large postholes. However, no such features were confirmed by the resistance surveys.

6.5 The remains of timber buildings and graves may still be present within the study area, however, they have not been identified in these surveys and interpretations.

6.6 Former ploughing, disturbed areas, land drains and recent services have been identified.

6.7 An illustrated talk on archaeological geophysical survey was presented to Hart History Group on 14th March 2012, together with the preliminary results from the surveys reported here.

7. Sources

David, A, Linford, N, & Linford, P, 2008 *Geophysical Survey in Archaeological Field Evaluation*. English Heritage

Gaffney, C, Gater, J, & Ovenden, S, 2002 *The use of geophysical techniques in archaeological evaluations*. Technical Paper **6**, Institute of Field Archaeologists

IfA 2011 *Standard and Guidance for archaeological geophysical survey*. Institute for Archaeologists

Schmidt, A, & Ernenwein, E, 2011 *Guide to Good Practice: Geophysical Data in Archaeology*. Archaeology Data Service

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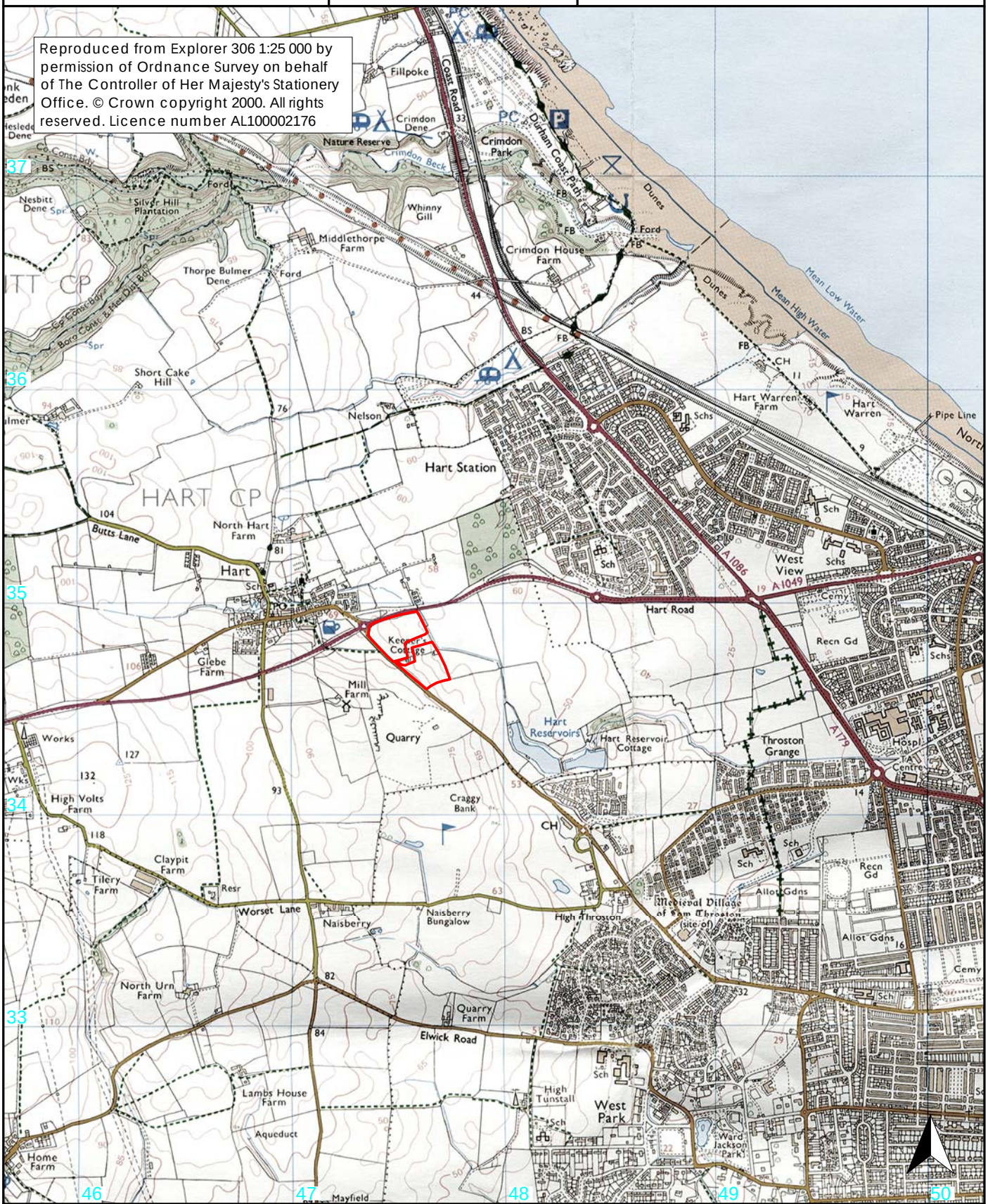
Figure 1: Site location



survey area

0 1km

scale 1:25 000 for A4 plot

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Figure 2: Geomagnetic survey overview

0 75m
scale 1:1500 for A3 plot

-5 nT 5

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60.8m

A 179

67.4m

A 179

349

Area 2

Area 1

348

Area 6

Area 4A

Keeper's Cottage

74.2m

347

Area 4

73.5m

346

474

475

476

477

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Figure 3: Resistance survey overview

0 75m

scale 1:1500 for A3 plot

resistance survey

Area 1
10 ohm 15

Area 2
10 ohm 18

Area 4
10 ohm 20

Area 4A
12 ohm 20

Area 6
12 ohm 17

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Area 1

Area 2

Area 3

Area 4

Area 5

Area 6

Area 7

67.4m

74.2m

73.5m

A 179

Keeper's Cottage

349

348

347

346

474

475

476

477

478

-5 nT 5

resistance survey

0 50m

scale 1:1000 for A2 plot

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Figure 4: Geomagnetic survey

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Area 1

Area 2

Area 3

Area 4

Area 5

Area 6

Area 7

67.4m

74.2m

73.5m

Keeper's Cottage

A 179

349

348

347

346

474

475

476

477

478

magnetic survey

resistance survey

dipolar magnetic anomaly

positive magnetic anomaly

negative magnetic anomaly

0 50m

scale 1:1000 for A2 plot

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Figure 5: Geophysical interpretation of geomagnetic survey

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67.4m

A 179

349

348

347

346

Area 1

Area 2

Area 4

Area 4A

Area 6

74.2m

73.5m

Keeper's Cottage

474

475

476

477

478

resistance survey

Area 1
10 ohm 15

Area 2
10 ohm 18

Area 4
10 ohm 20

Area 4A
12 ohm 20

Area 6
12 ohm 17

magnetic survey

0 50m
scale 1:1000 for A2 plot

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Figure 6: Resistance survey

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67.4m

A 179

349

348

347

346

Area 1

Area 2

Area 4

Area 4A

Area 6

Keeper's Cottage

74.2m

73.5m

474

475

476

477

478

resistance survey

magnetic survey

high resistance anomaly

low resistance anomaly

0 50m

scale 1:1000 for A2 plot

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Figure 7: Geophysical interpretation of resistance survey

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Area 1

Area 2

Area 3

Area 4

Area 5

Area 6

Area 7

67.4m

74.2m

73.5m

A 179

Keeper's Cottage

349

348

347

346

474

475

476

477

478

magnetic survey

resistance survey

soil-filled feature

possible stone feature

disturbed area

service pipes

former ploughing

former field boundary

telegraph pole

old plough

sheep feeder

0 50m

scale 1:1000 for A2 plot

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Figure 8: Archaeological interpretation

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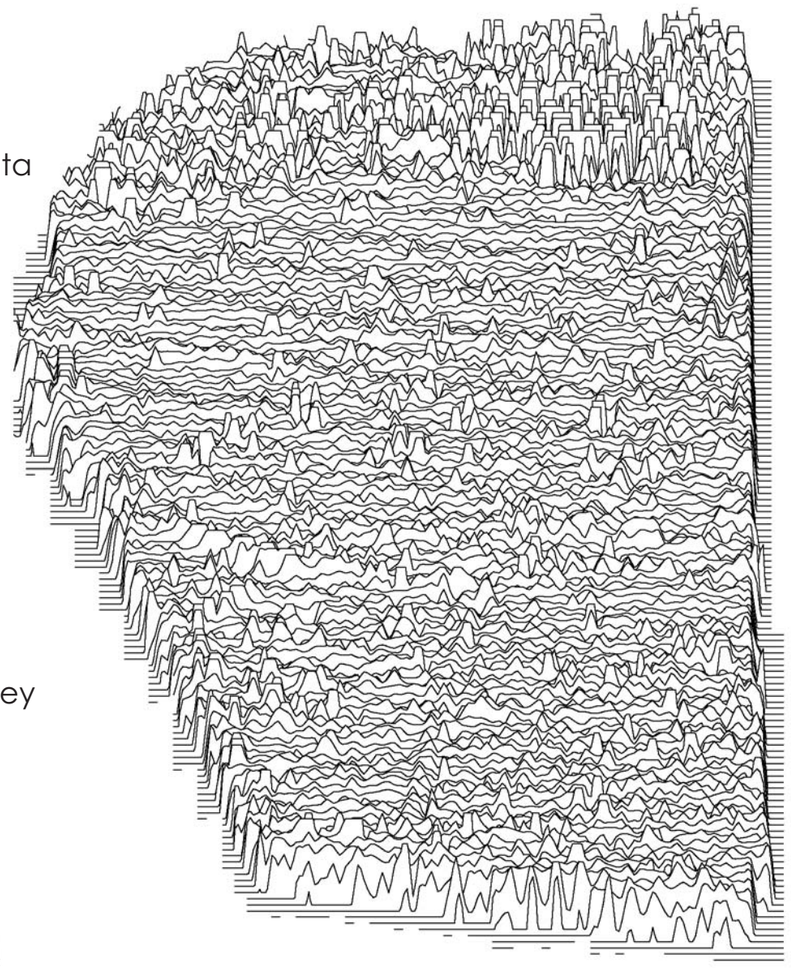
Figure 9: Trace plots of geophysical data

0 50m
scale 1:1000

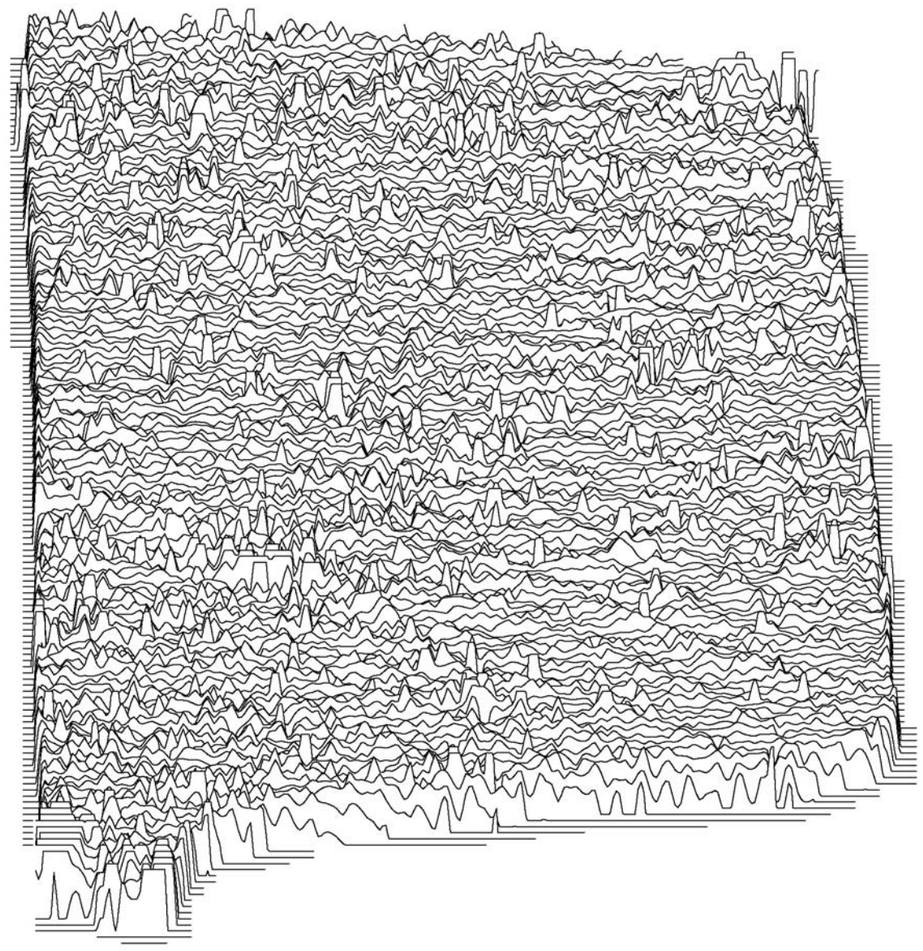
Area 1, geomagnetic survey

9.90nT



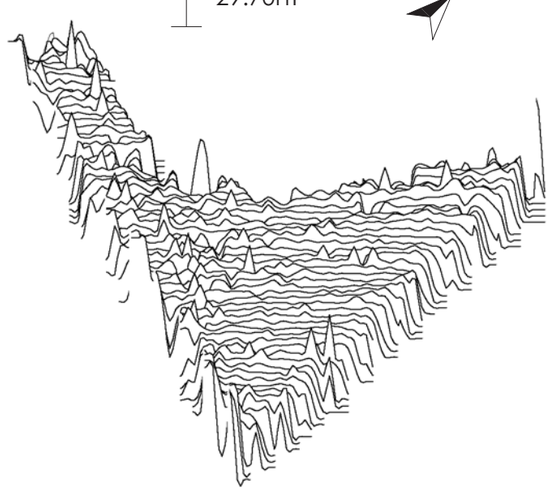
Area 2, geomagnetic survey

8.70nT



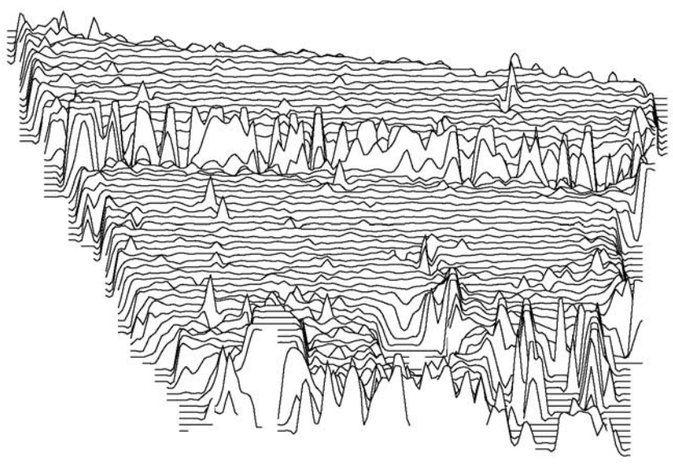
Area 5, geomagnetic survey

29.70nT



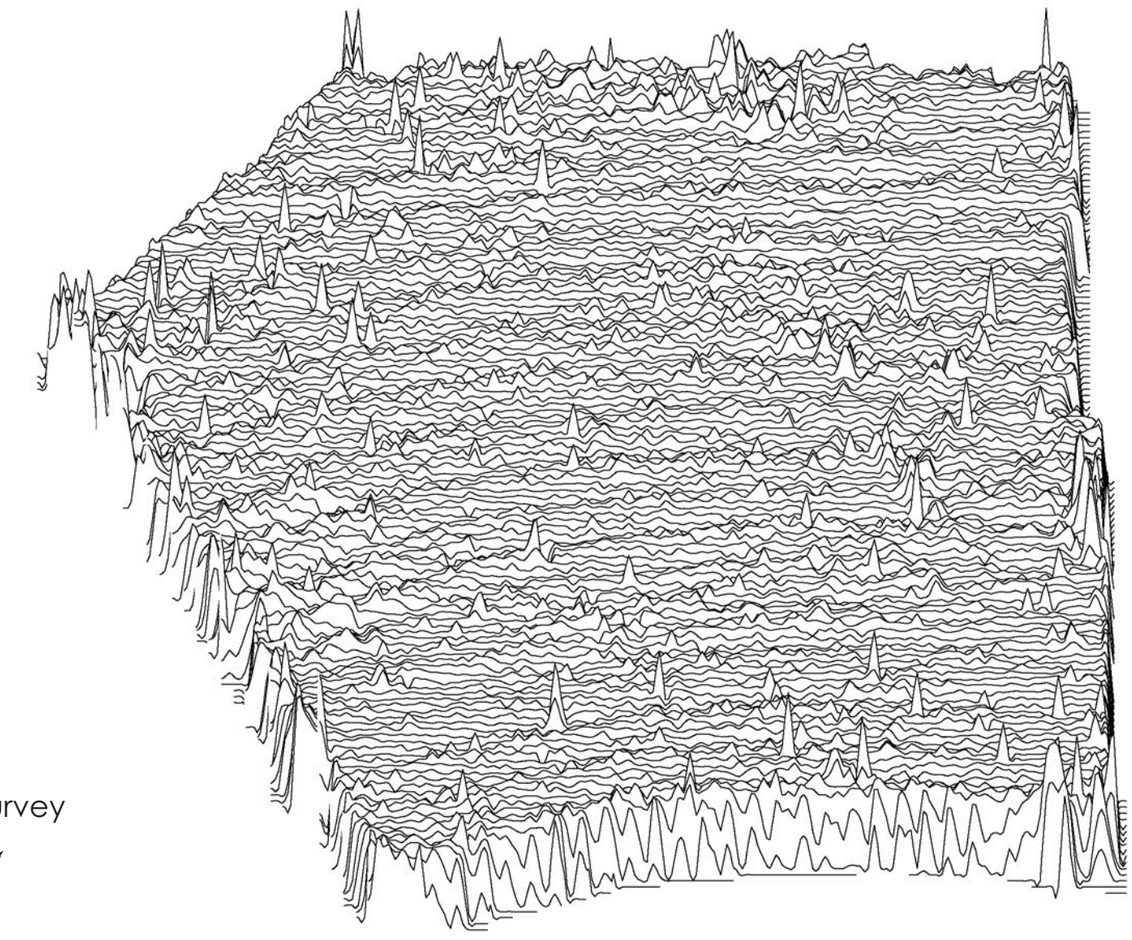
Area 3, geomagnetic survey

35.10nT



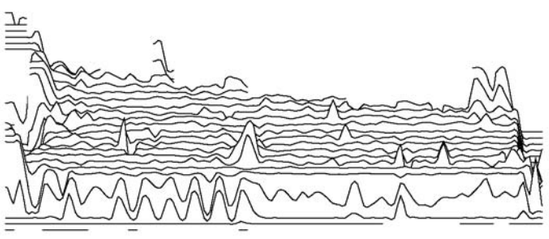
Area 4, geomagnetic survey

18.70nT



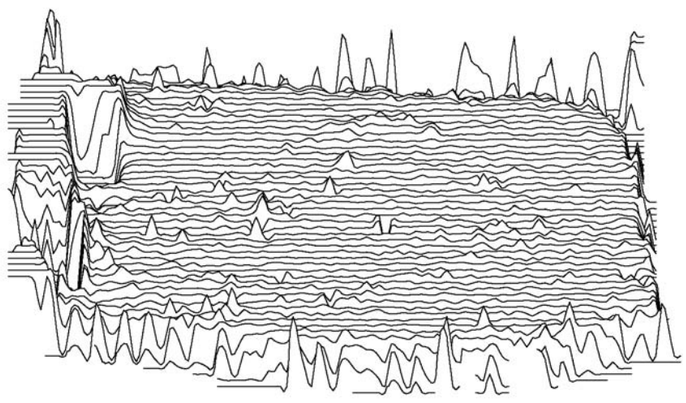
Area 6, geomagnetic survey

38.60nT



Area 7, geomagnetic survey

33.40nT

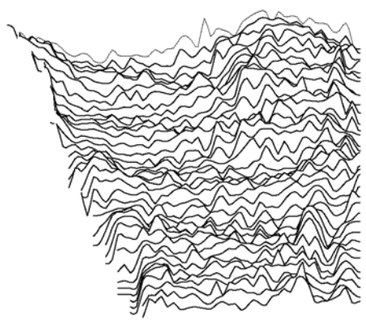


Area 4A, resistance survey

5.70ohm

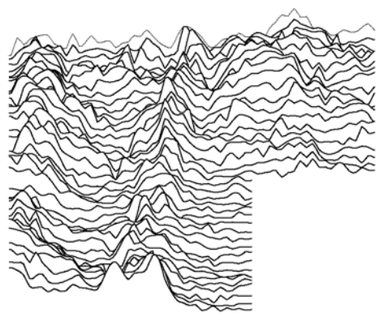
Area 1, resistance survey

4.20ohm



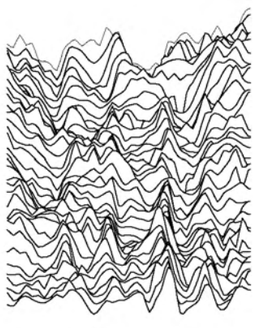
Area 2, resistance survey

6.00ohm



Area 4, resistance survey

4.00ohm



Area 6, resistance survey

6.10ohm