ARCHAEOLOGICAL SERVICES
DURHAM UNIVERSITY

for
JAF Ltd
on behalf of
Hartfell Homes

Auldton Mote
Moffat
Dumfries and Galloway

geophysical survey

report 5047
May 2019

Durham University

Contents

Figures

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1. Summary

The project

1.1 This report presents the results of geophysical surveys conducted in advance of proposed development of land near Auldton Mote, Moffat, Dumfries and Galloway. The works comprised approximately 4ha of magnetometer survey and three test areas of earth electrical resistance totalling approximately 0.5ha.

1.2 The works were commissioned by JAF Ltd on behalf of Hartfell Homes and conducted by Archaeological Services Durham University.

Results

1.3 Series of features which almost certainly represent former water courses have been identified.

1.4 Possible other soil-filled features, which could represent anthropogenic features, have also been identified, although the exact nature and origin of these remains uncertain.

1.5 Weak anomalies which almost certainly reflect natural variation in the underlying soils and geology have also been detected.

1.6 Former ploughing regimes and land drains have been detected.

2. Project background

Location (Figure 1)

2.1 The survey area was located on land south of Auldton Mote, Moffat, Dumfries and Galloway (NGR centre: NT 0938 0572). To the north and east was farmland; to the west and south were residential properties at the north-eastern edge of the town of Moffat.

2.2 One magnetometer survey of approximately 4ha was conducted across the survey area; three earth electrical resistance surveys totalling approximately 0.5ha were also conducted.

Development proposal

2.3 The area is proposed for residential development.

Objective

2.4 The 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.

2.5 The Scottish Archaeological Research Framework (ScARF) contains an agenda for archaeological research in Scotland, which is incorporated into planning policy implementation. In this instance, the scheme of works was designed to address research priorities for the medieval period (Hall & Price 2012).

Methods statement

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

Dates

2.7 Fieldwork was undertaken between 15th and 16th April 2019. This report was prepared for May 2019.

Personnel

2.8 Fieldwork was conducted by Richie Villis and Laura Watson. Geophysical data processing and report preparation was by Richie Villis, with illustrations by David Graham. The report was edited by Peter Carne.

Archive/OASIS

2.9 The site code is **MAM19**, for **M**offat **A**uldton **M**ote 20**19**. 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 **archaeol3-350594**.

3. Historical and archaeological background

3.1 Auldton Mote is a medieval motte and bailey just to the east of Moffat; it is a scheduled ancient monument (Canmore ID: 48331; Site Number: NT00NE 14). The survey area was located to the immediate south of the monument, on flatish land which has been proposed as a possible site of any associated village or settlement, although no evidence for this has been recorded.

3.2 Historic Ordnance Survey (OS) editions show little change in the land-use, which was probably agricultural land throughout the post-medieval period. Some marsh land and boggy areas are depicted on previous OS editions, particularly in the eastern parts of the survey area.

4. Landuse, topography and geology

4.1 At the time of survey the survey area comprised part of a large pastoral field.

4.2 The area undulated gently, with a general rise towards the north-eastern corner, with elevations of between 115m to 128m OD.

4.3 The underlying solid geology of the area comprises Permian sandstone of the Hartfield Formation, no overlying deposits are recorded.

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 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 post-holes, trackways, wall foundations and fired structures (for example kilns and hearths) might also be present.

5.4 Given the anticipated shallowness of targets 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.

5.5 It was also considered appropriate to test the results of the fluxgate gradiometer survey by conducting a small sample of earth electrical resistance survey. 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 Magnetic gradiometer measurements were determined using a Sensys Magneto MX V3 multi-sensor magnetometer survey system towed by a quad-bike. Eight FGM650/3 fluxgate gradiometer sensors were mounted at 0.5m intervals, logging data at less than 0.08m intervals along traverses, providing high density data collection.

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

5.8 Following consultation with the client a 20m grid was then established across three areas and related to the Ordnance Survey (OS) National Grid using a Leica GS15 global navigation satellite system (GNSS) with real-time kinematic (RTK) corrections.

5.9 Measurements of earth electrical resistance were determined using Geoscan RM15D advanced resistance meters with MPX15 multiplexers and 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.

5.10 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 Sensys MonMX, DLMGPS and MagnetoARCH software were used to record and display magnetic gradient and positional data and to create a greyscale image of gridded values at 0.2m by 0.2m intervals. TerraSurveyor software was used to produce a trace plot of the raw (minimally processed) data and to produce a continuous tone greyscale image of filtered data. Geoplot v.4 software was used to process the earth electrical resistance data and to produce both continuous tone greyscale images and trace plots of the raw (minimally processed) data. The greyscale images and trace plots are presented in Figures 2-5; the interpretations are presented in Figures 6 and 7. In the greyscale images, positive magnetic/high resistance anomalies are displayed as dark grey and negative magnetic/low resistance anomalies as light grey. Palette bars relate the greyscale intensities to anomaly values in nanoTesla/ohm.

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

clip	clips data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic
de-spike	locates and suppresses iron spikes in gradiometer 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 0.1m x 0.1m intervals

5.13 The following filter has been applied to the magnetic data (Figure 3):

low pass filter	(applied with Gaussian weighting) to remove high frequency, small-scale spatial detail; for enhancing larger weak features and smoothing data

5.14 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
de-spike	locates and suppresses spikes in data due to poor contact resistance
interpolate	increases the number of data points in a survey to match sample and traverse intervals; in this instance the data have been interpolated to 0.25m x 0.25m intervals

Interpretation: anomaly types

5.15 Colour-coded geophysical interpretation plans are provided. Three types of magnetic 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

5.16 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

5.17 A colour-coded archaeological interpretation plan is provided.

5.18 Several linear, curvilinear and sinuous positive magnetic anomalies have been detected, particularly across the western part of the survey area. These anomalies reflect relative increases in high magnetic susceptibility materials and almost certainly represent organic material deposited by water-action. These are typical of palaeochannels, natural former water-courses or streams. Earth-electrical resistance data in Area 3 has detected a series of corresponding low resistance anomalies, which would be consistent with higher moisture retention in organic or water-borne materials. The edges of these former channels are also defined by higher resistance anomalies, which probably represent faster draining sands and gravels.

5.19 Similar magnetic anomalies, but much narrower and possibly with more structure have been detected in the north-western part of the survey. It is possible that these could reflect anthropogenic soil-filled features, although the only evidence for this is the slightly more regular morphology of these anomalies.

5.20 Weak and diffuse positive magnetic anomalies have been detected in the north-eastern corner of the area, to the immediate east of the mote. These broadly correspond to a series of high and low resistance anomalies detected in Areas 1 and 2. These almost certainly reflect natural features in the underlying soils and geology, such as outwash sands and gravels or shallower bedrock horizons.

5.21 Series of straight and narrow, regularly and closely spaced, alternate positive and negative magnetic anomalies have been detected across the area, aligned both north/south and east/west. These almost certainly reflect recent and historic ploughing regimes. Occasional other, stronger positive and negative magnetic anomalies may also reflect land drains, many of which may also be in the same alignment as the former ploughing. The former ploughing regimes have also been detected as corresponding linear high and low resistance anomalies, and are most obvious in Area 1.

5.22 Intense dipolar magnetic anomalies have been detected across the north-eastern edge of the survey area. These almost certainly reflect a service; overhead power lines were also noted in this part of the field.

5.23 Small, discrete dipolar magnetic anomalies have been detected across the survey area. These almost certainly reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation plan.

6. Conclusions

6.1 Approximately 4ha of magnetometer survey and three test areas of earth electrical resistance survey totalling approximately 0.5ha were undertaken on land at Auldton Mote, Mofat, Dumfries and Galloway prior to proposed residential development.

6.2 Series of features which almost certainly represent former water courses have been identified.

6.3 Possible other soil-filled features, which could represent anthropogenic features, have also been identified, although the exact nature and origin of these remains uncertain.

6.4 Weak anomalies which almost certainly reflect natural variation in the underlying soils and geology have also been detected.

6.5 Former ploughing regimes and land drains have been detected.

7. Sources

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

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

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

Hall, M, & Price, N, 2012 *Medieval Scotland: A Future for its Past*. ScARF Summary Medieval Panel Document, Scottish Archaeological Research Framework

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

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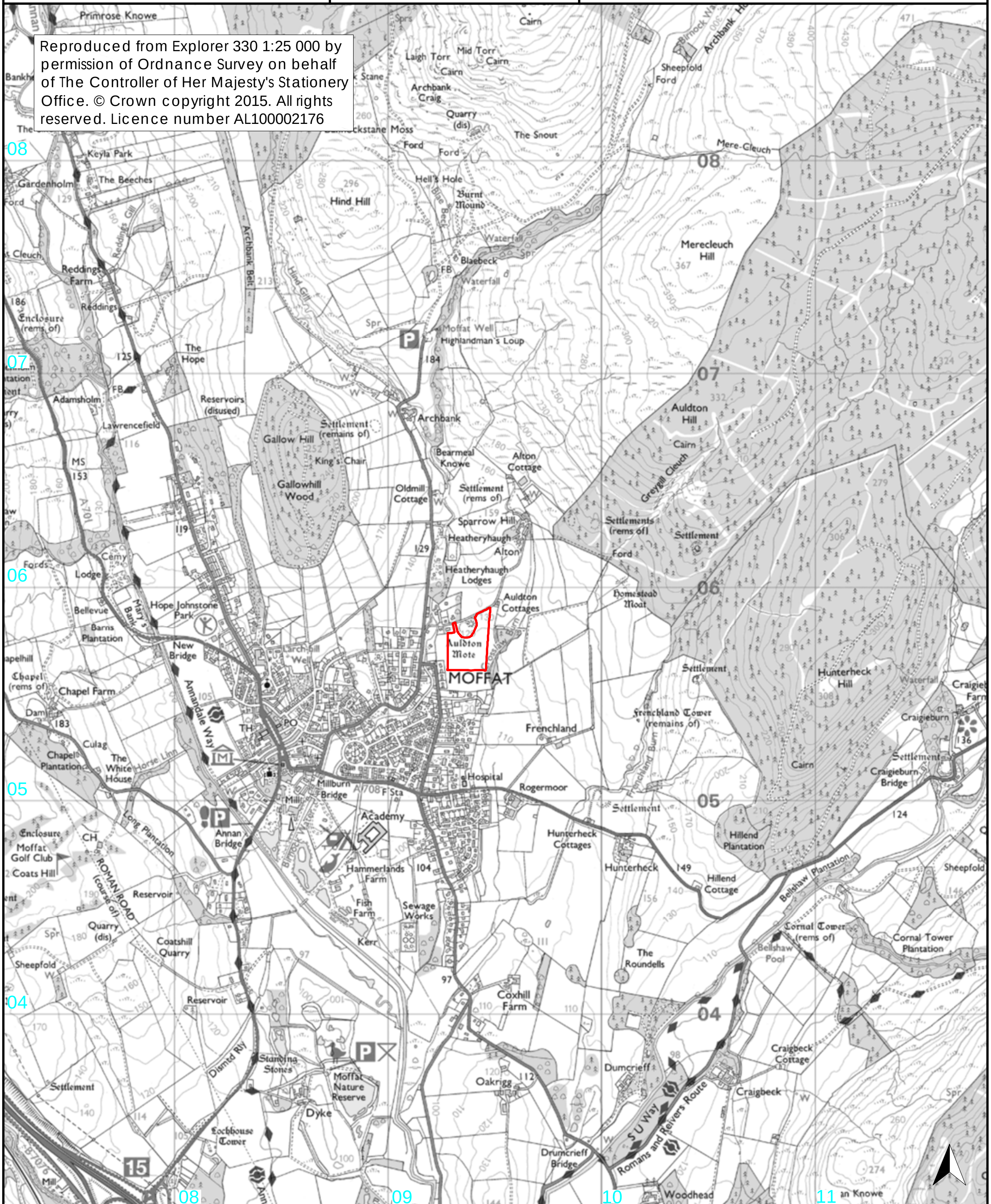
Figure 1: Site location

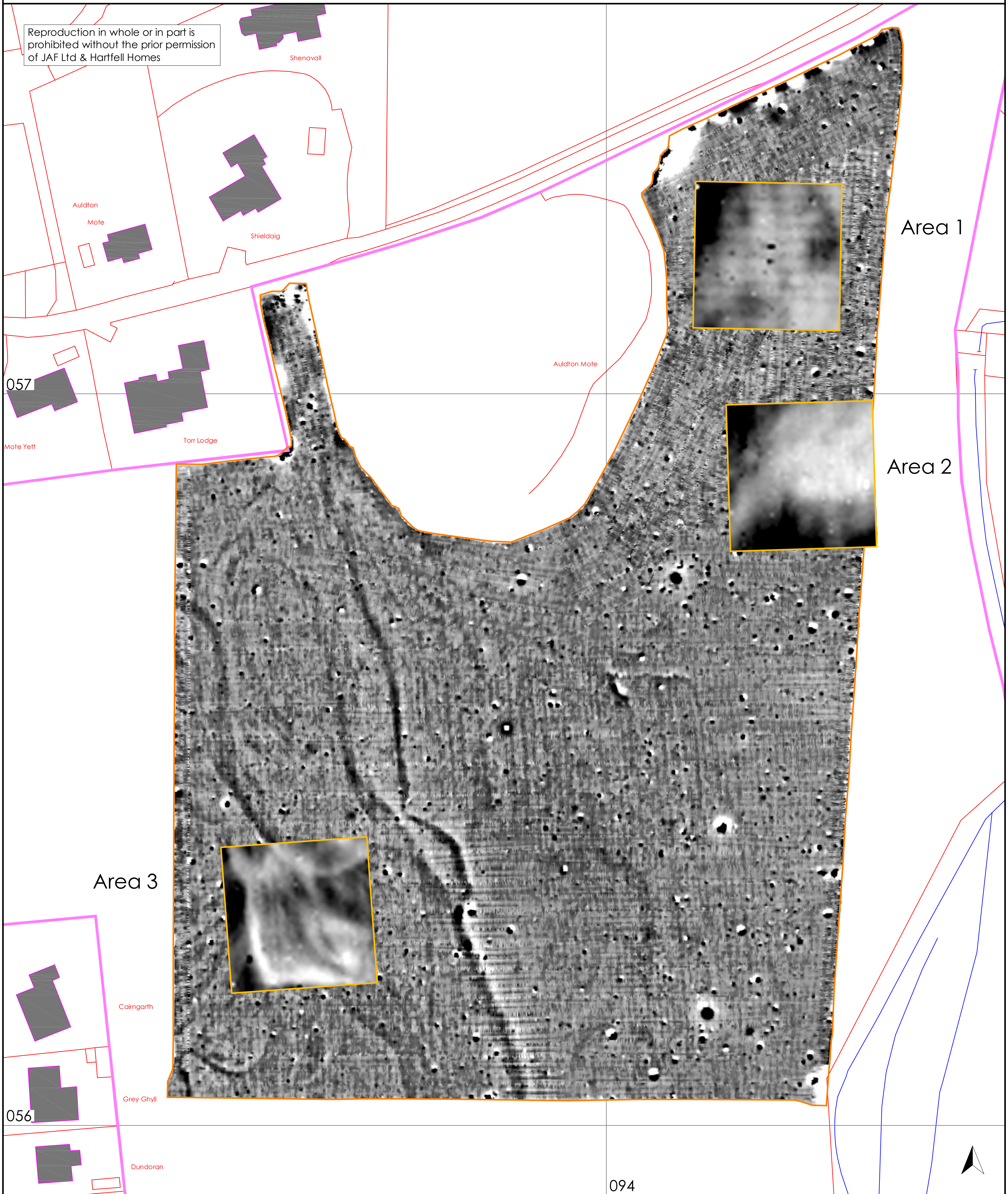


site location

0 1km
scale 1:25 000 for A4 plot

magnetic survey
resistance survey

	Area 1	Area 2	Area 3
-3 nT 3	410 ohm 850	190 ohm 370	320 ohm 510



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0 50m
scale 1:1000 for A3 plot

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Figure 2: Geophysical surveys overview

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0 50m
scale 1:1000 for A3 plot

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Figure 3: Geophysical survey (filtered)

resistance survey

magnetic survey

Area 1: 410 ohm 850

Area 2: 190 ohm 370

Area 3: 320 ohm 510

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0 50m
scale 1:1000 for A3 plot

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Figure 4: Earth electrical resistance survey

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scale 1:1000 for A3 plot

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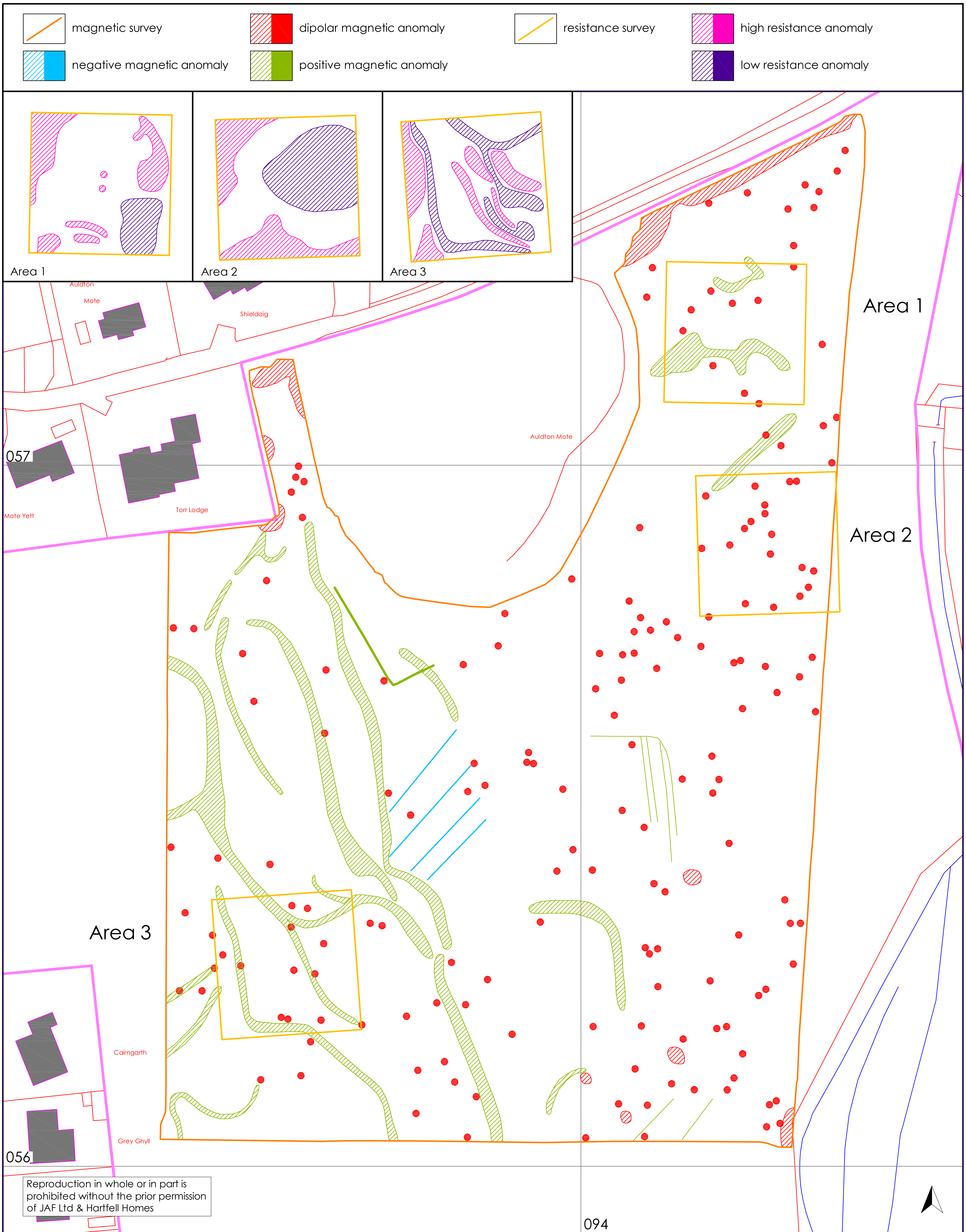
Figure 5: Trace plots of geophysical data



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scale 1:1000 for A3 plot

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Figure 6: Geophysical interpretation

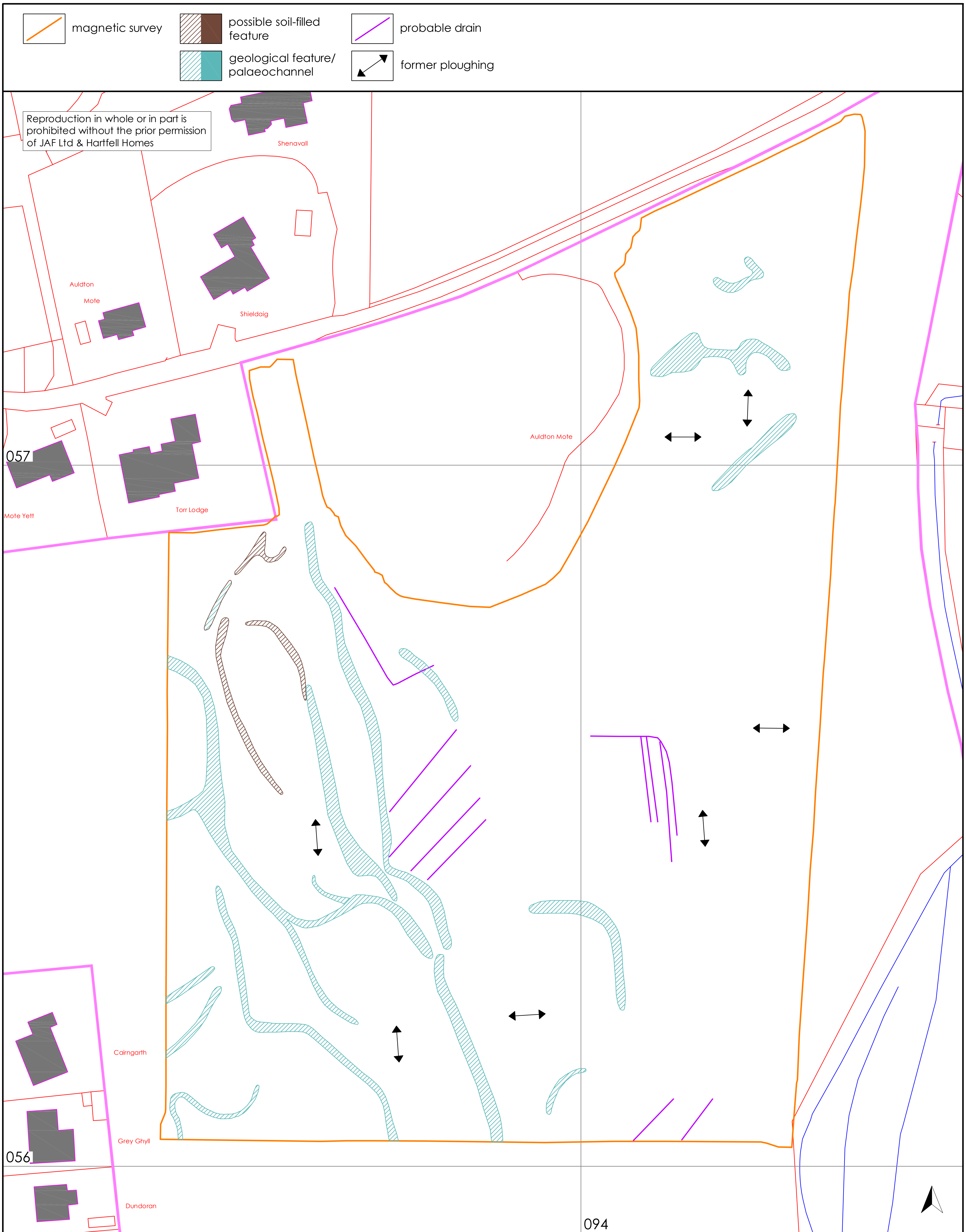

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Figure 7: Archaeological interpretation