Archaeological Services
University of Durham

Stewart Park, Middlesbrough, Teesside

geophysical surveys

on behalf of
Tees Archaeology

for
Southern Green

Report 2160
March 2009

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Sir William Gray House, Clarence Road, Hartlepool TS24 8BT

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Southern Green

Contents

1. Summary 1
2. Project background . . . 2
3. Archaeological and historical background 2
4. Landuse, topography and geology . 3
5. Geophysical survey . . . 3
6. Conclusions 7
7. Sources 7

Figures (inside back cover)

Figure 1: Study area

Figure 2: Survey locations

Figure 3: Area 1, geophysical surveys and interpretations

Figure 4: Area 2, geophysical surveys and interpretations

Figure 5: Area 3, geophysical surveys and interpretations

Figure 6: Area 4, geophysical surveys and interpretations

Figure 7: Area 5, geophysical surveys and interpretations

Figure 8: Trace plots of geophysical data

1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted in advance of a proposed re-generation scheme at Stewart Park, Middlesbrough. The works comprised five areas of geomagnetic and electrical resistance survey.

1.2 The works were commissioned by Tees Archaeology on behalf of Southern Green and conducted by Archaeological Services.

Results

1.3 Stone or brick features were identified in Area 1.

1.4 Probable walls, paths and other features of the former sunken garden were identified in Area 2. A probable ferrous service was also detected in Area 2.

1.5 Aspects of the former medieval road, including probable roadside ditches and a metalled surface, were detected in Areas 3, 4 and 5.

2. Project background

Location (Figures 1 & 2)

2.1 The study area was located at Stewart Park, Middlesbrough, Teesside (NGR centre: NZ 515 162). Five surveys were conducted in open parkland and wooded areas.

Development proposal

2.2 The surveys form part of an overall assessment of Stewart Park with regard to possible re-generation of former park features, such as the sunken flower garden.

Objective

2.3 The principal aim of the surveys was to assess the nature and extent of any sub-surface features of potential archaeological or historical significance within the survey areas (principally the layout of a former sunken garden and the position and nature of a medieval road as well as the nature and extent of a former 'fairy grotto' with water and gas pipes) so that an informed decision may be made regarding the nature and scope of any further scheme of archaeological works.

Methods statement

2.4 The surveys have been undertaken in accordance with a Project Design provided by Archaeological Services and approved by the client.

Dates

2.5 Fieldwork was undertaken between 26th February and 6th March 2009. This report was prepared between 18th and 23rd March 2009.

Personnel

2.6 Fieldwork was conducted by Edward Davies, Duncan Hale and Richie Villis. This report was prepared by Richie Villis (Supervisor) and Duncan Hale, the Project Manager, with illustrations by David Graham.

Archive/OASIS

2.7 The site code is **MSP09**, for **M**iddlesbrough, **S**tewart **P**ark 20**09**. The survey archive will be supplied on CD to the client for deposition with the project archive in due course. Archaeological Services 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 **archaeol3-57052**.

3. Archaeological and historical background

3.1 A field boundary along the suggested line of a medieval road is shown on old maps, as is a sunken flower garden defined by embankments.

4. Landuse, topography and geology

4.1 The study area was mixed-use parkland, including wooded and grassed areas.

Area	Size	Landuse	NGR
1	10m x 10m	woodland/overgrown	NZ 5175 1604
2	25m x 17m	woodland/overgrown	NZ 5156 1606
3	10m x 20m	grass	NZ 5165 1627
4	10m x 20m	grass	NZ 5160 1641
5	10m x 20m	grass	NZ 5154 1650

4.2 Each survey area was predominantly flat, within gently undulating parkland at between 32-45m OD.

4.3 The underlying solid geology of the area comprises sedimentary Mercia Mudstone strata, which are overlain by 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, 2nd edition* (David, Linford & Linford 2008); the Institute for Archaeologists Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2002).

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 variety of complementary techniques such as magnetometry, earth electrical resistance, ground-penetrating radar and electromagnetic survey. Some techniques are more suitable than others in particular situations, depending on a variety of 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 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 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 likely presence of wall-footings and tracks an electrical resistance survey was also considered appropriate. Earth electrical resistance is the most widely used electrical survey method and relies on the relative inability of materials to conduct an electrical current. When a small electrical current is injected through the earth it encounters sub-surface resistance which can be measured. In the dry state, most soils and rocks are insulators but, when they become moist, electric currents are able to flow through the movement of ions dissolved in the porewater. As the soil or rock absorbs more water its conductivity increases. Hence electrical resistance surveying primarily maps the volume concentration of ground moisture, which varies according to lithology, porosity and time of year.

5.6 Since electrical resistance is linked to moisture content and porosity, rocky features such as wall foundations will give relatively high resistance values while soil-filled features, which retain more moisture, will provide relatively low resistance values. When measurements are taken over a regular grid, a map of sub-surface archaeological features can be produced. Although more time-consuming than magnetometry, this method can be used in a wider range of locations since it is not affected by the presence of buildings/fences or igneous geology.

Field methods

5.7 A 20m grid was established across each survey area and tied-in to known, mapped Ordnance Survey points using a Trimble Pathfinder Pro XRS global positioning system (GPS) with real-time correction providing sub-metre accuracy.

5.8 Measurements of vertical geomagnetic field gradient were determined using a Bartington Grad601-2 dual fluxgate gradiometer. A zig-zag traverse scheme was employed and data were logged in 20m grid units. The instrument sensitivity was set to 0.1nT, the sample interval to 0.25m and the traverse interval to 1.0m, thus providing 1600 sample measurements per 20m grid unit.

5.9 Measurements of earth electrical resistance were determined using a Geoscan RM15D resistance meter 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 0.5m and the traverse interval to 1.0m, thus providing 800 sample measurements per 20m grid unit.

5.10 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

5.11 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 (unfiltered) data. The greyscale images and interpretations are presented in Figures 3-7; the trace plots are provided in Figure 8. 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 and ohm.

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

clip	clips, or limits 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 geomagnetic 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.
despike	locates and suppresses iron spikes in gradiometer data and poor contact resistance spikes in resistance data.
interpolate	increases the number of data points in a survey to match sample and traverse intervals. In this instance the data have been interpolated to 0.25m x 0.25m intervals.

Interpretation: anomaly types

5.13 Colour-coded geophysical interpretation plans are provided. Two 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.
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 Colour-coded archaeological interpretation plans are provided.

Area 1

5.16 Both dipolar magnetic and high electrical resistance anomalies have been detected in this area. These suggest ferrous, stone and/or brick features are present, some possibly associated with the former 'fairy grotto'.

5.17 The course of gas and water pipes was not determined due to the presence of upstanding iron pipes and large stone blocks.

Area 2

5.18 The strong dipolar magnetic anomaly detected along the north-east and south-east edges of the area almost certainly reflects a ferrous pipe. This corresponds with a low resistance anomaly, particularly in the north-east.

5.19 High electrical resistance anomalies forming a roughly octagonal shape have been detected in the survey area. These almost certainly reflect the footings of a former wall for the sunken garden. The general absence of corresponding magnetic anomalies suggests that the remains are likely to be of stone rather than fired brick.

5.20 Enclosed by the high electrical resistance anomaly, a weaker electrical resistance anomaly has been detected forming a rough oval shape. This has been interpreted as a path within the wall of the former sunken garden feature.

5.21 Other amorphous electrical resistance anomalies have been detected, enclosed by the former path; these are likely to reflect other garden structures.

Area 3

5.22 A strong positive magnetic anomaly and corresponding low electrical resistance anomaly have been detected in the south-western part of the survey area. These are likely to reflect a soil-filled feature, such as a drainage ditch alongside the former medieval road.

5.23 A high resistance anomaly which corresponds with areas of dipolar magnetic anomalies has been detected in the north-eastern part of the survey area. These form a broad linear feature parallel to the probable ditch and are likely to reflect a stone or brick rubble surface of the medieval road.

Area 4

5.24 The north-eastern part of the survey area contains a high electrical resistance anomaly which could represent the medieval road; the lack of any corresponding dipolar magnetic anomalies could indicate more use of stone here.

5.25 In the south-western part of the survey area a low electrical resistance anomaly has been detected. This would often be expected to correspond with a positive magnetic anomaly if a ditch were present, but strong dipolar magnetic

anomalies have been detected. It is likely that these anomalies reflect a roadside ditch which contains some ferrous debris within its fill.

Area 5

5.26 The survey area is dominated by a high electrical resistance anomaly flanked by dipolar magnetic anomalies. It is likely that these anomalies reflect the surface of the medieval road and ditches of variable fill to the side.

6. Conclusions

6.1 Five geomagnetic and electrical resistance surveys were undertaken at Stewart Park in Middlesbrough.

6.4 Stone or brick features were identified in Area 1.

6.2 Probable walls, paths and other features of the former sunken garden were identified in Area 2. A probable ferrous service was also detected in Area 2.

6.3 Aspects of the former medieval road, including probable roadside ditches and a metalled surface, were recorded in Areas 3, 4 and 5.

7. Sources

David, A, Linford, N, & Linford, P, 2008 *Geophysical survey in archaeological field evaluation, 2nd edition,* English Heritage

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

Schmidt, A, 2002 *Geophysical Data in Archaeology: A Guide to Good Practice*, Archaeology Data Service, Arts and Humanities Data Service

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Figure 1
Study area

for
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on behalf of
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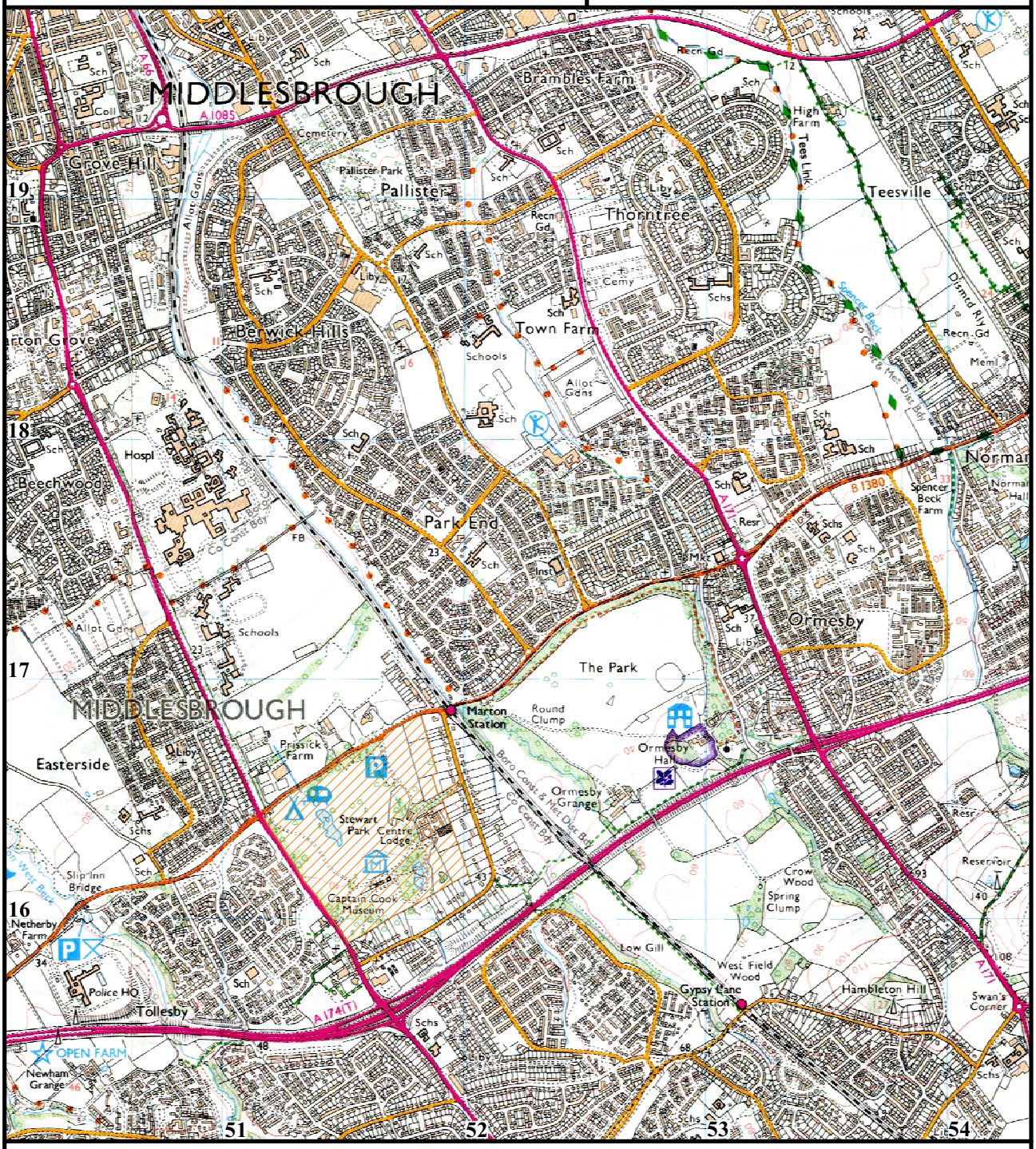

Stewart Park

0 1km

scale 1:25 000 - for A4 plot

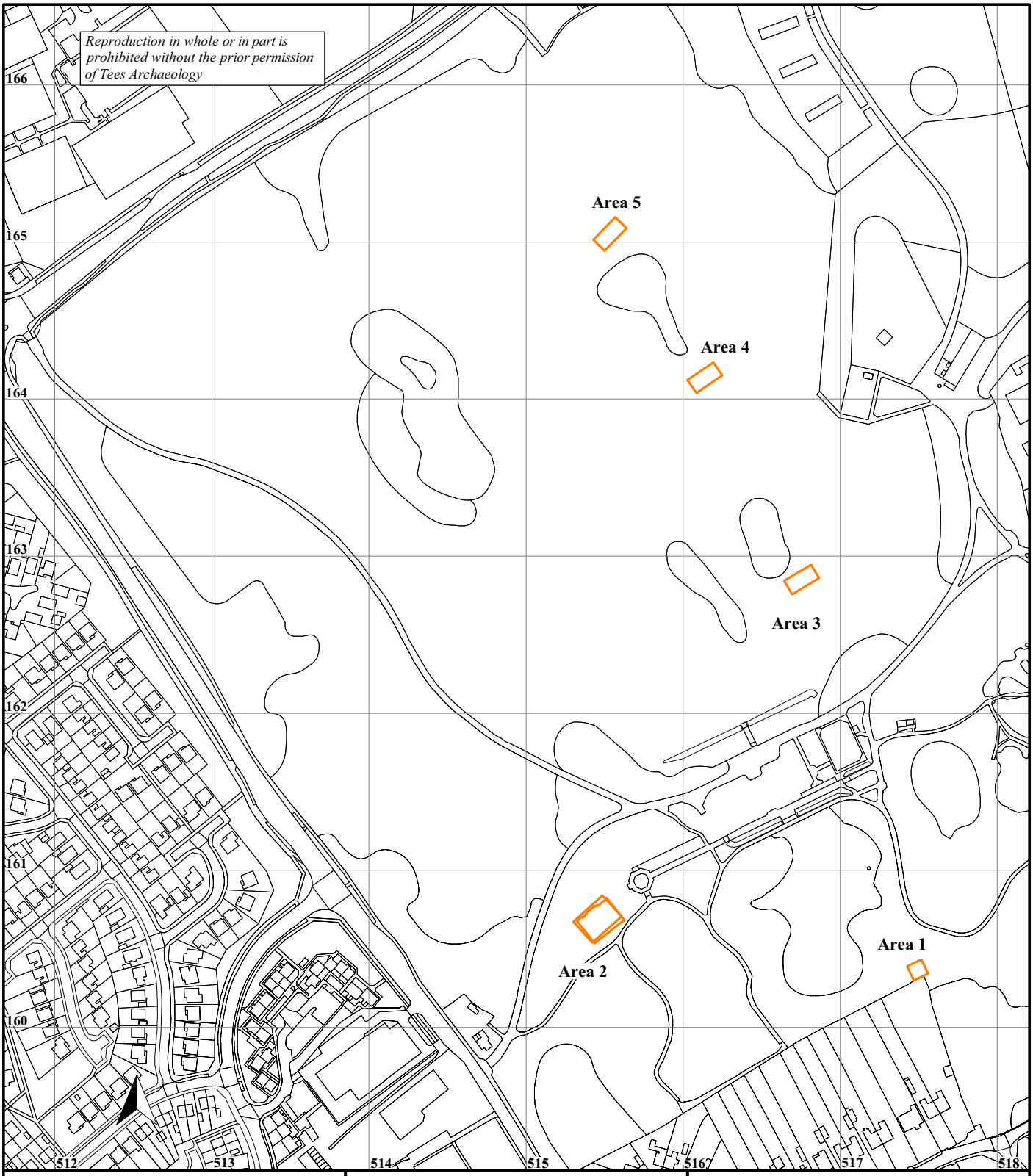

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Figure 2

Survey locations

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0 100m

scale 1:2500 - for A3 plot

outline of survey area

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for
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on behalf of
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0 10m
scale 1:200 - for A3 plot

outline of survey area

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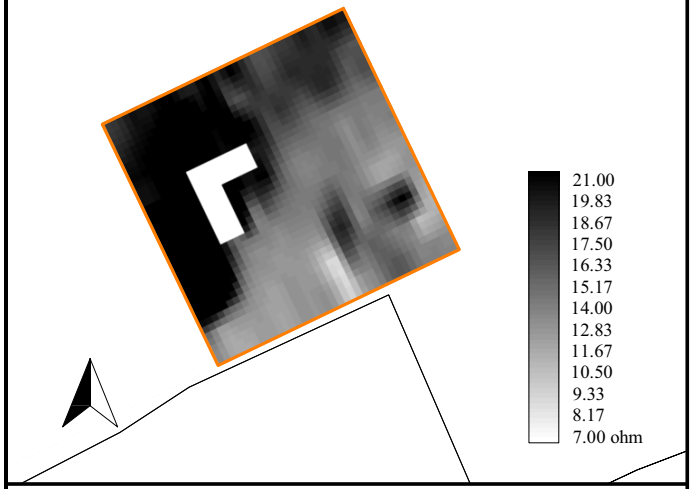
Figure 3
Area 1, geophysical surveys and interpretations

electrical resistance

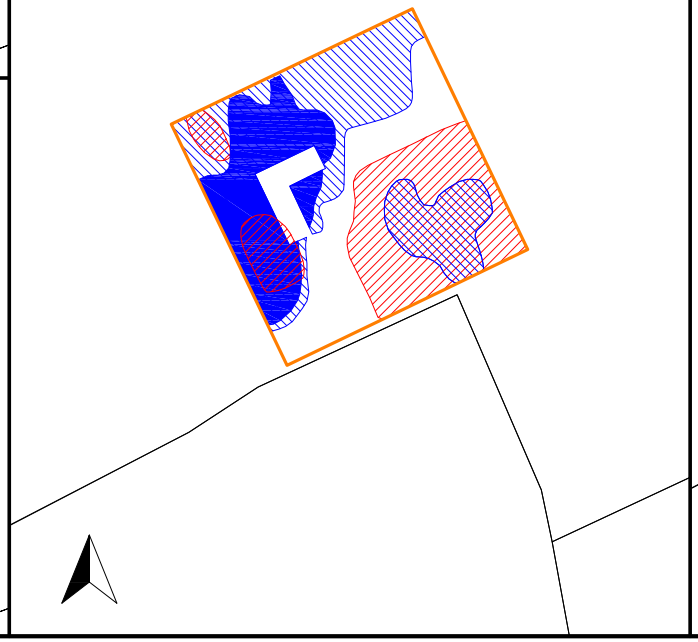


geomagnetic

geophysical interpretation

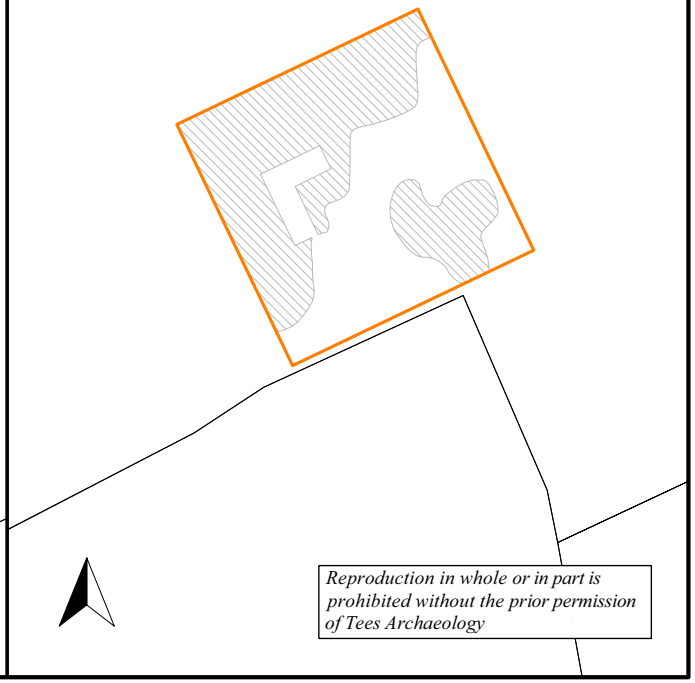
dipolar magnetic anomalies

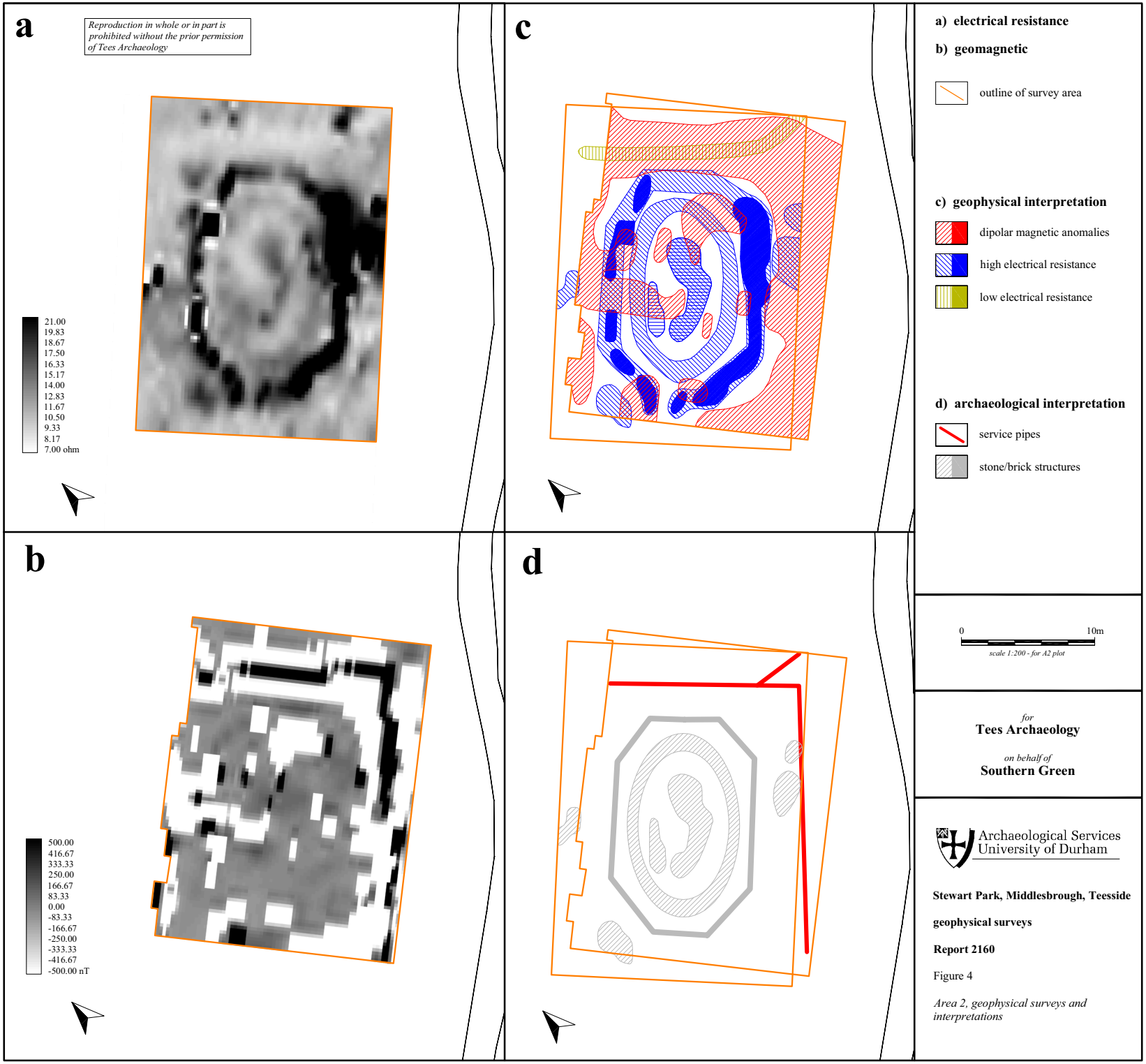
high electrical resistance



archaeological interpretation

stone/brick




a
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21.00
19.83
18.67
17.50
16.33
15.17
14.00
12.83
11.67
10.50
9.33
8.17
7.00 ohm
b
500.00
416.67
333.33
250.00
166.67
83.33
0.00
-83.33
-166.67
-250.00
-333.33
-416.67
-500.00 nT
c
d
a) electrical resistance
b) geomagnetic
outline of survey area
c) geophysical interpretation
dipolar magnetic anomalies
high electrical resistance
low electrical resistance
d) archaeological interpretation
service pipes
stone/brick structures
0
10m
scale 1:200 - for A2 plot
for
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on behalf of
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Figure 4
Area 2, geophysical surveys and interpretations

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0 10m
scale 1:200 - for A3 plot

outline of survey area

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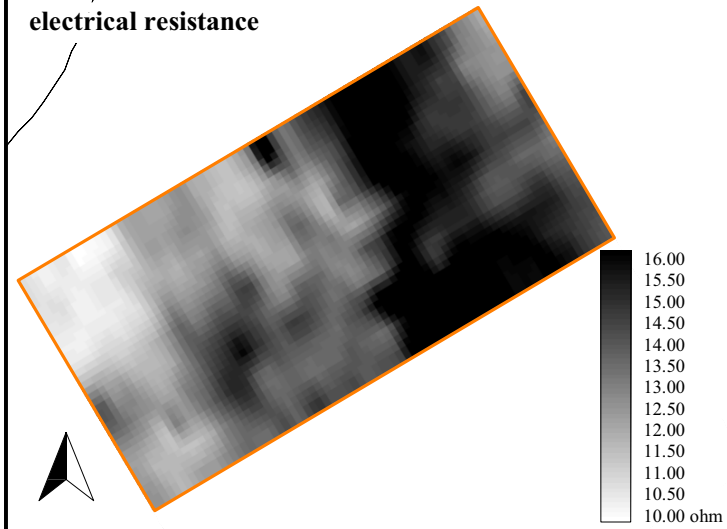
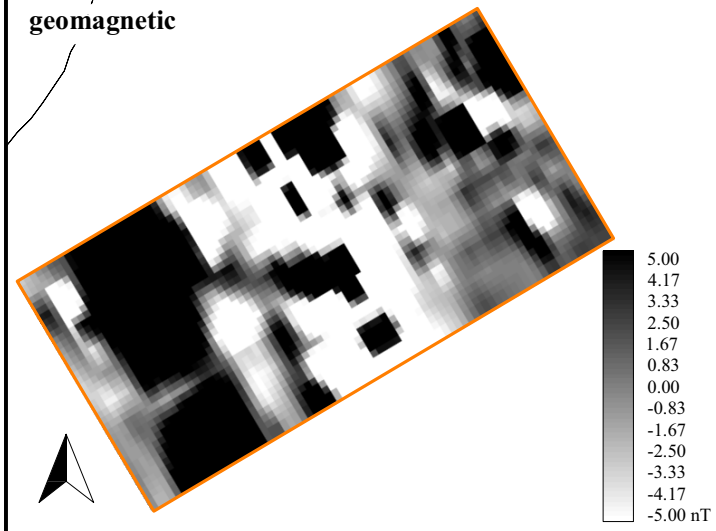
Figure 5
Area 3, geophysical surveys and interpretations

electrical resistance

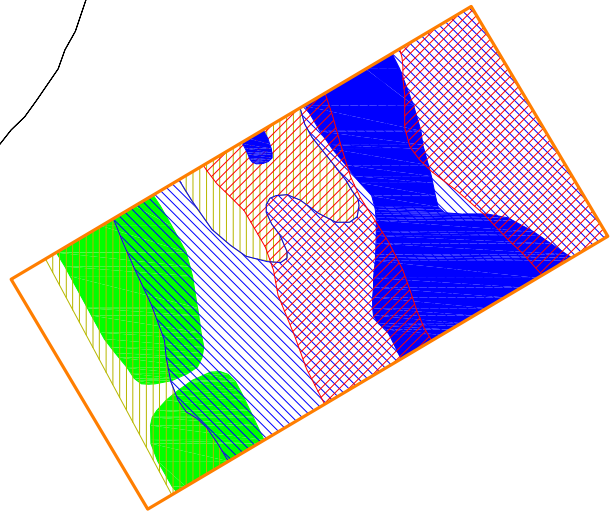


geomagnetic



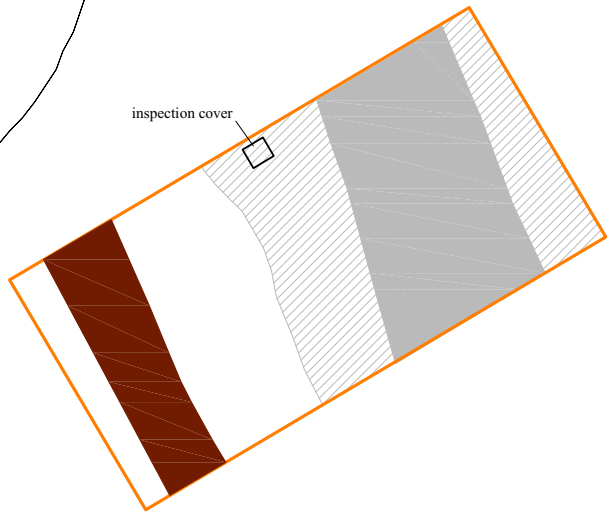
geophysical interpretation

- positive magnetic anomalies
- dipolar magnetic anomalies
- high electrical resistance
- low electrical resistance



archaeological interpretation

- soil-filled features
- stone/brick rubble



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0 10m
scale 1:200 - for A3 plot

outline of survey area

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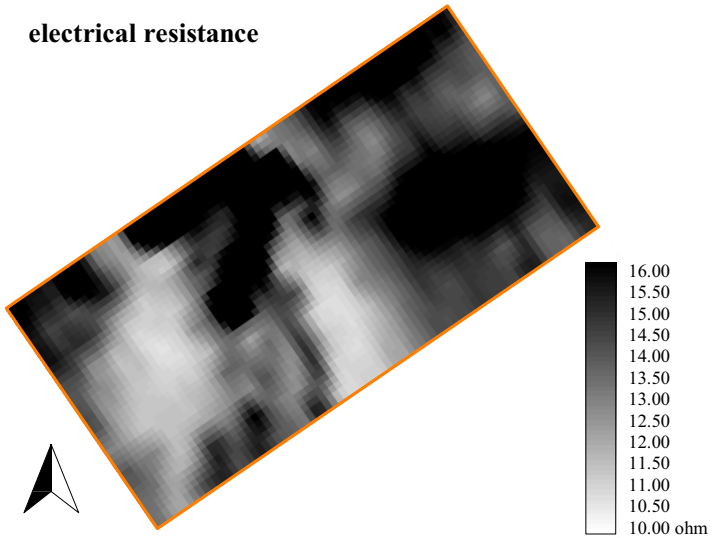
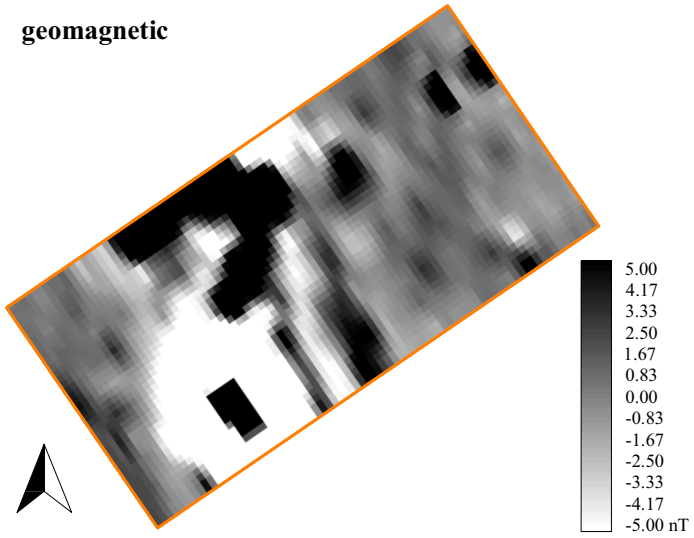
Figure 6
Area 4, geophysical surveys and interpretations

electrical resistance



geomagnetic

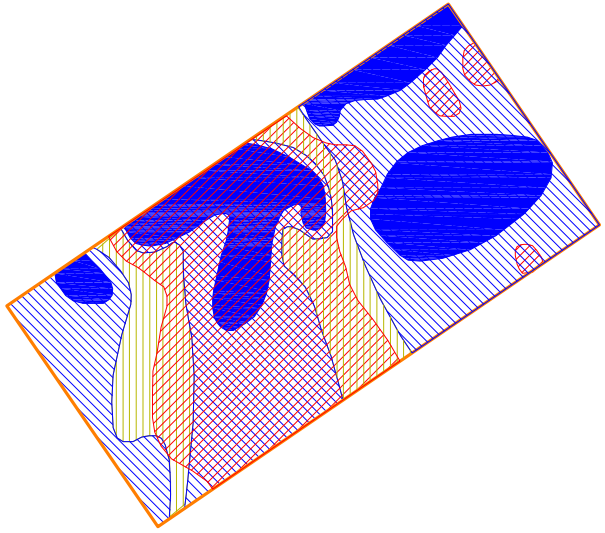


geophysical interpretation

dipolar magnetic anomalies

high electrical resistance

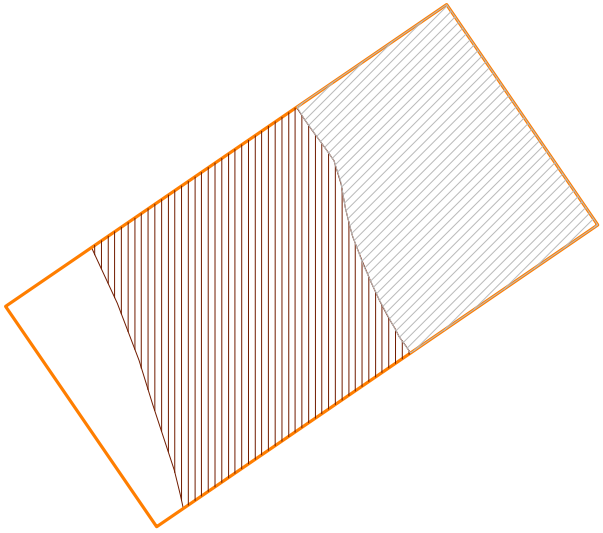
low electrical resistance



archaeological interpretation

soil-filled features

stone/brick rubble



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0 10m
scale 1:200 - for A3 plot

outline of survey area

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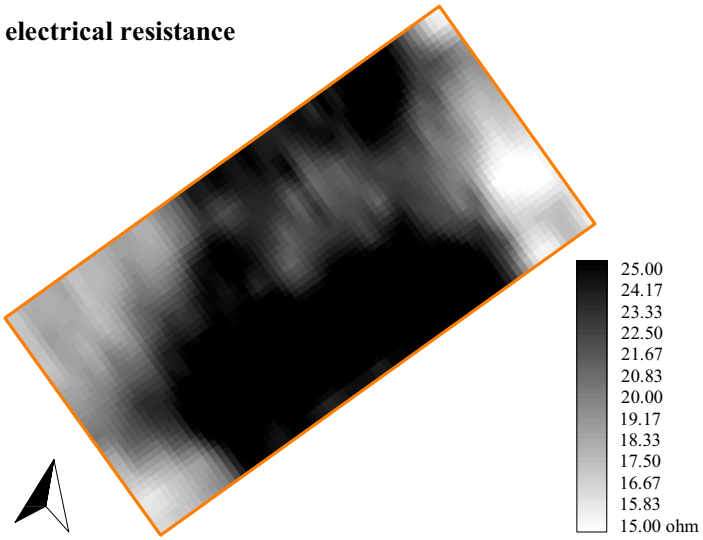
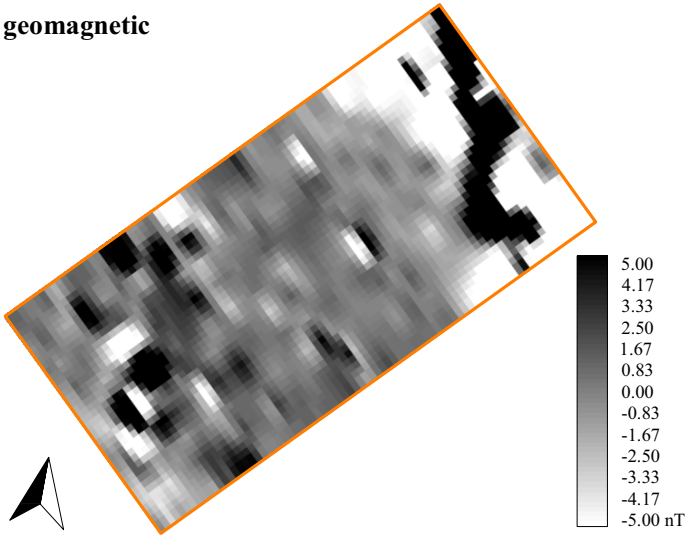
Figure 7
Area 5, geophysical surveys and interpretations

electrical resistance



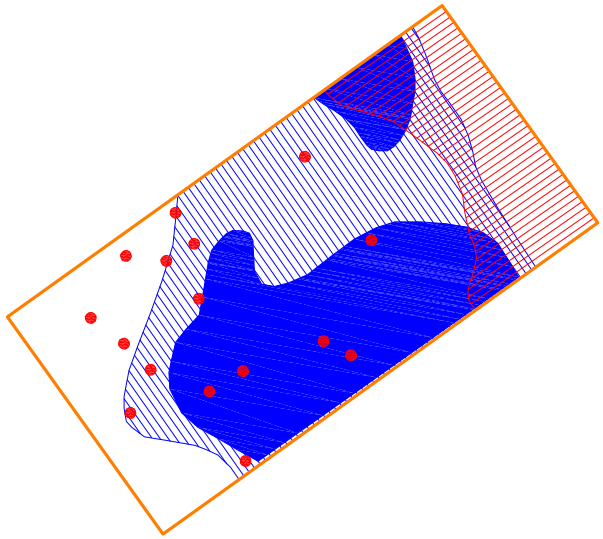
geomagnetic



geophysical interpretation

dipolar magnetic anomalies

high electrical resistance



archaeological interpretation

stone/brick rubble

soil filled features

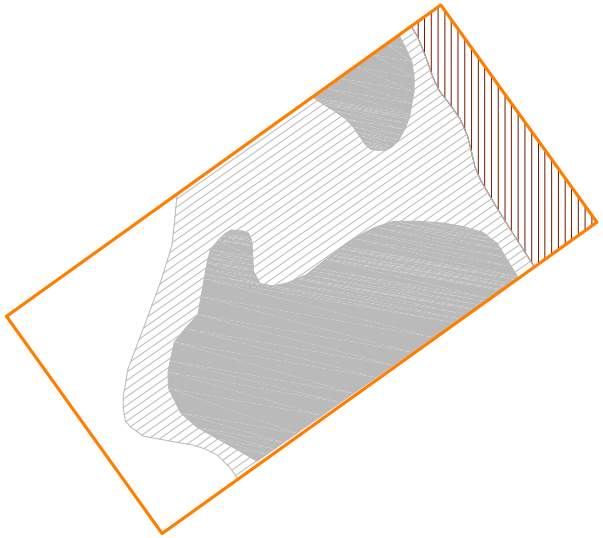


Figure 8: Trace plots of geomagnetic and resistance data