ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

on behalf of

ENGLISH HERITAGE

Underheugh Farm
Birdoswald
Gilsland
Cumbria

geophysical survey

report 3131
April 2013

Durham University

Contents

Figures

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1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted at Underheugh Farm, close to the Roman fort at Birdoswald, Gilsland, Cumbria, prior to the possible sale of the farm buildings by English Heritage.

1.2 The works were commissioned by English Heritage and conducted by Archaeological Services Durham University.

Results

1.3 Geomagnetic survey west of the disused farm buildings has detected a series of probable former ditches defining small enclosed areas. Elsewhere around the farm a few probable soil-filled pits have been detected but the majority of anomalies appear to reflect drainage and former ploughing.

1.4 Further west, where the floodplain narrows to a bottleneck below the fort, a few weak geomagnetic anomalies could possibly reflect soil-filled features, such as ditches or gullies, together with two anomalies which correspond to post-medieval field boundaries.

1.5 A probable former course of the River Irthing has been detected along the edge of the floodplain at the base of a terrace, most evident in the resistance data. The remains of a probable wall have been detected on the north-west side of the floodplain, below a narrow terrace. The remains of a field wall, almost certainly the same wall as that detected geophysically, are evident on the ground further east towards the farm.

1.6 Many strong geomagnetic anomalies have been detected on the narrow terrace in the west, below the fort, where an earlier survey suggested the presence of a possible bath-house (Biggins & Taylor 2004). The anomalies recorded in the present survey are relatively intense and irregular in form and there are no corresponding anomalies in the resistance survey, which is particularly smooth and featureless. With the benefit of using two complementary techniques, the geomagnetic anomalies are interpreted as reflecting re-deposited materials derived from the high ground at the fort above, either by landslips and/or by deliberate dumping over the escarpment, rather than reflecting *in situ* structural remains or other features. The re-deposited materials probably include fired and burnt material, possibly even metal-working debris, and small items of ferrous litter.

1.7 Geomagnetic survey of Area 8 at the top of the escarpment and north of the Wall detected a great many anomalies, the majority of which appear to reflect anthropogenic features.

1.8 Anomalies which might be associated with the 'camp' recorded on early Ordnance Survey editions are largely absent from the survey although a large mound and part of an earthen bank are present on the ground. A broad ditch identified in the survey could be associated with the bank. Similar broad potential ditches have been detected in the east of the area, possibly defining an escarpment-edge or promontory enclosure with internal features.

1.9 Elsewhere in this area are three series of rectilinear anomalies which appear to reflect groups of small ditched enclosures or paddocks with associated trackways. Many of the enclosed areas are up to 20m across and do not appear to contain further anomalies, with the exception of the usual scatter of small ferrous/fired litter. The purpose of these features is unclear but they could perhaps have been paddocks for stock, or small field or garden areas for crops. A similar rectilinear pattern of features was recently detected by geophysical survey outside the Roman fort at Whitley Castle (Archaeological Services 2009; Went & Ainsworth 2009).

1.10 Many pit-like features have been detected in the west of the area, and a few more in the south, possibly associated with the small enclosures. The orientation of three similar but more intense anomalies in the west could indicate features which have been heated or fired *in situ*, possibly clay ovens or small kilns.

1.11 The surveys have extended the geophysical coverage around Birdoswald Roman fort and met their primary objectives. The results of the surveys enhance existing knowledge of the area and can be used to inform the ongoing management of the site and its possible future development.

2. Project background

Location (Figure 1)

2.1 The surveys were undertaken at Underheugh Farm, Birdoswald, near Gilsland in Cumbria (NGR centre: NY 61928 66166), within the Hadrian's Wall World Heritage Site buffer zone but outside the scheduled areas.

2.2 Survey areas were located south-east of Birdoswald Roman fort (*Camboglanna*) around the disused farm buildings at the edge of the River Irthing floodplain (geomagnetic and earth resistance surveys), and on higher ground to the north-east of the fort (geomagnetic survey only).

Objective

2.3 The objective of the survey was to attempt to locate any significant archaeological remains or other activity within the designated areas.

2.4 English Heritage is considering the disposal of the Underheugh Farm buildings through sale on the open market. The farm has not been in use for some time and is likely to require some considerable modification. The aims of the geophysical survey were therefore to enhance existing knowledge of the site, to inform the ongoing management of the site and to determine whether any restriction to development may be imposed by the presence of archaeological remains. In addition, some areas in the wider vicinity of the farm were included to enhance the existing geophysical coverage of the Birdoswald Roman fort.

Methods statement

2.5 The surveys have been undertaken in accordance with an Invitation to Tender document, prepared by English Heritage (EH), and in line with national standards and guidance (para. 5.1 below).

Dates

2.6 Fieldwork was undertaken between 4th and 8th March 2013. This report was prepared for April 2013.

Personnel

2.7 Fieldwork was conducted by Duncan Hale (the Project Manager), Ashley Hayes, Paul Murtagh, Natalie Swann (Supervisor) and Richie Villis (Supervisor). The geophysical data were processed by Duncan Hale and Ashley Hayes. This report was prepared by Duncan Hale with illustrations by David Graham and Janine Watson.

Archive/OASIS

2.8 The site code is **BUF13**, for **B**irdoswald **U**nderheugh **F**arm **2013**. The survey archive will be supplied on CD to the English Heritage Geophysics Team. 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 **archaeol3-147608.**

Acknowledgements

2.9 Archaeological Services is grateful to Michael Baxter and Sally Antill (farmers), Vigo Nicolson and Robert Pickles (EH personnel) and the EH Geophysics Team for facilitating this scheme of works.

3. Historical and archaeological background

3.1 The following information is taken from the Invitation to Tender document, prepared by English Heritage, with only minor amendments.

3.2 The buildings at Underheugh originally date from the 18th century, or perhaps earlier, and were subject to later modification before falling out of use as a working farm in the 1960s. Part of the extensive geophysical coverage at Birdoswald, conducted by both Cumbria County Council and TimeScape Surveys, has revealed some significant activity immediately west of the farm buildings and the location of a possible bath-house complex in the river valley (Walker 1986; Biggins *et al.* 1999; Biggins & Taylor 2004). Further magnetic coverage was therefore requested in this area, together with earth resistance survey, to investigate the immediate vicinity of the standing buildings and the site of the possible bath-house.

4. Landuse, topography and geology

4.1 Survey Areas 1-7 were undertaken in fields of sheep pasture around the disused Underheugh Farm buildings. These fields contained a number of recently planted trees, each protected by a post and wire fence. Parts of these areas occupied the floodplain on the north side of the River Irthing while other parts (in the north and north-west) occupied the lower slopes of the steep escarpment below the fort; parts of the slopes were too steep for survey. The elevations of the surveyed areas ranged from 100m to 110m OD.

Area 1, looking NE

Area 2, looking S

Area 3, looking E

Area 4, looking NW to farm buildings

Area 5, looking SW to farm buildings

Area 6, looking W

Area 6, SW end

Area 7, looking W

4.2 Area 8 comprised a large pasture field for cattle at the top of the escarpment, north-east of the fort and north of the Wall. The land here varied in elevation between approximately 140m and 150m OD. The south-eastern corner of the field next to the car park was waterlogged marsh and could not be surveyed; other smaller parts of the field were also waterlogged. A pond was present in the north-central part of the field, adjacent to a large mound of probable natural origin, but which may have been modified or enhanced.

4.3 The underlying solid geology comprises Visean limestone of the Tyne and Appletree formations, which are overlain by glaciofluvial deposits of sand and gravel at the top of the escarpment and river terrace/alluvial clay, silt, sand and gravel down near the River Irthing.

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 the results of previous surveys, it was considered likely that both cut and built features could be present within the survey areas. These features might include, for example, ditches and pits, wall foundations, trackways and fired structures such as kilns and hearths.

5.4 Given the anticipated shallowness of targets and the non-igneous geological environment of the study areas 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 buildings and other structural remains (including a possible bath-house near the river) an electrical resistance survey was considered appropriate to complement the results of the magnetometer 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 Areas 1-7 and related to the Ordnance Survey National Grid using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections typically providing 10mm accuracy. A 30m grid was used for the geomagnetic survey of Area 8, established by the same means.

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 with MPX15 multiplexers and 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 2-11; the trace plots are provided in Figures 12-13. 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.

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 x 0.25m intervals

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

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 x 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 Strong dipolar magnetic anomalies along survey edges typically reflect adjacent wire fences, steel gates and fences around young trees, unless stated otherwise in the text below.

5.18 Small, discrete dipolar magnetic anomalies have been detected in all of the survey areas. These almost certainly reflect items of near-surface ferrous and/or fired debris (such as horseshoes and brick fragments, for example) 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. Where concentrations of such anomalies have been detected these are indicated on the archaeological interpretation plans.

Underheugh (Figures 2-8)

Areas 1-3

5.19 These surveys covered pasture and river banks around a triangular area of scrub woodland in the east of the study area. Some extremely weak positive magnetic anomalies have been detected in Area 1, which could possibly reflect soil-filled features, possibly the remains of ditches.

5.20 A probable land drain has been identified aligned north-west/south-east across the central part of Area 1. A number of additional, very weak, magnetic lineations on this axis could reflect a former plough regime.

5.21 The only other anomalies detected in these areas comprise probable near-surface ferrous materials and wire fences around young trees and field edges.

Area 4

5.22 Broad and subtle variations in both the geomagnetic and resistance data here almost certainly reflect background geological variation.

5.23 Very high resistance values adjacent to the farm buildings correspond to higher ground, a terrace at the edge of the floodplain. The resistance data indicate that the terrace may have been modified or enhanced by the addition of stone rubble in order to create a larger platform for the buildings.

5.24 Some rectilinear high resistance anomalies in the eastern part of the survey could possibly reflect wall footings. Although the values are not particularly high, their rectangular arrangement lends some support to their interpretation structural remains. These features are of unknown date and could reflect either post-medieval sheep pens or earlier structures.

5.25 Weak, narrow and parallel geomagnetic anomalies in the north-east of the field appear to reflect former ploughing.

Area 5

5.26 A weak, narrow positive magnetic anomaly near the farm buildings corresponds to a linear low resistance anomaly and could reflect a soil-filled ditch.

5.27 An extremely weak 'texture' in the geomagnetic data probably reflects former ploughing.

5.28 No other anomalies of likely archaeological origin have been identified in either the geomagnetic or resistance survey of this area. Intense geomagnetic anomalies detected here generally reflect the field boundaries, barn and a reinforced concrete slab. The other resistance anomalies have no corresponding magnetic anomalies and probably reflect geological variation.

Area 6

5.29 Broad bands of very subtle geomagnetic variation, mostly aligned east/west, could reflect a former plough regime and drainage features. Some linear low resistance anomalies appear to reflect ditch-like features, but with little corresponding enhancement of magnetic susceptibility; these probably reflect a system of drainage.

5.30 A linear low resistance anomaly along the eastern edge of the field corresponds to a slight linear hollow noted on the ground, again probably for drainage.

5.31 A broad sinuous band of low resistance has been detected along the base of the first river terrace at the edge of the floodplain. This anomaly corresponds to a band of marshy ground along the base of the slope and probably relates to a former course of the river.

5.32 Rectilinear high resistance anomalies in the east-central part of the survey, similar to those detected in Area 4, could possibly reflect wall footings. Three sides of a possible rectangular feature have been detected. As in Area 4, the resistance values are not high, but their arrangement at least suggests they could reflect wall footings. Again, these features are of unknown date and could reflect either post-medieval sheep pens or earlier structures.

5.33 Towards the west the floodplain narrows to the width of the farm track before widening again to the south-west. Just north of the bottleneck is a narrow raised terrace in a flattened D-shape. It was on this terrace that a possible bath-house was reported following trial survey in 2000 (Biggins & Taylor 2004). Some geomagnetic anomalies recorded in that survey are evident in the present geomagnetic survey, however, their interpretation differs.

5.34 The terrace is defined on its south-east side by a short steep bank, some of which could not be surveyed. In the central part of the bank, however, the gradient lessens and it was possible to collect data continuously up the bank onto the terrace. A narrow band of high resistance was detected across this slope, together with a corresponding band of negative magnetic anomalies, almost certainly reflecting stone used as a wall or revetment. The remains of an earlier boundary wall were noted on the ground around the north side of this survey area, following the edge of the terrace round to the farm buildings, and it is likely that this anomaly reflects more of this wall, which is probably post-medieval in date. Immediately north of this feature on the terrace are two linear positive magnetic anomalies which could reflect bands of high magnetic susceptibility material, possibly within ditches.

5.35 Many strong positive and magnetic anomalies have been detected on the terrace itself. Some form curvilinear bands while others are more diffuse and irregular. Although on the magnetic evidence alone some of the negative anomalies could be taken to represent possible wall remains, there are no corresponding high resistance anomalies. The resistance data are remarkably consistent across the terrace, with the exception of a marshy area in the north-east.

5.36 Given the absence of resistance anomalies it is suggested that the strong magnetic anomalies are associated with landslips from the steep escarpment above. The south-east corner of the fort sits directly above this part of the survey and it is likely that any landslips would contain high magnetic susceptibility materials derived from activities at the fort; it is possible that some materials could also have been deliberately dumped or disposed of over the edge of the escarpment. It is likely that these deposits at the base of the escarpment could include considerable quantities of fired and burnt material, possibly even metal-working debris, and small items of ferrous 'litter' such as nails, for example. Based on the present surveys it seems that the geomagnetic anomalies here reflect re-deposited materials derived from the high ground at the fort above, rather than *in situ* structural remains or cut features.

5.37 A few very weak, linear, positive magnetic anomalies have been detected south of the terrace. These could reflect soil-filled features, possibly former ditches. One strong anomaly corresponds to a former field corner shown on the 1926 OS map edition.

5.38 A narrow negative magnetic anomaly detected towards the south-west of the survey area corresponds to a visible wall-footing noted on the ground during survey. This footing corresponds to the location of a former field wall recorded on early OS map editions.

5.39 A series of parallel, alternate positive and negative magnetic anomalies has been detected in the south-western part of the survey. These anomalies almost certainly reflect former ploughing.

Area 7

5.40 This small field immediately west of the farm buildings contained a short steep bank. Parallel magnetic lineations detected in the north of the field, above the bank, could again reflect former ploughing. The land south of and below the bank contained a high number of small dipolar magnetic anomalies, which could indicate some dumping of materials in this area.

5.41 Several relatively strong magnetic anomalies were also detected in the east of this field, which probably reflect soil-filled ditches. The principal ditch is aligned north-east/south-west and could be a former continuation of the existing boundary along the north side of the track. Three further ditches are evident on the south side of the principal ditch; these appear to form small paddocks or enclosures, possibly associated with an early phase of activity at the farm.

Area 8 (Figures 9-11)

5.42 This larger field was located on the north side of Hadrian's Wall between Birdoswald Roman fort and Milecastle 49. Many geomagnetic anomalies have been detected.

5.43 A chain of small dipolar magnetic anomalies and positive magnetic anomalies detected across the north-eastern part of the field corresponds to a former field boundary shown on the 1975 OS map edition; it is not depicted on earlier or later maps. Immediately north of this former boundary is a large mound and linear bank, neither of which is evident in the geomagnetic survey except for small clusters of dipolar anomalies. The shape and annotation of the mound has changed on successive OS maps. Originally the mound and adjacent linear earthwork were recorded together as "camp" but there is no clear indication of settlement features in the survey. The survey has however detected a broad, diffuse positive magnetic anomaly just south of the bank. It is possible that this represents an associated ditch from which material was excavated for the earthen bank.

5.44 East of the mound, in the north-east of the field, the survey detected a concentration of intense dipolar magnetic anomalies, which could reflect either recent disturbance or perhaps earlier activities. A series of narrow, parallel magnetic lineations in this area almost certainly reflect former ploughing.

5.45 In the eastern corner of the field, broad positive magnetic anomalies could possibly reflect soil-filled ditches defining a small escarpment-edge or promontory enclosure with a west-facing entrance. Smaller, weaker anomalies east of the ditches, within the enclosed area, could possibly reflect contemporary internal features.

5.46 Another broad and weak positive magnetic anomaly has been detected crossing the western and central parts of the field, at first aligned broadly east/west then turning south. This feature could define one side of a former track or droveway, the other side being defined by a series of small enclosures or paddocks in the north-central part of the survey, each measuring approximately 20m in width. These latter features are evident as at least three weak rectilinear anomalies, with a further narrow track possibly detected along the east side of the eastern enclosure. As the main track turns south there is further evidence for small paddock-like enclosures on its eastern side, here measuring between 10-20m across; the anomalies here are again weak but appear to reflect a series of rectilinear features.

5.47 Several large, discrete positive magnetic anomalies both here and to the east could reflect large soil-filled pits, possibly associated with the enclosed areas.

5.48 To the west of these features two parallel positive magnetic anomalies probably reflect a former double-ditched trackway. It is not clear if this trackway is associated with the possible north/south track in this area.

5.49 A similar arrangement of small rectilinear positive magnetic anomalies has also been detected in the west of this field. These again appear to reflect a series of small ditched enclosures or paddocks. Immediately east of these features is a large concentration of discrete, strong magnetic anomalies. It is likely that most of these reflect soil-filled pits, however, the orientation of three similar but more intense anomalies in the north of this concentration could indicate that these three anomalies reflect features which have been heated or fired *in situ*, possibly clay ovens or small kilns.

5.50 A number of other magnetic anomalies have been detected in this western part of the field. Some are well-defined linear features, almost certainly further former ditches, while others are more irregular in shape but probably also reflect soil-filled features.

6. Conclusions

6.1 Geomagnetic and earth resistance surveys have been undertaken on land at Underheugh Farm, near Birdoswald Roman fort, Gilsland, Cumbria.

6.2 Geomagnetic survey west of the disused farm buildings has detected a series of probable former ditches defining small enclosed areas. Elsewhere around the farm a few probable soil-filled pits have been detected but the majority of anomalies appear to reflect drainage and former ploughing.

6.3 Further west, where the floodplain narrows to a bottleneck below the fort, a few weak geomagnetic anomalies could possibly reflect soil-filled features, such as ditches or gullies, together with two anomalies which correspond to post-medieval field boundaries.

6.4 A probable former course of the River Irthing has been detected along the edge of the floodplain at the base of a terrace, most evident in the resistance data. The remains of a probable wall have been detected at the north-west side of the floodplain, below a narrow terrace. The remains of a field wall, almost certainly the same wall as that detected geophysically, are evident on the ground further east towards the farm.

6.5 Many strong geomagnetic anomalies have been detected on the narrow terrace in the west, beneath the fort, where an earlier survey suggested the presence of a possible bath-house (Biggins and Taylor 2004). The anomalies recorded in the present survey are relatively intense and irregular in form and there are no corresponding anomalies in the resistance survey, which is particularly smooth and featureless. With the benefit of using two complementary techniques, the geomagnetic anomalies are interpreted as reflecting re-deposited materials derived from the high ground at the fort above, either by landslips and/or by deliberate

dumping over the escarpment, rather than reflecting *in situ* structural remains or cut features. The re-deposited materials probably include fired and burnt material, possibly even metal-working debris, and small items of ferrous litter.

6.6 Geomagnetic survey of Area 8 at the top of the escarpment and north of the Wall detected a great many anomalies, the majority of which appear to reflect anthropogenic features.

6.7 Features which might be associated with the 'camp' recorded on early OS editions are largely absent from the survey although a large mound and part of an earthen bank are present on the ground. A broad ditch identified in the survey could be associated with the bank. Similar broad potential ditches have been detected in the east of the area, possibly defining an escarpment-edge or promontory enclosure with internal features.

6.8 Elsewhere in this area are three series of rectilinear anomalies which appear to reflect groups of small ditched enclosures or paddocks with associated trackways. Many of the enclosed areas are less than 20m across and do not appear to contain further anomalies, with the exception of the usual scatter of small ferrous/fired litter. The purpose of these features is unclear but they could perhaps have been paddocks for stock, or small field or garden areas for crops. A similar rectilinear pattern of features was recently detected by geophysical survey outside the Roman fort at Whitley Castle (Archaeological Services 2009; Went and Ainsworth 2009).

6.9 Many pit-like features have been detected in the west of the area, and a few more in the south, possibly associated with the small enclosures. The orientation of three similar but more intense anomalies in the west could indicate features which have been heated or fired *in situ*, possibly clay ovens or small kilns.

6.10 The surveys have extended the geophysical coverage around Birdoswald Roman fort and met their primary objectives. The results of the surveys enhance existing knowledge of the area and can be used to inform the ongoing management of the site and its possible future development.

7. Sources

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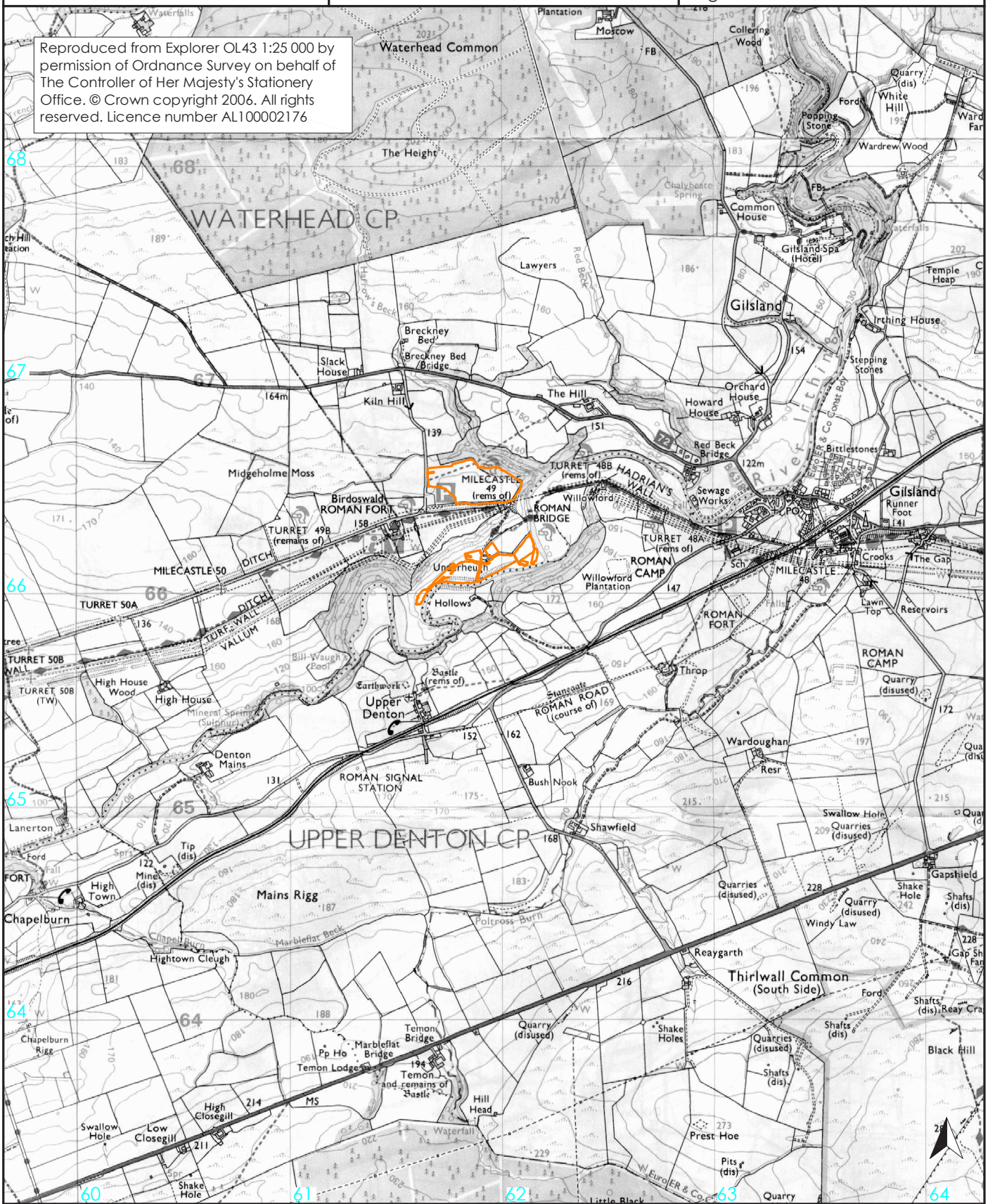
Figure 1: Site location



survey location

0 1km

scale 1:25 000 for A4 plot

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Figure 2: Geomagnetic survey overview

0 150m
scale 1:3000 for A3 plot

magnetic survey

Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7

Birdoswald Roman Fort
CAMBOGLANNA ROMAN FORT
MILECASTLE 49
ROMAN BRIDGE (remains of)
Harrow's Beck
River Irthing
Chapel Field
Harrow's Scar
Underheugh
Willowford Plantation
Hollows
Car Park
Foot Bridge
Pond
Tank
Well
VALLUM (course of)
Ditch
Path
Track
Spreads
Shingle
CR
DW
BM 133.74m
BM 148.87m
142.0m
157.6m
666
665
664
663
662
661
660
659
614
615
616
617
618
619
620
621
622

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resistance survey

60 ohm 150

0 75m

scale 1:1500 for A3 plot

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Figure 3: Resistance survey overview

Area 5

Area 7

Underheugh

Area 6

Area 4

Track

DW

CR

River Irthing

Shingle

Shingle

Hollows

662

661

660

616

617

618

619

620

621

DW

DW

Track

Area 1

Area 2

Area 3

Area 4

Area 5

Area 6

Area 7

Underheugh

CR

River Irthing

CR

Shingle

Shingle

Hollows

662

661

660

616

617

618

619

620

621

magnetic survey

-6 nT 8

0 50m

scale 1:1000 for A2 plot

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Figure 4: Areas 1-7, geomagnetic survey

DW

DW

Track

Area 1

Area 2

Area 3

Area 4

Area 5

Area 6

Area 7

Underheugh

CR

River Irthing

Shingle

Shingle

Hollows

662

661

660

616

617

618

619

620

621

magnetic survey

dipolar magnetic anomaly

positive magnetic anomaly

negative magnetic anomaly

0 50m

scale 1:1000 for A2 plot

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Figure 5: Areas 1-7, geophysical interpretation of geomagnetic data

DW

DW

Track

Area 5

Area 7

Underheugh

Area 6

Area 4

CR

CR

River Irthing

Shingle

Shingle

Hollows

662

661

660

616

617

618

619

620

621

resistance survey

Area 4
80 ohm 140

Area 5
70 ohm 240

Area 6
40 ohm 120

Area 7
60 ohm 120

0 50m
scale 1:1000 for A2 plot

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Figure 6: Areas 4-7, resistance survey

DW

DW

Track

Area 5

Area 7

Underheugh

Area 6

Area 4

CR

CR River Irthing

Shingle

Shingle

Hollows

662

661

660

616

617

618

619

620

621

resistance survey

high resistance anomaly

low resistance anomaly

0 50m

scale 1:1000 for A2 plot

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Figure 7: Areas 4-7, geophysical interpretation of resistance data

DW

DW

Track

Area 1

Area 2

Area 3

Area 4

Area 5

Area 6

Area 7

Underheugh

?palaeochannel

CR

River Irthing

CR

Shingle

Shingle

Hollows

662

661

660

616

617

618

619

620

621

magnetic survey

resistance survey

soil-filled feature

stone / rubble

former plough

former field boundary

wire fence

land drain

inspection cover

0 50m

scale 1:1000 for A2 plot

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Figure 8: Areas 1-7, archaeological interpretation

667

666

665

664

BM
133.74m

Pond

Foot Bridge

Harrow's Beck

Area 8

142.0m

Car Park

BM
148.87m

DITCH

MILECASTLE 49

Def

DW

DW

Harrow's Scar

VALLUM
(course of)

Chapel Field

Chapel Field

FB

616

617

618

619

620

621

magnetic survey

-6 nT 8

0 50m
scale 1:1000 for A2 plot

on behalf of

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Gilsland
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Figure 9: Area 8, geomagnetic survey

667

666

665

664

616

617

618

619

620

621

BM
133.74m

Pond

Foot Bridge

Harrow's Beck

Area 8

142.0m

Car Park

Track

DITCH

BM
148.87m

MILECASTLE 49

Def

DW

DW

Harrow's Scar

VALLUM
(course of)

Chapel Field

Chapel Field

FB

magnetic survey

dipolar magnetic anomaly

positive magnetic anomaly

negative magnetic anomaly

0 50m
scale 1:1000 for A2 plot

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Figure 10: Area 8, geophysical interpretation of geomagnetic data

667

666

665

664

BM
133.74m

Pond

Foot Bridge

Harrow's Beck

pond

Area 8

waterlogged

waterlogged

waterlogged

142.0m

Car Park

Track

DITCH

MILECASTLE 49

Def

BM
148.87m

Harrow's Scar

DW

DW

VALLUM
(course of)

Chapel Field

Chapel Field

FB

616

617

618

619

620

621

magnetic survey

soil-filled feature

disturbed area

former plough

possible oven / kiln

former field boundary

0 50m

scale 1:1000 for A2 plot

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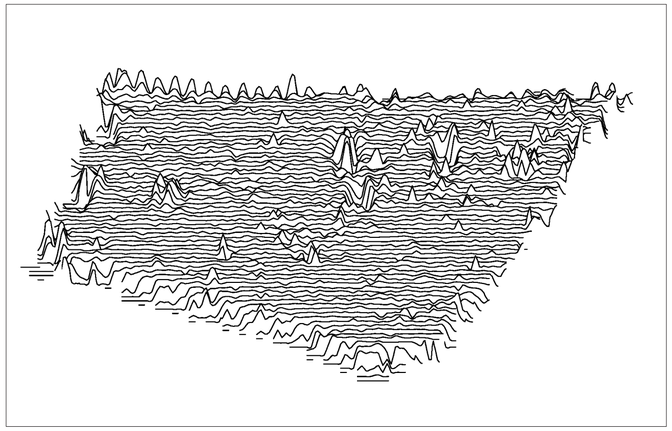
Figure 11: Area 8, archaeological interpretation

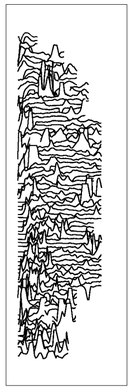
Area 1

47.40nT/cm



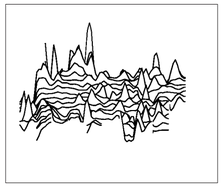
Area 2

61.10nT/cm



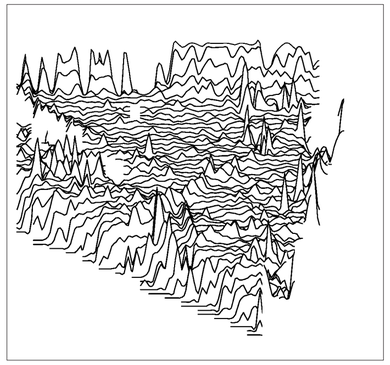
Area 3

29.20nT/cm



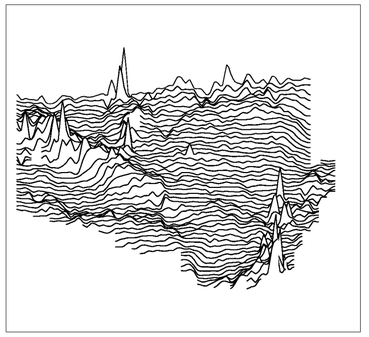
Area 7

21.20nT/cm



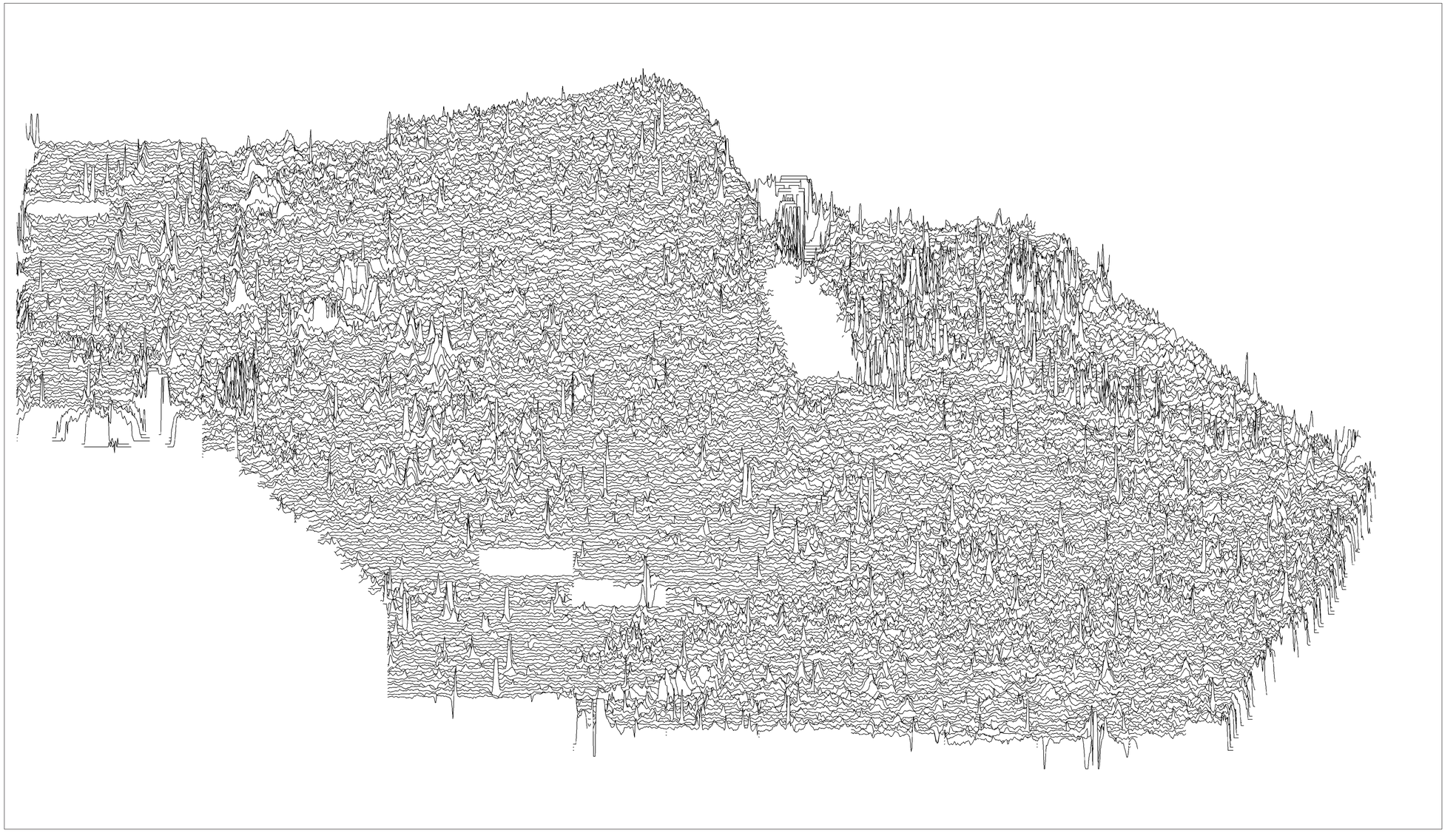
Area 7

86.80ohm/cm



Area 8

26.80nT/cm



0 50m

scale 1:1000 for A1 plot

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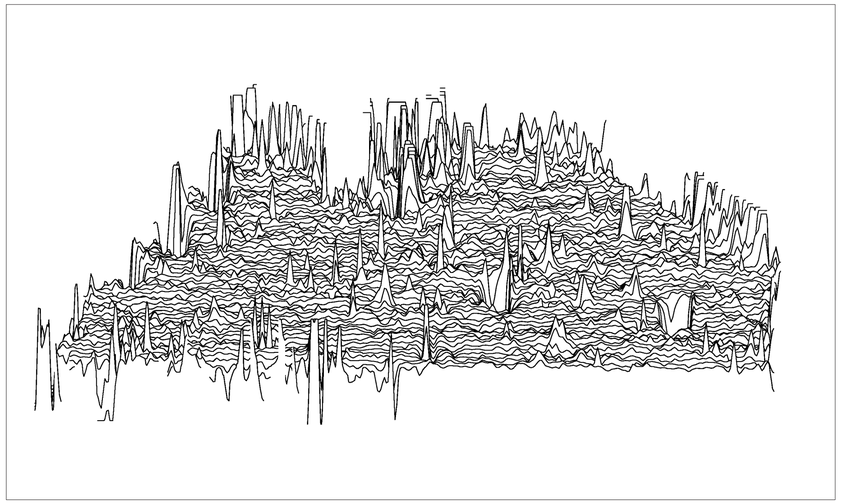
Figure 12: Trace plots of geomagnetic and resistance data

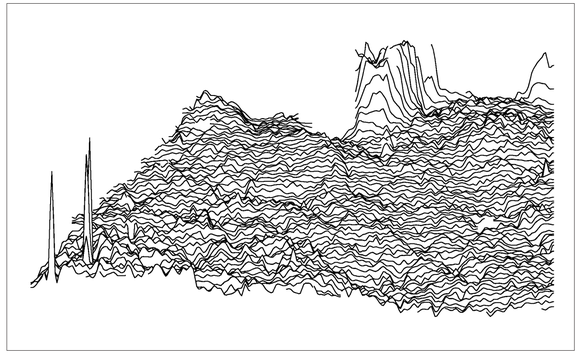
Area 4

8.70nT/cm



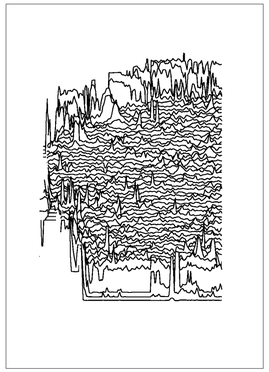
Area 4

62.60ohm/cm



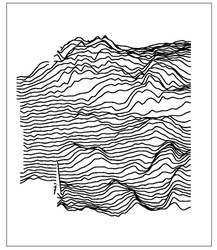
Area 5

27.70nT/cm



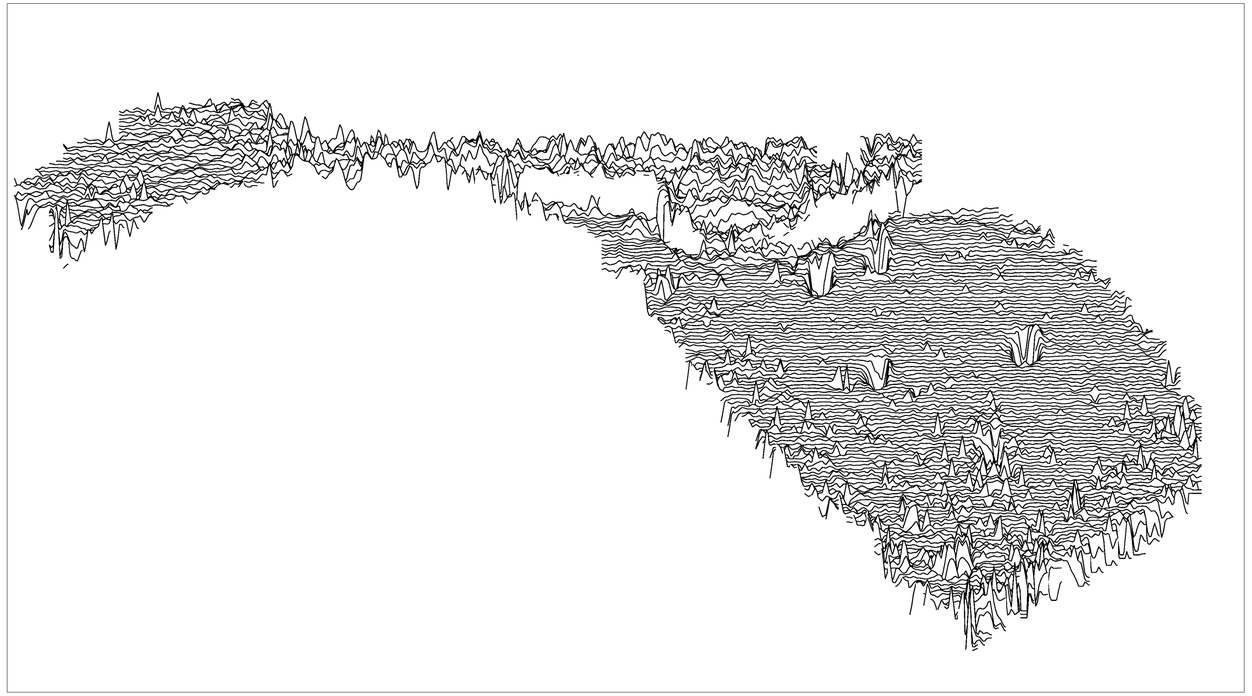
Area 5

172.40ohm/cm



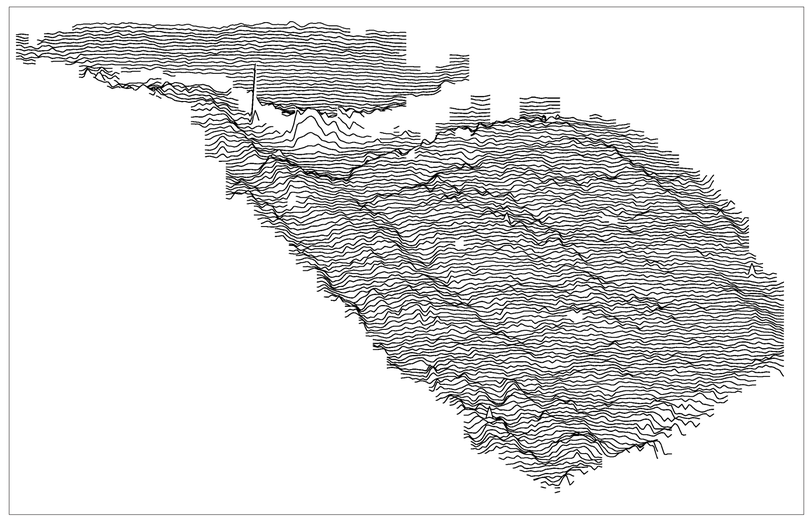
Area 6

28.40nT/cm



Area 6

108.30ohm/cm



0 50m

scale 1:1000 for A1 plot

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Figure 13: Trace plots of geomagnetic and resistance data