

ARCHAEOLOGICAL
SERVICES
DURHAM UNIVERSITY

on behalf of
The Lanchester Partnership
(Friends of *Longovicium*)

Land west and south of *Longovicium*
Lanchester
County Durham

geophysical survey

report 4575
December 2017



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1. Summary

The project

- 1.1 This report presents the results of further geophysical surveys conducted to the west and south of the Roman fort of *Longovicium*, south-west of Lanchester, County Durham. The works comprised geomagnetic survey of four areas totalling 8.8ha.
- 1.2 The works were commissioned by The Lanchester Partnership (Friends of *Longovicium*) and conducted by Archaeological Services Durham University.

Results

- 1.3 The surveys have extended the coverage of previous surveys and detected many new features of archaeological significance, including a possible aqueduct, field systems and enclosures, a probable industrial area and a considerable number of buildings, almost certainly including a bath-house.
- 1.4 The field immediately south of the fort (Area 4) had been surveyed in 1991 but was re-surveyed here with state-of-the-art instrumentation and software. The 1991 survey was exemplary at the time, but the present survey has demonstrated the advantages of current technology, enabling the rapid survey of areas with high density sampling, high resolution of anomalies, unparalleled positional accuracy and the removal of errors associated with surveyors walking with hand-held instruments.
- 1.5 Relatively few archaeological features survive to the immediate west of the fort due to the shallow rockhead there and ploughing over many years. However, there appears to be a greater depth of soil further west and south, and this has helped preserve more features in those areas.
- 1.6 An enclosure detected in Area 1, close to the north-west corner of the fort, contains two anomalies which could reflect fired structures, possibly kilns or ovens.
- 1.7 The possible course of the fort's main aqueduct may have been detected west of the fort, across Areas 1 and 2. Parts of a former field system and track have also been detected in Area 2. These features continue into Area 3 to the south, where many more enclosures are evident.
- 1.8 Many strong discrete anomalies were detected in Area 3, increasing towards the east. It is likely that several of the larger examples probably reflect furnaces for smithing or smelting. This land to the south-west of the fort appears to have been an industrial area, perhaps producing metal fittings for soldiers and horses, as well as tools, nails, weapons, utensils and many other items. A readily available supply of coal, metal ores and water would have facilitated this industry.
- 1.9 A considerable number of buildings have almost certainly been detected just south of the fort. One large building near the south gate is almost certainly the fort's bath-house. Several other buildings in this area also appear to be well-defined and some of these may also have had hypocausts, or at least an abundance of tiles.
- 1.10 The use of a multi-sensor magnetometer system in these areas has provided a very clear, detailed and accurate map of subsoil features close to the fort. Some areas around the fort are yet to be surveyed, and some previously surveyed areas would benefit from being re-surveyed with the technology now available.

2. Project background

Location (Figure 1)

- 2.1 Geophysical surveys were undertaken on land to the west and south of the Roman fort of *Longovicium*, 0.8km south-west of the town of Lanchester in County Durham (NGR fort centre: NZ 15945 46898). The fort and its surroundings are a Scheduled Ancient Monument (SAM, Asset UID 100236). Several geophysical surveys have been undertaken both within and adjacent to the scheduled area in recent years.
- 2.2 The present surveys covered 8.8ha across four fields. Two of the fields in the west had been partially surveyed in 2014 (Archaeological Services 2014), which had demonstrated their potential for further survey, whilst the small field immediately south of the fort was first surveyed in 1991 (Noel *et al.*1991). The locations of current and previous geophysical surveys are shown in Figure 2.

Objective

- 2.3 The majority of previous surveys at the site have focussed on the fort itself and the *vicus* along the Roman road of Dere Street to the north, east and south-east of the fort. The present surveys, however, continue a programme of research which started in 2014 and focussed on land to the west and south of the fort, including the site of a presumed 'Roman reservoir' outside the south-west corner of the fort and a series of buildings outside the south wall of the fort.
- 2.4 The principal aim of the present surveys was therefore to assess the nature and extent of any sub-surface features of potential archaeological significance to the west and south of the fort.
- 2.5 The regional research framework *Shared Visions: The North-East Regional Research Framework for the Historic Environment* (Petts & Gerrard 2006) contains an agenda for archaeological research in the region. In this instance, the scheme of works was designed to address the following research priorities: Roman Rii. Roads and communication, Riii. The Roman military presence, Riv. Native and civilian life, Rvi. Trade and industry, Rvii. Religion, Rviii. Burial and Rix. Landscape and environment.

Methods statement

- 2.6 The surveys have been undertaken in accordance with instructions from the client, with survey proposals and a methods statement prepared by Archaeological Services Durham University, and with national standards and guidance (see para. 5.1 below).
- 2.7 Since the survey areas all lie within the scheduled monument the surveys were undertaken in accordance with a licence granted by Historic England under Section 42 of the Ancient Monuments and Areas Act 1979 (as amended by the National Heritage Act 1983). A Historic England Geophysical Survey Database Questionnaire is included as an Appendix to this report.

Dates

- 2.8 Fieldwork was undertaken on the 22nd and 24th August 2017. This report was completed in December 2017.

Personnel

- 2.9 Fieldwork was conducted by Duncan Hale (Senior Archaeologist) and Mark Woolston-Houshold (Archaeological Geophysicist). The geophysical data were processed by Duncan Hale and Richie Villis (Senior Geophysicist). This report was prepared by Duncan Hale (the Project Manager) with illustrations by Dr Helen Drinkall and Janine Watson.

Archive/OASIS

- 2.10 The site code is **LLW17**, for Lanchester Longovicium West of the fort 2017. 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 Online AccesS to the Index of archaeological investigations project (**OASIS**). The OASIS ID number for this project is **archaeol3-303110**.

Acknowledgements

- 2.11 Archaeological Services is particularly grateful to the landowner, Mr Nicholas Greenwell, and to The Lanchester Partnership, The Friends of *Longovicium* and Historic England for facilitating this work.

3. Historical and archaeological background

- 3.1 The Roman fort of *Longovicium* was built in around AD150 and covers an area of about 2.3ha. It was rebuilt around AD230 and again in the early 4th century. The fort was a later addition to a chain of defensive forts along the Roman road of Dere Street. Detailed background information is presented elsewhere (for example, Casey *et al.* 1992; The Friends of *Longovicium* 2007 & 2011).
- 3.2 Previous archaeological work has shown that the interior of the fort could have held up to 1,000 soldiers and included barracks, granaries and a *praetorium* or commandant's house, and that there were aqueducts and a cemetery to the west and south-west of the fort (for example, Casey *et al.* 1992; Turner 1990). Elsewhere outside the fort geophysical surveys have shown that there was an extensive *vicus* to the north, east and south-east, along the line of Dere Street (Archaeological Services 2008a, 2008b, 2009, 2013; Cousins 1990; Noel *et al.* 1991; Payne 1991), that the remains of ditched enclosures, roads, pits, reservoirs and possible fired features survived to the west and south of the fort (Archaeological Services 2014), and that buildings in the field immediately south of the fort may have included a bath-house and Mithraeum (Cousins 1990; Noel *et al.* 1991).
- 3.3 In addition to the above, several small geophysical surveys were undertaken by Durham University students in the 1990s, with mixed results, in the fields immediately east and south of the fort.
- 3.4 Geophysical instrumentation and software have developed considerably since the first geophysical surveys at *Longovicium* in the early 1990s. Advances in technology now enable very high density datasets to be collected rapidly with great sensitivity and precision using multi-sensor arrays. In addition, global navigation satellite systems with real-time kinematic correction can now be integrated with these multi-sensor magnetometer arrays to enable positional data of 5-10mm accuracy to be logged simultaneously with the magnetic gradient data.

- 3.5 Although the early surveys demonstrated the efficacy of both geomagnetic and earth resistance techniques at the site (with excellent gradiometer results over the fort and two adjacent areas, in particular), much of the data from those surveys are lost or were stored in formats that are now obsolete. This, together with recent advances in survey technology, supports the case for re-surveying some of those areas when opportunities arise. With the kind permission of Mr Greenwell, and under the licence provided by Historic England, it was possible to include one such area south of the fort during the present survey programme.

4. Landuse, topography and geology

- 4.1 At the time of survey, the three western fields contained cereal stubble while the southern field contained grass, over 1m high in places.
- 4.2 The fort, *vicus* and associated features occupy high ground at the eastern end of a ridge, with extensive views in each direction. The land drops away north down to Alderdene Burn, east down to Lanchester and south down to the River Browney.
- 4.3 Area 1 was predominantly level with elevations typically between 183-184m OD. Area 2 was broadly level, rising gradually towards the west up to about 189m OD. Area 3 occupied a very gentle south-east-facing slope with elevations between 178-188m OD. Area 4 occupied the same very gentle south-east-facing slope but contained more variable topography, with elevations between 173-182m OD.
- 4.4 The underlying solid geology comprises strata of the Pennine Lower Coal Measures Formation, including mudstone, siltstone and sandstone with coal seams. In Areas 3 and 4 these strata were overlain by Devensian till.

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, 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 considered likely that cut features such as ditches and pits would be present on the site, and that other types of

feature such as trackways, wall foundations and fired structures (for example kilns and hearths) might also be present.

- 5.4 Given the anticipated shallow depth of targets and the non-igneous geological environment of the study area a geomagnetic technique, fluxgate gradiometry, was considered appropriate for detecting the types of feature mentioned above. This technique involves the use of 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.

Field methods

- 5.5 For the first time at this site, measurements of vertical geomagnetic field gradient were determined using a Sensys Magneto MX V3 multi-sensor magnetometer survey system towed by a quad-bike. Eight FGM650/3 fluxgate gradiometer sensors, with a resolution of less than 0.2nT, were mounted at 0.5m intervals on a frame. The sensors logged gradient data at less than 0.08m intervals as the array was towed along parallel traverses, providing high density data collection.



Multi-sensor gradiometer array in Area 1

- 5.6 Data collection point locations were recorded in relation to the Ordnance Survey (OS) National Grid using an integrated global navigation satellite system (GNSS) with real-time kinematic (RTK) correction typically providing 5-10mm accuracy.
- 5.7 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

- 5.8 Sensys MonMX, DLMGPS and MagnetoARCH software were used to record and display gradient and positional data and to create greyscale images of gridded values at 0.2m by 0.2m intervals. TerraSurveyor software was used to process and produce continuous tone greyscale images of both the raw (minimally processed) and filtered data and to produce trace plots of the filtered data. The greyscale images and trace

plots are presented in Figures 3-5; geophysical and archaeological interpretations are presented in Figures 6-7. In the greyscale images, positive magnetic anomalies are displayed as dark grey and negative magnetic anomalies as light grey. A palette bar relates the greyscale intensities to anomaly values in nanoTesla.

5.9 The following basic processing functions have been applied to each dataset:

<i>clip</i>	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
<i>de-spike</i>	locates and suppresses iron spikes in gradiometer data
<i>interpolate</i>	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.1m x 0.1m intervals

5.10 The following filter has been applied to the geomagnetic data:

<i>low pass filter</i>	(applied with Gaussian weighting) to remove high frequency, small-scale spatial detail; for enhancing larger weak features and smoothing data
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Interpretation: anomaly types

5.11 A colour-coded geophysical interpretation plan is provided. Three types of geomagnetic anomaly have been distinguished in the data:

<i>positive magnetic</i>	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
<i>negative magnetic</i>	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
<i>dipolar magnetic</i>	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

Interpretation: features

General comments

5.12 A colour-coded archaeological interpretation plans is provided. For ease of reference, anomaly numbers shown bold in the text below (eg **1a**, **1b**, etc) are also shown on the archaeological interpretation plan.

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

- 5.14 Series of parallel, weak, positive (and occasionally also negative) magnetic anomalies have been detected across each area. The anomalies are regularly spaced at 5-6m intervals and almost certainly reflect former ridge and furrow cultivation.
- 5.15 Series of closely-spaced positive and negative magnetic striations have been detected across Areas 1-3, which reflect the current plough regime.
- 5.16 Small, discrete, strong positive and dipolar magnetic anomalies have been detected in each survey area. Some of these will almost certainly reflect relatively recent items of near-surface ferrous and/or fired debris, such as ploughshare fragments, horseshoes and brick fragments, for example, with little or no archaeological significance. In this instance, however, it is also likely that some or many of these anomalies, particularly in Areas 1, 3 and 4, could reflect archaeological materials and features, including ferrous and fired industrial waste, artefacts, ovens and kilns, pits and large postholes. A sample of these anomalies is therefore shown on the interpretation plans.

Area 1

- 5.17 Several linear positive magnetic anomalies have been detected, particularly in the north of the area, which probably reflect soil-filled ditches.
- 5.18 One broad, strong anomaly near the eastern edge of the field (**1a**) is oriented parallel to the field wall and the fort; the edge of another similar anomaly was detected beneath the field wall in 2014. These anomalies almost certainly reflect the infilled remains of ditches around the fort. The remains of a causeway are evident across the outer, western, ditch. This is consistent with a road being present here, leaving the fort by the *Porta Decumana*. A very weak linear positive magnetic anomaly which was detected to the west of the causeway could reflect a drainage ditch (**1b**) along the side of this road; this ditch could also mark the northern side of a system of enclosures, however, the evidence is not clear. The rockhead is particularly shallow in this field, and to the west (Areas 1 & 2), and ploughing over the years is likely to have removed any shallow features in these areas.
- 5.19 Some of the stronger linear anomalies in the north-east of the area (**1c**) almost certainly reflect the remains of an enclosure there, on the north side of the probable road mentioned above. Some discrete, strong magnetic anomalies (**1d**) detected within the enclosure could reflect the bases of fired features such as ovens, kilns or furnaces. Additional smaller discrete anomalies in this part of the field could reflect pits, possibly large postholes and near-surface debris, perhaps associated with the possible fired features.
- 5.20 Several weak, narrow linear anomalies (**1e**) detected in the north of this area could possibly reflect the boundaries of small paddocks or fields.
- 5.21 Broad linear positive magnetic anomalies have been detected in the north-west of this area. The anomalies are typical of soil-filled features, though the irregular northern anomalies may reflect soil-filled fissures rather than archaeological features. The southernmost of the anomalies (**1f**) is quite regular in shape, is aligned east-west and continues westwards across Area 2. It is possible that this represents part of an aqueduct associated with the reservoir near the fort's south-west corner. The fort had an elaborate aqueduct system, with three known branches originating

on higher ground to the west. The aqueducts have suffered considerable damage since they were described by Hodgson (1822) but research by the Lanchester Society of Antiquaries in the 1970s managed to trace some surviving parts (Reed & Austin 1976). The nearest surviving trace may now be next to Hollinside Terrace, approximately 1km south-west of the fort, though Reed & Austin record the course of the aqueduct continuing close to the road as far as the north-west corner of Area 1, from where it turns southward to the reservoir. There is some evidence for a possible linear feature on the course of the aqueduct shown by Reed & Austin in the north-west corner of Area 1, though this would cross the enclosure detected in that area.

Area 2

- 5.22 Several more probable soil-filled features were detected across this area. One of the anomalies (2a) is a continuation of the possible aqueduct detected in Area 1. Another similar anomaly (2b), aligned north-east/south-west across Area 2, might possibly be associated with 2a. Many of the anomalies in this area are weak, probably due to truncation of the sub-surface features by ploughing, and so it is not clear if this anomaly joins 2a.
- 5.23 Elsewhere in this area, several other linear anomalies almost certainly reflect ditched boundaries (2c), some of which extend southward into Area 3, forming enclosures and probable fields. Two relatively strong parallel anomalies (2d), aligned north-west/south-east, could reflect ditches either side of a former track, as they align with a broad gap between more enclosures to the south in Area 3.

Area 3

- 5.24 A particularly high concentration of magnetic anomalies was detected throughout this field. Whilst some of these reflect current and former ploughing, many others almost certainly reflect archaeological remains. The features appear to be less truncated in this field; presumably a greater depth of soil has helped preserve more features beneath the ploughzone.
- 5.25 A series of ditched enclosures has been detected across most of the field, together with double-ditched trackways. The enclosures are generally rectilinear and most share boundaries with adjacent enclosures. One relatively large enclosure (3a) in the west of the field appears to be separated from any others by a broad track to the east and a relatively open area to the south.
- 5.26 A broad, weak, irregularly-shaped but well-defined positive magnetic anomaly (3b) at the south-east corner of the larger enclosure almost certainly reflects a greater depth of magnetically enhanced soil there and is probably a shallow infilled quarry. Two similar, though smaller, anomalies detected just to the north of the enclosure probably also reflect former quarry pits (3c, 2e).
- 5.27 The number of strong, discrete, anomalies detected increases towards the central and eastern parts of the field. As noted above, some of these will almost certainly reflect relatively recent materials and features (including pits and near-surface ferrous and/or fired debris), however, in this instance, it is also likely that some or many of these anomalies reflect archaeological materials and features, including ferrous and fired industrial waste, artefacts, ovens and kilns, pits and large postholes. Some of the larger (3-4m diameter), strong anomalies could reflect the

remains of features such as furnaces or kilns, or possibly pits containing ferrous or fired waste; several such anomalies have been detected here (3d), often occurring in pairs, similar to two anomalies in Area 1 (1d). It is likely that these larger anomalies do reflect the remains of fired structures, probably associated with metalworking, and that this area served as an industrial zone outside the south-western corner of the fort.

- 5.28 Coal was readily available in the general area and metal ores were mined nearby. The presence of two dams and the aqueducts associated with the fort, as well as local springs, attest to the considerable use of water at the fort and vicus. As well as provisioning kitchens, baths and latrines, this water supply could have been used for smithing and smelting in this area. Indeed, such were the apparent quantities of hearths, cinders and slaking troughs outside the fort that in 1822 Hodgson reports the local population here concluded that the Romans were 'a tribe of smiths' (The Friends of *Longovicium* 2011).
- 5.29 Although there are no apparent concentrations of industrial waste adjacent to these potential kilns or furnaces, there are two large concentrations in the north-east of the area, one of which corresponds to a presumed Roman reservoir (3e) as shown on early Ordnance Survey maps. The reservoir is evident in the data as a sub-rectangular concentration of particularly strong anomalies. The anomalies could reflect industrial waste, building rubble and other materials used to infill the hollow associated with the reservoir. A weak and diffuse positive anomaly heads south from the south-west corner of the reservoir. This could possibly be the remains of a drain associated with the reservoir.
- 5.30 Another cluster of strong magnetic anomalies has been detected just west of the above reservoir. These anomalies could reflect similar materials used to infill the remains of a second reservoir (3f); a slight depression is also evident on the ground here.
- 5.31 Further anomalies of probable archaeological origin detected south of the reservoirs take the form of linear and rectilinear anomalies, almost certainly reflecting ditches and gullies, enclosures and drains, and possibly also foundation trenches and stone footings, stone drains or kerbs.

Area 4

- 5.32 There is no recent plough texture in the data from this field, though traces of earlier ploughing are present, aligned parallel to the fort's south wall.
- 5.33 Part of the fort's south ditch (4a) is evident in the survey, with an abrupt break towards the east, opposite the south gate. A strong positive magnetic anomaly (4b) which heads south-east from the south gate almost certainly reflects a former channel or drain along the west side of the road that joins Dere Street a little further south.
- 5.34 A considerable number of negative magnetic anomalies have been detected in this field, many of which are well-defined and rectilinear in shape. These anomalies almost certainly reflect stone wall foundations for many buildings. Several buildings have been detected to both sides of the road; those to the west (4c) appear to comprise a series of regularly sized cells or rooms, typically 4-5m across, which

contain very strong magnetic anomalies. These anomalies appear to fill many of the rooms and it is likely that they reflect fired materials such as clay tiles, pipes, flues and *pilae* associated with hypocaust heating systems. It is likely that this range of rooms is the fort's bath-house, which was reported to have stood near the fort's south-east corner.

- 5.35 Similar-sized wall foundations (4d) were detected across the road to the east, with larger buildings (4e) identified to the south of them. Much of the interiors of these buildings are also characterised by strong anomalies, again probably reflecting fired clay tiles. Buildings in this south-east corner of the survey appear to measure between 10m and 15m in length and some correspond to a broad raised area evident on the ground.
- 5.36 At least three further buildings have been detected near the south-western edge of this field. As elsewhere in this area, some of the building plans are remarkably clear and indicate that the foundations at least, and possibly some lower floor levels, may be relatively undisturbed. At least two, perhaps three, buildings (4f) have been detected close to the dog-leg in the southern field boundary. These buildings are of uncertain length but measure approximately 5m in width.
- 5.37 Further walls have been detected in the south-west corner of the field. Some of these form a rectangular structure (4g), measuring approximately 15m east-west by 5m north-south. A concentration of strong magnetic anomalies in the west end of this building may indicate that there was a heated room at its west end.
- 5.38 Several linear positive magnetic anomalies in this area again probably reflect former ditches and pits associated with the settlement. Two curvilinear anomalies in the west of the field appear to define a double-ditched track, which probably post-dates the fort.
- 5.39 A ferrous pipe was detected close to this field's western boundary.

6. Conclusions

- 6.1 Approximately 9ha of high resolution magnetic survey was undertaken on land to the west and south of *Longovicium* Roman fort, Lanchester, County Durham, as part of ongoing research conducted by the Friends of *Longovicium*.
- 6.2 The surveys have extended the coverage of previous surveys and detected many new features of archaeological significance, including a possible aqueduct, field systems and enclosures, a probable industrial area and a considerable number of buildings, almost certainly including a bath-house.
- 6.3 The field immediately south of the fort (Area 4) had been surveyed in 1991 but was re-surveyed here with state-of-the-art instrumentation and software. The 1991 survey was exemplary at the time, but the present survey has demonstrated the advantages of current technology, enabling the rapid survey of areas with high density sampling, high resolution of anomalies, unparalleled positional accuracy and the removal of errors associated with surveyors walking with hand-held instruments.

- 6.4 Relatively few archaeological features survive to the immediate west of the fort due to the shallow rockhead there and ploughing over many years. However, there appears to be a greater depth of soil further west and south, and this has helped preserve more features in those areas.
- 6.5 An enclosure detected in Area 1, close to the north-west corner of the fort, contains two anomalies which could reflect fired structures, possibly kilns or ovens.
- 6.6 The possible course of the fort's main aqueduct may have been detected west of the fort, across Areas 1 and 2. Parts of a former field system and track have also been detected in Area 2. These features continue into Area 3 to the south, where many more enclosures are evident.
- 6.7 Many strong discrete anomalies were detected in Area 3, increasing towards the east. It is likely that several of the larger examples probably reflect furnaces for smithing or smelting. This land to the south-west of the fort appears to have been an industrial area, perhaps producing metal fittings for soldiers and horses, as well as tools, nails, weapons, utensils and many other items. A readily available supply of coal, metal ores and water would have facilitated this industry.
- 6.8 A considerable number of buildings have almost certainly been detected just south of the fort. One large building near the south gate contains several rooms, some of which probably contained hypocaust heating. This is almost certainly the fort's bath-house, previously reported to have been sited near the south-east corner of the fort. Several other buildings in this area also appear to be well-defined in the survey data and some of these may also have had hypocausts, or at least an abundance of tiles.
- 6.9 The use of the multi-sensor magnetometer system in these areas has provided a very clear, detailed and accurate map of subsoil features close to the fort. Some areas around the fort are yet to be surveyed, and some previously surveyed areas would benefit from being re-surveyed with the technology now available.

7. Sources

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Appendix: Geophysical Survey Database Questionnaire



Historic England

English Heritage Geophysical Survey Database Questionnaire

Survey Details

Name of Site: LONGOVICIUM ROMAN FORT AND VICUS

County: DURHAM

NGR Grid Reference: fort centre NZ 15945 46898

Start Date: 22 AUGUST 2017 **End Date:** 7 DECEMBER 2017

Geology at site (Drift and Solid):

The underlying solid geology comprises strata of the Pennine Lower Coal Measures Formation, including mudstone, siltstone and sandstone with coal seams. In Areas 3 and 4 these strata were overlain by Devensian till.

Known archaeological Sites/Monuments covered by the survey

(Scheduled Monument No. or National Archaeological Record No. if known)
LANCHESTER ROMAN FORT (LONGOVICIUM), LANCHESTER, CO DURHAM
Scheduled Ancient Monument, Asset UID 100236

Archaeological Sites/Monument types detected by survey

(Type and Period if known. "?" where any doubt).

Roman fort ditches, roadside ditches, enclosure ditches, infilled reservoirs and quarry pits, buildings (including bath-house), pits, industrial area with probable furnaces/ovens/hearths

Surveyor (Organisation, if applicable, otherwise individual responsible for the survey):

Duncan Hale, ARCHAEOLOGICAL SERVICES DURHAM UNIVERSITY

Name of Client, if any:

LANCHESTER PARTNERSHIP (THE FRIENDS OF LONGOVICIUM)

Purpose of Survey: RESEARCH

Location of:

a) Primary archive, i.e. raw data, electronic archive etc:
ARCHAEOLOGICAL SERVICES DURHAM UNIVERSITY

b) Full Report:

LANCHESTER PARTNERSHIP (THE FRIENDS OF LONGOVICIUM)
DURHAM COUNTY COUNCIL ARCHAEOLOGY SECTION/SMR
ENGLISH HERITAGE (NORTH EAST OFFICE, NEWCASTLE)
ENGLISH HERITAGE (GEOPHYSICS SECTION, PORTSMOUTH)
OASIS ref: **archaeol3-303110**
ARCHAEOLOGICAL SERVICES DURHAM UNIVERSITY

Technical Details

(Please fill out a separate sheet for each survey technique used)

Type of Survey (Use term from attached list or specify other):

MAGNETOMETRY

Area Surveyed, if applicable (In hectares to one decimal place): 8.8HA

Traverse Separation, if regular: 0.5m **Reading/Sample Interval:** 0.1m

Type, Make and model of Instrumentation:

SENSYS MAGNETO MX V3 MULTI-SENSOR MAGNETOMETER ARRAY

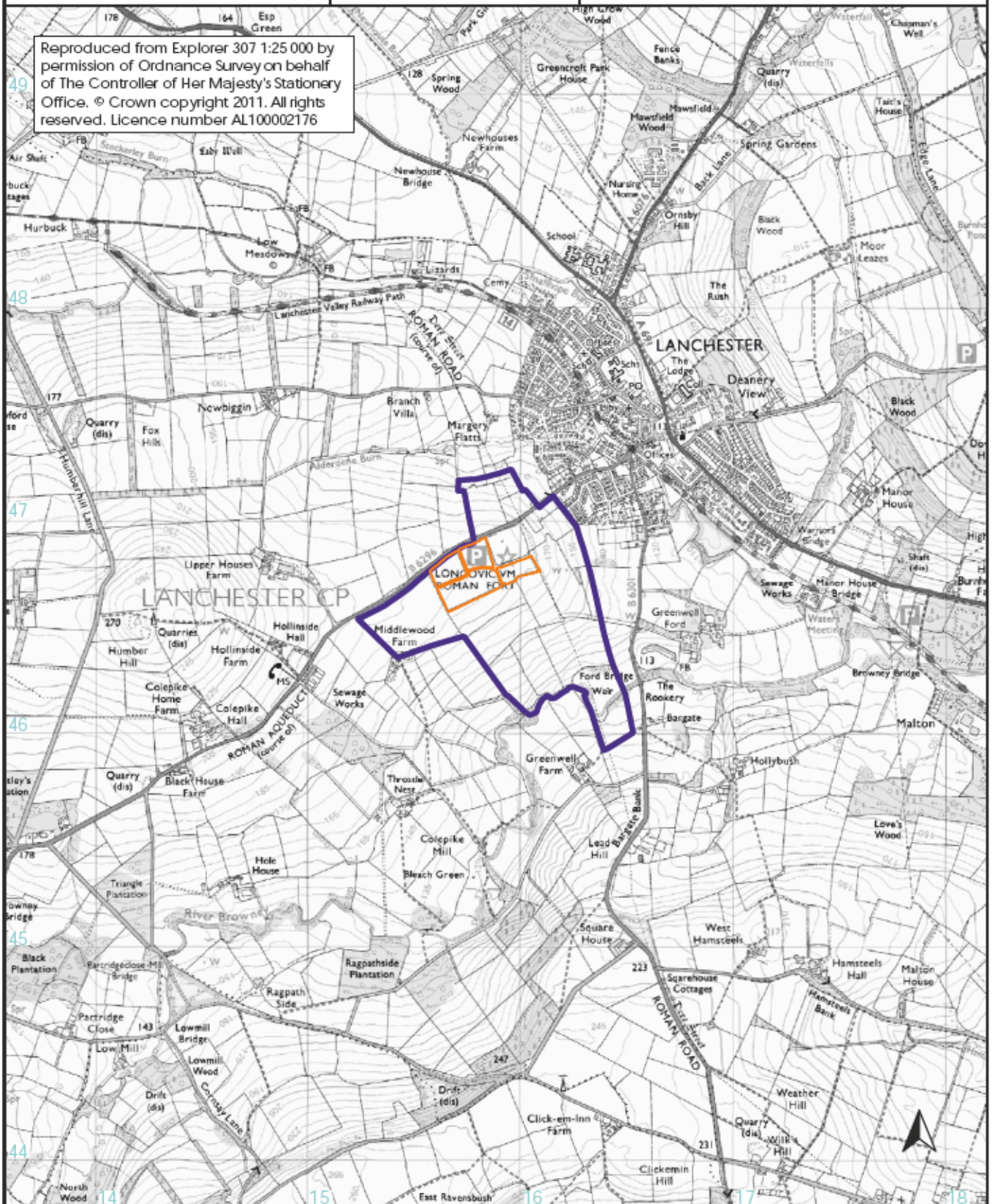
Land use at the time of the survey (Use term/terms from the attached list or specify other):

AREAS 1-3: CEREAL STUBBLE

AREA 4: GRASSLAND

Additional Remarks (Please mention any other technical aspects of the survey that have not been covered by the above questions such as sampling strategy, non standard technique, problems with equipment etc.):

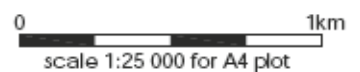
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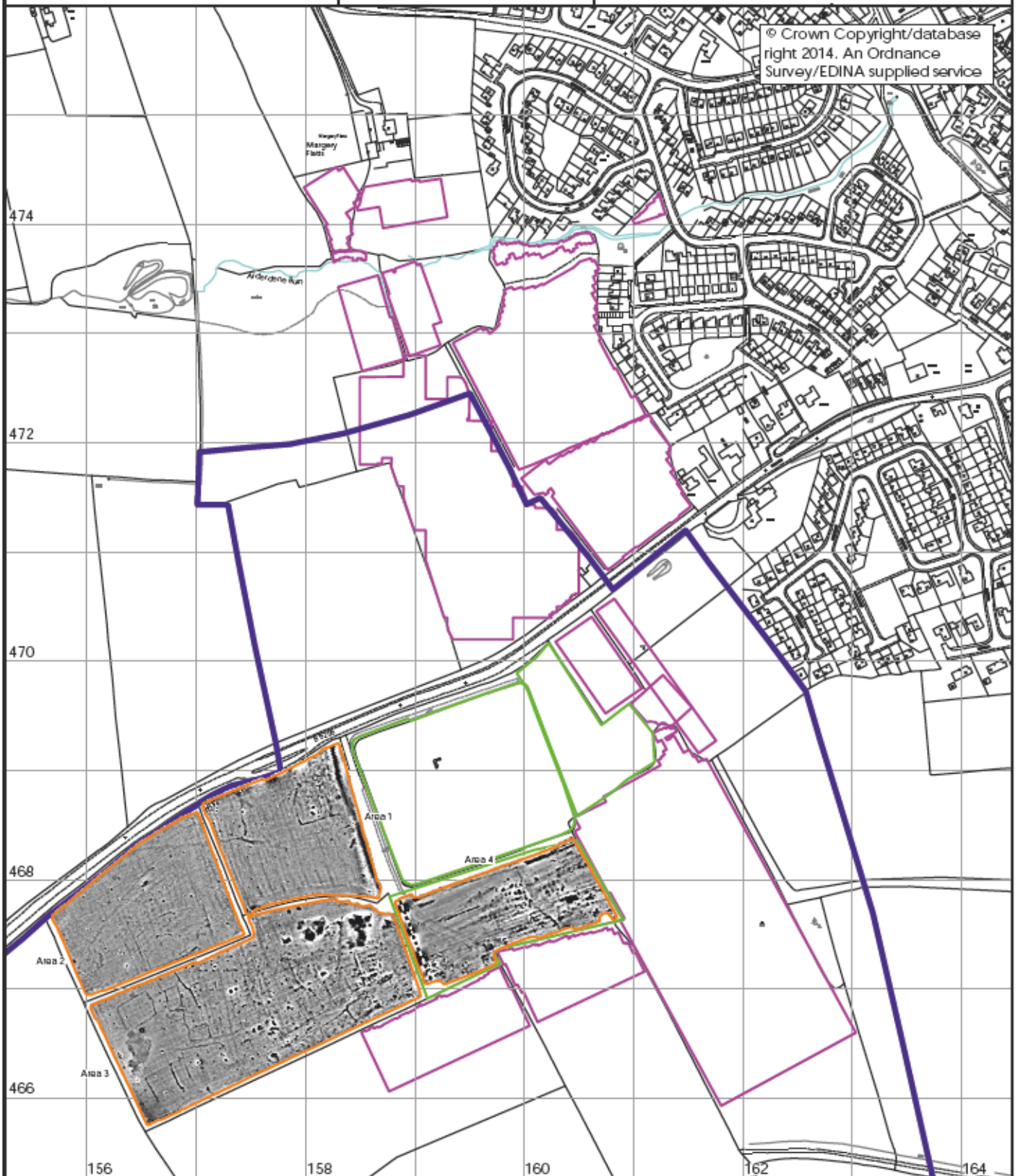


scheduled ancient monument



geophysical survey





scheduled monument



Geoquest 1991 survey



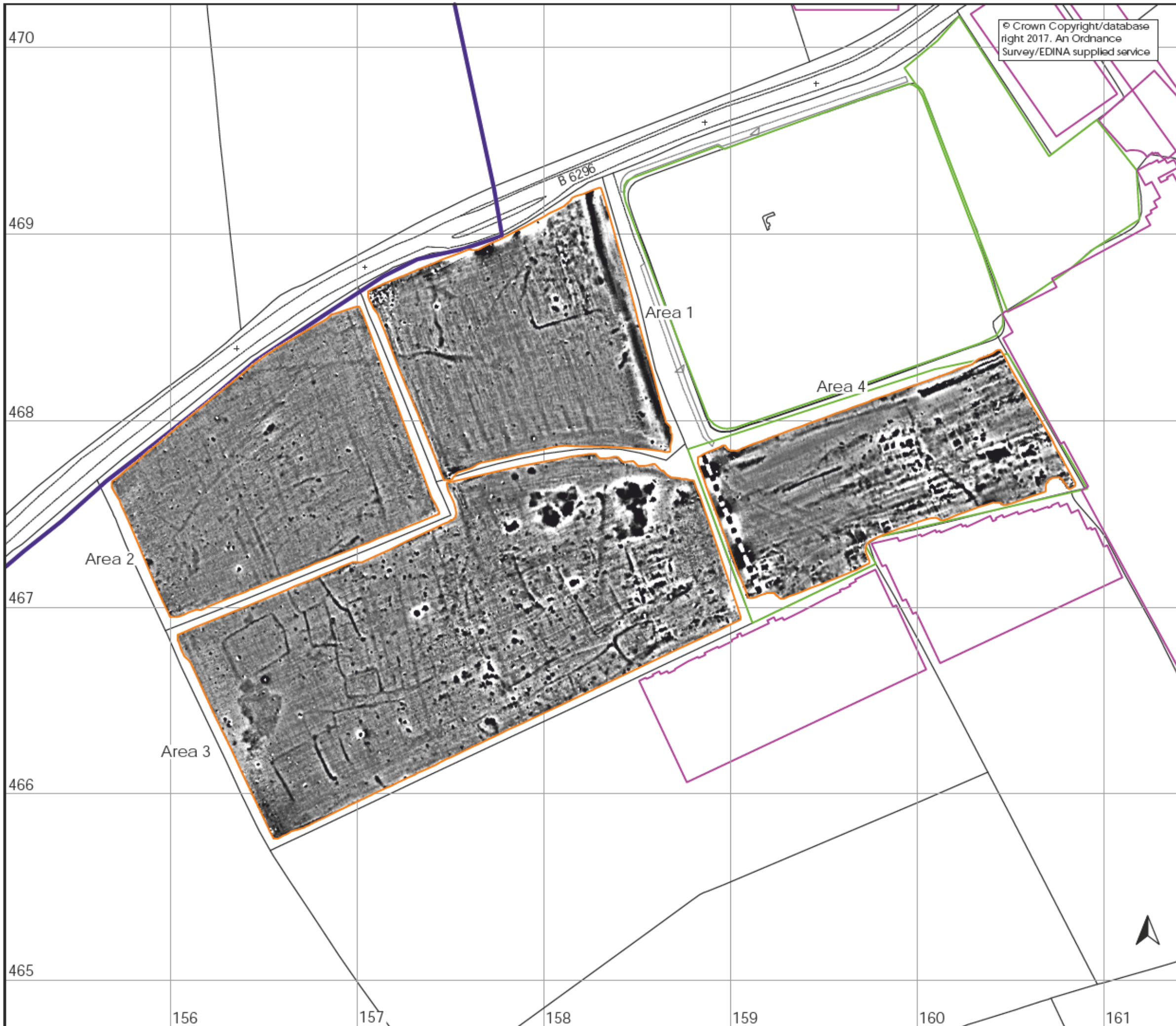
previous Archaeological Services surveys



2017 geophysical survey



0 250m
scale 1:5000 for A4 plot



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ARCHAEOLOGICAL SERVICES

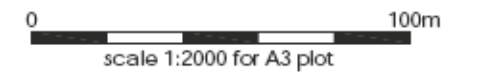
DURHAM UNIVERSITY




on behalf of
The Lanchester Partnership
(Friends of *Longovicium*)

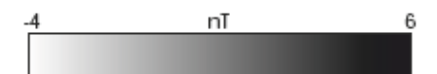
Land west and south of *Longovicium*
Lanchester
County Durham

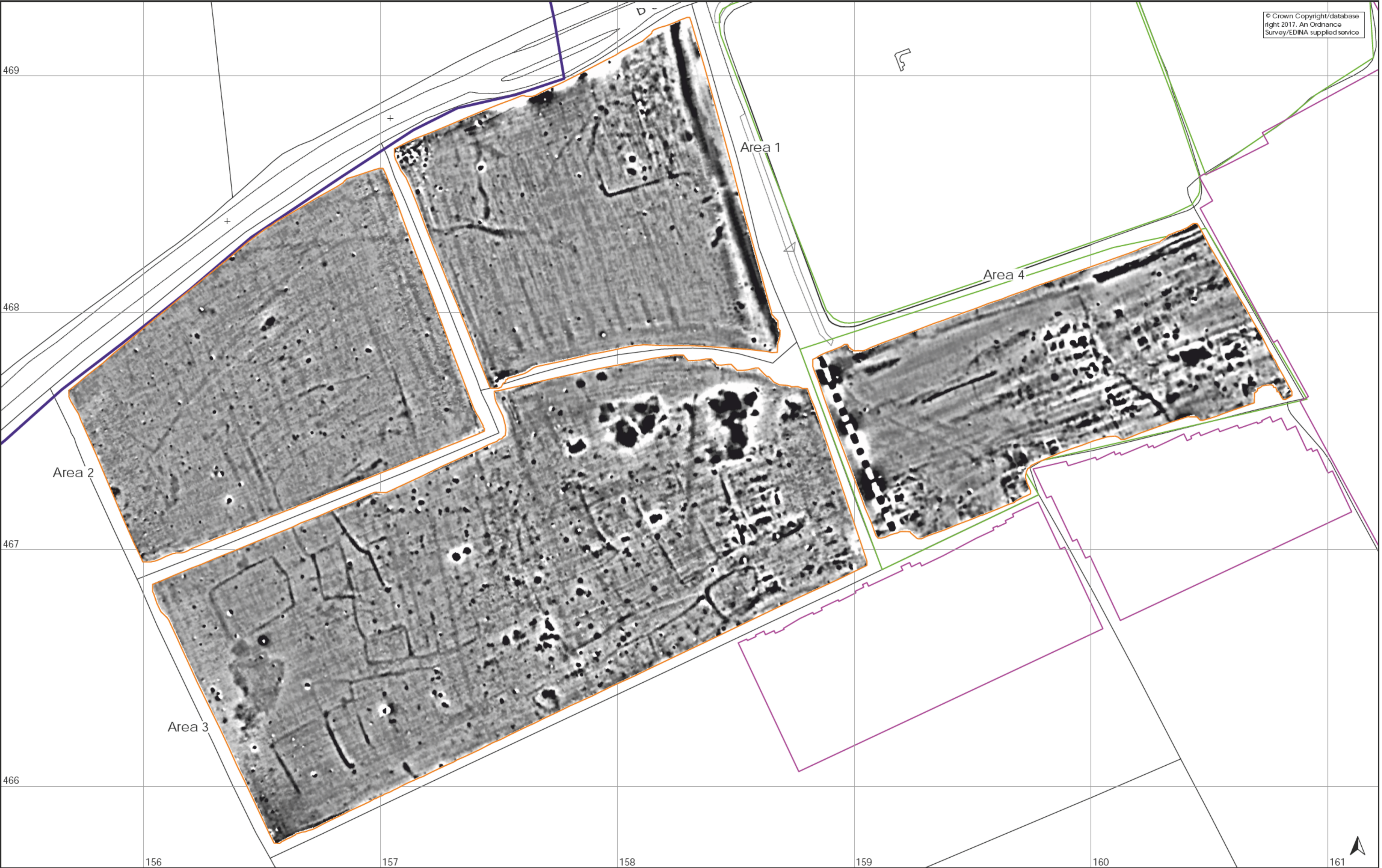
geophysical survey
report 4575




Figure 3: Geophysical survey overview

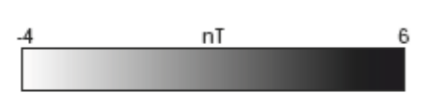


-  magnetic survey
-  previous Archaeological Services survey
-  Geoquest 1991 survey





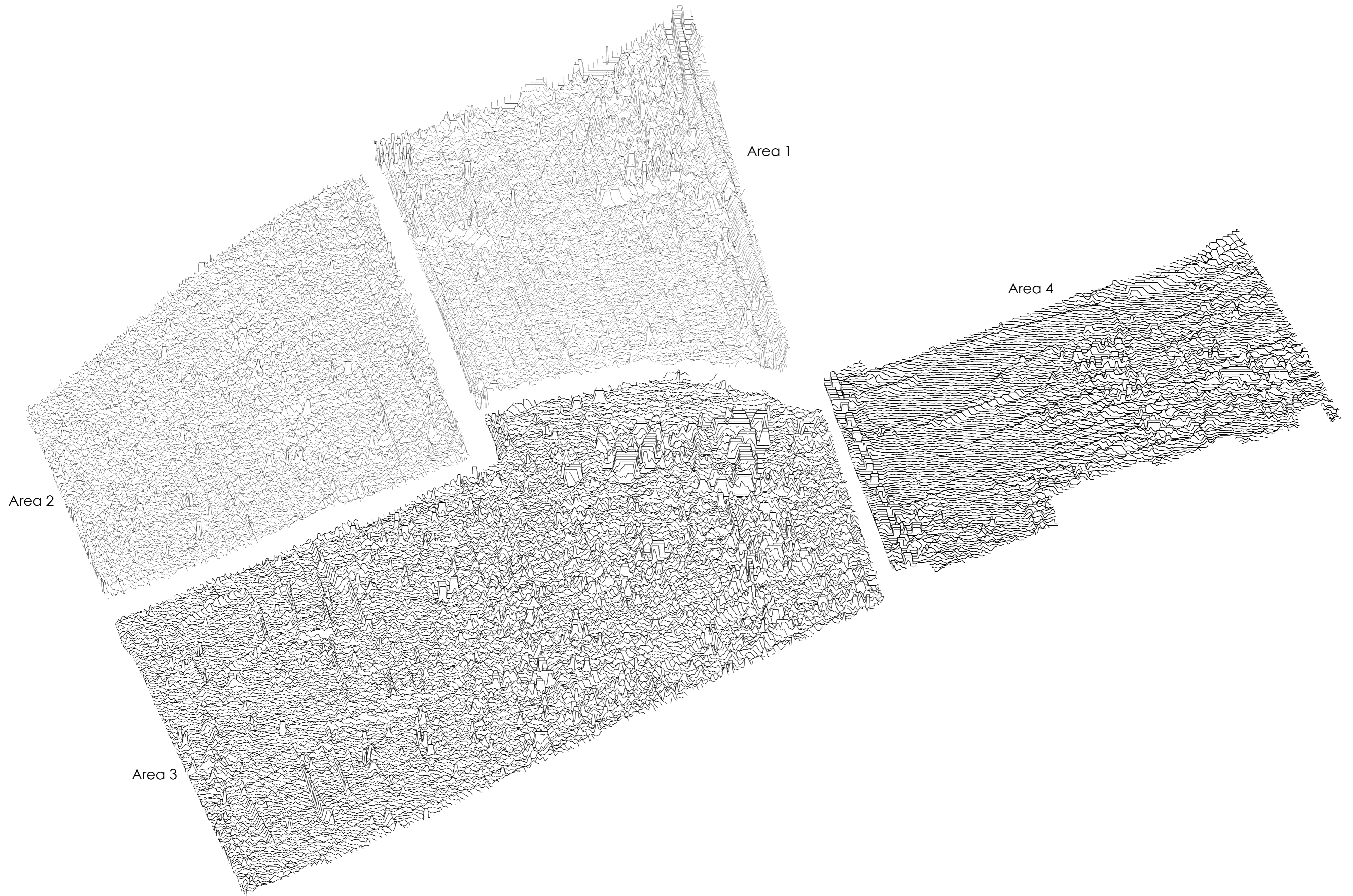
-  magnetic survey
-  previous Archaeological Services survey
-  Geoquest 1991 survey



on behalf of
The Lanchester
Partnership
(Friends of
Longovicium)



Land west and south of *Longovicium*
Lanchester
County Durham
geophysical survey
report 4575
Figure 4: Geophysical survey (filtered data)



Areas 1 and 2

15.00nT/cm

Areas 3 and 4

40.00nT/cm

0 50m
scale 1:1000 for A2 plot

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Lanchester
County Durham

geophysical survey
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Figure 5: Trace plots of geomagnetic data



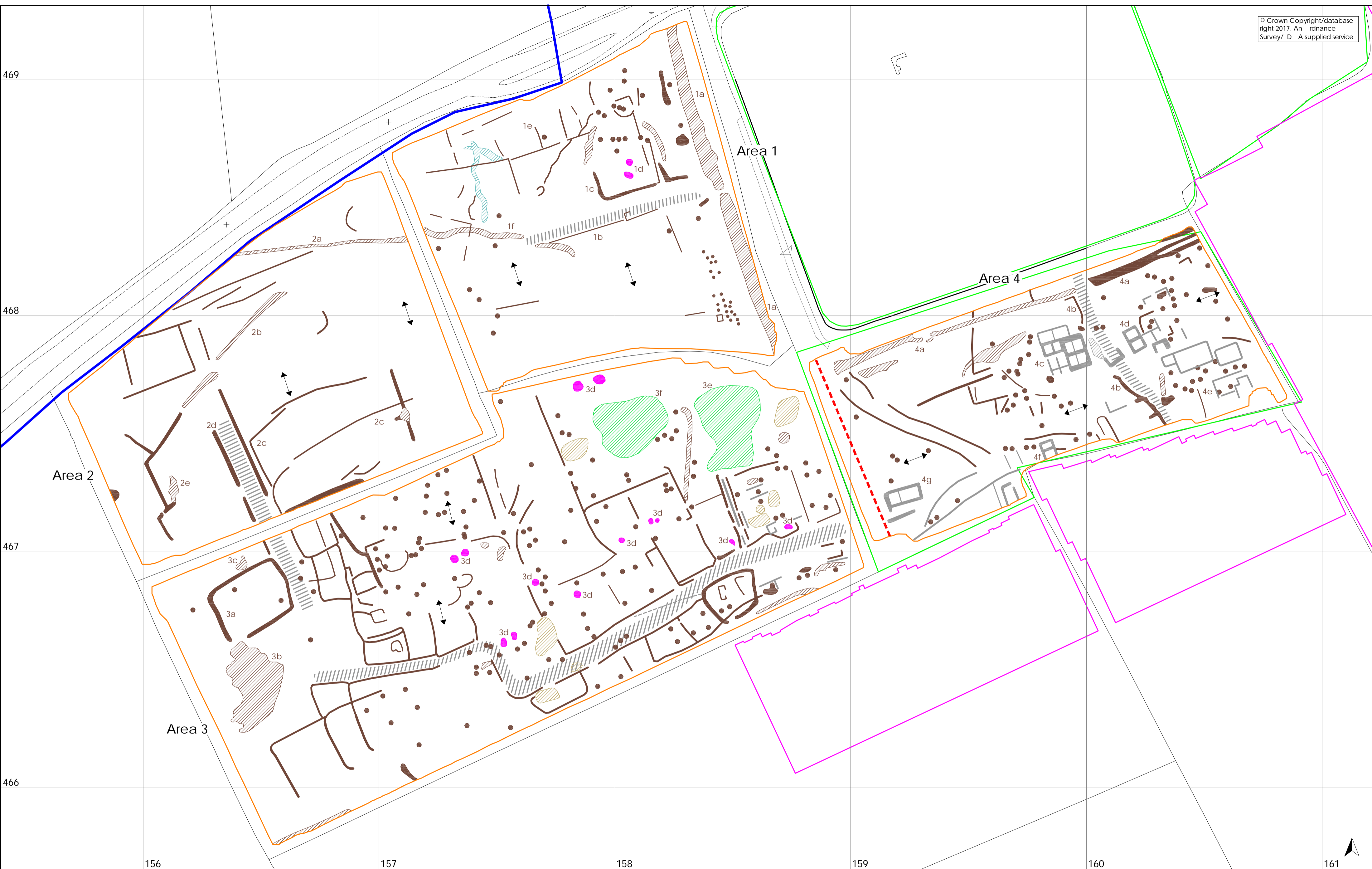
 magnetic survey	 positive magnetic anomaly
 previous Archaeological Services survey	 negative magnetic anomaly
 Geoquest 1991 survey	 dipolar magnetic anomaly

0  50m
scale 1:1000 for A2 plot

on behalf of
The Lanchester
Partnership
(Friends of
Longovicium)



Land west and south of *Longovicium*
Lanchester
County Durham
geophysical survey
report 4575
Figure 6: Geophysical interpretation



magnetic survey	possible stone footing	geological feature	ridge and furrow
previous Archaeological Services survey	industrial debris	presumed Roman reservoir	former tracks
Geoquest 1991 survey	soil filled feature	service pipe	possible kiln/furnace

0 50m
scale 1:1000 for A2 plot

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The Lanchester
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Longovicium)

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Lanchester
County Durham
geophysical survey
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Figure 7 Archaeological interpretation