Substrata
Archaeological Geophysical Surveyors

An archaeological gradiometer survey

Land at Trevassack Hill, Hayle, Cornwall

Centred on NGR (E/N): 156821,37572 (point)

Report: 1601TRE-R-1

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22 January 2016

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Website: substrata.co.uk

For an overview of Substrata, our archaeological geophysical surveying techniques and the results we obtain.

1 Survey description and summary

1.1 Survey

Type:	twin-sensor fluxgate gradiometer
Date:	12 and 13 January 2016
Area:	gradiometer survey: 3.9ha
Lead surveyor:	Mark Edwards BA
Author:	Ross Dean BSc MSc MA MIfA

1.2 Client

AC Archaeology Ltd, 4 1Halthaies Workshops, Bradninch, Nr Exeter, Devon EX5 4QL

1.3 Location

Site:	Land at Trevassack Hill
Civil Parish:	Hayle
County:	Cornwall
Nearest Postcode:	TR27 4NB
NGR:	SW 568 376
Ordnance Survey NGR (E/N):	156821,37572 (point)

1.4 Archive

OASIS number:	substrat1-239710
Archive:	At the time of writing, the archive of this survey will be held by Substrata.

1.5 Introduction

This report presents the results of an archaeological magnetometer survey across the above site. It was commissioned by AC Archaeology Limited on behalf of clients in preparation for a forthcoming planning application. The site location is shown in Figure 1.

1.6 Summary

The magnetic responses across the site were sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses.

Thirteen magnetic anomaly groups were mapped as possibly representing archaeological deposits or features. Two of these represent former field boundaries mapped by the Ordnance Survey. The remainder are typical of anomalies representing remnants of at least one phase of earlier fields. Two of the plots surveyed had anomaly patterns consistent with material dumping and ground clearance.

2 Survey aims and objectives

2.1 Aims

To establish the presence or absence, extent and character of any archaeological features and deposits within the site. The results of the survey and any subsequent trial trenching will be reviewed and used to inform any ensuing mitigation.

2.2 Survey objectives

1. Complete a gradiometer survey across agreed parts of the site.
2. Identify any magnetic anomalies that may be related to archaeological deposits, structures or artefacts.
3. Within the limits of the techniques and dataset, archaeologically characterise any such anomalies or patterns of anomalies.
4. Accurately record the location of the identified anomalies.
5. Produce a report based on the survey that is sufficiently detailed to inform any subsequent development on the site about the location and possible archaeological character of the recorded anomalies.

3 Standards

The standards used to complete this survey are defined by the Chartered Institute for Archaeologists (2014a) and Historic England (2010). The codes of approved practice that were followed are those of the Chartered Institute for Archaeologists (2014b) and the Archaeology Data Service/Digital Antiquity Guides (undated).

4 Site description

4.1 Landscape and land use

The proposed application area forms an irregular block of land comprising four discrete plots (areas A to D in Figure 2) in the parish of Hayle. The total area encompassed by the proposed development is approximately 3.9 hectares. The site is situated on a north facing slope at between approximately 27m and 33m AOD. To the west it is bordered by the Humphry Davy Lane and to the north, the railway embankment forms part of the boundary (Figure 1).

At the time of the survey the site was left to rough pasture and area of cleared former derelict structures in area C. The boundaries for all of the fields consist of overgrown low hedgebanks planted with topped with poorly maintained hedgerow species. The nature of the site reduced the area that could be surveyed using a magnetometer as shown in Figures 2 to 4.

4.2 Geology

The site has a solid geology comprising rocks of the Devonian Porthtowan Formation. Generically these rocks are interbedded grey and grey-green slaty mudstone and sandstone. The subordinate sandstone beds are up to 2m thick and are typical turbidites. The superficial geology across the rest of the site is unrecorded (British Geological Survey, undated).

5 Archaeological background

Archaeological sites, buildings, historic parks and gardens, conservation areas, registered battlefields and other aspects of the historic environment that are considered significant because of their historic, archaeological, architectural or artistic interest are considered *heritage assets*. *Designated heritage assets* are afforded protection as either scheduled monuments, listed buildings or through their inclusion within conservation areas. *Non-designated heritage assets* are potential archaeological remains and historic landscapes.

The following is a short summary of information obtained from an historic environment assessment completed by AC Archaeology as part of the same programme of work as this report (Cottam, 2015).

There are no designated or non-designated heritage assets currently recorded within the application area. The Historic Landscape Characterisation records the field pattern of the area as medieval farmland with little evidence of change within its boundaries during the post-medieval and modern periods. The large drops in height at boundaries within the application area are suggestive of lynchets. These may represent early, possibly medieval, agricultural terraces. In 1842, the land was largely owned by the Cornish Copper Company, a smelting and founding company whose arrival in Hayle in the mid-19th century saw significant growth in population and industry. Although mining adits are shown on either side of the application area, no evidence was found for mining or associated industrial activity within the site. A possible prehistoric barrow and a stone axe have been found in the vicinity of the application area (Cottam, 2015: 1, 24).

6 Results, discussion and conclusions

This survey was designed to record magnetic anomalies. The anomalies themselves cannot be regarded as actual archaeological features and the dimensions of the anomalies shown do not represent the dimensions of any associated archaeological features. The analysis presented below identifies and characterises anomalies and anomaly groups that may relate to archaeological deposits and structures.

Archaeological structures, features and deposits refer to any artefacts, material deposits or disturbance of natural deposits thought to be the result of human activity and not undertaken as recent land maintenance or farming.

The reader is referred to section 7.

6.1 Results

Figure 2 shows the interpretation of the survey data. It includes the anomaly groups identified as relating to archaeological deposits along with their numbers. Table 1 is an extract of the detailed analysis of the survey data which is sourced from the attribute tables of the GIS project provided in the project archive. For the purposes of description, the plots within the application area have been labelled A to D following the designations specified by Cottam (2015) as shown in Figure 2.

Figure 2 and Table 1 comprise the analysis of the survey data.

Figures 3 and 4 are plots of processed data as specified in Table 3. These plots represent different views of the data that were used to assess potential archaeology.

6.2 Discussion

6.2.1 General points

Discussion scope

Not all anomalies or anomaly groups identified in Table 1 are necessarily discussed below. All identified anomaly groups are recorded in the GIS project held the survey archive.

Data collection

Data collection along the site edges and within the site was restricted as shown in Figures 3 and 4 due to the presence of magnetic materials adjacent to the site, piles of cleared debris and areas of thick vegetation. Strong magnetic responses mapped close to survey boundaries are likely to relate to these materials except where otherwise indicated in Figure 2.

Anomaly characterisation and mapping

There are a number of anomaly groups that could be interpreted as relating to large postholes or pits although most will have natural origins. Anomalies of this sort are only mapped as potential archaeology if they are clustered in groups or otherwise form recognisable patterns.

Recent man-made objects such as manholes, water management equipment, drains, cables and other services were only mapped where they comprised significant magnetic responses across the dataset that needed clarification. If mapped, they are listed in Table 1 but are not discussed below.

Anomalies thought to relate to natural features were not mapped.

Data trends

The relatively large magnetic responses in areas C and D (Figures 3 and 4) denote areas of rubble and disturbed ground consistent with material dumping and ground clearance.

6.2.2 Data relating to historical maps and other records

Magnetic anomaly group **2** represent a former field boundary mapped by the Ordnance Survey as shown in Table 1. Group **10** represents a field boundary only recently removed and still mapped on the current Ordnance Survey digital tile.

6.2.3 Data with no previous archaeological provenance

Magnetic anomaly group **7** is most likely to represent a former field boundary. It may have been a Cornish hedge which is a stone-faced earthen bank often with flanking ditches.

Anomaly group **9** may represent a former Cornish hedge or a narrow ditch-lined track.

Group **11** is most likely to represent a field lynchet.

All of the other mapped anomaly groups are most likely to represent fragments of linear deposits such as ditches and are typical of anomalies representing remnants of earlier fields.

6.3 Conclusions

The magnetic responses across the site were sufficient to be able to differentiate between anomalies representing possible archaeological features and background magnetic responses.

Thirteen magnetic anomaly groups were mapped as possibly representing archaeological deposits or features. Two of these represent former field boundaries mapped by the Ordnance Survey. The remainder are typical of anomalies representing remnants of at least one phase of earlier fields. Two of the plots surveyed had anomaly patterns consistent with material dumping and ground clearance.

7 Disclaimer and copyright

The description and discussion of the results presented in this report are the authors, based on his interpretation of the survey data. Every effort has been made to provide accurate descriptions and interpretations of the geophysical data set. The nature of archaeological geophysical surveying is such that interpretations based on geophysical data, while informative, can only be provisional. Geophysical surveys are a cost-effective early step in the multi-phase process that is archaeology. The evaluation programme of which this survey is part may also be informed by other archaeological assessment work and analysis. It must be presumed that more archaeological features will be evaluated than those specified in this report.

8 Acknowledgements

Substrata would like to thank John Valentin of AC Archaeology Ltd for commissioning us to complete this survey.

9 Bibliography

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Historic England (2010) *Geophysical Survey in Archaeological Field Evaluation*, [Online], Available: https://content.historicengland.org.uk/images-books/publications/geophysical-survey-in-archaeological-field-evaluation/geophysics-guidelines.pdf/ [January 2016]

Appendix 1 Analysis table and supporting plots

General Guidance

The anomalies represented in the survey plots provided in this appendix are magnetic anomalies. The apparent size of such anomalies and anomaly patterns are unlikely to correspond exactly with the dimensions of any associated archaeological features.

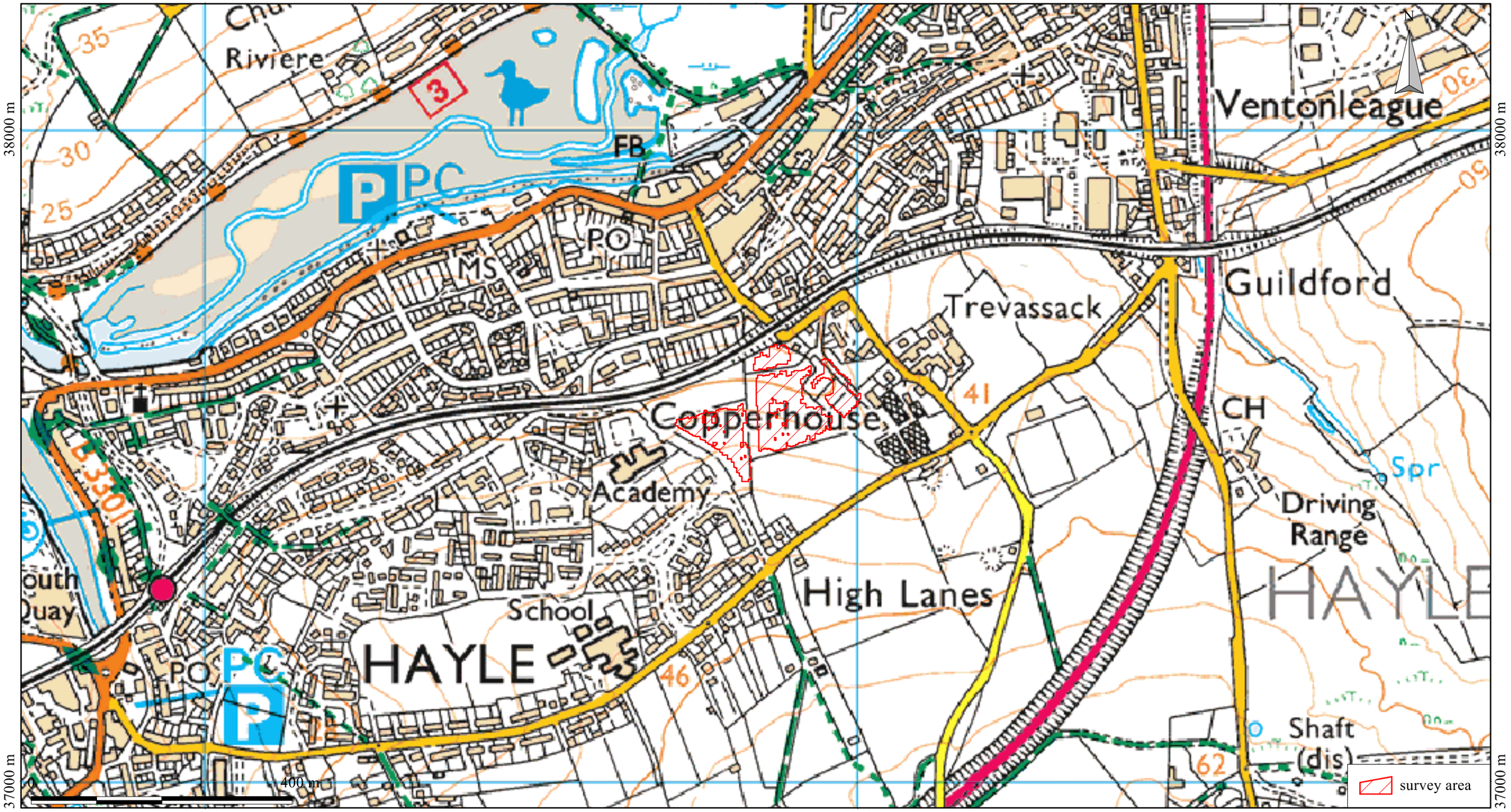
A rough rule for interpreting magnetic anomalies is that the width of an anomaly at half its maximum reading is equal to the width of the buried feature, or its depth if this is greater (Clark, 2000: 83). Caution must be applied when using this rule as it depends on the anomalies being clearly identifiable and distinct from adjacent anomalies. In northern latitudes the position of the maximum of a magnetic anomaly will be displaced slightly to the south of any associated physical feature.

156000 m

157000 m

38000 m

38000 m



37000 m

37000 m

156000 m

157000 m

British Grid
centre X: 156843.89 m, centre Y: 37575.74 m

Scale: 1:6000 @ A3. Spatial Units: Meter. Do not scale off this drawing

An archaeological gradiometer survey
Land at Trevassack Hill, Hayle, Cornwall
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Figure 2: survey interpretation

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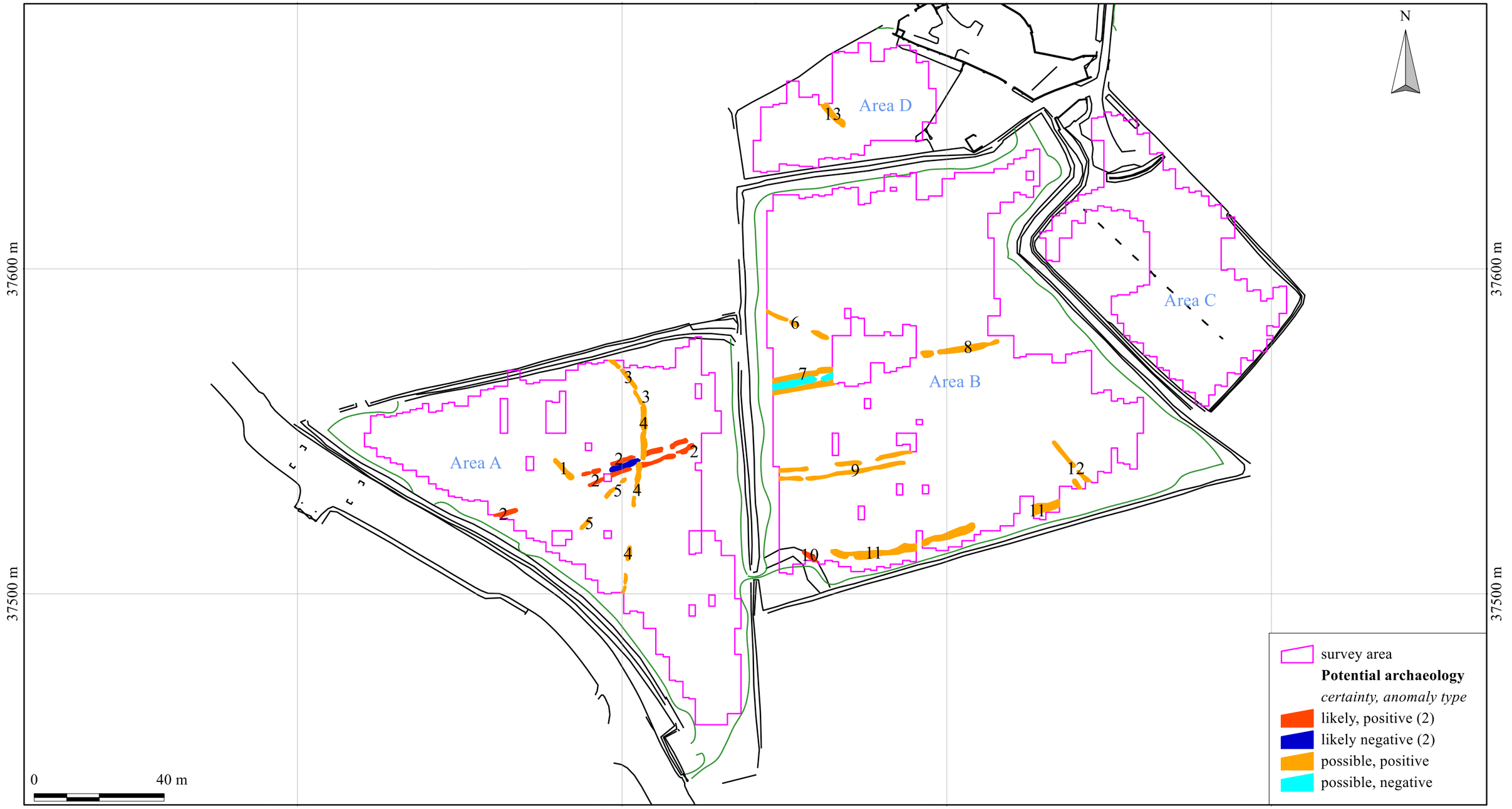

British Grid
centre X: 156841.04 m, centre Y: 37558.32 m

Scale: 1:1200 @ A3. Spatial Units: Meter. Do not scale off this drawing

Notes:
1. All interpretations are provisional and represent potential archaeological deposits.
2. Anomalies designated "likely archaeology" have supporting evidence e.g. historical maps and or visible earthworks.
3. Anomalies likely to represent geological or other natural deposits are not mapped unless relevant to potential archaeological events or deposits.

An archaeological gradiometer survey
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Figure 2: survey interpretation

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Site: An archaeological gradiometer survey
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area	anomaly group	anomaly characterisation certainty & class	anomaly form	additional archaeological characterisation	comments	supporting evidence
A	1	possible, positive	linear			
A	2	likely positive/negative/positive	disrupted linear	field boundary - possible Cornish hedge	anomaly group approximately coincides with a field boundary mapped by the Ordnance Survey between 1877 and 1938 but not on earlier maps	1842 Phillack Tithe map, 1853 Plan of Wheal Mining District, Ordnance Survey maps 1887 to 1938
A	3	possible, positive	disrupted linear			
A	4	possible, positive	disrupted linear			
A	5	possible, positive	disrupted linear			
B	6	possible, positive	disrupted linear			
B	7	possible, positive/negative/positive	disrupted linear	field boundary - possible Cornish hedge		
B	8	possible, positive	disrupted linear			
B	9	possible, positive	disrupted curvilinear	field boundary (Cornish hedge) or narrow ditch-lined lane		
B	10	likely, positive	linear		anomaly group coincides with a recently removed field boundary as mapped on the latest Ordnance Survey digital tile	
B	11	possible, positive	disrupted curvilinear	cultivation lynchet	a less likely but possible origin for this anomaly group is that it reflects recent vehicle tracks	
B	12	possible, positive	disrupted linear	field boundary (Cornish hedge) or narrow ditch-lined lane		
C	13	possible, positive	curvilinear			

Table 1: data analysis

British Grid
centre X: 156841.04 m, centre Y: 37558.32 m

Scale: 1:1200 @ A3. Spatial Units: Meter. Do not scale off this drawing

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Figure 3: shade plot of processed data

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156700 m 156800 m 156900 m 157000 m

37600 m

37500 m

N

Processed gradiometer data
contour plot (nT)
> 8.00
4.00 - 8.00
2.00 - 4.00
1.00 - 2.00
-1.00 - 1.00
-2.00 - -1.00
-4.00 - -2.00
-8.00 - -4.00
< -8.00

0 40 m

British Grid
centre X: 156841.04 m, centre Y: 37558.32 m

Scale: 1:1200 @ A3. Spatial Units: Meter. Do not scale off this drawing

An archaeological gradiometer survey
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Figure 4: contour plot of processed data

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Appendix 2 Methodology Summary

Table 2: methodology summary	
Documents Survey methodology statement: Dean (2016)	
Methodology 1. The work was undertaken in accordance with the survey methodology statement. The geophysical (gradiometer) survey was undertaken with reference to standard guidance provided by the Chartered Institute for Archaeologists (2014) and Archaeology Data Service/ Digital Antiquity Guides (undated). 2. The survey grid location information and grid plan was recorded as part of the project in a suitable GIS system. 3. Data processing was undertaken using appropriate software, with all anomalies being digitised and geo-referenced. The final report included a graphical and textual account of the techniques undertaken, the data obtained and an archaeological interpretation of that data and conclusions about any likely archaeology.	
Grid *Method of Fixing:* DGPS set-out using pre-planned survey grids and Ordnance Survey coordinates. *Composition:* 30m by 30m grids *Recording:* Geo-referenced and recorded using digital map tiles. *DGPS used:* Spectra Precision PM5V2 GPS with external antenna and survey pole and DigiTerra Explorer 7 as the survey control program.	
Equipment *Instrument:* Bartington Instruments grad601-2 *Firmware:* version 6.1	**Data Capture** *Sample Interval:* 0.25m *Traverse Interval:* 1 metre *Traverse Method:* zigzag *Traverse Orientation:* GN
Data Processing, Analysis and Presentation Software IntelliCAD Technology Consortium IntelliCAD 8.0 DW Consulting TerraSurveyor3 Manifold System 8 GIS Microsoft Corp. Office Excel 2013 Microsoft Corp. Office Publisher 2013 Adobe Systems Inc Adobe Acrobat 9 Pro Extended	

Appendix 3 Data processing

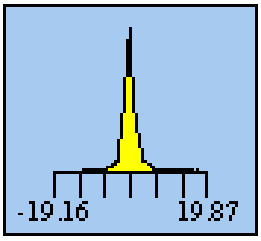
Table 3: gradiometer survey - processed data metadata

SITE
Instrument Type: Bartington Grad 610
Units: nT
Direction of 1st Traverse: see below
Collection Method: ZigZag
Sensors: 2 @ 1.00 m spacing.
Dummy Value: 32702

PROGRAM
Name: TerraSurveyor
Version: 3.0.28.1

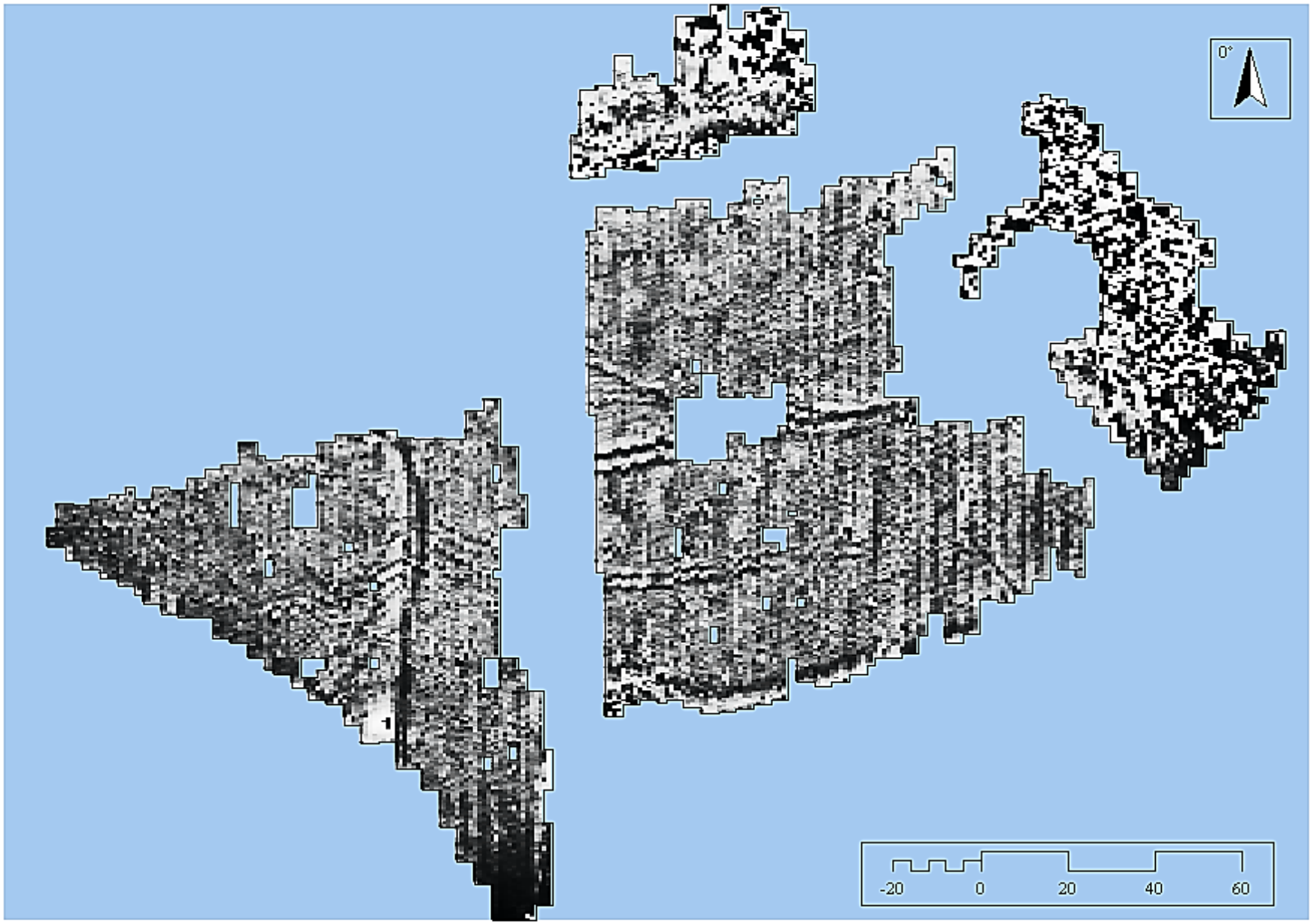
Stats

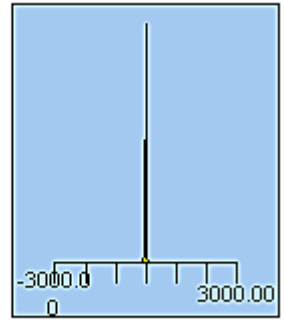
Max:	256.72
Min:	-128.33
Std Dev:	9.76
Mean:	0.36
Median:	0.05

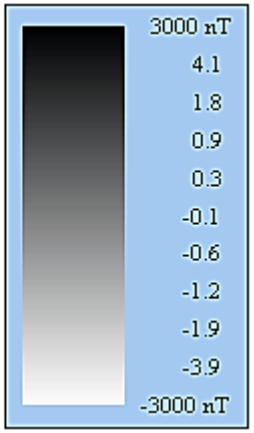


Processes: 13
1 Base Layer
2 Clip at 1.00 SD
3 Clip at 1.00 SD
4 De Stagger: Grids: All Mode: Both By: -1 intervals
5 De Stagger: Grids: b21.xgd b20.xgd b19.xgd b18.xgd Mode: Both By: -1 intervals
6 De Stagger: Grids: a11.xgd a12.xgd a13.xgd a14.xgd a15.xgd Mode: Both By: 1 intervals
7 De Stagger: Grids: b1.xgd b4.xgd b9.xgd a16+b2.xgd b5.xgd b8.xgd b7.xgd b6.xgd Mode: Both By: -1 intervals
8 De Stagger: Grids: a20+b3.xgd b10.xgd Mode: Both By: -1 intervals
9 DeStripe Median Traverse: Grids: b15.xgd b20.xgd a1+b23.xgd a10.xgd a11.xgd b11.xgd b14.xgd b16.xgd b19.xgd a2.xgd a9.xgd a12.xgd a18.xgd a19.xgd b12.xgd b13.xgd b17.xgd b18.xgd a3.xgd a8.xgd a13.xgd a17.xgd a20+b3.xgd b10.xgd a4.xgd a7.xgd a14.xgd b1.xgd b4.xgd b9.xgd a5+a21.xgd a6+a24.xgd a15.xgd a16+b2.xgd b5.xgd b8.xgd a22.xgd a23.xgd a25.xgd b7.xgd b6.xgd
10 DeStripe Median Sensors: b21.xgd b22.xgd
11 Edge Match (Area: Top 90, Left 0, Bottom 119, Right 119) to Right edge
12 Edge Match (Area: Top 120, Left 0, Bottom 149, Right 119) to Right edge
13 Interpolate: Match X & Y Doubled.

Appendix 4 Unprocessed data plot







Instrument Type: Bartington Grad 610
Units: nT
Direction of 1st Traverse: 0 deg
Collection Method: ZigZag
Sensors: 2 @ 0.00 m spacing.
Dummy Value: 32702

Dimensions
Composite Size (readings): 840 x 300
Survey Size (meters): 210 m x 300 m
Grid Size: 30 m x 30 m
X Interval: 0.25 m
Y Interval: 1 m

Stats
Max: 3000.00
Min: -3000.00
Std Dev: 309.78
Mean: -1.55
Median: -0.10

PROGRAM
Name: TerraSurveyor
Version: 3.0.28.1

Processes: 1
1 Base Layer

Figure 5: shade plot of unprocessed data