ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

on behalf of

Altogether Archaeology

NORTH PENNINES
Area of Outstanding Natural Beauty

GLOBAL GEOPARKS NETWORK

and

Andrew Fitzpatrick
University of Leicester

Kirkhaugh cairn
Tynedale
Northumberland

geophysical survey

report 3500
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Durham University

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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 Kirkhaugh in Tynedale. The works comprised detailed geomagnetic and earth resistance surveys over a Bell beaker barrow prior to renewed excavation; the site had been partially excavated in 1935.

1.2 The surveys 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 recorded an oval feature around the cairn near the northern end of the promontory. Based on the geophysical evidence this was thought to be a ring-ditch associated with the cairn. On excavation of a sondage to the south of the cairn, however, this was found to be a natural soil-filled feature.

1.4 Other geophysical anomalies almost certainly reflect former ridge and furrow cultivation and a headland, variation in the rockhead topography and more recent activity.

2. Project background

Introduction

2.1 Herbert Maryon partially excavated two stone cairns at Kirkhaugh in 1935. The cairns covered Bell Beaker graves, and the recognition of metalworking tools in the assemblage from the northern grave 'Cairn 1' has afforded particular significance to that burial and prompted new research at the site. The burial has parallels with the Amesbury Archer, a very early metalworker buried near Stonehenge, excavated by Andrew Fitzpatrick in 2002 (Fitzpatrick 2009). It seems likely that the grave at Kirkhaugh could be that of another early metalworker and ore prospector.

2.2 The results of a recent earthwork survey, this geophysical survey and subsequent excavation are being prepared for publication in *Archaeologia Aeliana*.

Location (Figure 1)

2.3 The geophysical survey covered a small promontory above the River South Tyne, near Kirkside Wood, Tynedale, Northumberland (NGR centre: NY 70547 49298), approximately 3km north-north-west of the Cumbrian town of Alston. Cairn 1, the northern Bell Beaker barrow and the principal target of this survey, is located near the northern end of the promontory.

2.4 Geomagnetic survey was undertaken over the whole promontory, approximately 0.6ha, while resistance survey targeted the mound and its immediate environs.

Objective

2.5 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; in this instance such features might include, for example, ring-ditches, graves and early excavation trenches

Methods statement

2.6 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 Andrew Fitzpatrick (University of Leicester), and national standards and guidance (see para. 5.1 below).

Dates

2.7 Fieldwork was undertaken on 2nd July 2014. This report was prepared for October 2014.

Personnel

2.8 Fieldwork was conducted by students Emily Brunell and Jess Woodley-Stewart, with Paul Frodsham (North Pennines AONB) 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

2.9 The site code is **TKH14**, for **T**ynedale **K**irk**H**augh 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 **archaeol3-194052**.

Acknowledgements

2.10 Archaeological Services is grateful to the landowners, North Pennines AONB, English Heritage and Durham County Council for supporting this research.

3. Historical and archaeological background

3.1 The archaeological background to the site, and the renewed research interest in the site, is described in the *Archaeologia Aeliana* paper (Fitzpatrick forthcoming).

3.2 In summary, the 1935 excavation of this cairn (and another nearby cairn) was published in 1936 (Maryon 1936). The cairn was thought not to have been disturbed previously, though no trace of a grave, nor any fragments of bone, were found. A concentration of artefacts was recovered from an area in the centre of the cairn, including an All-Over-Cord decorated Bell Beaker. This variety of Bell Beaker is one of, if not the, earliest type of beaker found Britain and it is likely to date between 2400-2200 BC, much earlier than the late or middle-late Bronze Age date initially ascribed to the vessel, as it was originally identified as a Food Vessel (Fitzpatrick forthcoming). The identification of the vessel as a Bell Beaker also changes the cultural context of the find, from Late Bronze Age to the late Neolithic/Early Bronze Age, or the Copper Age (*ibi*d.). Other finds included a gold hair braid, flint tools, flakes and cores, a 'cushion stone' (metalworking anvil) and a probable hammer stone.

3.3 The only other example of stone tools for metalworking from a Bell Beaker grave in Britain is from the burial of the Amesbury Archer at Boscombe Down, Wiltshire (*ibi*d.).

3.4 It has been suggested that the Kirkhaugh barrow may originally have comprised a small earthen mound over the grave, within which may have been a wooden coffin or chamber, with the stone cairn being a later addition (Fitzpatrick pers. comm.). If this is the case, Fitzpatrick has also suggested that an early ring-ditch, if there was one, would probably have been overlain by the later, more extensive cairn.

4. Site, landuse, topography and geology

4.1 The geophysical survey covered a small promontory within a field of pasture and was bounded on its west by a drystone wall and on its east by a small dry valley.

4.2 Cairn 1 is sited near the northern end of the promontory. It is oval, aligned north-west/south-east, and measures approximately 11m along its longer axis. The cairn sits on top of a natural low knoll in the limestone rockhead at an elevation of about 334m OD.

Cairn 1 on promontory in foreground; Whitley Castle Roman fort and Castle Nook behind

Cairn 1 on narrow promontory, looking south-west

4.3 Analysis of the landscape setting and detailed earthwork survey of this and other nearby cairns has been undertaken (Oswald & Went 2014). The locally distinctive promontory sits above the River South Tyne and was formed by the incursion of a small dry valley into a limestone bench nearly half way up the eastern side of the valley. The bench has a steep south-west-facing escarpment, and, although it affords extensive views up and down the valley, it is unlikely that the cairns themselves would have been visible from the lower slopes or valley floor, except perhaps from a considerable distance to the north-west. Oswald & Went have suggested that this could indicate that the principal contemporary route into the orefield was from the north, with Cairn 1 sitting in a deliberate, conspicuous clearing.

4.4 The topsoil in the area around the cairn is thin, measuring between 10-20cm in depth, and directly overlies the bedrock.

4.5 The bench on which the cairn sits is a layer of Namurian limestone known as the Great Limestone Member. Further layers of mudstone, siltstone, limestone and sandstone of the Alston and Stainmore Formations form a series of additional benches on the valley side.

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 investigations, it was anticipated that cut features such as ditches, graves or pits might be present on the site and that other types of feature such as trackways, voids or 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 the types of archaeological features mentioned above.

5.5 Earth electrical resistance survey can be particularly useful for mapping the contrast between, for example, earth and 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 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 the promontory 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. The grid incorporated two survey markers previously established by English Heritage.

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 2-9; the trace plots are provided in Figures 10-11. 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-stagger	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
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 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 can 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 horeseshoes and service pipes) and/or fired structures such as kilns or hearths

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

high resistance	regions of anomalously high resistance, which may reflect cairn material, bedrock, 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 Except where stated otherwise in the text below, positive magnetic anomalies are taken to reflect relatively high magnetic susceptibility materials, often sediments in cut archaeological features (such as ditches or pits) whose magnetic susceptibility has been enhanced by decomposed organic matter or by burning. Increased depths of topsoil, often due to ploughing, can also give rise to these anomalies.

5.18 The most prominent geomagnetic anomalies detected here comprised slightly curving positive and negative magnetic anomalies, broadly aligned north-west/south-east, which almost certainly reflect former ridge and furrow cultivation, as also recorded in the earthwork survey (Oswald & Went 2014). A well-defined negative magnetic anomaly detected along the north-eastern edge of the survey almost certainly marked the edge of the formerly ploughed area there, above the steep drop into the dry valley. Anomalies associated with former ploughing were not detected near the tip of the promontory. All these anomalies, except one anomaly along either edge of the promontory, appeared to stop at a discontinuous positive magnetic anomaly, which was detected across the south-eastern part of the cairn, perpendicular to the ploughing. This anomaly probably reflected the remains of a headland, and broadly corresponded to the earthwork feature recorded here.

5.19 A very weak curvilinear magnetic anomaly was detected near the northern end of the promontory. The anomaly was distinctly oval in shape with its longer axis aligned with the promontory; the maximum dimensions of the anomaly were approximately 28m north-west/south-east and 23m north-east/south-west. Although the anomaly did not form a continuous circuit, there was sufficient to suggest that it reflected an oval or ‘ring’ ditch, which fitted the promontory with up to 5m to spare on either side. Arcs of low resistance, also taken to reflect soil-filled features, were also detected, corresponding to the locations of the positive magnetic anomalies. The remains of the cairn were located within this apparent ditch.

Rockhead in sondage to south side of cairn

5.20 On excavation, the anomaly corresponded to a soil-filled feature which was determined to be of natural origin; no anthropogenic indicators or stratigraphy was noted within the feature. A similar sondage was excavated on the north side of the cairn but no features were identified there (Fitzpatrick forthcoming).

5.21 Many very small linear and curvilinear magnetic anomalies were detected throughout the survey, typically only 5m or less in extent. Given their limited extents and the shallow depth of the bedrock, it seems unlikely that these anomalies reflect rock-cut soil-filled archaeological features. It is more likely that they reflect natural fissures and other variation in the topography of the limestone rockhead. Some of these anomalies are shown on the geophysical interpretation plan but have been omitted from the archaeological interpretation plan.

5.22 Two parallel, curvilinear, weak positive magnetic anomalies were detected in the south-east corner of the survey. It is possible that these could reflect soil-filled gullies, although the distance between the anomalies is broadly equivalent to the track of a farm vehicle and it is perhaps more likely that these reflect relatively recent wheel ruts, though none was noted in the field.

5.23 The resistance survey recorded marked variation in resistance values, which almost certainly reflect the degree to which near-surface stone is present or absent. Two areas of high resistance reflect concentrations of stone and/or bedrock close to the surface, one at the top of the western edge to the dry valley, and the other forming a broad band near the top of the escarpment to the west.

5.24 Other resistance anomalies comprised straight lines of low resistance, which are taken to reflect soil-filled features. These features are parallel to the north-south band of high resistance and probably reflect natural fissures in the rockhead rather than land drains or plough scars; the plough direction is aligned more north-west/south-east.

5.25 A low concentration of small, discrete dipolar magnetic anomalies was detected across the 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 plan, however, they have been omitted from the archaeological interpretation plan.

6. Conclusions

6.1 Geomagnetic and earth resistance surveys were undertaken over and around a Bell Beaker barrow at Kirkhaugh in Tynedale as part of the North Pennines AONB Altogether Archaeology project.

6.2 Both techniques recorded an oval feature around the cairn near the northern end of the promontory. Based on the geophysical evidence this was thought to be a ring-ditch associated with the cairn. On excavation of a sondage to the south of the cairn, however, this was found to be a natural soil-filled feature.

6.3 Other geophysical anomalies almost certainly reflect former ridge and furrow cultivation and a headland, variation in the rockhead topography and more recent activity.

7. Sources

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

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Oswald, A, & Went, D, 2014 *Analysis of the landscape setting of the barrows and detailed earthwork survey*. Unpublished report for the Kirkhaugh cairn 'Altogether Archaeology' project, NP AONB

Schmidt, A, 2013 *Geophysical Data in Archaeology: A Guide to Good Practice*. Archaeology Data Service & Digital Antiquity, Oxbow

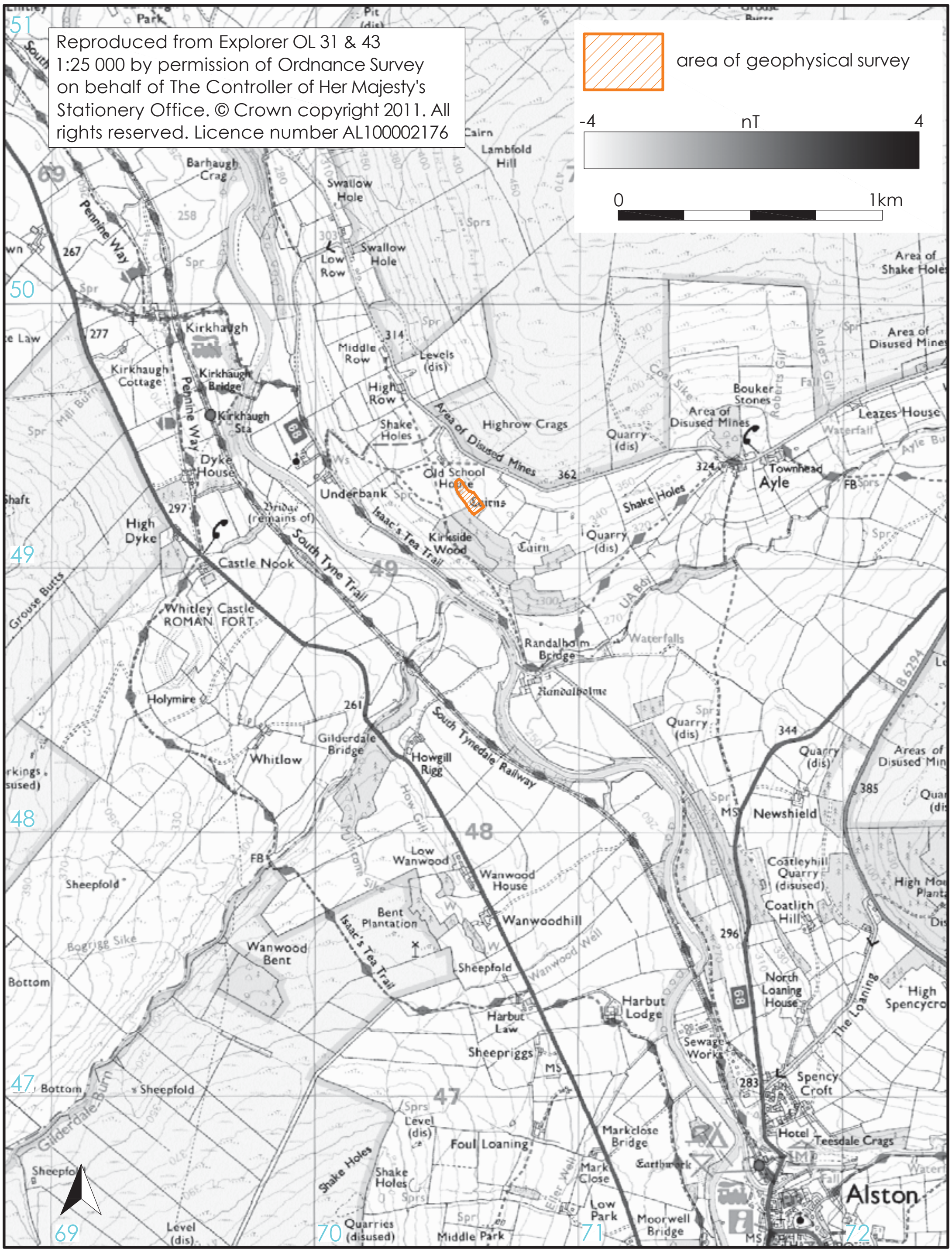

Figure 1: Site location

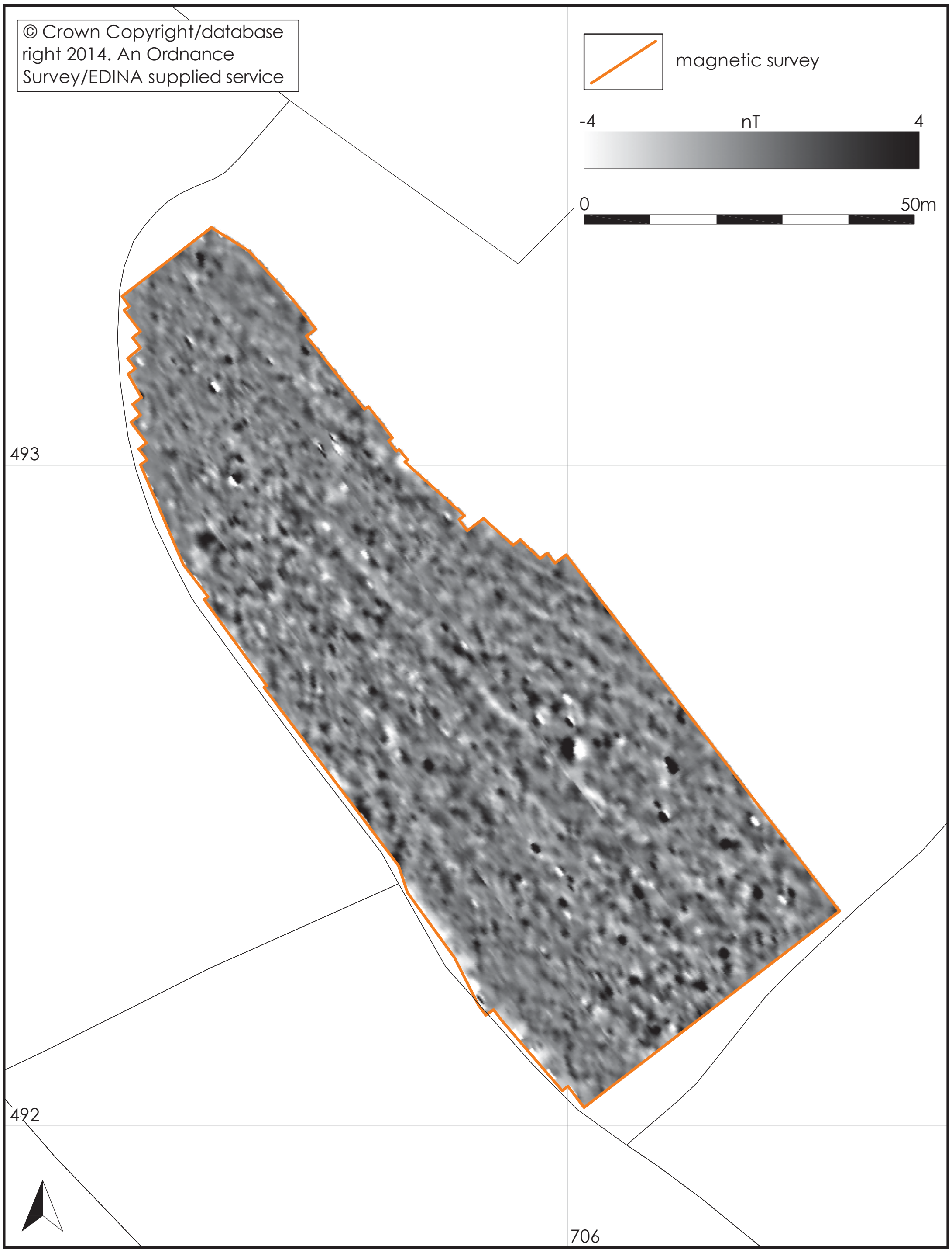

Figure 2: Geomagnetic survey

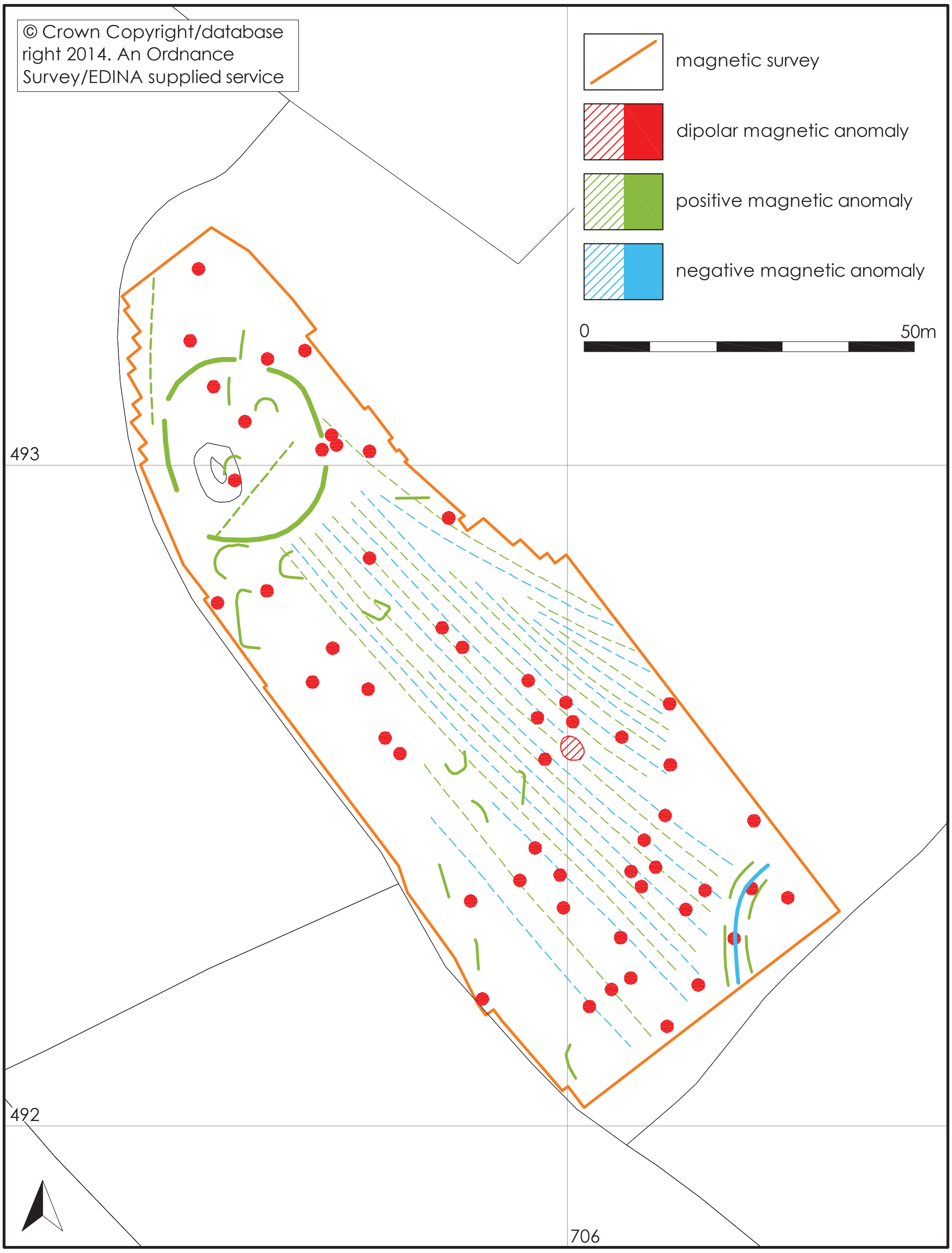

Figure 3: Geophysical interpretation of geomagnetic survey

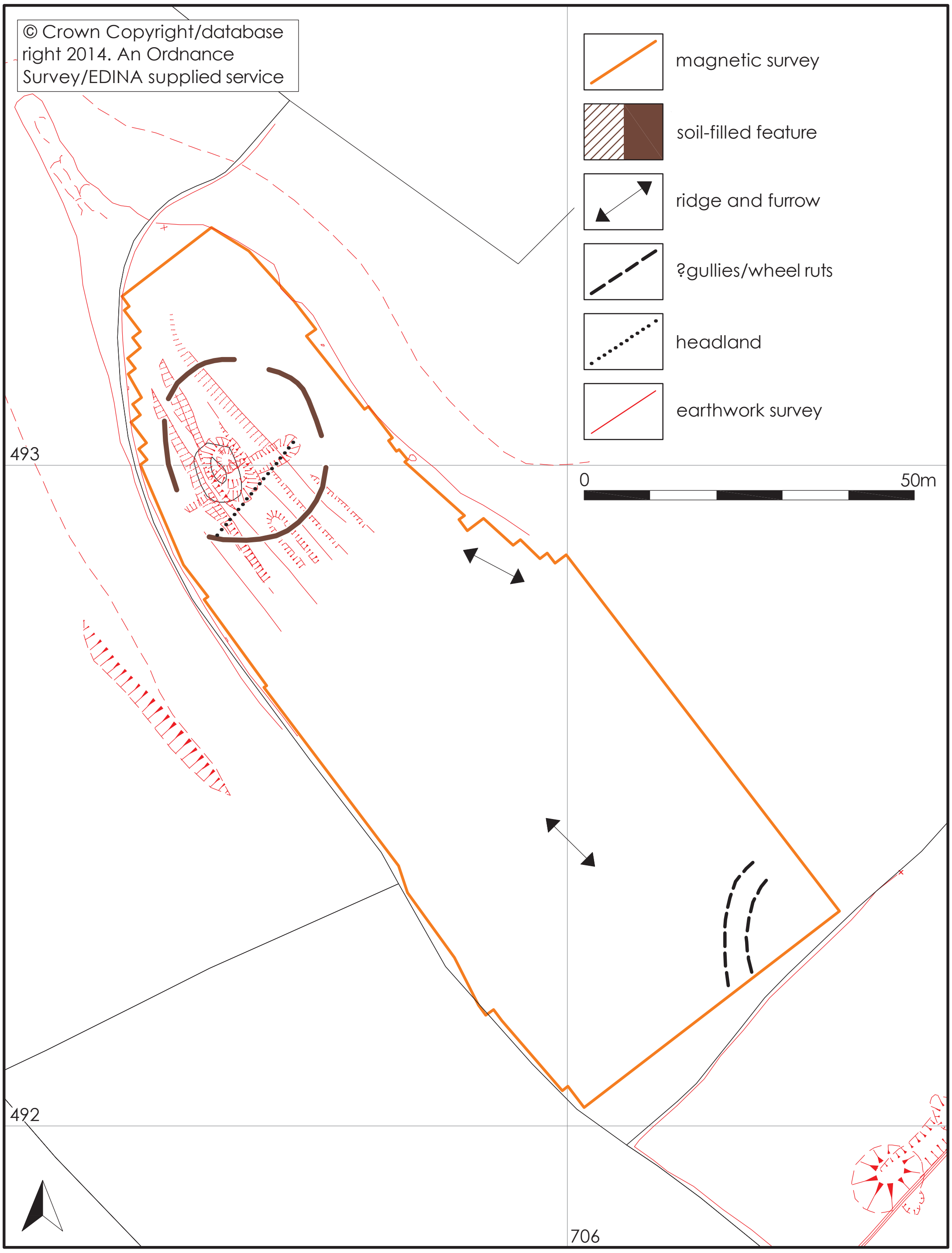

Figure 4: Archaeological interpretation of geomagnetic survey, with earthwork survey

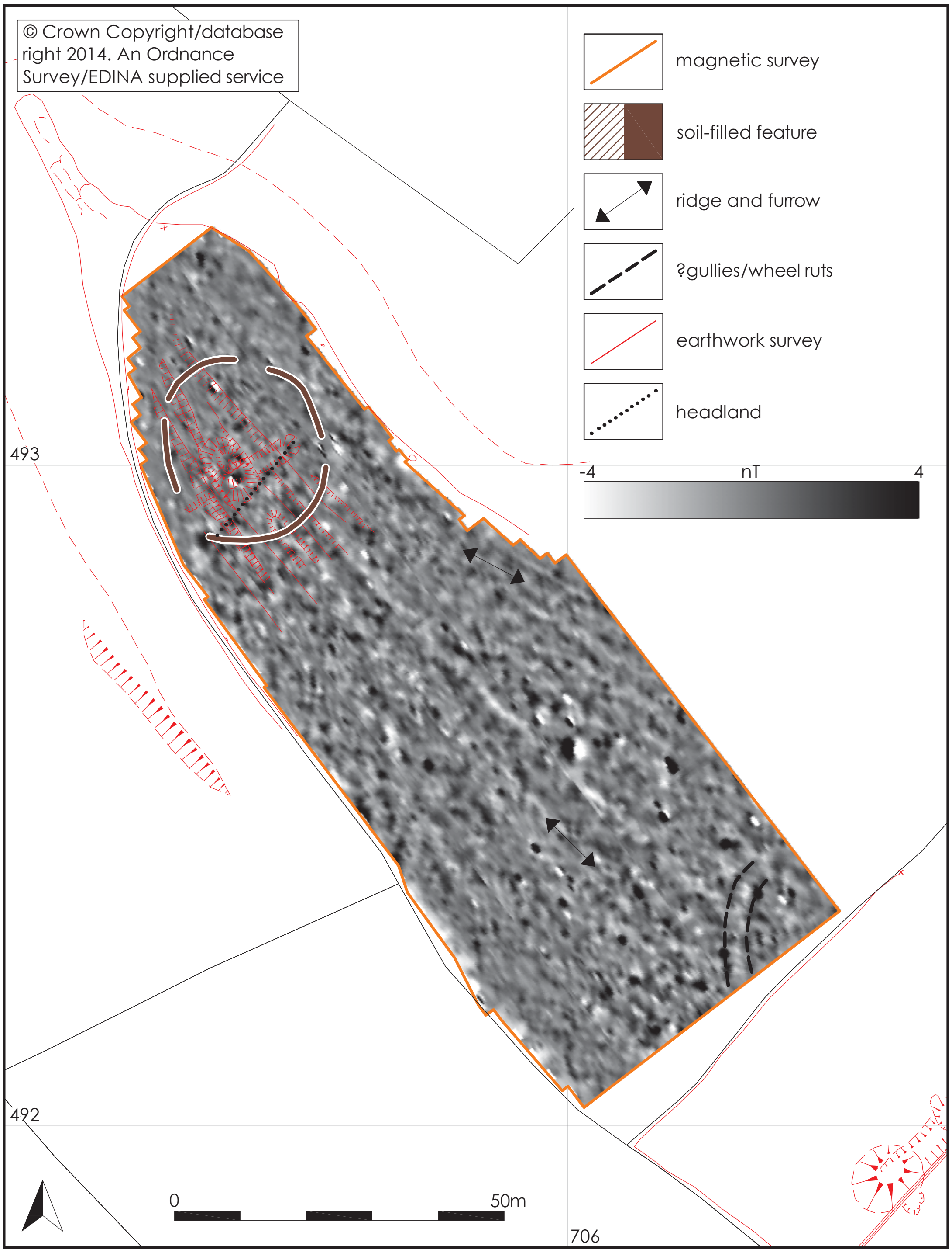

Figure 5: Geomagnetic survey with interpretation and earthwork survey

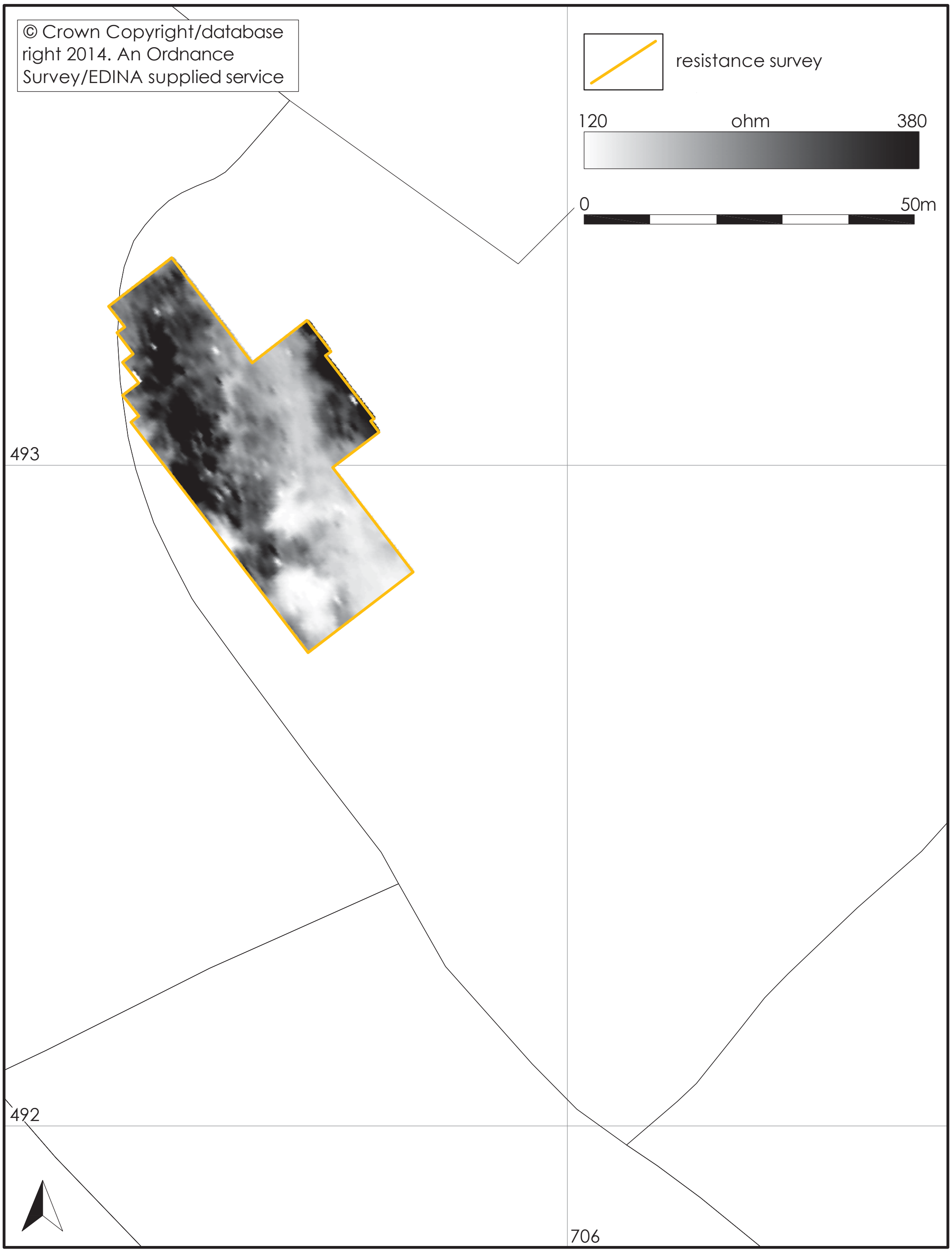

Figure 6: Resistance survey

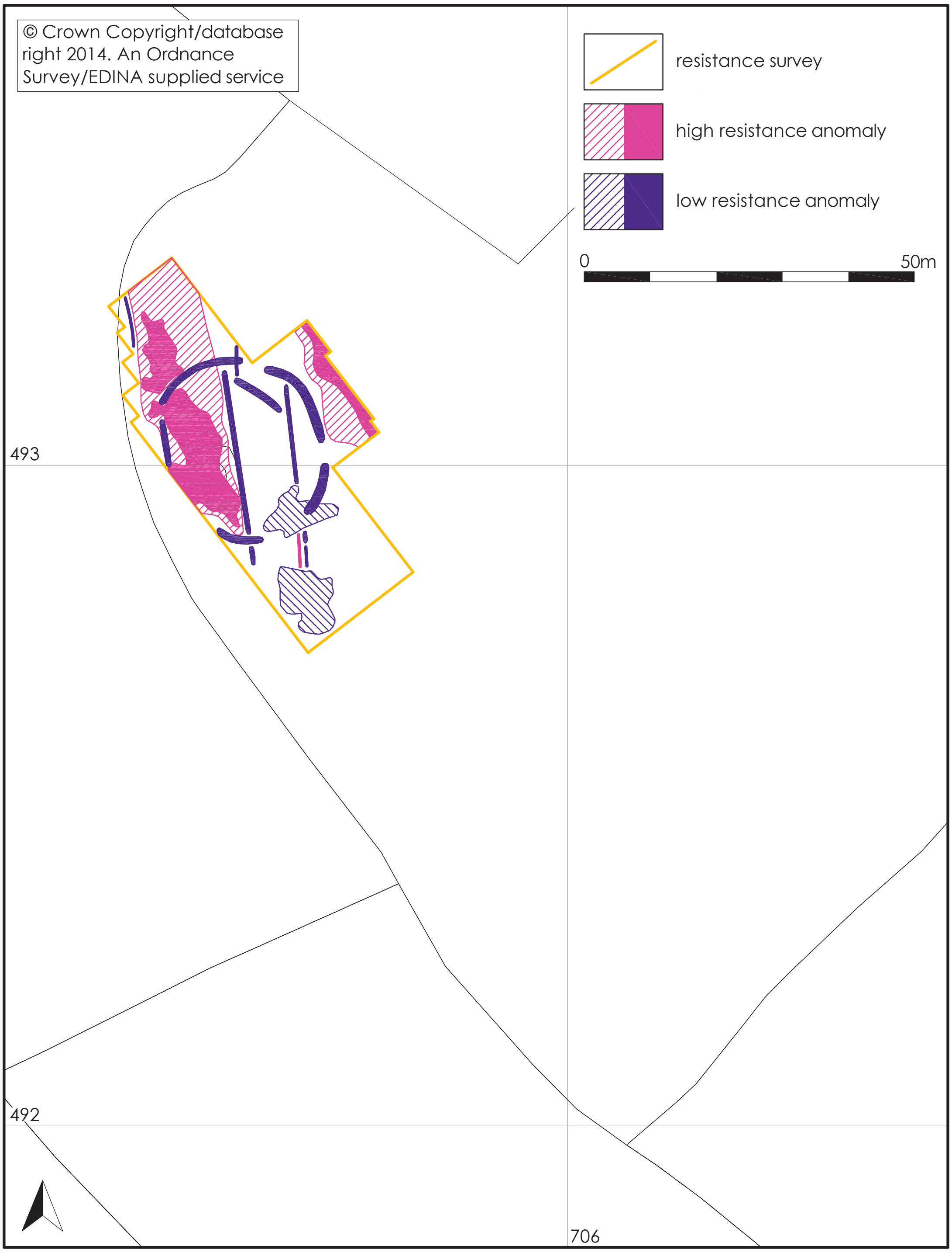

Figure 7: Geophysical interpretation of resistance survey

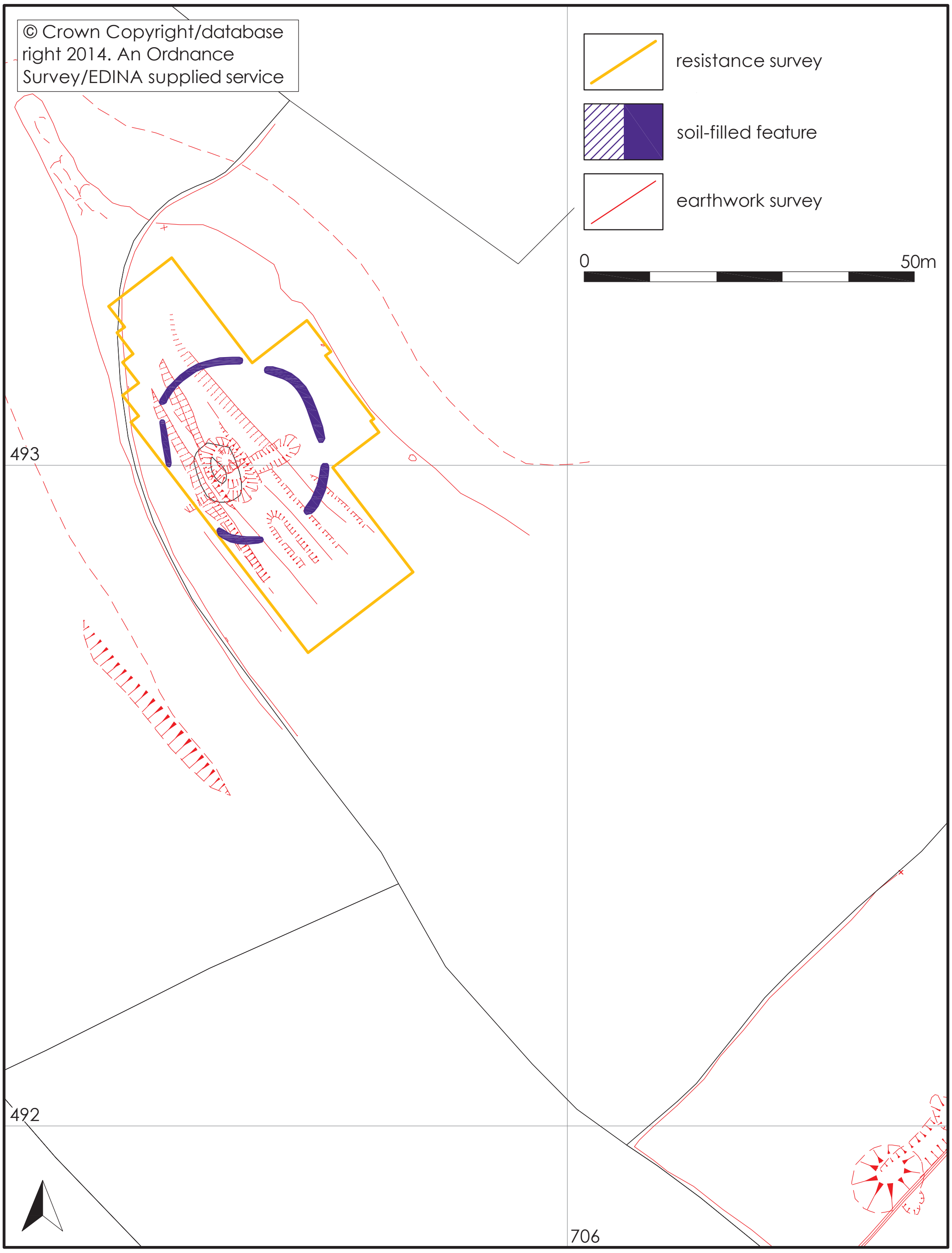

Figure 8: Archaeological interpretation of resistance survey, with earthwork survey

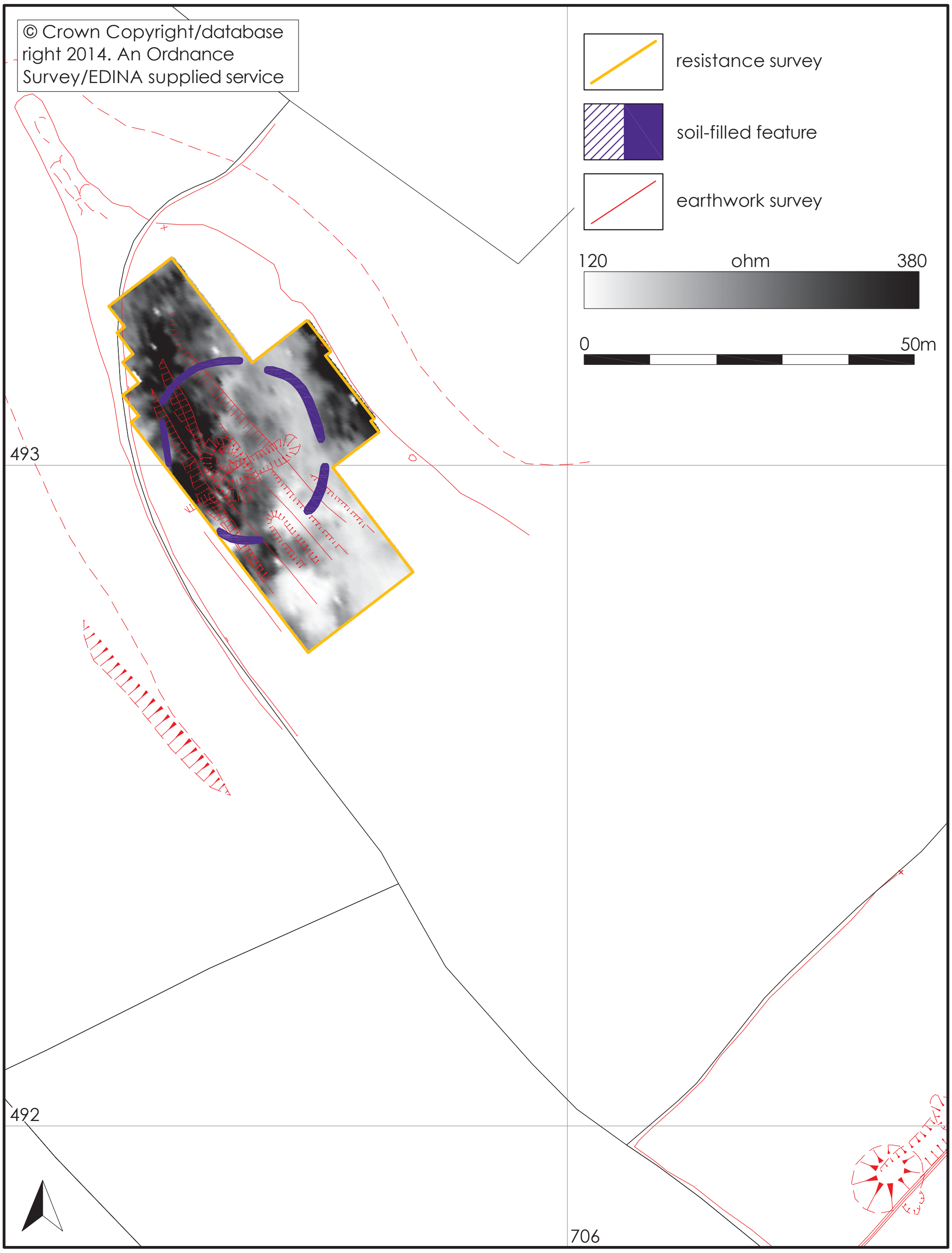

Figure 9: Resistance survey with interpretation and earthwork survey

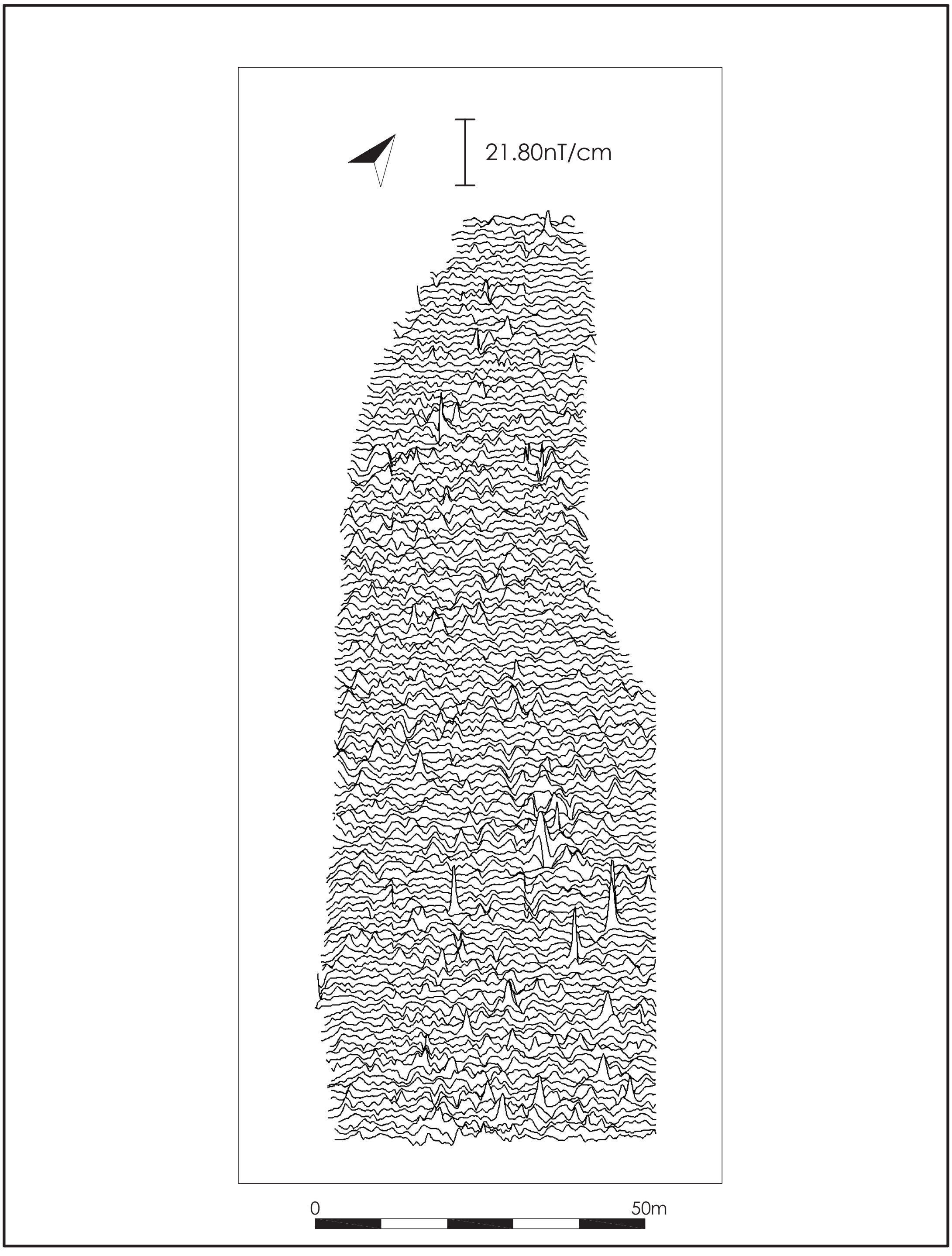

Figure 10: Trace plot of geomagnetic data

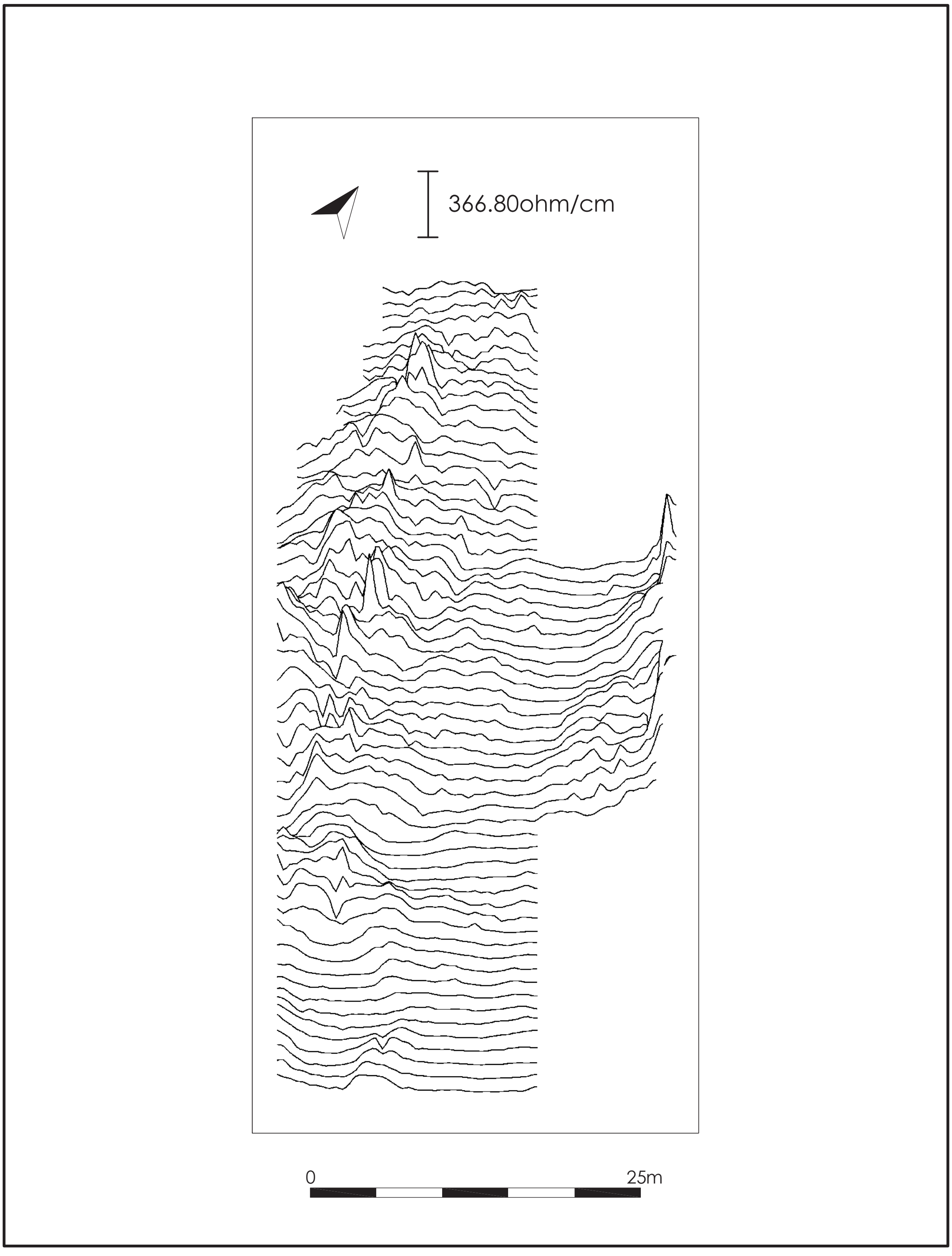

Figure 11: Trace plot of resistance data