ARCHAEOLOGICAL
SERVICES
DURHAM UNIVERSITY

on behalf of

Headlands to Headspace
Morecambe Bay Partnership

Jenny Brown's Point
Silverdale
Lancashire

geophysical surveys

report 4215
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Durham
University

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1. Summary

The project

1.1 This report presents the results of geophysical surveys at Jenny Brown's Point, near Silverdale in Lancashire, conducted as part of Morecambe Bay Partnership's Headlands to Headspace Landscape Partnership Scheme. The works comprised undertaking archaeological geophysical surveys as a community-based participation and training project. Geomagnetic, earth electrical resistance and ground-penetrating radar techniques were used.

1.2 The works were commissioned by Cumbria County Council, on behalf of Morecambe Bay Partnership, and conducted by Archaeological Services Durham University.

Results

1.3 In the pasture field above the chimney, both the geomagnetic and electrical resistance techniques have effectively mapped the extent of the near-surface limestone bedrock. The limestone in the Morecambe Bay area contains significant quantities of iron ore (haematite), and this was mined on a relatively small scale in the Silverdale area during the 18th and 19th centuries, to the immediate north of the site at Heald Brow and to the north-west at Lindeth. It is possible that the chimney and a small disturbed area in the west of Area 1 could be associated with the exploitation of either haematite or copper carbonate ores.

1.4 Geomagnetic survey on the foreshore detected high concentrations of very strong anomalies, which almost certainly reflect ferrous and fired debris, intense burning and iron ore; it has not been possible to identify specific features within those data. GPR surveys here have however indicated the probable continuations of wall footings, aligned with those evident on the ground.

2. Project background

Introduction

2.1 These archaeological geophysical surveys have been undertaken as a community-based participation and training project, as part of Morecambe Bay Partnership's (MBP) Headland to Headspace Landscape Partnership Scheme, funded by the Heritage Lottery Fund. The project at Jenny Brown's Point supports the delivery of Headlands to Headspace (H2H) Project 1 (Built Heritage and Lookouts) and Project 17 (Community Archaeology).

The chimney at Jenny Brown's Point

2.2 Project 1 (Built Heritage and Lookouts) includes the development and implementation of conservation management plans to secure the long-term management of key built heritage assets within their landscape context. These assets include (i) Second World War Heritage, (ii) Headlands and Lookouts, (iii) Ritual and Religious Sites. Eight key sites were identified during the development stage of H2H to be the focus of this project namely: (i) Walney Island WWI & WWII heritage, (ii) Birkrigg, (iii) Kirkhead Summer House, (iv) Hampsfell Hospice, (v) Jenny Brown's Point, (vi) Warton Crag, (vii) Heysham and Heysham Head and (viii) Cockersands Observation Tower.

2.3 Geophysical survey training and participation projects will also be undertaken at Kirkhead and Cockersands in 2016, to further support the delivery of H2H Project 1 (above) and also Project 17 (Community Archaeology and Training).

2.4 The H2H Scheme will raise the profile and appreciation of Morecambe Bay's rich cultural heritage, provide better local protection of aspects of the Bay's built

heritage, increase local pride and engender a sense of ownership of lookouts and heritage assets by the local community.

Location (Figures 1 & 2)

2.5 The present surveys were located next to the Grade II listed chimney at Jenny Brown's Point, just south of Silverdale, near Carnforth, Lancashire (NGR chimney: SD 46623 73520). Surveys were conducted in two areas: Area 1 was in the pasture field immediately north of the chimney; Area 2 was on the foreshore immediately east of the chimney.

Objectives

2.6 Headlands to Headspace will put local people at the heart of managing and looking after the heritage assets of the Bay for the long term, especially the very features that local people value most. Headlands to Headspace offers the chance to celebrate and explore what is distinctive about the Bay and make this better connected, more accessible to all, better appreciated and better understood. The scheme will help communities to restore, enhance and celebrate the cultural and natural heritage of Morecambe Bay.

2.7 The specific aims of the geophysical survey projects are to:

- promote research, interpretation and capacity building, with community engagement as the primary focus
- prepare and deliver a high quality training programme to community groups to ensure community participants acquire the necessary skills and knowledge to undertake geophysical surveys and understand the results
- provide opportunities for community members to undertake geophysical surveys within specified H2H Scheme areas as community participation and training events
- process all data and assess the nature and extent of any sub-surface features of potential archaeological interest
- produce comprehensive reports for community benefit and accession to the local Historic Environment Record (HER) and Archaeology Data Service (ADS)

2.8 The specific research aims of the present surveys were to assess the nature and extent of any sub-surface features of potential archaeological or historic significance near the chimney, which might shed further light on the function and use of the chimney.

Research

2.9 Research objectives are built into archaeological projects in accordance with the Historic England national policy framework and its objectives, outlined in *Exploring Our Past* (Historic England 1991), *Frameworks for our Past* (Historic England 1996), the *Research Agenda* (Historic England 1997), and the *Policy Statement on implementation* (1999). This project addresses research priorities set out in *The Archaeology of North West England: an archaeological research framework for the North West Region. Volume 2: research agenda and strategy* (Brennand *et al*. 2007), specifically the following 'Themes and priorities':
E) Early Industries
F) Collaboration and Community

L) Field methods and standards
Q) Coastal, marine and maritime
R) Making information Accessible

Methods statement

2.10 The surveys have been undertaken in accordance with a brief provided by Morecambe Bay Partnership (Appendix), a Project Design provided by Archaeological Services Durham University, and national standards and guidance (para. 5.1 below).

Dates

2.11 The project began with an evening presentation and introduction to archaeological geophysics on 24th May 2016. Fieldwork was undertaken on 25th and 26th May 2016 and a data processing workshop was held on 27th May 2016. This report was prepared for September 2016.

Personnel

2.12 Fieldwork was conducted by H2H community members: Claire Asplin, Andrew Davies, Pam Davies, Sarah Fishwick, Kevin Grice, Sue Hunter (Arnside & Silverdale AONB Officer), Tommy Ingham, Louise Martin, John Mather, Ser-Hunang Poon, Andy Pringle, Dawn Sharples, John Stubbs, Simon Williams and Duncan Woodcock.

2.13 Participants were trained and supervised by Duncan Hale and Richie Villis (Archaeological Services Durham University). Geophysical data processing was by project members (resistance data), Duncan Hale (magnetic data) and Richie Villis (gpr data). This report was prepared by Duncan Hale (the Project Manager for Archaeological Services) and Richie Villis, with illustrations by Janine Watson and Dr Helen Drinkall.

2.14 Overall project management and coordination was provided by Louise Martin (H2H Cultural Heritage Officer, MBP).

Team photo

Acknowledgements

2.15 Archaeological Services Durham University and MBP are grateful to Craig McCoy and colleagues at the National Trust (the landowners of Heald Brow). The chimney site is in private ownership and thanks are extended to the landowners for allowing the work to be extended around the chimney site. The Silverdale Hotel is gratefully acknowledged for providing a comfortable base for the training.

Archive/OASIS

2.16 The site code is **MBJ16**, for **M**orecambe **B**ay **J**enny Brown's Point 20**16**. The survey archive will be retained at Archaeological Services Durham University and a copy 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 **archaeol3-263783**.

3. Historical and archaeological background

3.1 The historical background to the site is currently being researched as part of the H2H Scheme and will be covered in more detail in subsequent reports.

3.2 Previous works at the chimney have included rapid survey as part of the North West Rapid Coastal Zone Assessments, NWRCZA (Johnson 2009, 141-2; Eadie 2012, 155-157), topographic survey by Furness Mapping Services and aerial imagery by Oxford Archaeology North.

3.3 The chimney is a Grade II listed building (no. 1317165; UID 181949), which stands on the shore at Jenny Brown's Point. It is built of squared coursed limestone, of hollow round section, about 10m high and tapering, with a rectangular opening on its east side, near ground level. A second rectangular opening (now blocked) is present on the north-west of the chimney. The remains of walls from probably associated structures can be seen to the immediate east of the chimney.

3.4 The purpose of the chimney is still a matter of debate. It has been said that it was associated with copper smelting works active between *c*.1780-1820 (Bolton and Fogg, no date). Other possible interpretations are that it was it was a pumping house for a mining shaft, a beacon and even a limekiln (Cuthbert Woods 1946, 173).

4. Landuse, topography and geology

4.1 Area 1 comprised a long, narrow, pasture field aligned north-east/south-west to the immediate north of the chimney. The north-western side of the field occupied a gentle south-east-facing slope with occasional outcropping bedrock. A small area of disturbed ground and exposed bedrock in the west of Area 1 could not be surveyed due to tree cover.

4.2 The land along the south-eastern edge of the field was predominantly level at approximately 10m OD; beyond the fence the ground dropped steeply to the foreshore and chimney at approximately 6m OD (Area 2). The foreshore comprised some patches of short grass, areas of loose rock and exposed dipping bedrock; some stone wall footings were exposed to the east of the chimney.

4.3 The underlying solid geology of the area comprises Visean limestone of the Great Scar Limestone Group, which outcrops within both survey areas. It is partly overlain by tidal flat deposits of clay and silt (salt marsh) along the foreshore in Area 2; no superficial deposits are recorded for Area 1.

Area 1, resistance survey

Area 2, chimney and foreshore

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with Historic England guidelines, *Geophysical survey in archaeological field evaluation* (David, Linford & Linford 2008); the Chartered Institute for Archaeologists (CIfA) *Standard and Guidance for archaeological geophysical survey* (2014); the CIfA 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 (GPR), 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, it was considered possible that features associated with the chimney might be present in the pasture field to the north (Area 1); such features might include ditches, pits, trackways, wall foundations and fired structures (for example kilns and hearths). The remains of stone walls were exposed on the foreshore adjacent to the chimney (Area 2); these were surrounded by rock rubble and bedrock, however, it was considered possible that further features might also be present.

5.4 Given the anticipated nature and depth of targets, and the non-igneous geological environment of the study area, two complementary geophysical survey techniques were initially considered appropriate: geomagnetic and earth electrical resistance. It was not originally intended to use ground-penetrating radar (GPR) at the chimney site due to the largely uneven ground surface and the salt content of the deposits, however, subsequent to a GPR demonstration for participants, GPR data were collected over a small grassed area close to the exposed wall footings by the chimney.

5.5 The selected 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.

5.6 Given the likely presence of wall footings, hard surfaces and tracks, an electrical resistance survey was also considered appropriate. 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 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.

5.7 GPR generates a short high-frequency radar pulse which is transmitted into the ground via an antenna; the energy is reflected by buried interfaces and the return signal is received by a second antenna. The amplitude of the return signal relates to the electromagnetic responses of different sub-surface materials and conditions, which can be features of archaeological or historic interest. The time which elapses between the transmission and return of radar pulses to the surface can be used to estimate the depth of reflectors. As well as conducting traditional 2D area surveys, GPR also has a depth component and so can be used to create pseudo 3D models of the data, provided sufficient data are collected at closely-spaced intervals; these models can then be viewed in plan at selected depths known as 'time-slices'.

Field methods

5.8 A 20m grid was established across each survey area 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.

5.9 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. In Area 1, the sample interval was 0.25m and the traverse interval was 1m, thus providing 1,600 sample measurements per 20m grid unit; in Area 2 (where wall footings were exposed) the sample interval was 0.25m and the traverse interval was 0.5m, thus providing 3,200 sample measurements per 20m grid unit.

Geomagnetic survey in Area 2

Resistance survey in Area 1

5.10 Measurements of earth electrical resistance in Area 1 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 1ohm, the sample interval was 1m and the traverse interval was 1m, thus providing 400 sample measurements per 20m grid unit.

5.11 GPR data were collected to the east of the chimney on the foreshore (Area 2) using a Malå Ramac X3M radar system. Data were collected over a 6m by 4m grid and an adjacent 5m x 2m grid, targeted over areas of relatively flat ground (to provide good antenna coupling) and the projected lines of near-by exposed walls. Surveys were conducted over the same search area using different frequency antennae (500MHz and 800MHz) to provide better resolution at greater and lesser depths respectively. Returned energy wavelets were recorded from many depths in the ground to produce a series of reflections generated at one location, called a reflection trace. Series of traces collected along each transect produce a radar profile or radargram. For these grid-based surveys, data traces were logged at 0.05m intervals along parallel traverses spaced 0.5m apart. Within each grid, data were collected along two sets of perpendicular traverses which were then combined to form one dataset.

5.12 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.

GPR demonstration by the chimney

Data processing

5.13 Geoplot v3 software was used to process the geomagnetic and electrical resistance data and to produce both continuous tone greyscale images and trace plots of the raw (minimally processed) data. The greyscale images, trace plots and geophysical interpretations are presented in Figures 3-8. 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.

5.14 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

5.15 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

5.16 ReflexW v7.5 software was used to process the 2D GPR radargrams, to stack and interpolate the 2D radargrams to produce 3D data cubes, and to produce greyscale images of profiles and time-slices (Figures 9-10).

5.17 Combinations of the following processing functions have been applied to the 2D radargrams:

dewow	removes very low frequency components by subtracting the mean from each trace
static correction	moves the start times for traces in each profile to 0nS
gaining the data	compensates for energy loss as the radio pulse penetrates deeper and/or amplifies the area of interest by adding a determined value
bandpass filter	removes low-amplitude frequencies (Butterworth values)
background removal	reduces data ringing

Interpretation: anomaly types

5.18 Colour-coded geomagnetic and resistance 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

5.19 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

5.20 A colour-coded archaeological interpretation plan is provided (Figure 11).

5.21 The majority of geomagnetic anomalies detected in Area 1 are small, discrete dipolar magnetic anomalies. These typically reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments, however, in this instance it is likely that they reflect ferrous material within the bedrock, which outcrops in several places across Area 1. The distribution of these geomagnetic anomalies corresponds with both the mapped areas of high resistance and the observed outcropping limestone. The limestone in the Morecambe Bay area contains significant quantities of iron ore (haematite), particularly in the west at Furness though this ore has also been exploited near Jenny Brown's point at Heald Brow to the north and Lindeth (Greywalls) to the north-west of the site (Moseley 2010, 84). Deposits of haematite and copper carbonate ores were prospected and mined on a relatively small scale in the Silverdale area during the 18th and 19th centuries, and probably earlier (Murphy and Moseley, 2015). The most extensive mine workings were on Warton Crag, to the east of Jenny Brown's Point, but small workings for haematite have also been investigated to the west of the site at Red Rake (Moseley 2010, 84), just north of Jenny Brown's Point.

5.22 For the present project, the extent of the near-surface limestone in Area 1 has been mapped by the resistance survey, whilst the haematite content of the rock is indicated by the geomagnetic survey.

5.23 The only other geomagnetic anomalies in Area 1 comprise very weak parallel positive magnetic anomalies in the east and occasional small strong dipolar anomalies at the western edge. The former are almost certainly too insubstantial to reflect soil-filled ditches, but may reflect land drains in this instance, or possibly former ploughing along the field edge; the latter anomalies almost certainly reflect small items of ferrous debris.

5.24 Much of Area 2, particularly the western half, contains very strong dipolar magnetic anomalies, which probably have varied causes such as ferrous and fired debris (including bricks), intense burning and iron ore. Burnt materials were apparent across parts of the area, particularly at one location where turf had been removed and burnt materials were exposed next to two wall footings (photograph below).

5.25 An irregular, weak negative magnetic anomaly in the south-east quarter of the survey corresponds to the abrupt break in slope at the eroding edge of the grassed area. Any weak anomaly associated with the continuation of this meandering vertical edge in the western half of the survey area has been obscured by the strong dipolar magnetic anomalies there.

Burnt materials and wall footings in Area 2

5.26 One intense dipolar magnetic anomaly near the southern edge of the survey reflects a steel anchor-mark for a survey station established by Oxford Archaeology North.

Further wall footings exposed in Area 2

5.27 Two small areas of GPR survey were conducted to the east of the chimney (Grids 1 & 2). In the following discussion of the GPR results, a hyperbola fitting technique has

been used to estimate a wave velocity of 0.11m/ns for enabling time/depth conversions; depth estimates are presented below, rather than reflection times.

5.28 As was anticipated prior to survey, the relatively high electrically conductive materials (salt marsh and wet limestone) of the survey area have inhibited the effectiveness of GPR as a sub-surface mapping tool. In this instance the 500MHz antenna appears to have produced more useful results. Higher frequency antennae (800-900MHz) are designed for mapping features within approximately 1m of the ground surface, and can provide high feature resolution, but their use in electrically conductive ground can lead to energy attenuation within 0.3m of the ground surface (Conyers 2012).

5.29 GPR profiles from Grid 1 at y=3.1m show quite clear high amplitude reflections at between 3.5-4.5m. This is most obvious in the 500MHz antenna data at approximately 0.2-0.6m depth (Figure 9). A less obvious reflective anomaly has also been detected in the 800MHz profile at around 0.2m (Figure 10). Similar clear reflections have been identified in 500MHz profile x=4.4m, between 2m and 3m along the profile direction. In the *c*.0.4m deep time-slice of 500MHz data these high amplitude reflections create an ill-defined, *c*.0.5m wide, linear anomaly, aligned approximately north-east/south-west. This can be identified in time-slices between 0.2-0.45m depth and broadly corresponds to the line of an exposed wall to the east of the survey grid.

5.30 High amplitude dipping reflectors have been identified, which are likely to reflect the underlying limestone bedrock. This outcropped in the north of Grid 1, and can be clearly identified in both the 500MHz and 800MHz antenna data. The *c*.0.04m depth time-slice of 800MHz data clearly shows a region of high amplitude reflections from the limestone bedrock at the north of Grid 1.

5.31 High amplitude reflections have been identified in radar profiles across Grid 2. Profile x=0.95m from both antennae show high amplitude reflections at around 4.2-4.7m along the profile direction, around 0.05-0.1m depth. The 500MHz data also show reflections at approximately 2.5m to 3.2m along the profile at 0.3m depth, which can also be less clearly identified in the 800MHz data due to energy attenuation. Time-slices of Grid 2 data (800MHz: *c*.0.02-0.25m; 500MHz: *c*.0.07-0.75m) show these high amplitude reflections in plan view; two broadly north-west/south-east aligned linear anomalies can be distinguished in the north-east corner of Grid 2. Both of these anomalies have the same orientation as nearby exposed walls, and are indicative of at least two courses of stonework surviving, probably along two abutting walls, only 2-3cm below the surface.

5.32 High amplitude reflections in the north-west corner of Grid 2 are likely to reflect packing stones and rubble associated with the walls, as well as a continuation of the exposed wall to the north, which has been identified continuing to the south-west in Grid 1.

5.33 Other reflections have been identified across all profiles and time-slices for both antennae in both grids. These are often irregularly distributed or discrete anomalies, and are likely to reflect individual rocks throughout the survey area. Reflections can also be received from unidentifiable origins, such as differences in moisture content in the underlying materials.

6. Conclusions

6.1 Geophysical training and survey has been undertaken at Jenny Brown's Point in Lancashire as part of Morecambe Bay Partnership's programme of community participation heritage projects.

6.2 Geomagnetic, earth electrical resistance and ground-penetrating radar (GPR) surveys have been undertaken to help investigate the history and use of a chimney on the foreshore.

6.3 In the pasture field above the chimney, both the geomagnetic and electrical resistance techniques have effectively mapped the extent of the near-surface limestone bedrock. The limestone in the Morecambe Bay area contains significant quantities of iron ore (haematite), and this was mined on a relatively small scale in the Silverdale area during the 18th and 19th centuries, both to the east at Warton Crag and to the north at Heald Brow and Red Rake and to the north-west at Lindeth. It is possible that the chimney and a small disturbed area in the west of Area 1 could be associated with the exploitation of either haematite or copper carbonate ores.

6.4 Geomagnetic survey on the foreshore detected high concentrations of very strong anomalies, which almost certainly reflect ferrous and fired debris, intense burning and iron ore; it has not been possible to identify specific features within the data. GPR surveys here have however indicated the probable continuations of wall footings, aligned with those evident on the ground.

7. Sources

Bolton, TE, and Fogg, IJ, (no date) *Silverdale*

Brennand, M, Chitty, G, & Nevell, M, (eds) 2007 Research and Archaeology in North West England: an archaeological research framework for the North West Region, Volume 2: research agenda and strategy. *Archaeology North West* vol **9**, ALGAO, EH & CBA

CIfA 2014 *Standard and Guidance for archaeological geophysical survey*. Chartered Institute for Archaeologists

Conyers, LB, 2012 *Interpreting Ground-Penetrating Radar for Archaeology*. Walnut Creek, California

Cuthbert Woods, E. 1946, 'Some History of Coastwise Lights of Lancashire and Cheshire, Part II', 159- 180, in *Transactions of the Historic Society of Lancashire and Cheshire* Vol. XCVII. Liverpool

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

Eadie, G, 2012 North West Rapid Coastal Zone Assessment: Phase 2. Archaeological Research Services Ltd Report 2012/69. https://content.historicengland.org.uk/images-books/publications/nwrcza-phase2-project-report/nwrcza-phase2-chap4.pdf/

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

Johnson, B, 2009 North West Rapid Coastal Zone Assessment (NWRCZA). Archaeological Research Services Ltd Report 2009/53. https://historicengland.org.uk/images-books/publications/nwrcza/

Moseley, M, 2010, *The Metalliferous Mines of Cartmel and South Lonsdale*. Monograph of the Northern Mine Research Group. British Mining No. 89

Murphy, PJ, and Moseley, M, 2015 Sediment-filled cavities in the Morecambe Bay karst (UK): examples from the Warton and Silverdale area. *Cave and Karst Science*, Vol.42, No.3, 144–147. British Cave Research Association

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

Appendix: Project brief

MORECAMBE BAY PARTNERSHIP

Headlands to Headspace

Contractors brief for delivering geophysical surveys and volunteer participation/training

1. Project Overview

1.1. As part of the Heritage Lottery Funded Headland to Headspace Landscape Partnership Scheme, Morecambe Bay Partnership wishes to appoint a contractor to undertake geophysical surveys, including a participation/training project for community participants/volunteers.

1.2. This training project will support the delivery of Headlands to Headspace (H2H) Project 1 (Built Heritage and Lookouts) and Project 17 (Community Archaeology and Training). Further information on the Headlands to Headspace Landscape Partnership Scheme and an overview of the projects (including outputs and outcomes) is provided in Appendix 1. This project should follow current Chartered Institute for Archaeologists (CIfA 2014) and Historic England (formally English Heritage; English Heritage 2008) guidance/best practice for undertaking geophysical surveys.

2. Aim

2.1. The aim of this work is to:

- Undertake geophysical surveys within the H2H Scheme area as community participation training events, record data and report results.

2.2. Outputs:

- Develop a training programme to ensure community participants acquire the necessary skills and knowledge to undertake geophysical surveys and understand the results;
- Provide community participation/training opportunities as part of all surveys undertaken;
- Process all data and produce comprehensive reports for accession to the local Historic Environment Record and Archaeological Data Service (ADS).

3. Scope of the work

3.1. The contractor will work in liaison the H2H Cultural Heritage Office (CHO) to:

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- Develop a training programme for small groups (20 people max per group) of community participants/volunteers in the techniques and approaches to geophysical survey;
- Develop a volunteer training pack to include guidance on undertaking geophysical survey;
- Deliver on-site survey of sites (minimum of 4 sites) to include training sessions/workshops for small groups of community participants/volunteers;
- Co-ordinate and monitor data collection by project participants/volunteers;
- Ensure all data is processed and reported and results are accessioned to the Historic Environment Record and Archaeological Data Service (ADS).

4. Project delivery

4.1. This project will be developed and delivered from Winter 2015. The training programme/resources will be developed during winter 2015/6 with workshops/survey being delivered throughout 2016-7 (as appropriate).

4.2. The minimum number of training sessions and sites to be surveyed is four with a maximum of 10 sites (no greater than 40 hectares per site). It is hoped that at least one training session/survey will be held during the 2016 Festival of Archaeology (16th-31st July) and the contractor should be available to deliver a training session/survey during this time.

4.3. The contractor will work in liaison with the H2H Cultural Heritage Office (CHO). The H2H Cultural Heritage Group will provide strategic guidance to the programme. Other members of the H2H team will be involved as appropriate – e.g. volunteer opportunities and recruitment will be overseen by the H2H Community and Training Officer and CHO.

4.4. The contractor will be required to quote for:

- Preliminary site visits (if required);
- Production of site specific Risk Assessments;
- Development of volunteer training programme, guide and resources;
- Provision of survey equipment;
- Delivery on site survey/ training sessions;
- Processing and reporting data collected;
- Accessioning the recording to the Historic Environment Record and ADS.

The planning and delivery of the training sessions will be supported by the CHO.

5. Training content

5.1. The training sessions are expected to include an overview of the principals and approaches to geophysical survey, including the techniques used for different sites, establishing site survey grids, processing data sets and reporting/archiving results.

5.2. A guide to accompany the training sessions should be developed and be provided to each participant/volunteer. This guide will become copyright of Morecambe Bay Partnership and is to shared as an online resource and used for future training (if required).

6. Responsibilities of the contractor

6.1. The contractor will be expected to:

- Develop relevant training materials/resources and deliver a quality community training programme to four separate groups (in liaison with the CHO);
- Produce lesson plans for the workshops in liaison with the CHO);
- Obtain landowner (and any other third party) consent for site visits (in liaison with the CHO);
- Produce Risk Assessments for each event/workshop
- Oversee the volunteers and quality/results of their work;
- Produce reports for each site surveyed.

6.2. In addition, consultants should monitor the success of the training sessions on an ongoing basis, and adjust future sessions as necessary to reflect group needs. A final short evaluation of the training sessions should be provided and a photographic record of the sessions should be provided to the client, with permission for the client to use them in digital media and print

6.3. To assist with the tendering process an *indicative* list of sites is shown, including size and current land use. This list is only indicative at this stage and may be subject to change/landowner permission. Tenders should include provision to establish the training programme/guide, a rate per hectare of undertaking site surveys and processing/reporting results for each survey undertaken.

Site	Approximate Survey Area	Current Land Use
Cockerham Sands	Up to 3.2 hectares	Private ownership. Pasture. Currently used for grazing horses
Jenny Browns Point	Up to 1.2 hectares	Land around chimney Private ownership, eroding saltmarsh Land to north of chimney National Trust with tenant farmer. Pasture
Kirkhead	Up 4.8 hectares	Private ownership. Pasture. Currently used for grazing horses
Furness Peninsular/Barrow-in-Furness area (sites to be determined).	Up to 5 sites and c. 100 hectares	TBC

Site	Approximate Survey Area	Current Land Use
Possibly 5 separate sites		

6.4. Please note that the above is indicative and tenders submitted should reflect the contractor's cost for the following elements of the project:

- Fixed price for developing of training workshop/materials;
- Day rates/price per site for delivering on site survey/training (please indicate what area is anticipated to be surveyed in a day with volunteers and price per hectare);
- Travel expenses (per mile/day/accommodation);
- Production of report (maximum/minimum per site);
- Archiving.

6.5. Contractors will be expected to have a robust contingency plan in place to cover accident/illness, will be expected to provide such information to Morecambe Bay Partnership and will be responsible for ensuring a contingency plan is in place throughout the entirety of the project/contract. This plan is to include time/cost of project handover and delivery of sessions at short notice (if required).

7. Health and Safety

7.1. The contractor will be responsible for health and safety during all training sessions.

7.2. Specific and comprehensive Risk Assessments must be produced prior to the commencement of training and be provided to the CHO.

8. Reporting

8.1. The contractor will be expected to produce a report for each site surveyed and should include:

- Introduction/background to the project;
- Brief historical background to the site;
- Methodologies employed for data collection;
- Overview of results of the project (including illustrations/photographs and maps, as appropriate).

8.2. Contractors are required to submit draft reports for comments before any report is finalised.

8.3. Morecambe Bay Partnership requires 1 hard copy and a digital copy (in MS Word and PDF format) of each final report, which should be fully proof-read. A copy of the report should also be produced and accessioned to the Historic Environment Record and be archived with the ADS. Costs for report production and archiving should be included in the tender.

8.4. The client will hold the copyright on the reports produced and its publication (including copyright on the brand and design). Permission will be granted by contractor to disseminate all data collected/produced through digital media (such as websites). Use of any of the information contained within the reports must be appropriately referenced.

8.5. Any information supplied by the client to the contractor during the project must be returned no later than one month after the end of the contract period.

9. Insurance

9.1. The contractor should hold £2m public liability and £1m professional indemnity insurance. Proof of insurance should be included in the tender submission.

10. Work proposals and deadlines

10.1. Interested consultants should submit a work proposal/project design and quotation to arrive by 5pm Friday 27th November 2015.

10.2. Submissions should be sent by email to Louise Martin louise@morecambebay.org.uk and to Sophie Cringle h2h@morecambebay.org.uk and will be acknowledged. These should arrive by date shown on the timetable. Late submissions will not be accepted.

10.3. The work proposal/project design and quotation should demonstrate the following award criteria:

- Your understanding and summary of the task;
- How you propose to work with us and help us to achieve the outcomes of the project;
- Methodologies proposed;
- A work plan including schedule of tasks and milestones;
- Expertise in undertaking similar work;
- Team structure and competencies - lead and contributors;
- Costs including a breakdown of each consultant's role, day rate, number of days working on the project, purchases, travel costs and other expenses;
- Value for money;
- What systems you have in place to ensure that you can meet the deadlines – e.g. who you will collaborate with in case of illness or other delays.
- CVs (2 pages max) for the consultant(s) who will work on the project;
- Two referees

10.4. The deadline for submission of quotations is 5pm Friday 27th November 2015. Training sessions will be planned during November/December 2015, with delivery timetabled to commence in Spring 2016. A proposed timetable is shown below. Sessions should be held to ensure that a wide variety of audiences are reached.

Deadline for quotation submission	5pm Friday 27th November 2015

Production of training resources	Winter 2015
Delivery of Training	2016-2017 (as appropriate to the site/land use)

10.5. The successful contractors should initially discuss the scope of the work with the client to agree a detailed timetable for the work.

10.6. All work, is required to be accessioned with the Historic Environment Record and ADS within 3 months of the completion of the project.

11. Quotations and Contract

11.1. The quotations should include all training materials, transport and subsistence, production of fully illustrated printed and digital reports.

11.2. A full contract will be drawn up, following the award of the contract, by Cumbria County Council, which acts as the Lead Body for Morecambe Bay Partnership. By submitting a tender for this contract, contractors are bound to the Standard Terms and Conditions of Cumbria County Council (Appendix 2) and Morecambe Bay Partnership Procurement Policy and Delegated responsibility for financial decisions (Appendix 3). Any queries regarding this contract and the T+Cs should be raised prior to submission of a tender. Payment will be made in stages on the satisfactory completion of the set milestones.

12. Project Management

12.1. The project will be managed by Morecambe Bay Partnership's Cultural Heritage Officer.

12.2. The contractor will report to the client immediately if there are any un-foreseen delays, which may limit the ability to complete the work to schedule.

12.3. Training materials, workshop contents and all events should be discussed with Cultural Heritage Officer before being organised, printed or run.

13. Background and Essential Guidance

13.1. The H2H Landscape Conservation Action Plan (LCAP) will be provided on appointment along with details of the H2H Project area.

13.2. The H2H team has access to data and support from their partners. This will be shared when appropriate/possible.

13.3. Heritage Lottery issue a number of guidance documents. The consultants are expected to be familiar with and work with these, especially:

- Planning Activities in Heritage Projects
- Thinking about Audience Development
- Thinking about Community Participation

14. Contract manager:

14.1. The contract manager is Louise Martin, H2H Cultural Heritage Officer. Contact details are Morecambe Bay Partnership, The Factory, Castle Mills, Aynam Road, Kendal, LA9 7DE. louise@morecambebay.org.uk 01539 734888/ 07760 881581

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Headlands to Headspace Morecambe Bay Partnership

Jenny Brown's Point
Silverdale
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Figure 1: Site location

site location

0 1km
scale 1:25 000 for A4 plot

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magnetic survey
resistance survey
GPR survey
FMS survey station

0 25m
scale 1:500 for A3 plot

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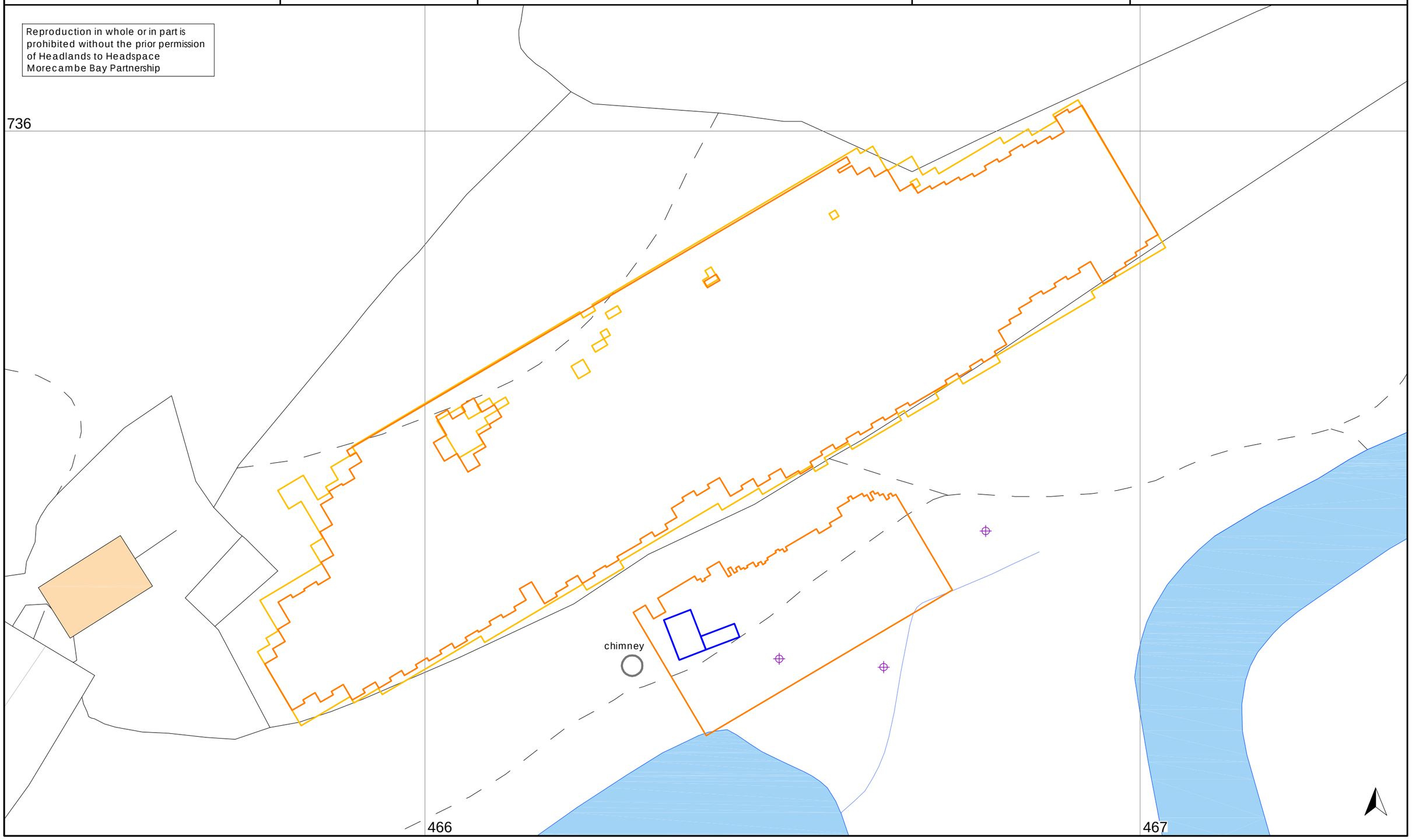
Figure 2: Geophysical survey areas



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magnetic survey

-4 nT 6

0 25m
scale 1:500 for A3 plot

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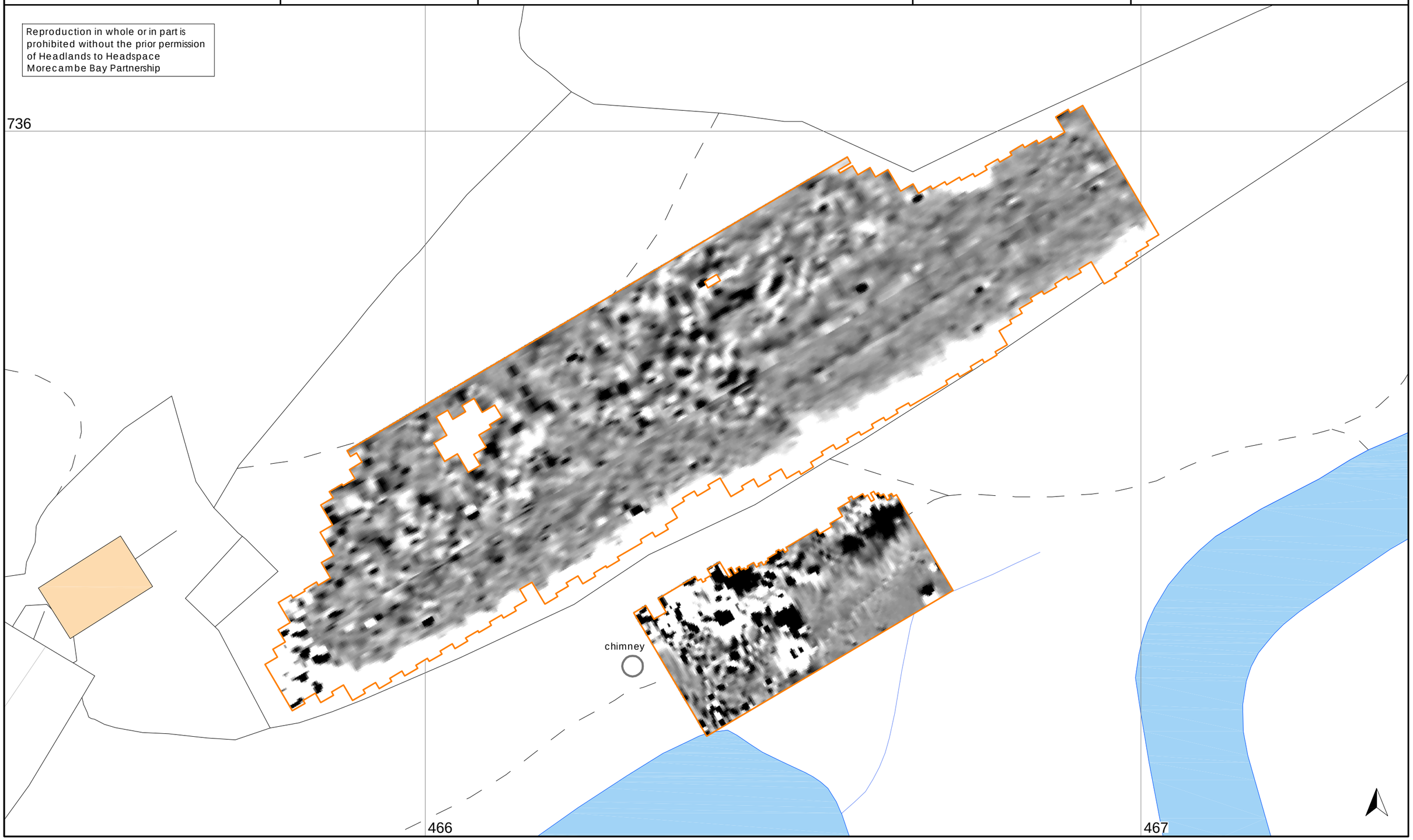
Figure 3: Geomagnetic survey greyscales



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0 25m
scale 1:500 for A3 plot

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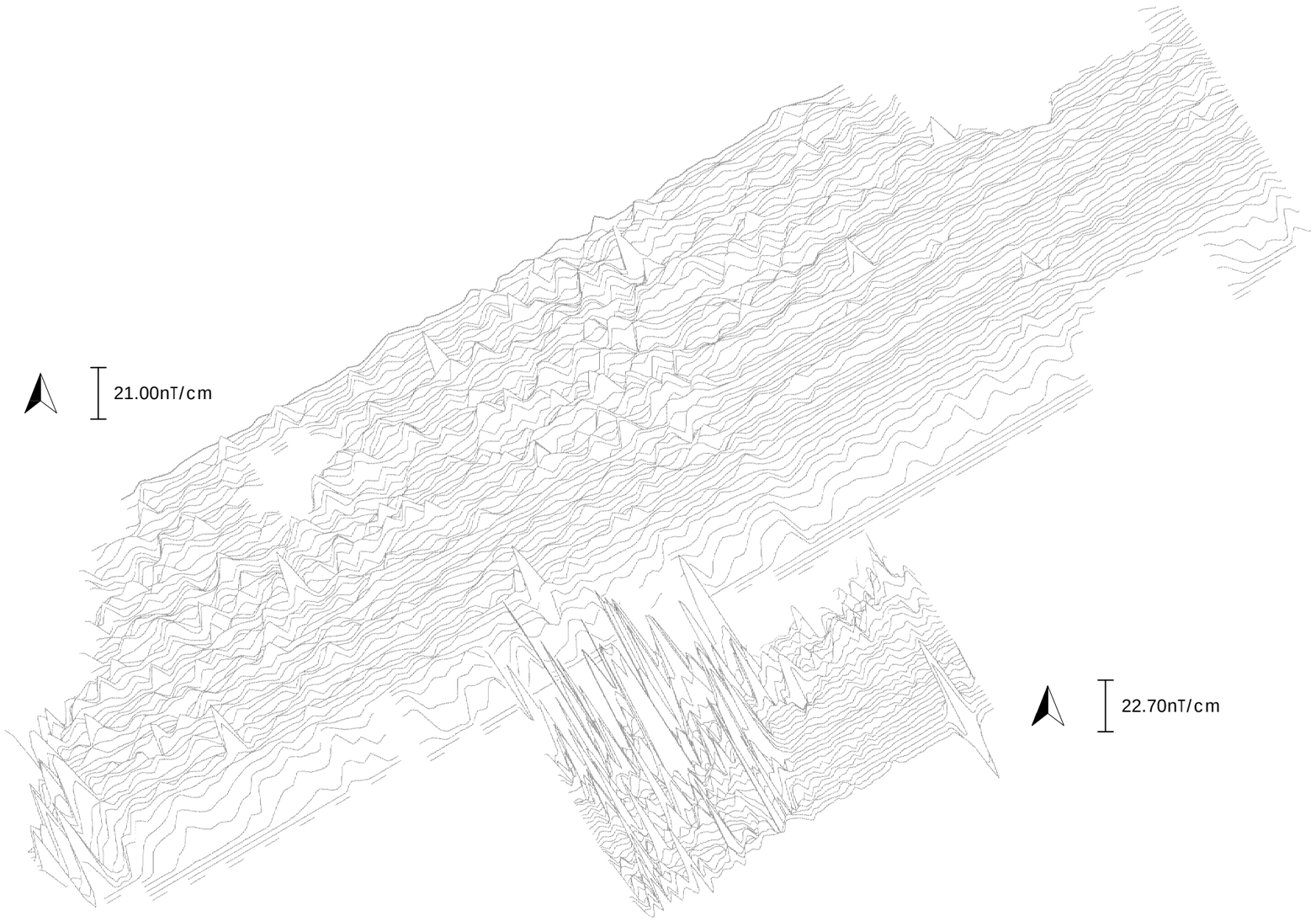
Figure 4: Geomagnetic survey trace plots



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magnetic survey
negative magnetic anomaly
dipolar magnetic anomaly
positive magnetic anomaly

0 25m
scale 1:500 for A3 plot

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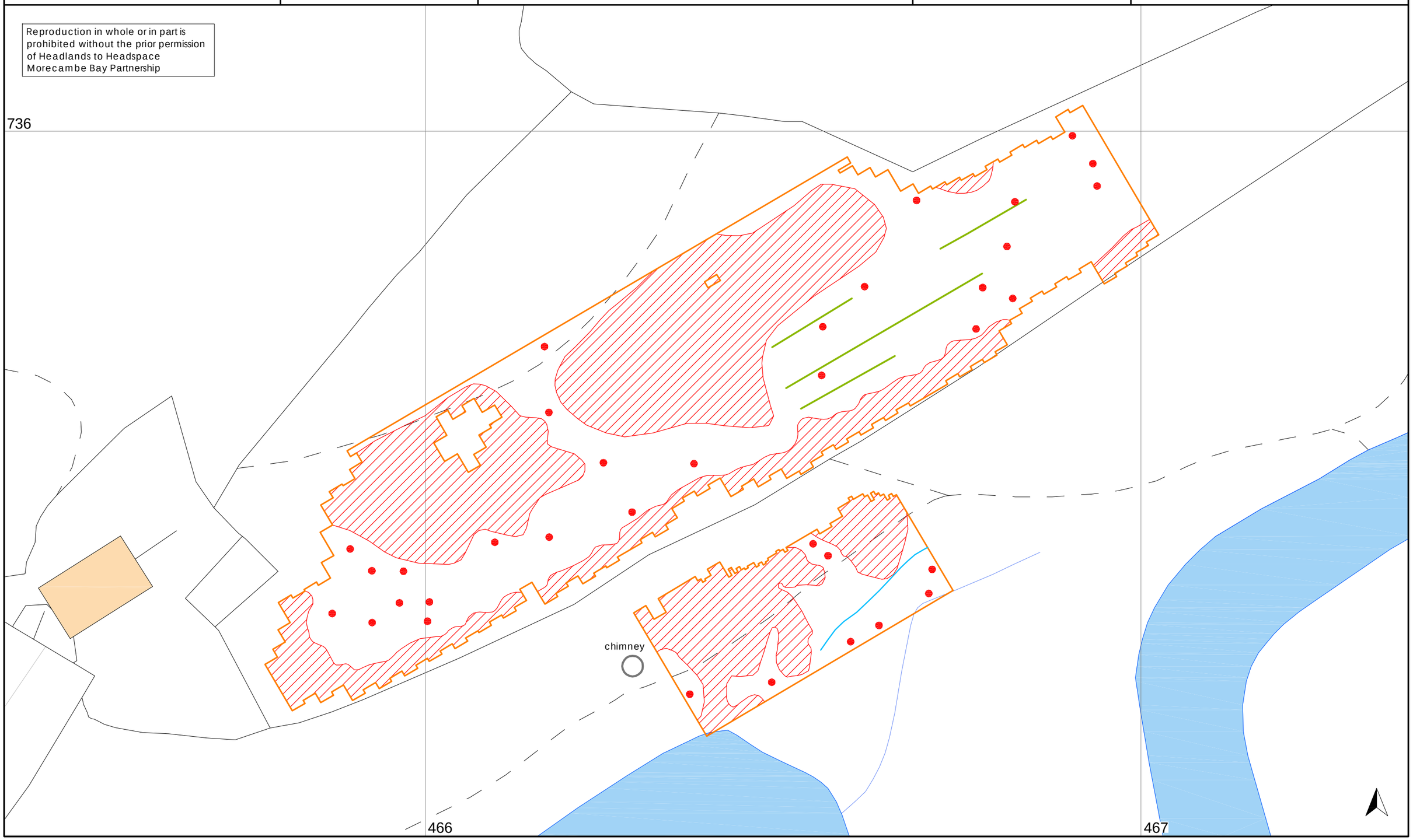
Figure 5: Geophysical interpretation of geomagnetic data



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resistance survey

100 ohm 500

0 25m
scale 1:500 for A3 plot

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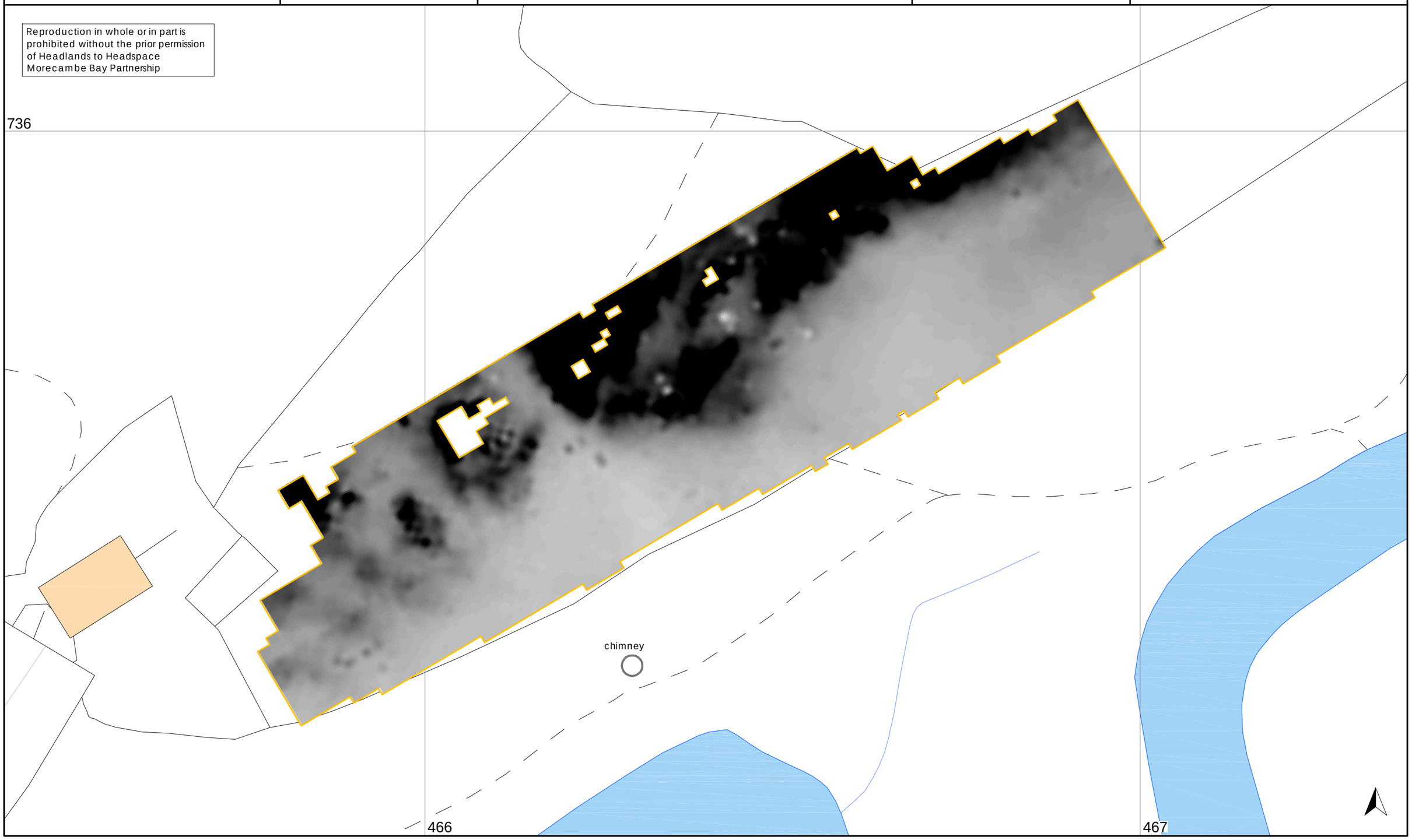
Figure 6: Resistance survey greyscale



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0 25m
scale 1:500 for A3 plot

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Figure 7: Resistance survey trace plot

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resistance survey

high resistance anomaly

0 25m
scale 1:500 for A3 plot

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Figure 8: Geophysical interpretation of resistance data

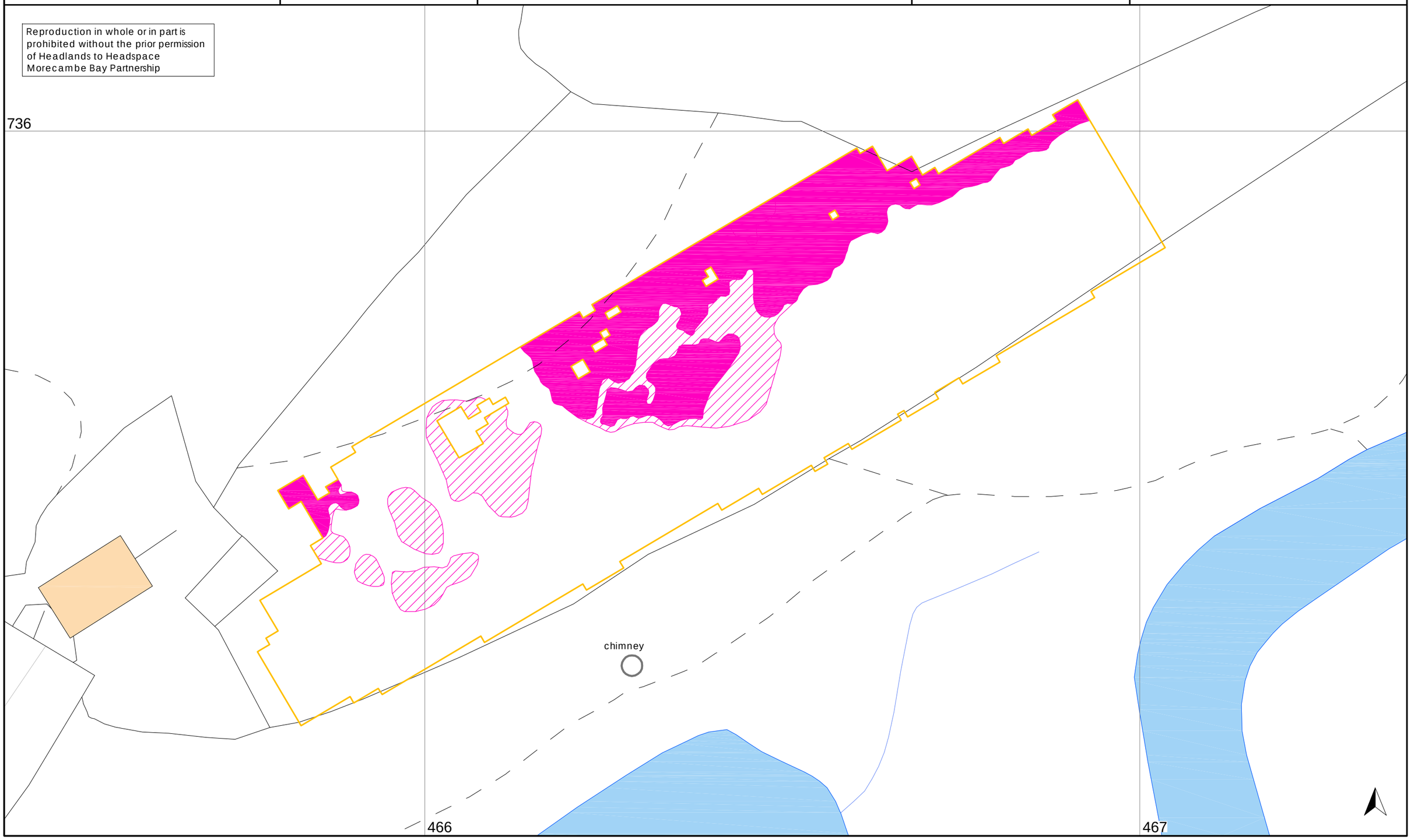

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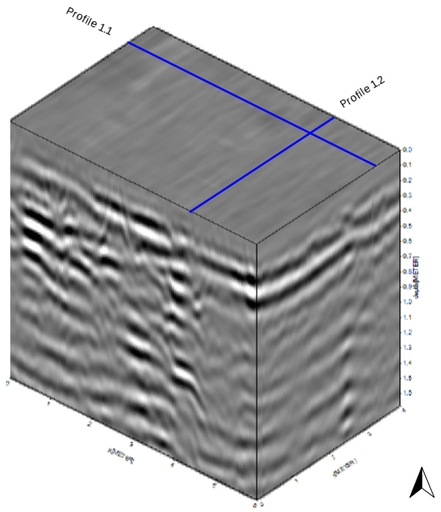
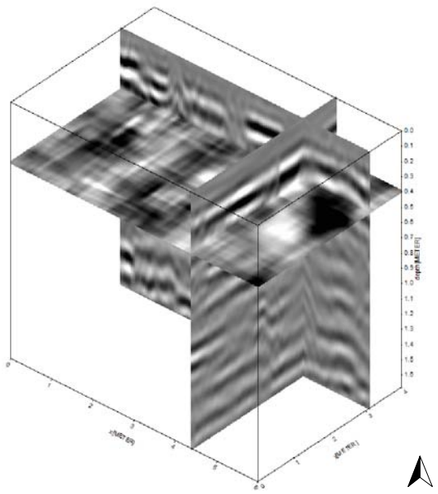
Figure 9: 500MHz GPR profiles and time-slices





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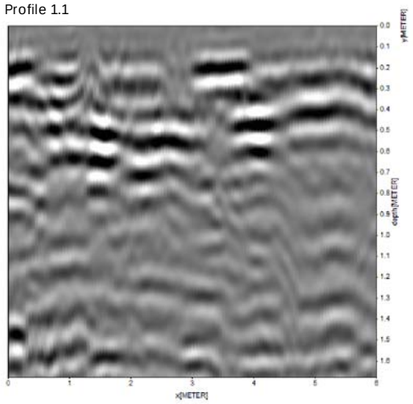

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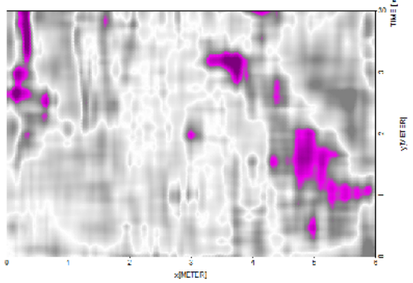

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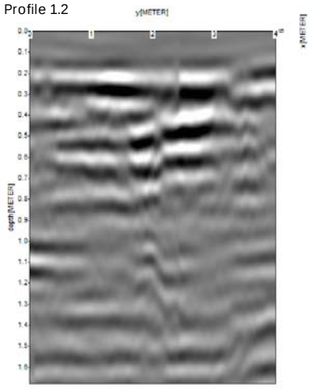

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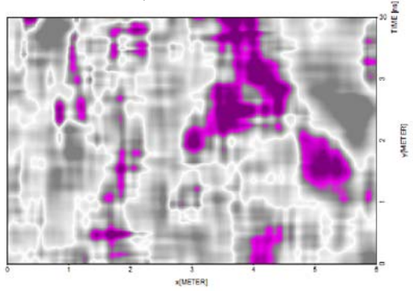

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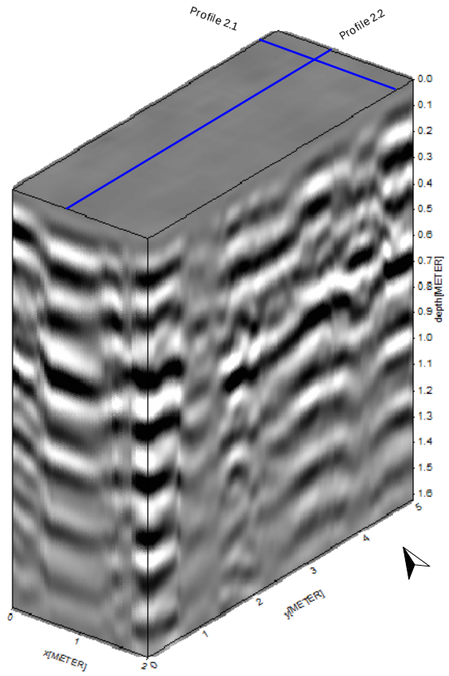

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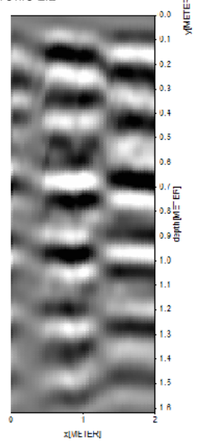

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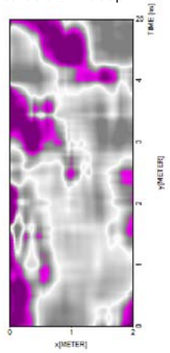

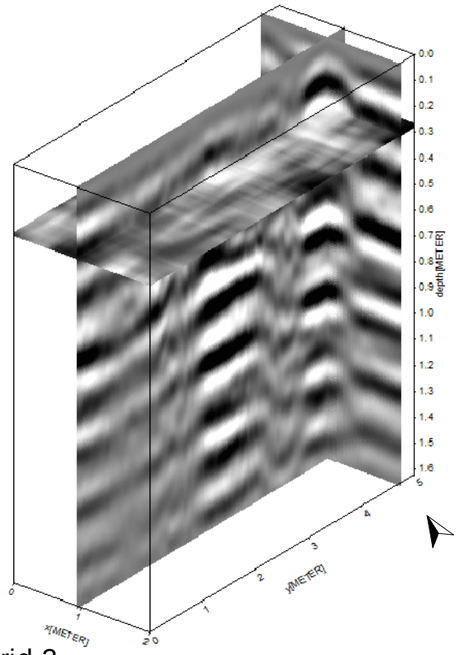

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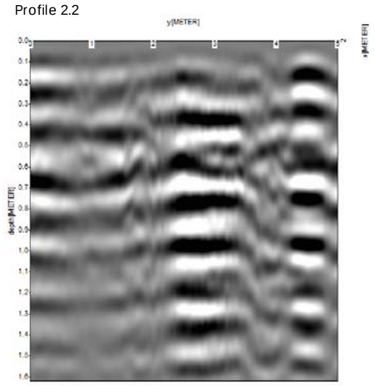

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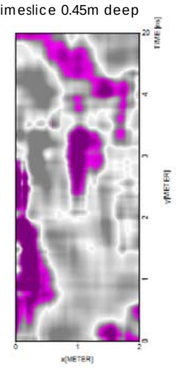

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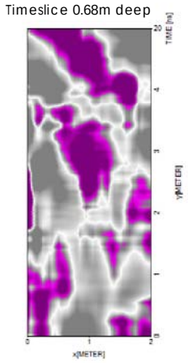

Grid 2

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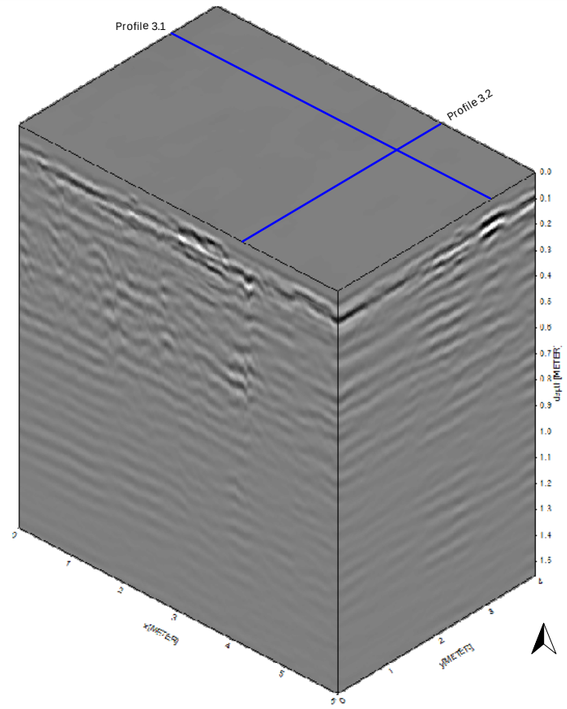
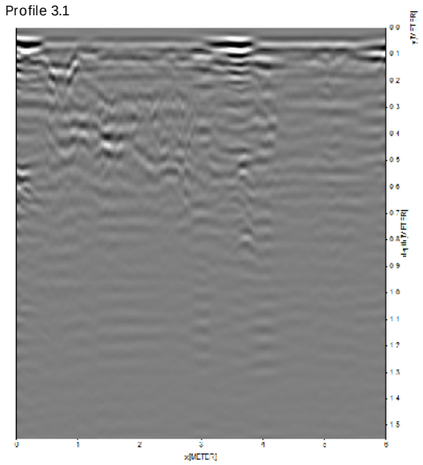
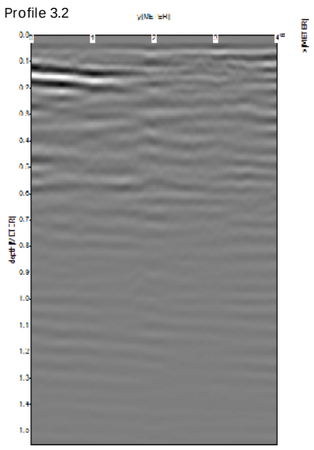
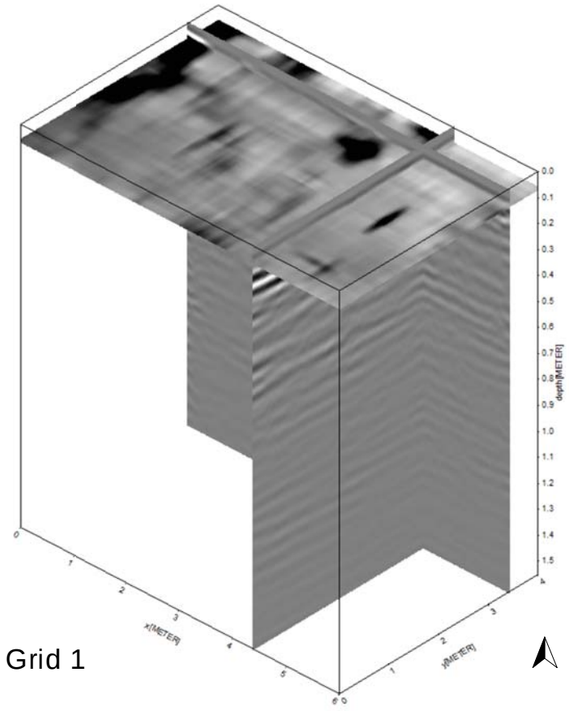
Figure 10: 800MHz GPR profiles and time-slices









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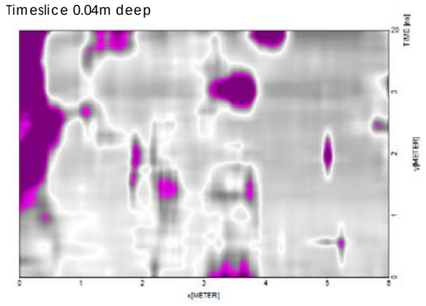

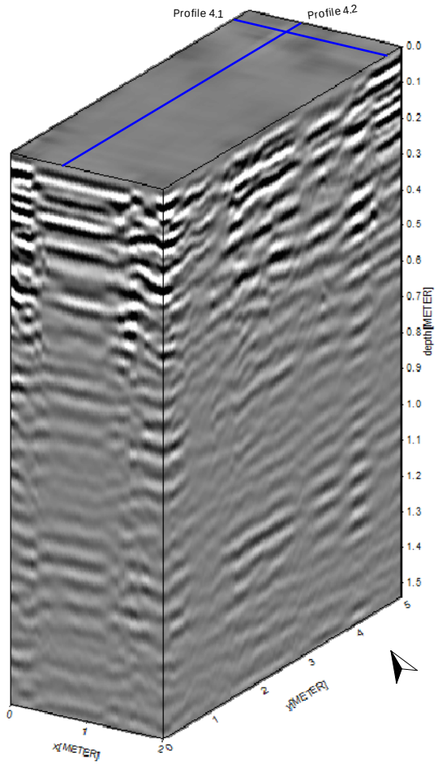

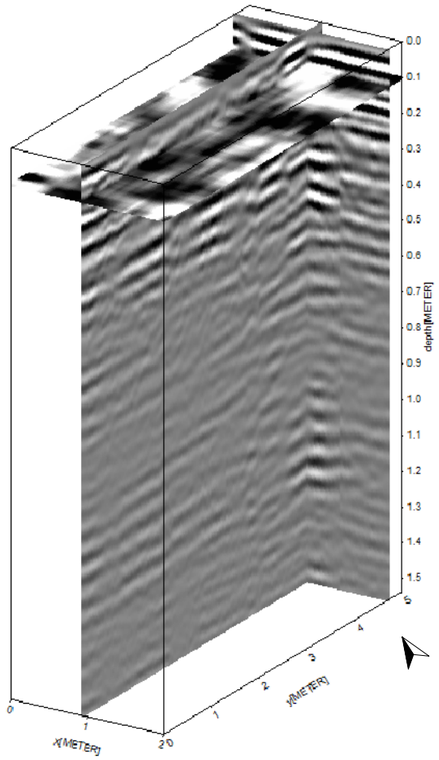

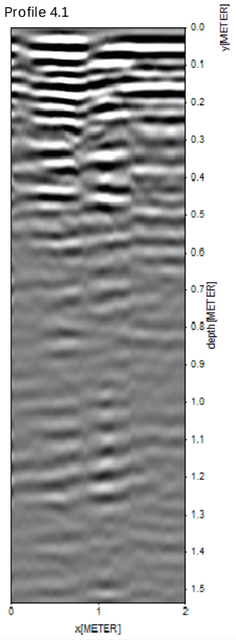

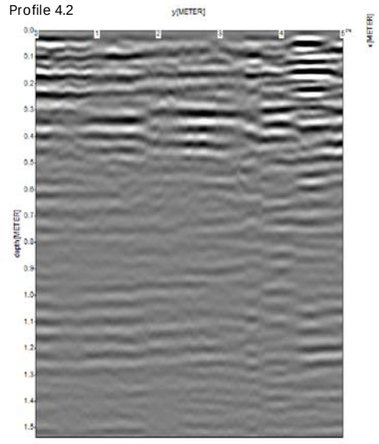

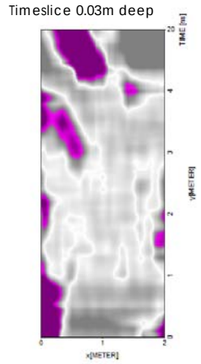

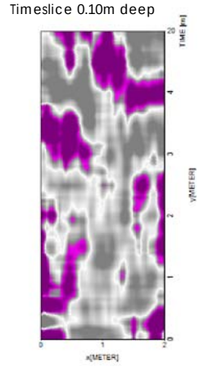

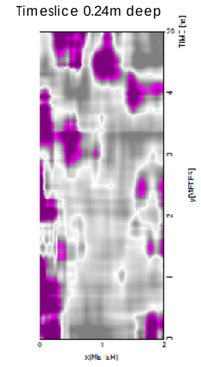

Grid 2

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magnetic survey
resistance survey
GPR survey
near-surface rockhead
land drain / plough feature
probable wall footing
eroding edge of grassland
FMS survey station
B bedrock outcrop

0 25m
scale 1:500 for A3 plot

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Silverdale
Lancashire

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Figure 11: Archaeological interpretation