THAMES VALLEY

ARCHAEOLOGICAL

SERVICES

SOUTH WEST

Hazeldene, Moorcroft Quarry, Elburton, Plymouth

Geophysical Survey (Magnetic)

by Kyle Beaverstock and Tim Dawson

Site Code: MQP16/165

(SX 5375 5393)

Hazeldene, Moorcroft Quarry, Elburton, Plymouth

Geophysical Survey (Magnetic) Report

For Aggregate Industries UK Ltd

by Kyle Beaverstock and Tim Dawson

Thames Valley Archaeological Services Ltd

Site Code MQP 16/165

November 2016

Summary

Site name: Hazeldene, Moorcroft Quarry, Elburton, Plymouth

Grid reference: SX 5375 5393

Site activity: Magnetometer survey

Date and duration of project: 31st August 2016

Project manager: Steve Ford

Site supervisor: Kyle Beaverstock

Site code: MQP 16/165

Area of site: 3.2ha (1.05ha surveyed)

Summary of results: Several magnetic anomalies were recorded. These are likely to reflect ground disturbance caused by both agricultural and archaeological activity. Of particular note are a cluster of positive anomalies in the north-western corner of the survey which appear to form an arc, possibly representing part of a buried ring ditch similar to those excavated immediately to the west.

Location of archive: The archive is presently held at Thames Valley Archaeological Services, Reading in accordance with TVAS digital archiving policies.

Report edited/checked by: Steve Ford✓ 30.11.16

Thames Valley Archaeological Services Ltd, 47–49 De Beauvoir Road, Reading RG1 5NR
Tel. (0118) 926 0552; Fax (0118) 926 0553; email **tvas@tvas.co.uk;** *website: www.tvas.co.uk*

Hazeldene, Moorcroft Quarry, Elburton, Plymouth
A Geophysical Survey (Magnetic)

by Kyle Beaverstock and Tim Dawson

Report 16/165

Introduction

This report documents the results of a geophysical survey (magnetic) carried out on a parcel of land at Hazeldene, Moorcroft Quarry, Elburton, Plymouth (SX 5375 5393) (Fig. 1). The work was commissioned by Mr Clive Tompkins, Aggregate Industries UK Ltd, Stoneycombe Quarry, Bickley Road, Kingskerswell, Newton Abbot, Devon, TQ12 5LL.

An application to extend the current workings of Moorcroft Quarry eastwards is to be made to Plymouth City Council. A geophysical survey was requested in order to inform the application in light of the archaeological discoveries immediately to the west of the proposal site. This is in accordance with the Department for Communities and Local Government's National Planning Policy Framework (NPPF 2012) and the City's policies on archaeology. The fieldwork was undertaken by Kyle Beaverstock and Ellen McManus-Fry on 31st August 2016 and the site code is MQP 16/165.

The archive is presently held at Thames Valley Archaeological Services, Reading in accordance with TVAS digital archiving policies.

Location, topography and geology

The site is located on a 3.2ha parcel of land on the eastern edge of the current workings at Moorcroft Quarry, the area of which forms the northern limit of Elburton and Plymstock. Plymouth lies *c*.5km to the west. The site consists of two irregularly shaped fields with the northern one occupied by a single large spoil heap and the southern one being slightly overgrown cleared ground (Pl. 1-2). The land slopes down from 42m above Ordnance Datum in the northern corner to 31m aOD in at the southern tip. The underlying geology is recorded as Middle Devonian Limestone for the majority of the site although this is overlain by head deposits along the southern edge of the area (BGS 1974). Conditions during the survey were overcast but dry.

Site history and archaeological background

The site lies in a landscape that has significant archaeological content. To the east, within 1.5km of the site, are the remains of a prehistoric enclosure, a barrow and Roman and medieval field systems. A little further afield, to

the north-east, are the remains of Wasteberry Camp an Iron Age hill fort and approximately 4.5km to the west of the site is the site of the ancient port of Mount Batten which is believed to have been active from the late Bronze Age though to the Roman period.

Two recording actions, one to the north-west of the site and the other to the west, only uncovered modern features (Weale 2012) and 19th and 20th century field boundaries (Weale 2014). A further recording action immediately to the west of the site (Weale in prep) discovered two large ring ditches which appear to contain pottery from the late Neolithic to Bronze Age. These two *c.*30m diameter monuments are both located are on the approximate 34.5m aOD contour line which continues into the site. To the east and south of the site a very large scale geophysical survey and excavation has been conducted by (Pickstone pers comm), which has revealed a rich archaeological landscape including a further two Bronze Age barrows and a range of prehistoric, Romano and medieval features.

Methodology

Sample interval

Data collection required a temporary grid to be established across the survey area using wooden pegs at 20m intervals with further subdivision where necessary. Readings were taken at 0.25m intervals along traverses 1m apart. This provides 1600 sampling points across a full 20m × 20m grid (English Heritage 2008), providing an appropriate methodology balancing cost and time with resolution. It was planned to survey the entire area covered by the two fields which comprise the site however it was found that the majority of the northern field was occupied by a spoil heap while the southern and western boundaries of the southern field were marked with large soil bunds. The survey area was therefore dramatically reduced.

The Grad 601-2 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. Under normal operating conditions it can be expected to identify buried features >0.5m in diameter. Features which can be detected include disturbed soil, such as the fill of a ditch, structures that have been heated to high temperatures (magnetic thermoremnance) and objects made from ferro-magnetic materials. The strength of the magnetic field is measured in nano Tesla (nT), equivalent to 10^{-9} Tesla, the SI unit of magnetic flux density.

Equipment

The purpose of the survey was to identify geophysical anomalies that may be archaeological in origin in order to inform a targeted archaeological investigation of the site prior to development. The survey and report generally follow the recommendations and standards set out by both English Heritage (2008) and the Chartered Institute *for* Archaeologists (2002, 2011, 2014).

Magnetometry was chosen as a survey method as it offers the most rapid ground coverage and responds to a wide range of anomalies caused by past human activity. These properties make it ideal for the fast yet detailed surveying of an area.

The detailed magnetometry survey was carried out using a dual sensor Bartington Instruments Grad 601-2 fluxgate gradiometer. The instrument consists of two fluxgates mounted 1m vertically apart with a second set positioned at 1m horizontal distance. This enables readings to be taken of both the general background magnetic field and any localised anomalies with the difference being plotted as either positive or negative buried features. All sensors are calibrated to cancel out the local magnetic field and react only to anomalies above or below this base line. On this basis, strong magnetic anomalies such as burnt features (kilns and hearths) will give a high response as will buried ferrous objects. More subtle anomalies such as pits and ditches, can be seen from their infilling soils containing higher proportions of humic material, rich in ferrous oxides, compared to the undisturbed subsoil. This will stand out in relation to the background magnetic readings and appear in plan following the course of a linear feature or within a discrete area.

A Trimble Geo7x handheld GPS system with sub-decimetre real-time accuracy was used to tie the site grid into the Ordnance Survey national grid. This unit offers both real-time correction and post-survey processing; enabling a high level of accuracy to be obtained both in the field and in the final post-processed data.

Data gathered in the field was processed using the TerraSurveyor software package. This allows the survey data to be collated and manipulated to enhance the visibility of anomalies, particularly those likely to be of archaeological origin. The table below lists the processes applied to this survey, full survey and data information is recorded in Appendix 1.

Process	**Effect**
Clip from -4.80 to 5.20 nT	Enhance the contrast of the image to improve the appearance of possible archaeological anomalies.
Interpolate: *y* doubled	Increases the resolution of the readings in the *y* axis, enhancing the shape of anomalies.
De-stripe: median, all sensors	Removes the striping effect caused by differences in sensor calibration, enhancing the visibility of potential archaeological anomalies.
De-spike: threshold 1, window size 3×3	Compresses outlying magnetic points caused by interference of metal objects within the survey area.

De-stagger: all grids, both by -1 intervals	Cancels out effects of site's topography on irregularities in the traverse speed.

The raw data plot is presented as a greyscale plot shown in relation to the site (Fig. 3) with the processed data then presented as a second figure (Fig. 4), followed by a third plan to present the abstraction and interpretation of the magnetic anomalies (Fig. 5). Anomalies are shown as colour-coded lines, points and polygons. The grid layout and georeferencing information (Fig. 2) is prepared in EasyCAD v.7.58.00, producing a .FC7 file format, and printed as a .PDF for inclusion in the final report.

The greyscale plot of the processed data is exported from TerraSurveyor in a georeferenced portable network graphics (.PNG) format, a raster image format chosen for its lossless data compression and support for transparent pixels, enabling it to easily be overlaid onto an existing site plan. The data plot is combined with grid and site plans in QGIS 2.16.2 and exported again in .PNG format in order to present them in figure templates in Adobe InDesign CS5.5, creating .INDD file formats. Once the figures are finalised they are exported in .PDF format for inclusion within the finished report.

Results

A range of magnetic anomalies were recorded across the area of the southern field and into the entrance into the northern field (Fig. 4). These included several positive anomalies which usually represent buried cut features such as pits and ditches and may be archaeological in origin.

In the north-western corner of the survey area are a somewhat amorphous patch of positive readings **[Fig. 5: 1]** and a slightly better defined linear shape **[2]** at a distance of *c.*28m from each other. They are joined by linear positive anomaly **[3]** although this extends further southwards as **[4]** and probably represents an old field boundary ditch. Together, **[1]**, **[2]** and the possible disturbance caused by a later boundary ditch **[3]** could be interpreted as part of a ring ditch. However, if this was the case, it would be positioned very close to the easternmost excavated one and would extend into the area that was stripped during the excavations where no further evidence was found.

In the south-western corner of the field are a pair of linear positive anomalies **[5]** which run parallel for 11m in a north-west – south-east direction, possibly indicating a section of trackway. Immediately to the west is a wider section of linear positive anomaly which is likely associated with other sections of a similar anomaly **[7]** that lead north-eastwards, parallel t the site's south-eastern boundary. This and the linear anomaly that runs almost north – south **[3, 4]** probably represent the ditches of old field boundaries which, as they both follow the

line of the current boundaries, are most likely post-medieval in date. A shorter section of weaker linear positive anomaly **[8]** was recorded at right-angles to the eastern end of anomaly **[7]**.

The whole field shows signs of heavy ploughing with a strong pattern of parallel linear positive anomalies **[9]** running in a north-west – south-east direction covering the majority of the area. Several strong magnetic spikes were identified along the south-eastern and north-eastern areas of the survey. These most likely represent ferrous objects buried in the subsoil, probably fragments of farm machinery. An area of strong magnetic disturbance in the part of the survey that covers the entrance into the northern field is most likely caused by metal, e.g. wire fencing, within the field boundaries.

Conclusion

Several magnetic anomalies were recorded by the geophysical survey despite the reduced area available for survey. These are likely to reflect ground disturbance caused by both agricultural and archaeological activity. Of particular note are a cluster of positive anomalies in the north-western corner of the survey which appear to form an arc, possibly representing part of a buried ring ditch similar to those excavated immediately to the west. The remaining linear anomalies most likely represent infilled field boundary ditches which, due to their alignment with the current boundaries, are probably of post-medieval date.

References

BGS, 1974, *British Geological Survey*, 1:50,000, Sheet 349, Drift Edition, Keyworth

CIfA, 2002, *The Use of Geophysical Techniques in Archaeological Evaluation*, IFA Paper No. 6, Reading

CIfA, 2011, *Standard and Guidance: for archaeological geophysical survey*, Reading

CIfA, 2014, *Standard and Guidance: for archaeological geophysical survey*, Reading

English Heritage, 2008, *Geophysical Survey in Archaeological Field Evaluation*, English Heritage, Portsmouth (2nd edn)

NPPF, 2012, *National Planning Policy Framework*, Dept Communities and Local Government, London

Weale, A, 2012, 'Hazeldene, Moorcroft Quarry, Elburton, Plymouth: An archaeological recording action', Thames Valley Archaeological Services report no. 12/46, Reading

Weale, A, 2014, 'Hazeldene, Moorcroft Quarry, Elburton, Plymouth: An archaeological recording action', Thames Valley Archaeological Services report no. 14/145, Reading

Appendix 1. Survey and data information

Programme:
Name: TerraSurveyor
Version: 3.0.29.3

Raw data
Survey corner coordinates (X/Y):
Northwest corner: 253644.05, 53885.2 m
Southeast corner: 253804.05, 53725.2 m
Direction of 1st Traverse: 20.60571 deg
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 2047.5

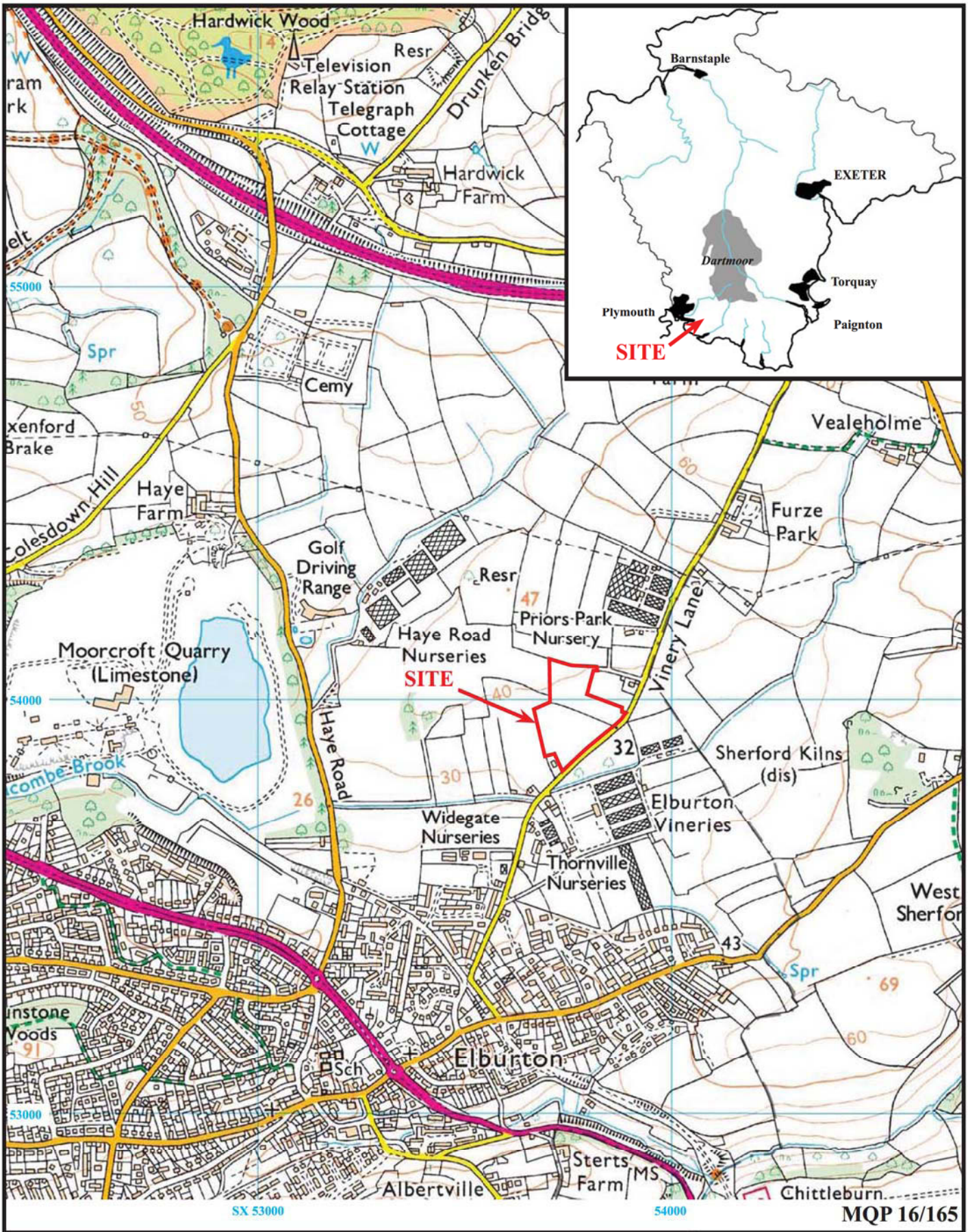
Dimensions
Composite Size (readings): 640 x 160
Survey Size (meters): 160 m x 160 m
Grid Size: 20 m x 20 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 96.52
Min: -100.00
Std Dev: 5.11
Mean: -0.40
Median: -0.43
Composite Area: 2.56 ha
Surveyed Area: 1.0569 ha

Source Grids: 44
1 Col:0 Row:2 grids\41.xgd
2 Col:0 Row:3 grids\42.xgd
3 Col:0 Row:4 grids\45.xgd
4 Col:1 Row:2 grids\39.xgd
5 Col:1 Row:3 grids\40.xgd
6 Col:1 Row:4 grids\43.xgd
7 Col:1 Row:5 grids\44.xgd
8 Col:2 Row:1 grids\33.xgd
9 Col:2 Row:2 grids\34.xgd
10 Col:2 Row:3 grids\35.xgd
11 Col:2 Row:4 grids\36.xgd
12 Col:2 Row:5 grids\37.xgd
13 Col:2 Row:6 grids\38.xgd
14 Col:3 Row:1 grids\27.xgd
15 Col:3 Row:2 grids\28.xgd
16 Col:3 Row:3 grids\29.xgd
17 Col:3 Row:4 grids\30.xgd
18 Col:3 Row:5 grids\31.xgd
19 Col:3 Row:6 grids\32.xgd
20 Col:4 Row:0 grids\19.xgd
21 Col:4 Row:1 grids\20.xgd
22 Col:4 Row:2 grids\21.xgd
23 Col:4 Row:3 grids\22.xgd
24 Col:4 Row:4 grids\23.xgd
25 Col:4 Row:5 grids\24.xgd
26 Col:4 Row:6 grids\25.xgd
27 Col:4 Row:7 grids\26.xgd
28 Col:5 Row:0 grids\11.xgd
29 Col:5 Row:1 grids\12.xgd
30 Col:5 Row:2 grids\13.xgd
31 Col:5 Row:3 grids\14.xgd
32 Col:5 Row:4 grids\15.xgd
33 Col:5 Row:5 grids\16.xgd
34 Col:5 Row:6 grids\17.xgd
35 Col:5 Row:7 grids\18.xgd
36 Col:6 Row:1 grids\01.xgd
37 Col:6 Row:2 grids\05.xgd
38 Col:6 Row:3 grids\06.xgd
39 Col:6 Row:4 grids\07.xgd
40 Col:6 Row:5 grids\08.xgd
41 Col:6 Row:6 grids\09.xgd
42 Col:6 Row:7 grids\10.xgd
43 Col:7 Row:1 grids\02.xgd
44 Col:7 Row:2 grids\04.xgd

Processed data
Stats
Max: 5.20
Min: -4.80
Std Dev: 2.10
Mean: -0.03
Median: 0.00

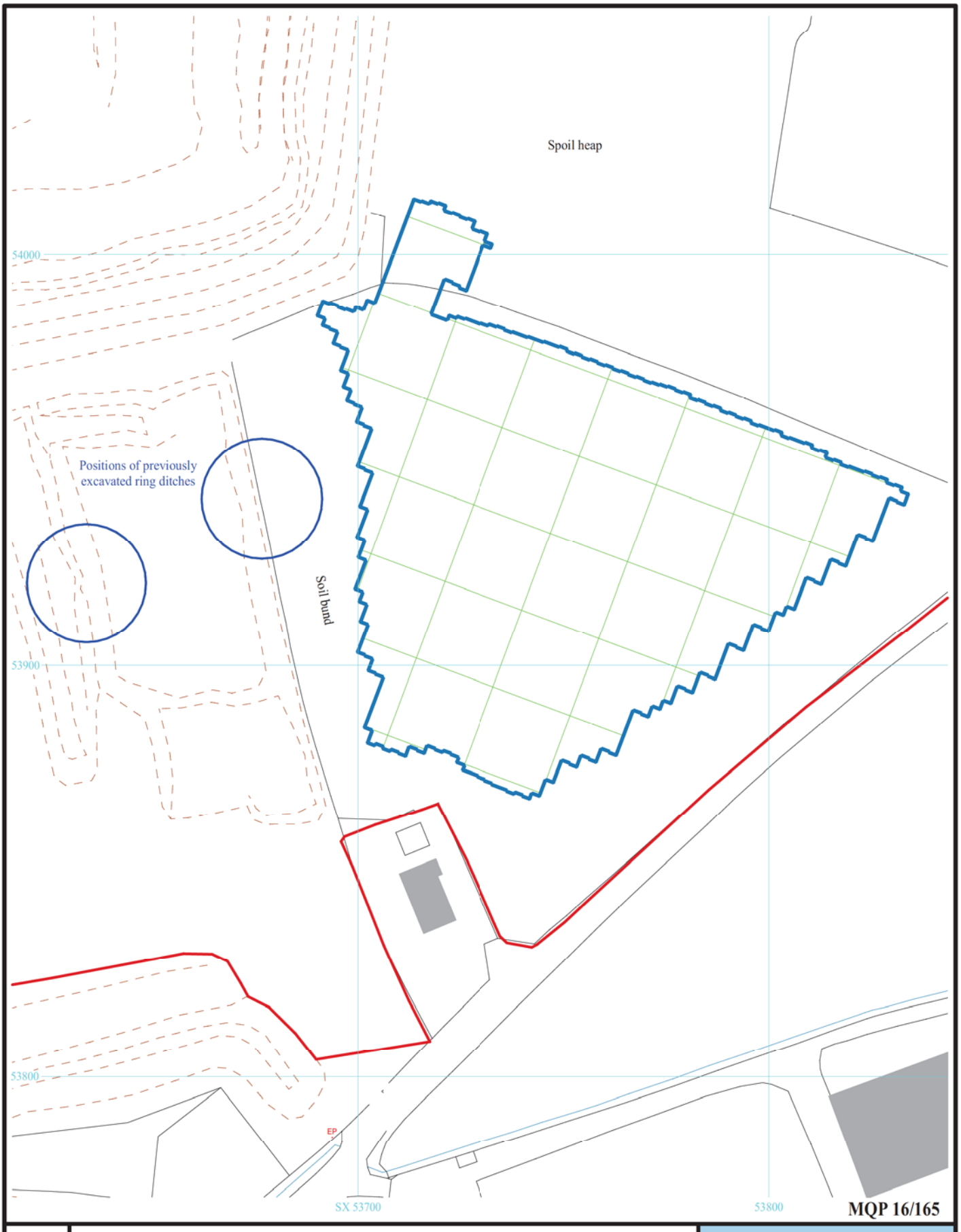
Processes: 6
1 Base Layer
2 DeStripe Median Sensors: Grids: All
3 De Stagger: Grids: All Mode: Both By: -1 intervals
4 Despike Threshold: 1 Window size: 3x3
5 Interpolate: Y Doubled.
6 Clip from -4.80 to 5.20 nT



Hazeldene, Moorcroft Quarry,
Elburton, Plymouth, 2016
Geophysical Survey (Magnetic)

Figure 1. Location of site within Elburton and Devon.

TVAS
SOUTH WEST



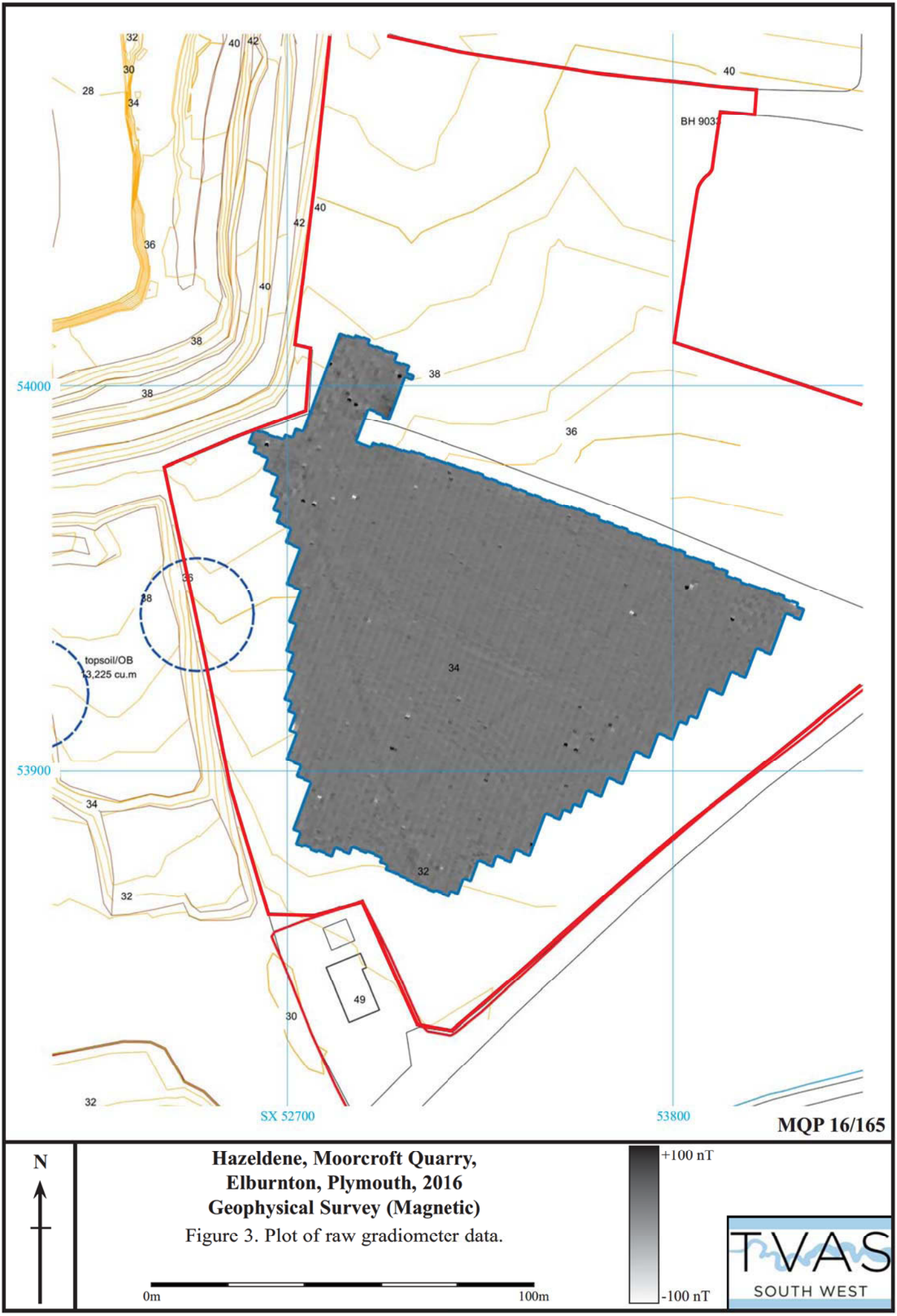
N

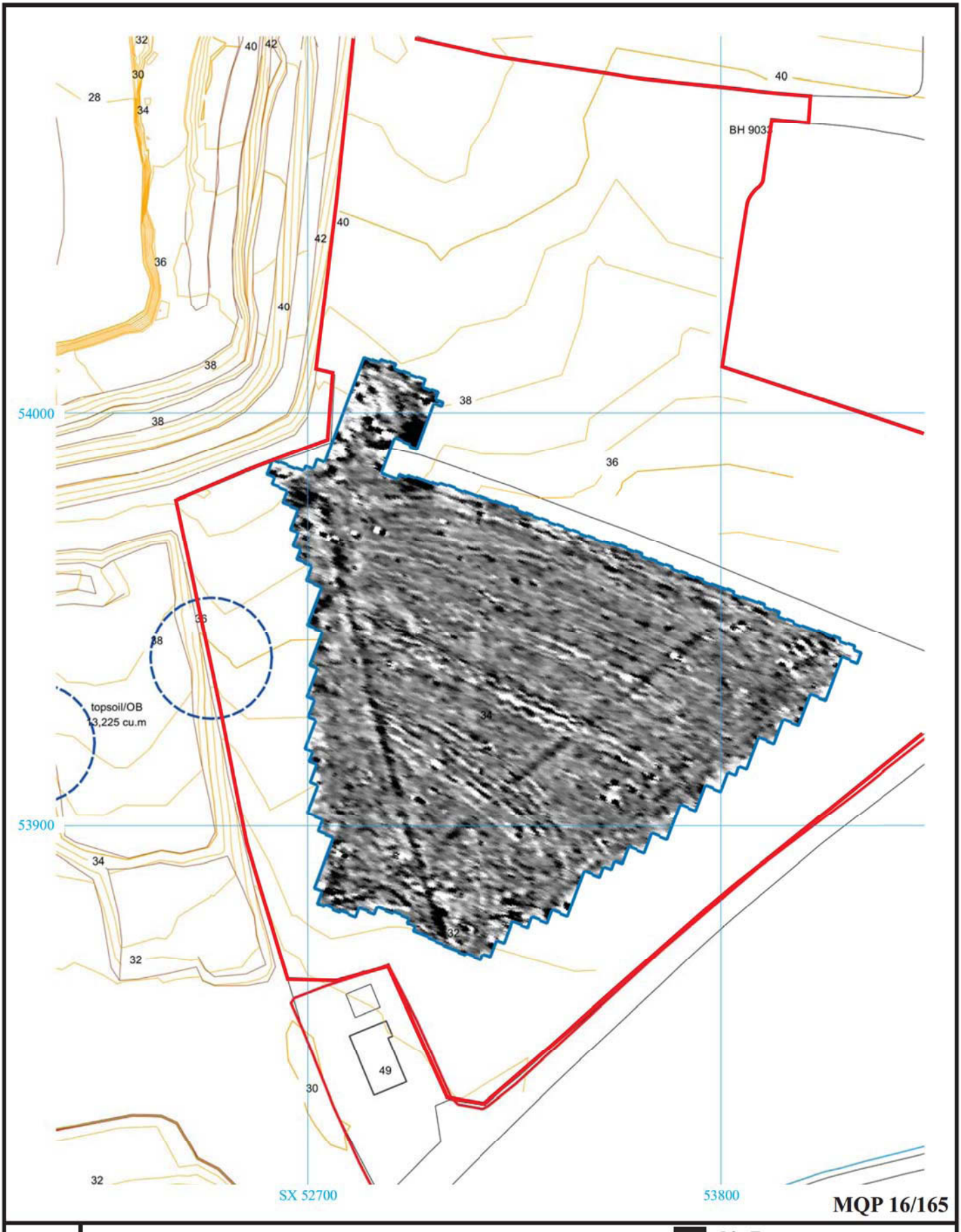
**Hazeldene, Moorcroft Quarry,
Elburton, Plymouth, 2016
Geophysical Survey (Magnetic)**

Figure 2. Survey grid layout.

0 100m

TVAS SOUTH WEST


32
40
42
30
28
34
40
BH 903
42
40
36
40
38
38
54000
38
36
35
38
topsoil/OB
3,225 cu.m
34
53900
34
32
32
49
30
32
SX 52700
53800
MQP 16/165
N
Hazeldene, Moorcroft Quarry,
Elburnton, Plymouth, 2016
Geophysical Survey (Magnetic)
Figure 3. Plot of raw gradiometer data.
+100 nT
-100 nT
0m
100m
TVAS
SOUTH WEST



N

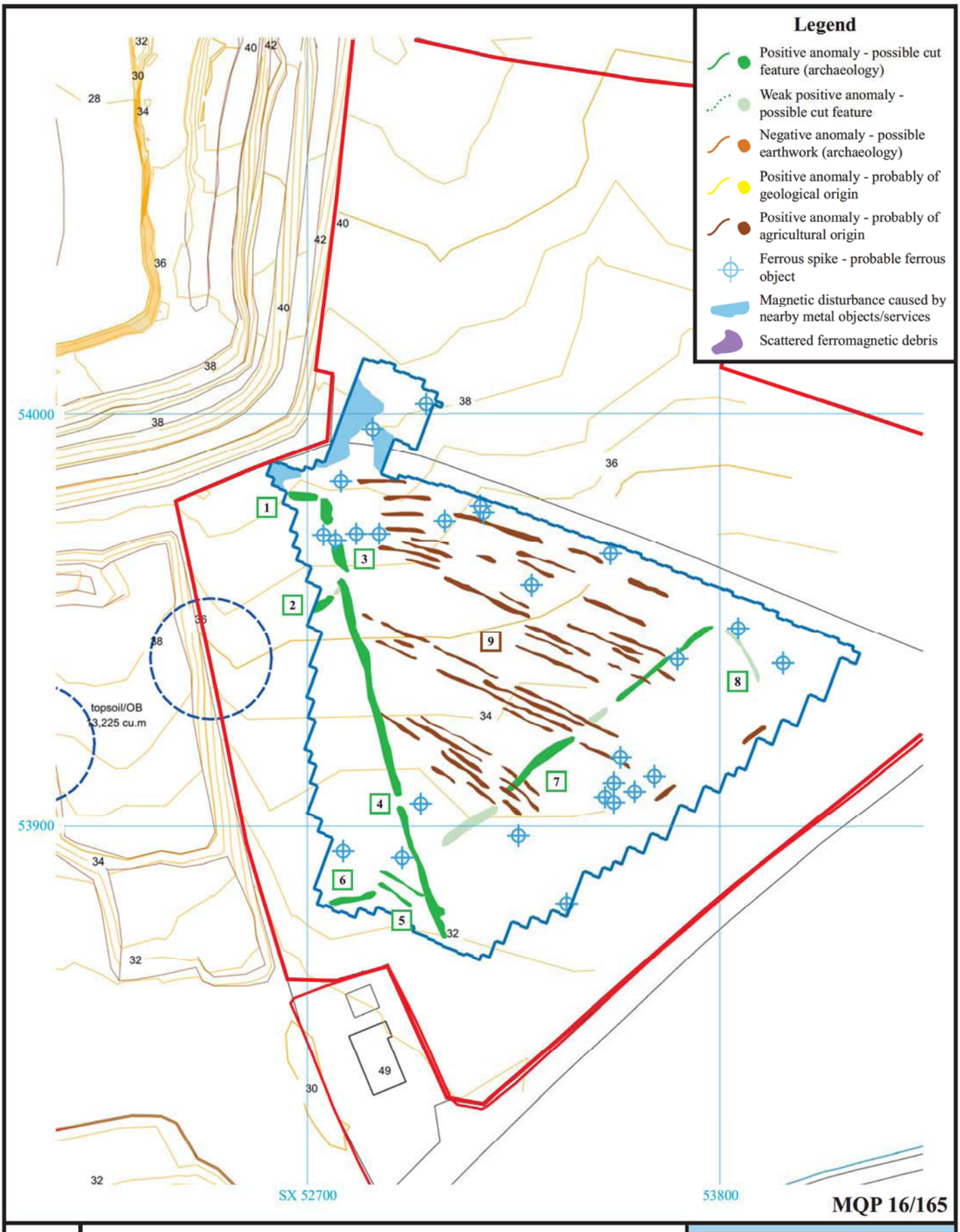
Hazeldene, Moorcroft Quarry,
Elburnton, Plymouth, 2016
Geophysical Survey (Magnetic)

Figure 4. Plot of minimally processed gradiometer data.

0m 100m

+5.2 nT
-4.8 nT

TVAS SOUTH WEST



N

Hazeldene, Moorcroft Quarry, Elburnton, Plymouth, 2016
Geophysical Survey (Magnetic)
Figure 5. Interpretation plot.

0m 100m

TVAS SOUTH WEST

Plate 1. The southern field, looking south-east along the boundary with the northern field.

Plate 2. The southern field, looking south.

MQP 16/165

Hazeldene, Moorcroft Quarry,
Elburton, Plymouth, 2016
Geophysical Survey (Magnetic)
Plates 1 - 2.

TVAS
SOUTH WEST

TIME CHART

	Calendar Years
Modern	AD 1901
Victorian	AD 1837
Post Medieval	AD 1500
Medieval	AD 1066
Saxon	AD 410
Roman	AD 43
Iron Age	BC/AD 750 BC
Bronze Age: Late	1300 BC
Bronze Age: Middle	1700 BC
Bronze Age: Early	2100 BC
Neolithic: Late	3300 BC
Neolithic: Early	4300 BC
Mesolithic: Late	6000 BC
Mesolithic: Early	10000 BC
Palaeolithic: Upper	30000 BC
Palaeolithic: Middle	70000 BC
Palaeolithic: Lower	2,000,000 BC

TVAS (South West),
Unit 21 Apple Business Centre,
Frobisher Way, Taunton,
Somerset, TA2 6BB

Tel: 01823 288 284
Fax: 01823 272 462
Email: southwest@tvas.co.uk
Web: www.tvas.co.uk