ARCHAEOLOGICAL
SERVICES
DURHAM UNIVERSITY

on behalf of

AOC Archaeology Group

Orchard View
Eskbank
Dalkeith
Midlothian

geophysical survey

report 2601
February 2011

Durham University

Contents

Figures

South Road · Durham · DH1 3LE · tel 0191 334 1121 · fax 0191 334 1126
archaeological.services@durham.ac.uk · www.dur.ac.uk/archaeological.services

1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted in advance of proposed development west of Orchard View, Eskbank, Dalkeith, Midlothian. The works comprised 3.5ha of geomagnetic survey and 2ha of earth electrical resistance survey.

1.2 The works were commissioned by AOC Archaeology Group and conducted by Archaeological Services Durham University.

Results

1.3 Anomalies reflecting a change in geology were detected in the northern half of the survey area.

1.4 Possible pits, ditches and accumulations of stone were identified in the north of the site matching features identified from aerial photographs. Additional possible features including ditches, a ring ditch and a pit alignment not shown on the aerial photographs were identified. These features may be geological in origin.

1.5 A land drain was identified aligned northeast-southwest across the site which corresponds to the position of a feature identified as a Roman ditch from aerial photographs. Further land drains were also identified across the site.

1.6 Modern services and a possible mine shaft were also identified.

2. Project background

Location (Figure 1)

2.1 The survey area was located west of Orchard View, Eskbank, Dalkeith, Midlothian (NGR centre: NT 3187 6685). Approximately 3.5ha of geomagnetic survey and 2ha of earth electrical resistance survey was conducted in one land parcel. The site is bounded to the east and north by woodland, to the south by the A768 Lasswade Road and to the west by farmland.

Development proposal

2.2 The development proposal is for a new residential development.

Objective

2.3 The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological significance within the survey area, so that an informed decision may be made regarding the nature and scope of any further scheme of archaeological works that may be required in relation to the development.

Methods statement

2.4 The surveys have been undertaken in accordance with instructions from the client and with current national standards and guidance (see para. 5.1 below).

Dates

2.5 Fieldwork was undertaken between 7th and 10th February 2011. This report was prepared for 24th February 2011.

Personnel

2.6 Fieldwork was conducted by Edward Davies, Tudor Skinner and Natalie Swann (Supervisor). The geophysical data were processed by Natalie Swann. This report was prepared by Natalie Swann with illustrations by Edward Davies and edited by Duncan Hale, the project manager.

Archive/OASIS

2.7 The site code is **DEB11**, for **D**alkeith**, E**sk**b**ank 20**11**. The survey archive will be supplied on CD to the client for deposition with the project archive in due course. Archaeological Services Durham University is registered with the **O**nline **A**cces**S** to the **I**ndex of archaeological investigation**S** project (**OASIS**). The OASIS ID number for this project is **archaeol3-49120**.

3. Historical and archaeological background

3.1 Oblique aerial photography has identified two suites of cropmark features occupying the survey area.

3.2 The first cropmark shows a pit alignment (NMRS NT36NW108), aligned roughly northwest- southeast which transects the northern part of the survey area. These cropmarks may represent a continuation of a pit alignment located to the southeast and excavated by Barber in 1981; a radiocarbon date of 110 +/- 70 BC was obtained from the primary deposits in one of the excavated pits (Barber 1985).

3.3 The second cropmark, located to the southeast of the pit alignment, is a linear feature believed to be the continuation of a Roman ditch revealed during excavations of a large Roman temporary camp that were carried out in 1972 prior to the construction of a housing estate to the immediate east of the survey area (Maxfield 1975).

3.4 The wider landscape is rich in archaeological remains; similar pit alignments to the one excavated by Barber were excavated northeast of the survey area during the construction of the A68 Dalkeith Northern Bypass; this excavation also revealed remains of a Roman temporary camp (Anderson 2010). The scheduled ancient monuments of Elginhaugh Roman temporary camp, native fort and palisaded enclosure (SAM 119) and Elginhaugh Roman fort, annexe and bathhouse (SAM 1236) lie to the north of the proposed development area.

4. Landuse, topography and geology

4.1 At the time of survey the proposed development area comprised a single field of arable land that was boggy and flooded in places.

4.2 The area was predominantly level with a mean elevation of approximately 73m OD. The site is bounded on its north edge by a steep scarp which falls to the valley of the River North Esk; the bottom of the valley lies at approximately 50m OD.

4.3 The underlying solid geology of the area comprises lower coal measures of the carboniferous period. In the north of the survey area this is overlain by glaciofluvial sheet deposits of sand and gravel. Across the rest of the survey area there is a drift geology of devensian till.

5. Geophysical survey

Standards

5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation* (David, Linford & Linford 2008); the Institute for Archaeologists (IfA) *Draft Standard and Guidance for archaeological geophysical survey* (2010); the IfA Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Guide to Good Practice: Geophysical Data in Archaeology* (draft 2nd edition, Schmidt & Ernenwein 2010).

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 aerial photographic cropmark evidence and previous work, it was considered likely that cut features such as ditches and pits might 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 shallowness 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 hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

5.5 Given the possibility of the presence of wall-footings and other structural remains an electrical resistance survey was considered appropriate. Earth electrical resistance survey can be particularly useful for mapping stone and brick features. When a small electrical current is injected through the earth it encounters resistance which can be measured. Since resistance is linked to moisture content and porosity, stone and brick features will give relatively high resistance values while soil-filled features, which retain more moisture, will provide relatively low resistance values.

Field methods

5.6 A 20m grid was established across the survey area and tied-in to known, mapped Ordnance Survey points using a total survey station instrument.

5.7 Measurements of vertical geomagnetic field gradient were determined using Bartington Grad601-2 dual fluxgate gradiometers. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was nominally 0.03nT, the sample interval was 0.25m and the traverse interval was 1.0m, thus providing 1600 sample measurements per 20m grid unit.

5.8 Measurements of earth electrical resistance were determined using Geoscan RM15D 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 set to 0.1ohm, the sample interval to 1.0m and the traverse interval to 1.0m, thus providing 400 sample measurements per 20m grid unit.

5.9 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

5.10 Geoplot v.3 software was used to process the geophysical data and to produce both continuous tone greyscale images and trace plots of the raw (minimally processed) data. The greyscale images and interpretations are presented in Figures 2-6 the trace plots are provided in Figure 7. In the greyscale images, positive magnetic and high resistance anomalies are displayed as dark grey and negative magnetic and low resistance anomalies as light grey. Palette bars relate the greyscale intensities to anomaly values in nanoTesla for the geomagnetic data and ohm for the electrical resistance data.

5.11 The following basic processing functions have been applied to the geomagnetic data:

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
zero mean traverse	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities
destagger	corrects for displacement of geomagnetic anomalies caused by alternate zig-zag traverses
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

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

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
add	adds or subtracts a positive or negative constant value to defined blocks of data; used to reduce discontinuity at grid edges
despike	locates and suppresses spikes in data due to poor contact resistance
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

Interpretation: anomaly types

5.13 Colour-coded geophysical interpretation plans are provided. Three types of geomagnetic anomaly have been distinguished in the data:

positive magnetic	regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches
negative magnetic	regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids
dipolar magnetic	paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths

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

high resistance	regions of anomalously high resistance, which may reflect foundations, tracks, paths and other concentrations of stone or brick rubble
low resistance	regions of anomalously low resistance, which may be associated with soil-filled features such as pits and ditches

Interpretation: features

5.15 A colour-coded archaeological interpretation plan is provided.

5.16 Broad bands of positive and negative magnetic anomalies and high and low resistance anomalies were detected aligned northwest-southeast across the survey area. These anomalies are likely to correspond to a change in geology from gravels and sands in the north to boulder clay (devensian till) in the south.

5.17 Several linear and rectilinear positive magnetic anomalies were identified northeast of the geological bands which may reflect soil-filled features such as ditches.

5.18 Several linear negative magnetic anomalies were also identified northeast of the geological bands which may reflect wall footings or concentrations of stone in the geology.

5.19 North of the main geological bands there is a large concentration of high resistance anomalies which are likely to correspond to the gravel geology in this part of the site. Within this area there are a number of low resistance anomalies that could reflect soil-filled features such as pits and ditches but may also reflect waterlogging within the geology, as this part of the site was waterlogged and flooded when the survey was undertaken.

5.20 In the northwest corner of the survey area a concentration of discrete positive magnetic anomalies was identified which may reflect soil-filled features such as pits and match a series of pits identified on aerial photographs of the site. A further concentration of possible pits was identified along the north edge of the site.

5.21 At the centre of the northern part of the survey area a ring of low resistance was detected which may reflect a small ring ditch approximately 11m across.

5.22 South of the geological bands two linear positive magnetic anomalies aligned in a T-shape were detected which may reflect soil-filled ditches.

5.23 West and north of these ditches there was a high concentration of discrete positive magnetic anomalies which could reflect soil-filled features such as pits. Some of these anomalies appear to form a pit alignment running northwest-southeast, on the south edge of the geological bands. These pits could possibly be a continuation of the pit alignment excavated to the east of the survey area in 1981. Between the pits two weak linear negative magnetic anomalies aligned northwest-southeast were detected which are likely to reflect gravel bands in the geology.

5.24 A chain of dipolar magnetic anomalies detected along the north and northeast edges of the survey area reflect a modern service pipe or cable and associated manholes.

5.25 Two intense dipolar magnetic anomalies within the survey reflect metal caps over geotechnical boreholes.

5.26 A linear negative magnetic anomaly was detected aligned northeast-southwest across the survey area. This corresponds to a linear low resistance anomaly. These anomalies are likely to reflect the course of a land drain. The negative magnetic anomaly is likely to reflect the drain; the low resistance reflects a relative increase in the moisture content of the backfilled service trench. These anomalies match a linear feature identified as a possible Roman ditch on the aerial photographs.

5.27 Further land drains aligned approximately north-south were detected as a series of parallel low resistance anomalies spaced approximately 10m apart.

5.28 Small, discrete dipolar magnetic anomalies were detected across the survey area. These almost certainly reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments.

5.29 On the west edge of the survey area a strong dipolar magnetic anomaly was detected which may reflect a mine shaft shown on historic Ordnance Survey maps.

5.30 The semi-circular dipolar magnetic anomaly on the west edge of the survey area is a result of the proximity of a pylon. The dipolar magnetic anomalies in the southeast corner and on the south edge of the survey area reflect brick and rubble debris.

6. Conclusions

6.1 Approximately 3.5ha of geomagnetic survey and 2ha of earth electrical resistance survey was undertaken on land west of Orchard View, Dalkeith, Eskdale, Midlothian prior to proposed development.

6.2 Anomalies reflecting a change in geology were detected in the northern half of the survey area.

6.3 Possible pits, ditches and accumulations of stone were identified in the north of the site matching features identified from aerial photographs. Additional possible features including ditches, a ring ditch and a pit alignment not shown on the aerial photographs were identified. These features may be geological in origin.

6.4 A land drain was identified aligned northeast-southwest across the site which corresponds to the position of a feature identified as a Roman ditch from aerial photographs. Further land drains were also identified across the site.

6.5 Modern services and a possible mine shaft were also identified.

7. Sources

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Figure 1: Site location

site location

0 1km
scale 1:25 000 for A4 plot

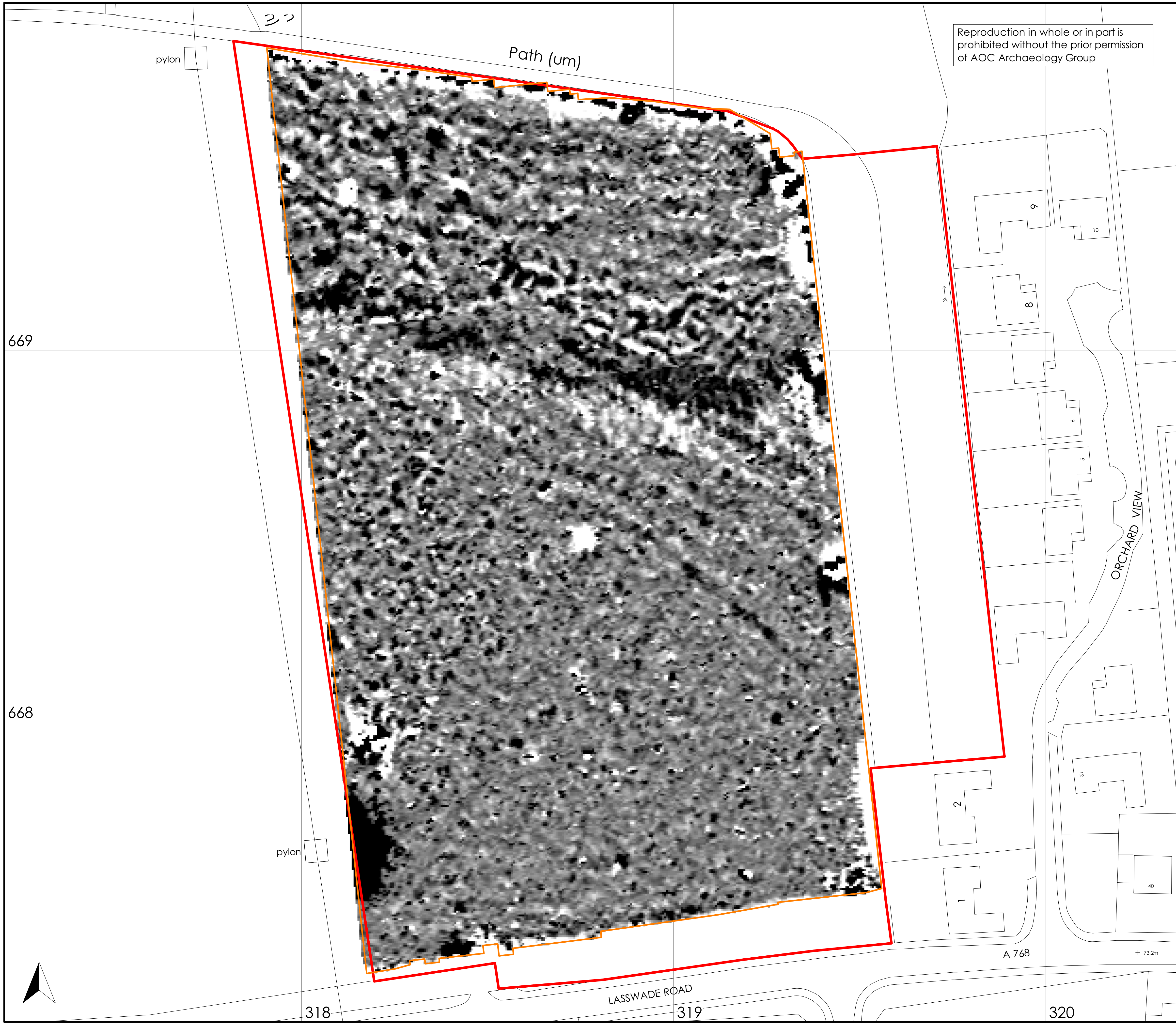

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Figure 2: Geomagnetic survey

0 50m
scale 1:1000 for A3 plot

magnetic survey

-5 nT 5

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Figure 3: Geophysical interpretation of geomagnetic survey

0 50m
scale 1:1000 for A3 plot

- magnetic survey
- dipolar magnetic anomaly
- positive magnetic anomaly
- negative magnetic anomaly

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Midlothian

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Figure 4: Resistance survey

0 50m
scale 1:1000 for A3 plot

resistance survey

20 ohm 100

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Figure 5: Geophysical interpretation of resistance survey

0 50m
scale 1:1000 for A3 plot

resistance survey
high resistance anomaly
low resistance anomaly

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Midlothian

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Figure 6: Archaeological interpretation

0 50m
scale 1:1000 for A3 plot

- soil-filled feature
- stone / rubble
- geological feature
- service pipe
- land drain
- inspection cover
- geotechnical borehole
- possible former mine shaft

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Dalkeith
Midlothian

geophysical surveys
report 2601

Figure 7:
Trace plots of geomagnetic
and resistance data