ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

on behalf of
Altogether Archaeology

NORTH PENNINES
Area of Outstanding Natural Beauty
GLOBAL GEOPARKS NETWORK

and
Stewart Ainsworth
University of Chester

Gilderdale Burn
Tynedale
Northumberland

geophysical survey

report 3499
August 2014

Durham University

Contents

Figures

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1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted as part of the North Pennines AONB Partnership's 'Altogether Archaeology' community project at Gilderdale Burn in Tynedale. The works comprised detailed geomagnetic and earth resistance surveys over a Romano-British settlement.

1.2 The works were commissioned by Durham County Council for the North Pennines AONB Partnership and conducted by Archaeological Services Durham University with volunteer assistance.

Results

1.3 Both techniques mapped broad anomalies in the northern field, which correspond to existing earthworks. There is generally a close correlation between the high resistance anomalies, the strong geomagnetic anomalies and the earthwork features previously surveyed by English Heritage.

1.4 In each case the anomalies almost certainly reflect stone, which has a magnetic component here, and which was used in wall-footings and the settlement's perimeter bank or wall. Many of the anomalies will reflect stone in the form of tumble and rubble, but it is likely that wall footings might be preserved underneath.

1.5 The geomagnetic survey to the south of the field wall has not identified similar concentrations or bands of anomalies there, which might have been associated with structures or other settlement features. One small rectilinear anomaly which could indicate a man-made feature has been detected just west of a former roundhouse visible on the ground.

1.6 It is likely that hearths, and possibly small industrial features, are present on the site and that they have been detected as geomagnetic anomalies. However, largely due to the nature of the stone here, there are many small anomalies which could be interpreted as hearths, and as such it has not been possible to identify specific anomalies amongst so many candidates.

2. Project background

Location (Figure 1)

2.1 The survey area covered the upstanding earthworks of a Romano-British settlement to the north of Gilderdale Burn and west of the River South Tyne in Tynedale, Northumberland (NGR centre: NZ 69795 48141). The Cumbrian town of Alston lies approximately 2.5km to the south-west. The survey area covered 1ha and spanned a field wall. Geomagnetic survey was undertaken over the whole 1ha study area while resistance survey targeted part of the settlement north of the existing field wall.

Objective

2.2 The principal objectives of these surveys were twofold:

- to provide an opportunity for student members of the North Pennines AONB 'Altogether Archaeology' project to receive survey training and to engage in local heritage research
- to determine the nature and extent of any sub-surface features of potential archaeological or historic significance through geophysical survey

Methods statement

2.3 The surveys have been undertaken in accordance with a methods statement prepared by Archaeological Services Durham University (ref DH 14.221), instructions from Paul Frodsham (North Pennines AONB) and Stewart Ainsworth (University of Chester), and national standards and guidance (see para. 5.1 below).

Dates

2.4 Fieldwork was undertaken on 3rd July 2014. This report was prepared for August 2014.

Personnel

2.5 Fieldwork was conducted by students Emily Brunell and Jess Woodley-Stewart, together with Paul Frodsham, Stewart Ainsworth and Duncan Hale (Archaeological Services Durham University); the latter also provided training and supervision. Geophysical data processing and report preparation was by Duncan Hale (the Project Manager for Archaeological Services) with illustrations by David Graham and Janine Watson (Archaeological Services).

Archive/OASIS

2.6 The site code is **TGB14**, for **T**ynedale **G**ilderdale **B**urn 20**14**. 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 **archaeol3-187634**.

Acknowledgements

2.7 Archaeological Services is grateful to the following for supporting and facilitating this survey: the landowners John and Elaine Edgar of Castle Nook Farm; Stewart Ainsworth and the English Heritage (EH) Archaeological Survey and Investigation team for the earthwork survey; Paul Frodsham of North Pennines AONB; and Durham County Council for administration.

3. Historical and archaeological background

3.1 The earthworks at Gilderdale are understood to be the remains of a Romano-British settlement and were initially recorded as part of the English Heritage Miner-Farmer Project. An oval enclosure with internal features, covering up to 0.5ha, is evident in LiDAR data analysed as part of that research. The earthworks were subsequently surveyed by the EH team and their plan has recently been enhanced by Stewart Ainsworth.

3.2 The earthworks are relatively subtle in the hay field north of the wall, but at least three roundhouses were identified during the earthwork survey. One roundhouse is particularly clear in the moorland area to the south.

3.3 The well-preserved and scheduled remains of Whitley Castle Roman fort (*Epiacum*) lie just 500m to the north-west. The fort's location was almost certainly chosen to enable control of the production and transportation of lead from the Alston ore-fields. The Maiden Way, a Roman military road, passes immediately west of the Gilderdale settlement and east of the fort. It is not only possible that the Gilderdale site may have been contemporary with the fort and Maiden Way, but it may even have housed some of the workers associated with the lead mining. Whitley Castle has been the subject of considerable research in recent years (Went & Ainsworth 2009, Archaeological Services 2009).

4. Landuse, topography and geology

4.1 The survey area was divided into two parts by a drystone field wall. The smaller southern part (Area 1) lay in moorland with reeds up to 1m in height, while the larger northern part (Area 2) lay within a hay field, soon to be harvested. Corrugated iron sheets were present next to the wall in the north-west of the survey area.

4.2 The site occupies the north-eastern end of a slight spur, overlooking the South Tyne valley, at elevations between approximately 290-300m OD.

4.3 The underlying solid geology of the area comprises north-east/south-west aligned bands of Alston Formation strata in the north-west and south-east (a Visean-Namurian succession of limestones, sandstones, mudstones, siltstones and occasional coals), which are separated by a narrow band of Visean limestone of the Five Yard Limestone Member across the central part of the site. These strata are overlain by boulder clay.

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 & Digital Antiquity *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2013).

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 work, it was anticipated that cut and built features such as ditches and wall footings would be present on the site, and that other types of feature such as pits, trackways and fired structures (for example kilns and hearths) might also be present.

5.4 Given the known shallowness of targets and the geological environment of the study area, both geomagnetic and electrical resistance survey techniques were considered appropriate. A geomagnetic technique, fluxgate gradiometry, 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 Earth electrical resistance survey can be particularly useful for mapping stone features. When a small electrical current is injected through the earth it encounters resistance, which can be measured. Since resistance is linked to soil moisture content and porosity, stone features will give relatively high resistance values while soil-filled features, which typically retain more moisture, will provide relatively low resistance values.

Field methods

5.6 A 20m grid was established across each field 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.

5.7 Measurements of vertical geomagnetic field gradient were determined using a Bartington Grad601-2 dual fluxgate gradiometer. 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 a Geoscan RM15D Advanced resistance meter and MPX15 multiplexer, 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 0.5m and the traverse interval was 1m, thus providing 800 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, unfiltered) data. The greyscale images and interpretations are presented in Figures 2-5; the trace plots are provided in Figure 6. 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
de-spike	locates and suppresses iron spikes in gradiometer data
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
de-spike	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.

5.14 In this instance all the recorded geomagnetic anomalies are either small strong positive magnetic anomalies or discrete dipolar magnetic anomalies. Positive magnetic anomalies typically reflect relative increases in high magnetic susceptibility materials, often sediments within cut archaeological features such as ditches and pits, however, in this instance, both the strong positive and dipolar magnetic anomalies correspond to the earthwork features previously surveyed, and reflect a magnetic component of the stone used here. This phenomenon has also been noted during previous geomagnetic surveys at nearby Whitley Castle and Gossipgate, where small strong geomagnetic anomalies were often densely concentrated and

corresponded to the remains of stone walls or rubble spreads (Archaeological Services 2009 & 2012).

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

high resistance	regions of anomalously high resistance, which may reflect wall footings, surfaces, tracks and other concentrations of stone rubble
low resistance	regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches

Interpretation: features

5.16 Colour-coded archaeological interpretation plans are provided.

5.17 The concentrations of small geomagnetic anomalies detected in Area 2 almost certainly reflect the remains of stone or earth-and-stone features. The variation within the concentrations may reflect the finer detail of former structures, but it is assumed that there will be a certain amount of tumble over *in situ* features and that much of the subtle geomagnetic variation will reflect this haphazard rubble material. The interpretation plots therefore show the broader areas of stone rather than over-interpreting small variations.

5.18 There are many discrete dipolar magnetic anomalies with a strong positive component to the south and a negative 'shadow' component to the north, any of which could reflect materials which were fired *in situ* or, similarly, could reflect individual pieces of ferrous debris or magnetised rock with a particular orientation. It has therefore not been possible to identify likely hearths amongst so many candidates.

5.19 The majority of discrete geomagnetic anomalies will almost certainly reflect individual stones or items of near-surface ferrous debris, such as horseshoes. In most cases these small, individual anomalies will have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation and the following discussion.

5.20 The resistance survey has also been very effective and recorded marked variation in resistance values, which almost certainly reflect the degree to which near-surface stone is present or absent. The bands of high resistance reflect concentrations of stone and correspond to the earthworks previously surveyed. As with the geomagnetic survey, some of the high resistance areas will almost certainly reflect tumble and rubble, though it is likely that wall footings may be preserved beneath.

5.21 There is generally a close correlation between the high resistance anomalies, the strong geomagnetic anomalies and the recorded earthworks.

5.22 Areas of low resistance in this survey probably do not reflect large soil-filled features, but could possibly reflect areas of hard earthen floors, which would impede drainage and give rise to relatively low resistance values.

5.23 The broad band of high resistance along the eastern edge of that survey corresponds to the curving outer bank or wall of the settlement. A possible break or void in the enclosure bank/wall is defined by a high resistance and strong geomagnetic arc, which surrounds a small low resistance area and corresponds to a small shallow depression on the ground.

5.24 The geomagnetic survey in the moorland to the south of the wall (Area 1) has not detected broad bands of stone, as detected to the north. Rather than concentrated bands of smaller anomalies, the area is characterised by fewer, more irregular anomalies. Although the remains of one roundhouse are clearly visible on the ground, next to the existing field wall, it is not clear in the geomagnetic data; some strong anomalies there broadly correspond to parts of the known roundhouse wall-footing, however, the roundhouse would not have been identified solely on the basis of the geomagnetic data.

5.25 Three sides of a small rectilinear anomaly have been detected just west of the roundhouse. It is probable that the anomalies do reflect stone, and possible that they form a deliberate structure. The remainder of the anomalies in this area do not form recognisable patterns or structures.

6. Conclusions

6.1 Geomagnetic and earth resistance surveys were undertaken at a Romano-British settlement at Gilderdale Burn in Tynedale as part of the North Pennines AONB Altogether Archaeology project.

6.2 Both techniques mapped broad anomalies in the northern field, which correspond to existing earthworks. There is generally a close correlation between the high resistance anomalies, the strong geomagnetic anomalies and the earthwork features previously surveyed by English Heritage.

6.3 In each case the anomalies almost certainly reflect stone, which has a magnetic component here, and which was used in wall-footings and the settlement's perimeter bank or wall. Many of the anomalies will reflect stone in the form of tumble and rubble, but it is likely that wall footings might be preserved underneath.

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6.5 It is likely that hearths, and possibly small industrial features, are present on the site and that they have been detected as geomagnetic anomalies. However, largely due to the nature of the stone here, there are many small anomalies which could be interpreted as hearths, and it has not been possible to identify specific anomalies amongst so many candidates.

7. Sources

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on behalf of
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and
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Gilderdale Burn
Tynedale
Northumberland

geophysical survey

Figure 1: Site location

site location

0 1km
scale 1:25 000 for A4 plot

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A. Geomagnetic survey

magnetic survey

-3 nT 4

B. Geophysical interpretation

dipolar magnetic anomaly

location of resistance survey

0 50m
scale 1:1000 for A3 plot

Gilderdale Burn
Tynedale
Northumberland

geophysical survey

Figure 2: Geomagnetic survey and geophysical interpretation

A

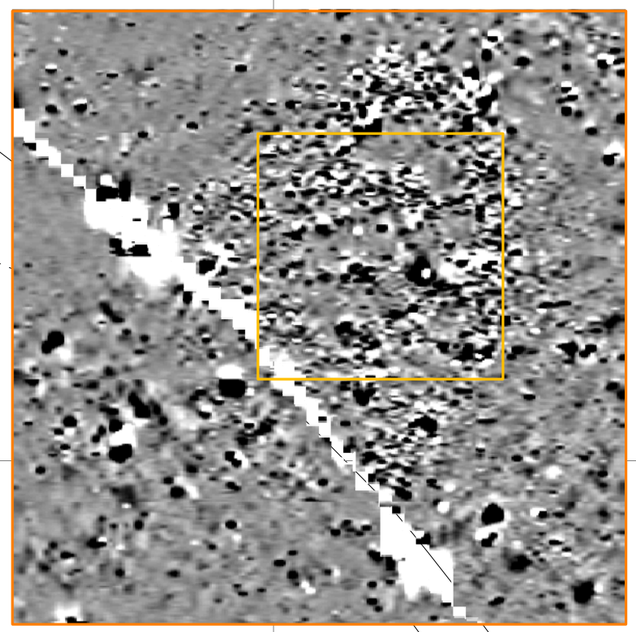
B

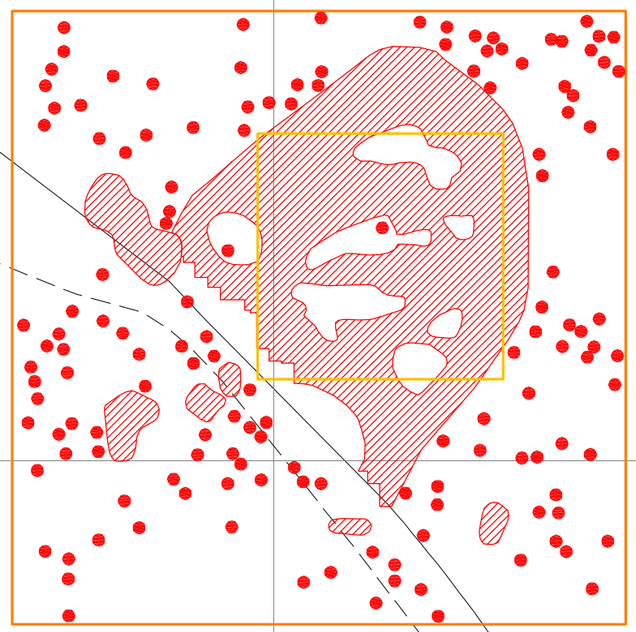
482

481

698

Path





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A. Geomagnetic survey

magnetic survey

-3 nT 4

earthworks survey

B. Archaeoloical interpretation

probable stone

location of resistance survey

0 50m
scale 1:1000 for A3 plot

Gilderdale Burn
Tynedale
Northumberland

geophysical survey

Figure 3: Geomagnetic survey (with earthworks survey overlain) and archaeological interpretation

A

B

482

481

698

Path

corrugated iron sheets

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A. Resistance survey

resistance survey

80 ohm 190

B. Geophysical interpretation

high resistance anomaly

low resistance anomaly

location of magnetic survey

0 50m
scale 1:1000 for A3 plot

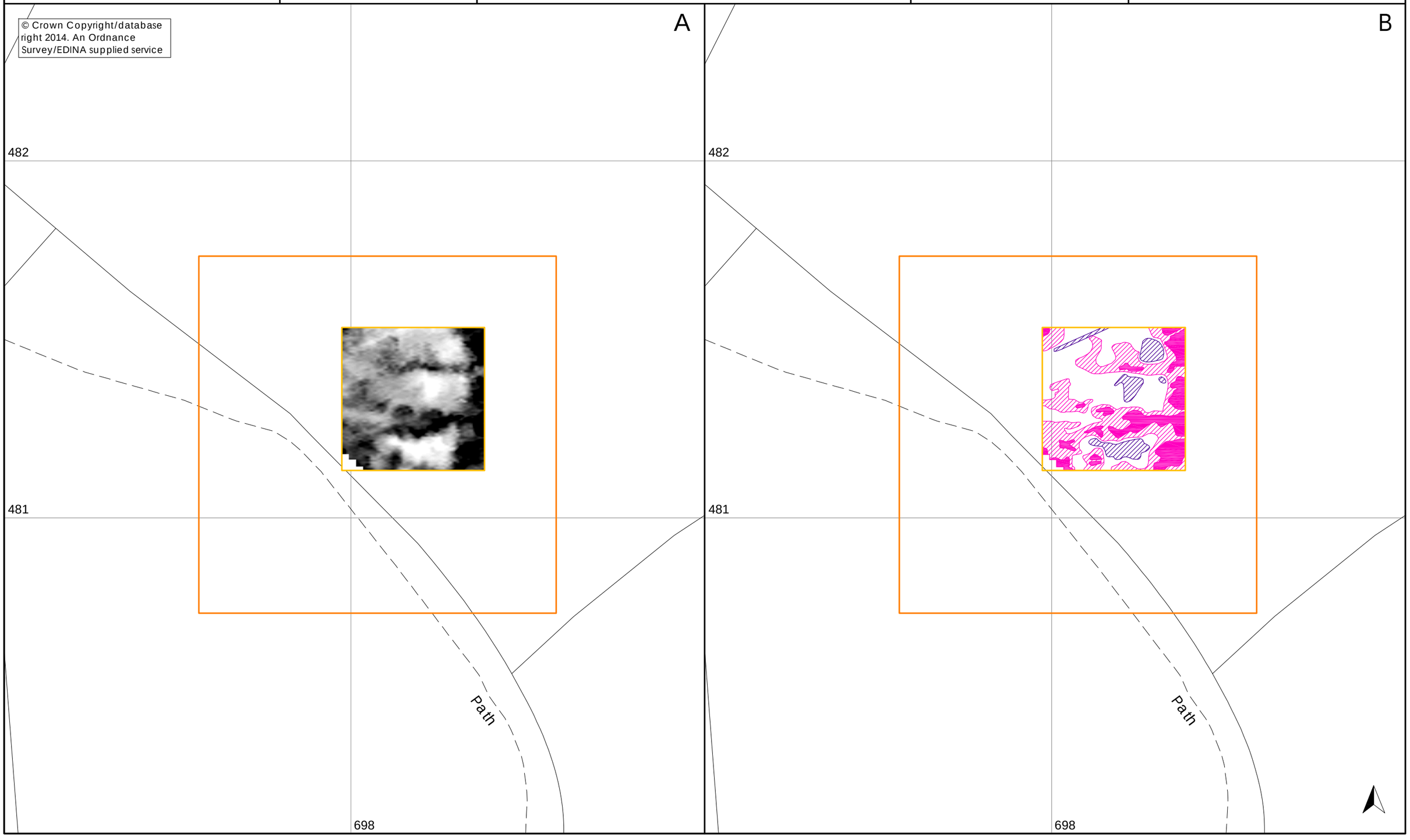
Gilderdale Burn
Tynedale
Northumberland

geophysical survey

Figure 4: Resistance survey and geophysical interpretation

A

B



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and
Stewart Ainsworth

A. Resistance survey

resistance survey

80 ohm 190

earthworks survey

B. Archaeological interpretation

probable stone

location of magnetic survey

0 50m
scale 1:1000 for A3 plot

Gilderdale Burn
Tynedale
Northumberland

geophysical survey

Figure 5: Resistance survey (with earthworks survey overlain) and archaeological interpretation

A

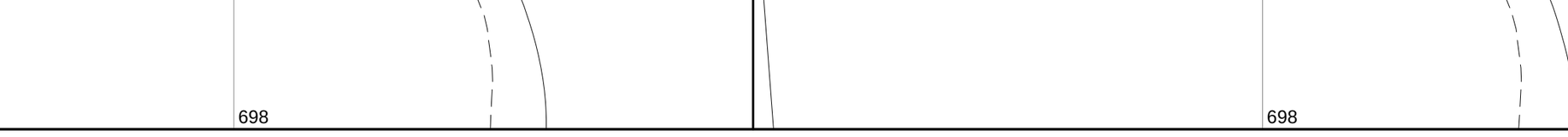
B

482

481

698

Path



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0 25m
scale 1:500 for A3 plot

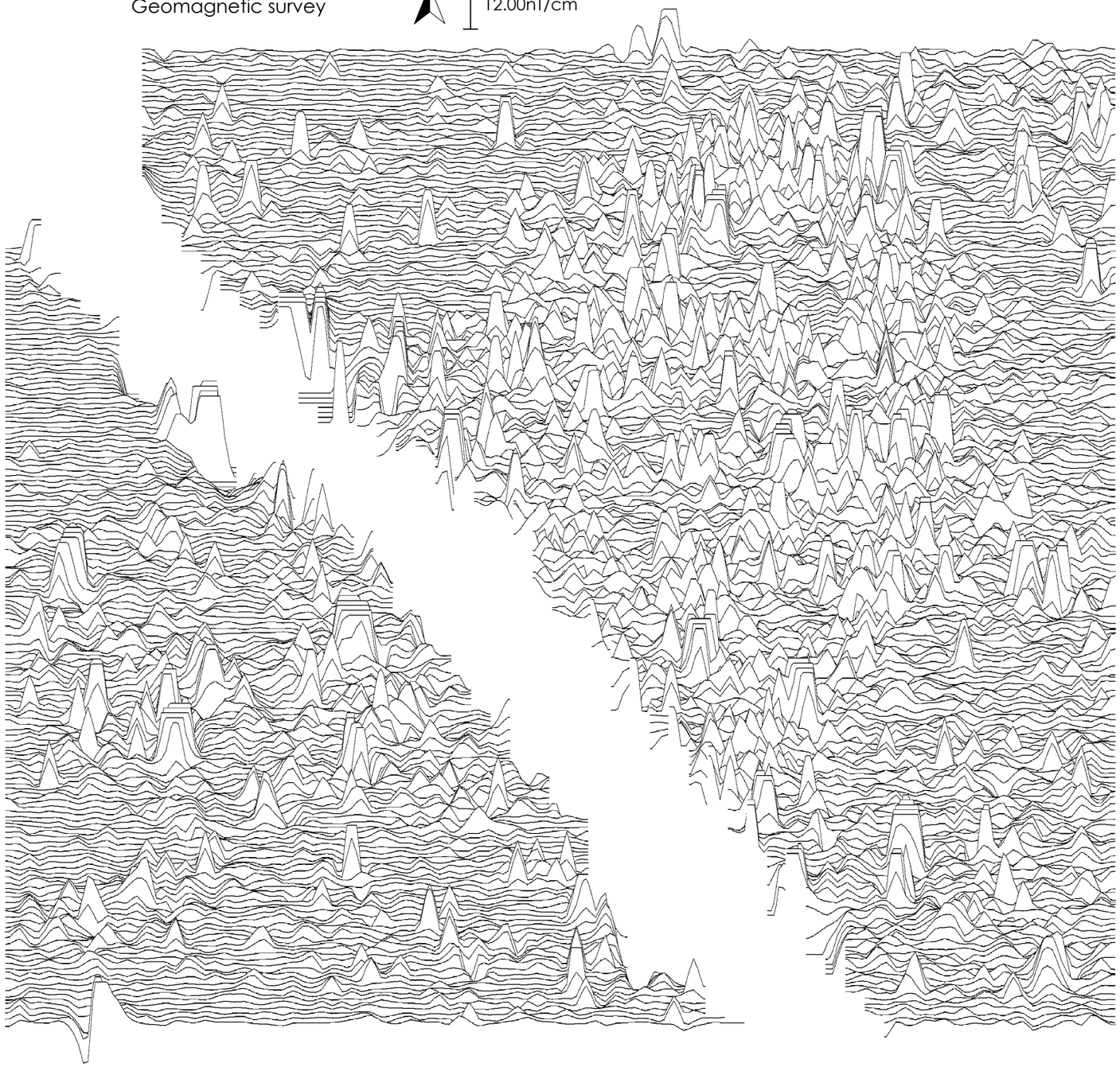
Gilderdale Burn
Tynedale
Northumberland

geophysical survey

Figure 6: Trace plots of geophysical data

Geomagnetic survey

12.00nT/cm



Resistance survey

231.30ohm/cm