

# **GSB**

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## **PROSPECTION Ltd**

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### **GEOFYSICAL SURVEY REPORT** **2008/27**

### **Looe & Looe Island** **Cornwall**



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*Specialising in Shallow and Archaeological Prospection*

**GSB Survey No. 08/27****Looe & Looe Island, Cornwall*****Time Team Series XVI Programme V***

<b>NGR</b>	SX 250 521 (mainland) SX 256 514 (island).		
<b>Location</b>	The areas under investigation are Lammana Chapel on the mainland, approximately 12km south of Liskeard and St Michael's Chapel on Looe Island, approximately 1km south of Looe, Cornwall.		
<b>District</b>	Caradon	<b>Parish</b>	Looe
<b>Topography</b>	Sloping from northwest to southeast on the mainland and on a prominent mound on the island.		
<b>Current land-use</b>	Public recreation/tourist attraction (mainland) and nature reserve (island).		
<b>Soils</b>	Soils of the area belong to the Denbigh 1 (541j) association (SSEW 1983).		
<b>Geology</b>	Sedimentary and igneous rocks and some beach deposits (BGS sheet 348).		
<b>Archaeology<sup>#</sup></b>	Lammana Chapel dates from the 12 <sup>th</sup> century and has a monastic building associated with it known as 'The Monks House'. Excavation was carried out at Lammana in the 1930s. St Michael's Chapel was recently discovered via a 1290 document and pre-dates the mainland chapel. Structural remains consist of a few earthworks, a small platform and some carved stones. Amphora fragments have also been found on the island dating to 500AD. GSB Prospection conducted a geophysical survey on the island in 2003 (GSB 03/45) in which a few targets of interest were identified.		
<b>Survey Methods</b>	Fluxgate Gradiometer and Resistance.		

**Aims**

To locate any detectable archaeology within the survey areas. The work forms part of a wider archaeological assessment being carried out by Channel 4's **Time Team**.

**Summary of Results**

Magnetic data were collected on the mainland site only and show a number of ditches which may represent former land divisions, perhaps associated with the chapel. Natural anomalies are located throughout the dataset. A modern pipe has also been detected within the data.

Small areas of resistance survey were carried out over the Monks House site and St Michael's Chapel. Both datasets indicated that archaeological remains were present.

**Project Information**

**Project Co-ordinator:** Emma Wood BSc MIFA  
**Project Assistants:** Dr John Gater & Ruth Green  
**Date of Fieldwork:** 28<sup>th</sup> – 30<sup>th</sup> May 2008  
**Date of Report:** 12<sup>th</sup> November 2008

<sup>#</sup> Taken from Mower *et al* 2008.

### Survey Specifications

#### Method

The survey grid was set out and tied in to the Ordnance Survey (OS) grid using a Trimble R8 Real Time Kinematic (RTK) GPS system by **Dr Henry Chapman**.

Technique	Traverse Separation	Reading Interval	Instrument	Survey Size
Magnetometer – Detailed (Appendix 1)	1m	0.25m	Bartington Grad 601-2	1.8ha
Resistance – Twin Probe (Appendix 1)	1m	1m	Geoscan RM15 Meter and MPX15 Multiplexer	0.2ha
GPR (Appendix 1)	-	-	-	-

#### Data Processing

	Magnetic	Resistance	GPR
Tilt Correct	Y	N	-
De-stagger	Y	N	-
Interpolate	Y	Y	-
Filter	N	N	-

#### Presentation of Results

Report Figures (Printed & Archive CD): Location plots, data plots and interpretation diagrams on base map (Figures 1-5).

Reference Figures (Archive CD): Data plots and interpretations at 1:500 - for reference and analysis (Figures A1-A6).

Plot Formats: See Appendix 1: Technical Information, at end of report.

#### General Considerations

Small scale ferrous responses within the magnetic data are likely to be of modern origin and will not be discussed within the report unless necessary. These responses can be seen in the XY trace plots (on the Archive CD) as sharp peaks.

The topography on the mainland was, in places quite steep which made walking with the instrument difficult; this however, has not hindered the data quality. Resistance survey on the island was restricted to a small area due to overgrowth and topography.

## Results of Survey

### 1. Gradiometer Survey

- 1.1 An area of increased magnetic response (A) in the northeast of the survey is in the approximate vicinity of 'The Monks House', and may be related to this monastic building.
- 1.2 In the southwest of the data, three ditches (B) are evident. These may reflect a possible monastic boundary or a former field division. Ditches elsewhere, such as (C) could also be given the same interpretation.
- 1.3 Other potential archaeological anomalies have been identified throughout the data which may be related to the monastic site; interpretation is difficult due to the lack of clarity and the surrounding natural responses.
- 1.4 The data are dominated by some strong magnetic responses, particularly those at (D) which are likely to reflect the local igneous geology of the area. Other swathes of natural responses have been identified. These responses have made any interpretation difficult as the potential archaeology will have been masked by these strong anomalies.
- 1.5 A ferrous response (E), according to a local habitant, was the location of a naval gun platform. A curving ferrous response can be seen running through the south/southeast of the data, this may reflect metalling of the current footpath or a pipe/cable buried in a trench containing a highly magnetic fill. Other ferrous responses are likely to be of a modern origin.

### 2. Resistance Survey

#### Mainland

- 2.1 This area was positioned to cover 'The Monks House'. An area of high resistance (1) is likely to be rubble associated with the building. A handful of trends (2), both linear and curvilinear, may be of interest and associated with the house; possibly indicating garden features, although they may relate to natural features.
- 2.2 A band of low resistance corresponds to the curving ferrous anomaly as seen in the magnetic data.

#### Looe Island

- 2.3 An area was surveyed over the remains of St Michael's Chapel, unfortunately due to the overgrowth, topography and the small size of the survey area the interpretation is difficult.
- 2.4 There are some areas of high resistance, on an east-west alignment, that are likely to be the remains of the chapel. Other high and low readings are due to the topography.

### 3. Conclusions

- 3.1 On the mainland, the magnetic results show a number of possible archaeological features including ditches and pits along with an area of increased response which may be associated with 'The Monks House', the latter being also visible in the resistance data.
- 3.2 The resistance data from the island correspond with the earthworks associated with the site of St Michael's Chapel; unfortunately due to the nature of the site the survey could not be extended.

<b>List of Figures</b>
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<b>Report Figures</b>
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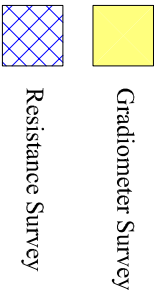
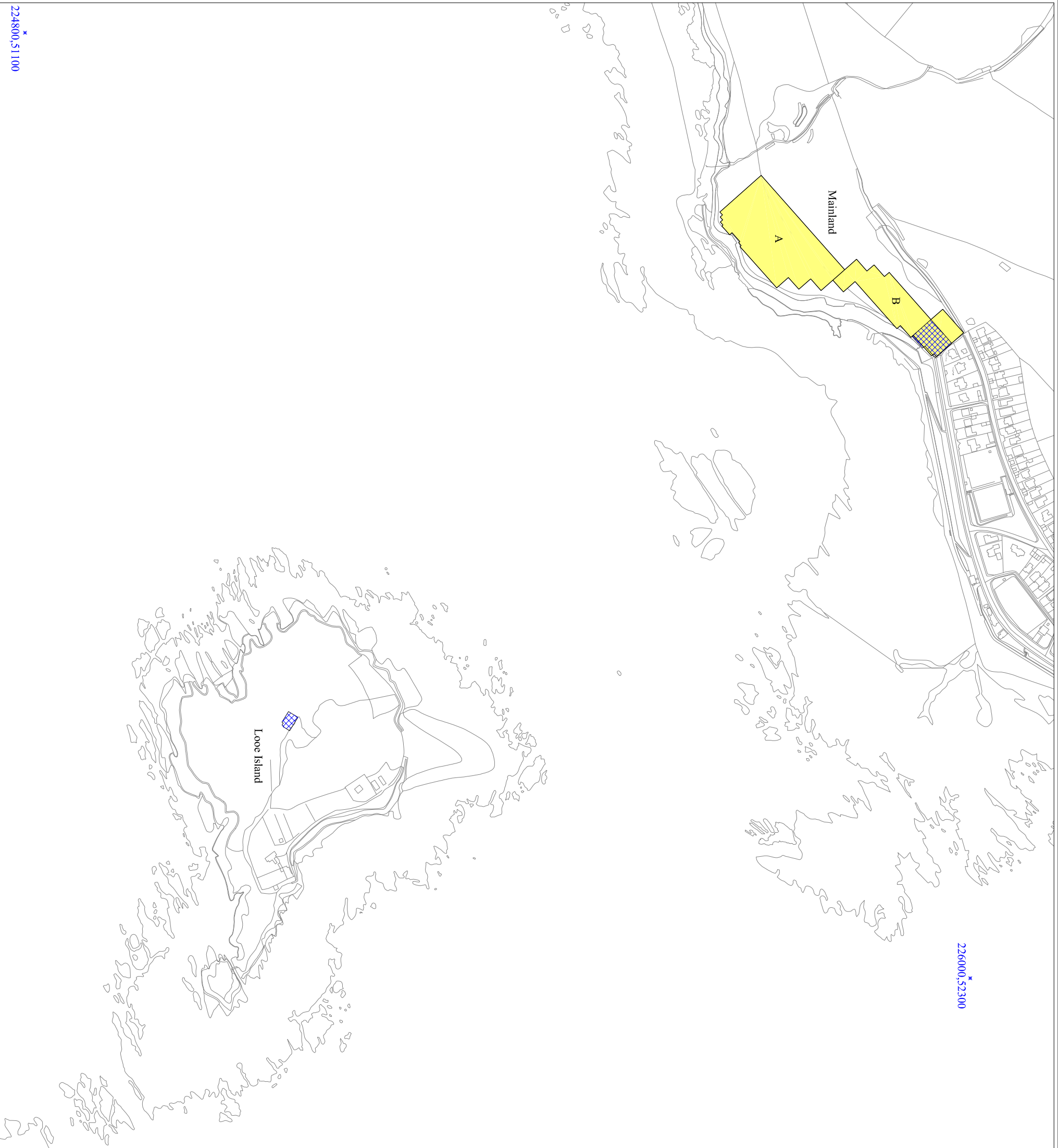
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Figure 3	Summary Gradiometer Interpretation	1:2000
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<b>Reference Figures on CD</b>
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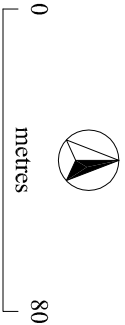
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<b>References</b>
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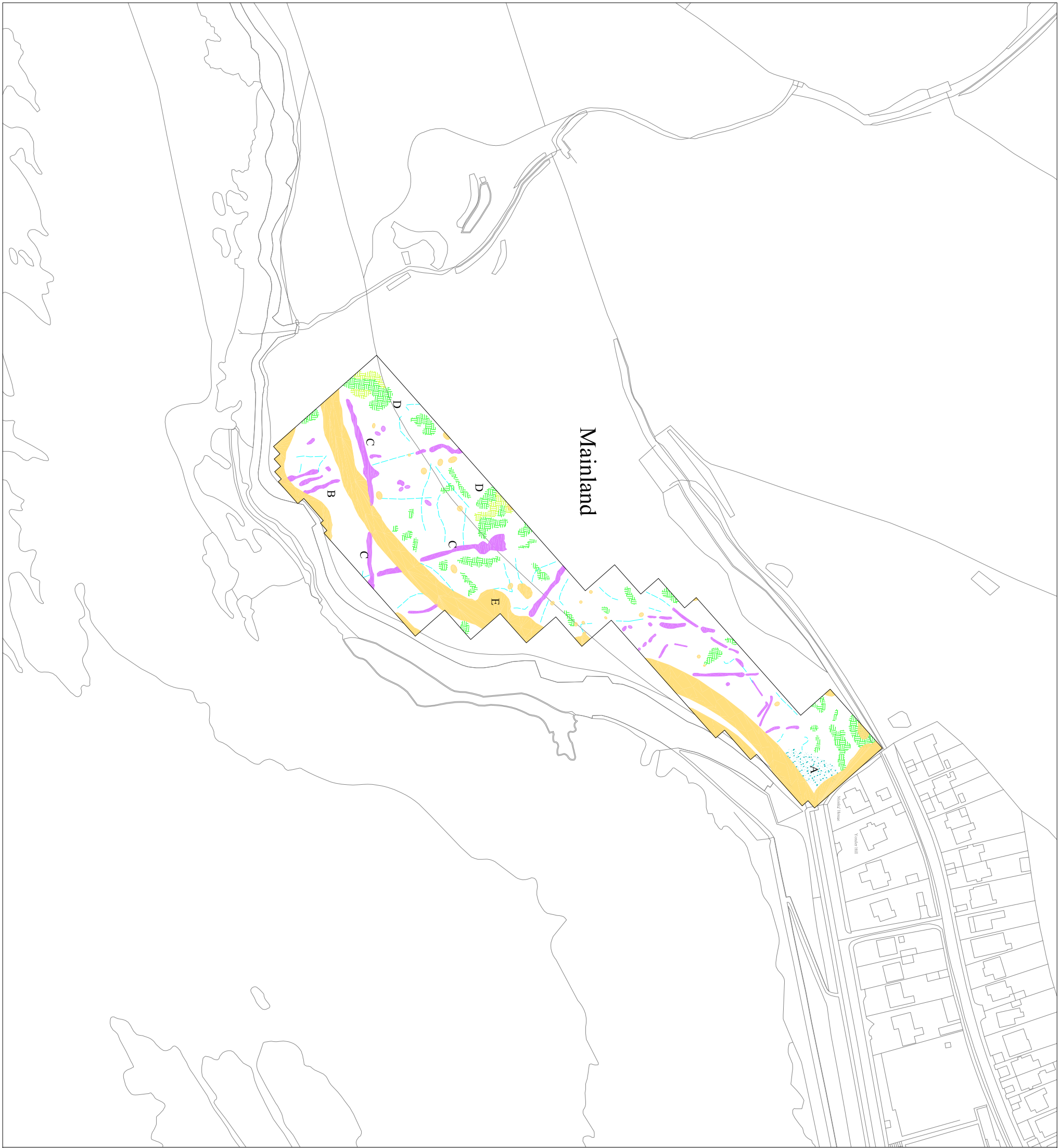
BGS	<i>Sheet 348, Plymouth.</i> Solid and Drift Edition. 1:50000, Institute of Geological Sciences.
GSB 03/45	<i>Geophysical Survey Report 2003/45: Looe Island.</i> Unpublished Report.
Mower, J. Scott, T. & Willers, J. 2008	<i>Proposed Archaeological Evaluation at St Michaels Chapel/Lammana Chapel, Cornwall.</i> Unpublished Report.
SSEW 1983	Soils of England and Wales. <i>Sheet 5 South West England.</i> Soil Survey of England and Wales.



<b>GSB PROSPECTION Ltd.</b>
2008/27 Looe, Cornwall
Location of Survey Areas
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<b>Figure 1</b>



<b>GSB PROSPECTION Ltd.</b>
2008/27 Looe, Cornwall
Summary Gradiometer Greyscale
Reproduced from the Ordnance Survey Map supplied by Time Team with the permission of the Controller of HMSO © Crown Copyright (AL100018665)
<b>Figure 2</b>

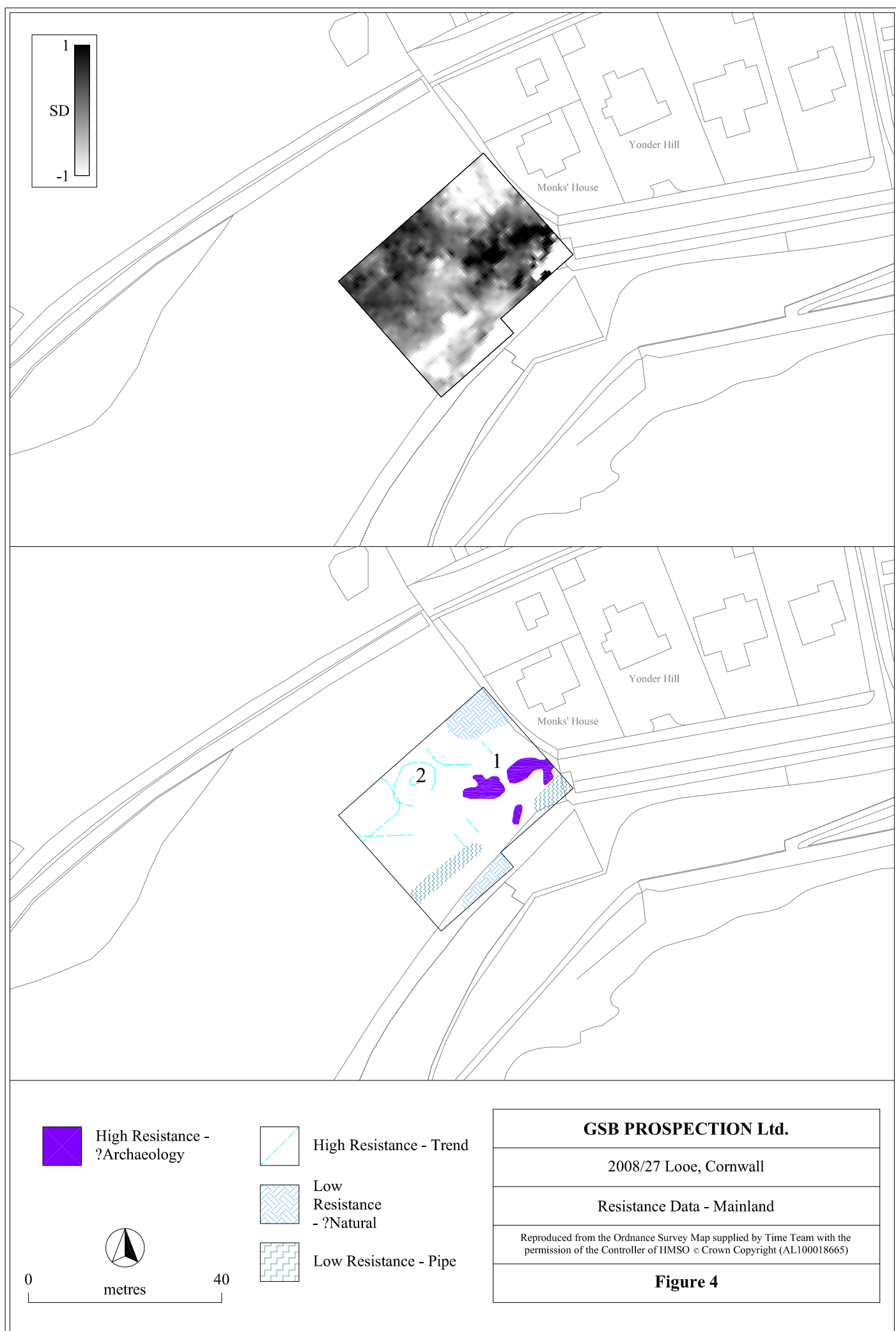


- ?Archaeology
- Increased Magnetic Response
- Trends
- ?Natural - Positive Response
- ?Natural - Negative Response
- Ferrous

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2008/27 Looe, Cornwall
Summary Gradiometer Interpretation
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Figure 3







Looe Island

Looe Island



High Resistance -  
?Archaeology



High Resistance - Trend



High Resistance -  
?Natural



Low Resistance - ?Natural



0 40  
metres

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2008/27 Looe, Cornwall

Resistance Data - Looe Island

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**Figure 5**

## Appendix 1: Technical Information

### Instrumentation

#### Fluxgate Gradiometer: Geoscan FM36/256 and Bartington *Grad601-2*

Both the Geoscan and Bartington instruments comprise two fluxgate sensors mounted vertically apart; the distance between the sensors on the former is 500mm, on the latter 1000mm. The gradiometers are carried by hand, with the bottom sensor approximately 100-300mm from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT). The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0.1nT) is used. The fluxgate gradiometer suppresses any diurnal or regional effects. Generally, features up to 1m deep may be detected by this method. Having two gradiometer units mounted laterally with a separation of 1000mm, the Bartington instrument can collect two lines of data per traverse.

#### Resistance Meter: Geoscan RM15

This instrument measures the electrical resistance of the earth, using a system of four electrodes (two current and two potential.) Depending on the arrangement of these electrodes an exact measurement of a specific volume of earth may be acquired. This resistance value may then be used to calculate the earth resistivity. The most common arrangement is the Twin Probe configuration which involves two pairs of electrodes (one current and one potential): one pair remain in a fixed position, whilst the other measures the resistance variations across a grid. The resistance is measured in ohms and, when calculated, resistivity is in ohm-metres. The resistance method as used for standard area survey employs a probe separation of 0.5m, which samples to a depth of approximately 0.75m. The nature of the overburden and underlying geology will cause variations in this depth.

#### GPR: Sensors & Software Noggin Smartcart

The Noggin system includes an onboard digital video logger (DVL III), 250 MHz or 500MHz antenna, an odometer wheel and battery. It is, therefore, a fully integrated system. The built-in software uses the integrated odometer to provide an accurate distance measurement to the response. The data are recorded in digital format and can be processed to produce depth slice maps, 2D sections or 3D cubes.

### Display Options

#### XY Trace

This involves a line representation of the data. Each successive row of data is equally incremented in the Y axis, to produce a stacked profile effect. This display may incorporate a hidden-line removal algorithm, which blocks out lines behind the major peaks and can aid interpretation. The advantages of this type of display are that it allows the full range of the data to be viewed and shows the shape of the individual anomalies. The display may also be changed by altering the horizontal viewing angle and the angle above the plane. The output may be either colour or black and white.

#### Greyscale

This format divides a given range of readings into a set number of classes. Each class is represented by a specific shade of grey, the intensity increasing with value. All values above the given range are allocated the same shade (maximum intensity); similarly all values below the given range are represented by the minimum intensity shade. Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values. The assigned range (plotting levels) can be adjusted to emphasise different anomalies in the data-set.

#### Relief Plot

This is a method of display that creates a three dimensional effect by directing an imaginary light source on a given data set. Particular elements of the results are highlighted depending on the angle of strike of the light source. This display method is particularly useful when applied to resistance data to highlight subtle changes in resistance that might otherwise be obscured.

#### 3D Surface Plot

This is similar to the XY trace, but in 3 dimensions. Each data point of a survey is represented in its relative position on the x and y axes and the data value is represented in the z axis. This gives a digital terrain, or topographic effect.

#### Radargram

Radar data comprise a record of reflection intensity against the time taken for the emitted energy to travel from the transmitter down to the reflector and back to the receiver. The resultant plot is effectively a vertical section through the ground along the line of the traverse, with time (depth) on the vertical axis, displacement on the horizontal axis and reflection intensity as a grey or colour scale.

#### Time Slice

If a number of radargrams are collected over a grid, or in conjunction with GPS data, it is possible to reconstruct the entire dataset into a 3D volume. This can then be resampled to compile 'plan' maps of response strength at increasing time (or depth) offsets, thus simplifying the visualisation of how anomalies vary beneath the surface across a survey area.

## Data Processing

<b>Zero Mean Traverse</b>	This process which sets the background mean of each traverse within each grid to zero. The operation removes striping effects and edge discontinuities over the whole of the data set. It is usually only applied to gradiometer data.
<b>Step Correction</b>	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors
<b>Interpolation</b>	When geophysical data are presented as a greyscale, each data point is represented as a small square. The resulting plot can sometimes have a 'blocky' appearance. The interpolation process calculates and inserts additional values between existing data points. The process can be carried out with points <i>along</i> a traverse (the <i>x</i> axis) and/or <i>between</i> traverses (the <i>y</i> axis) and results in a smoother greyscale image.
<b>Despike</b>	In resistance survey, spurious readings can occasionally occur, usually due to a poor contact of the probes with the surface. This process removes the spurious readings, replacing them with values calculated by taking the mean and standard deviation of surrounding data points. It is not usually applied to gradiometer data.
<b>High Pass Filter</b>	Carried out over the whole a resistance data-set, the filter removes low frequency, large scale spatial detail, such as that produced by broad geological changes. The result is to enhance the visibility of the smaller scale archaeological anomalies that are otherwise hidden within the broad 'background' change in resistance. It is not usually applied to gradiometer data.
<b>GPR Filters</b>	There are a wide range of GPR filters available and their application will vary from project to project. The most commonly used are: Dewow (removes low frequency, down-trace instrument noise); DC-Shift (re-establishes oscillation of the radar pulse around the zero point); Bandpass Filtering (suppresses frequencies outside of the antenna's peak bandwidth thus reducing noise); Background Removal (can remove ringing, instrument noise and minimize the near-surface 'coupling' effect); Migration (collapses hyperbolic tails back towards the reflection source).

## Tie-in Techniques and Information

<b>Tapes</b>
A number of points on each survey grid are recorded by triangulating to at least two fixed points on the base map. If there is a lack of 'hard detail' in the mapping, some form of survey marker will be left <i>in-situ</i> for reference. <b>NOTE:</b> When re-establishing the grid (for excavation or other post-survey work) only data from the supplied tie-in diagram should be used and NOT the report figures.
<b>Electronic Distance Measurers (EDM) / Total Stations (TST)</b>
This type of instrument measures the distance and angle to features with reference to a fixed point. Where possible the EDM will be set up over a point that can be re-established with relative ease, e.g. over map detail, a survey marker or at a point measureable by tapes. Distances and angles to permanent points of reference and/or map detail are recorded as well as at least two points per survey grid. <b>NOTE:</b> When re-establishing the grid (for excavation or other post-survey work) only data from the supplied tie-in diagram should be used and NOT the report figures.
<b>Global Positioning Systems (GPS)</b>
Using a roving receiver unit, these systems record the longitude, latitude and altitude of a given point by triangulating between a network of satellites. For survey-grade measurements, the accuracy is refined by integrating data from a fixed base station or local reference network. In addition to grid points, elements of map detail are collected to assess the existing base-map accuracy and, in worst-case scenarios, use the data on a non-georeferenced map. If the supplied mapping is found to be inaccurate, it is sometimes necessary to shift the position of GPS points (keeping their relative positions fixed) within the site plan to correlate cartographic features with the 'real-world' co-ordinates; this should be considered when using GPS to re-establish an existing survey grid (see note below). It should be noted that the accuracy of any GPS-positioned point is dependent upon both the system and the satellite geometry at the time of survey. On projects where multiple contractors have used GPS, the possibility of compound errors between original survey grid creation, tie-in information and grid re-establishment should be borne in mind when positioning trenches over recorded anomalies. <b>NOTE:</b> If re-establishing the grid with a GPS (for excavation or other post-survey work), use only the co-ordinates recorded on the tie-in diagram or, if supplied, the GPS data file included on the Archive CD; relative positions in the report diagrams may be correct but absolute co-ordinates can vary if discrepancies in the base mapping have been encountered.

## Terms Commonly used in the Interpretation of Results

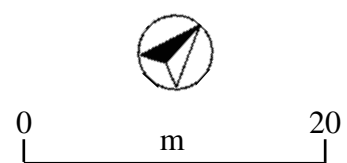
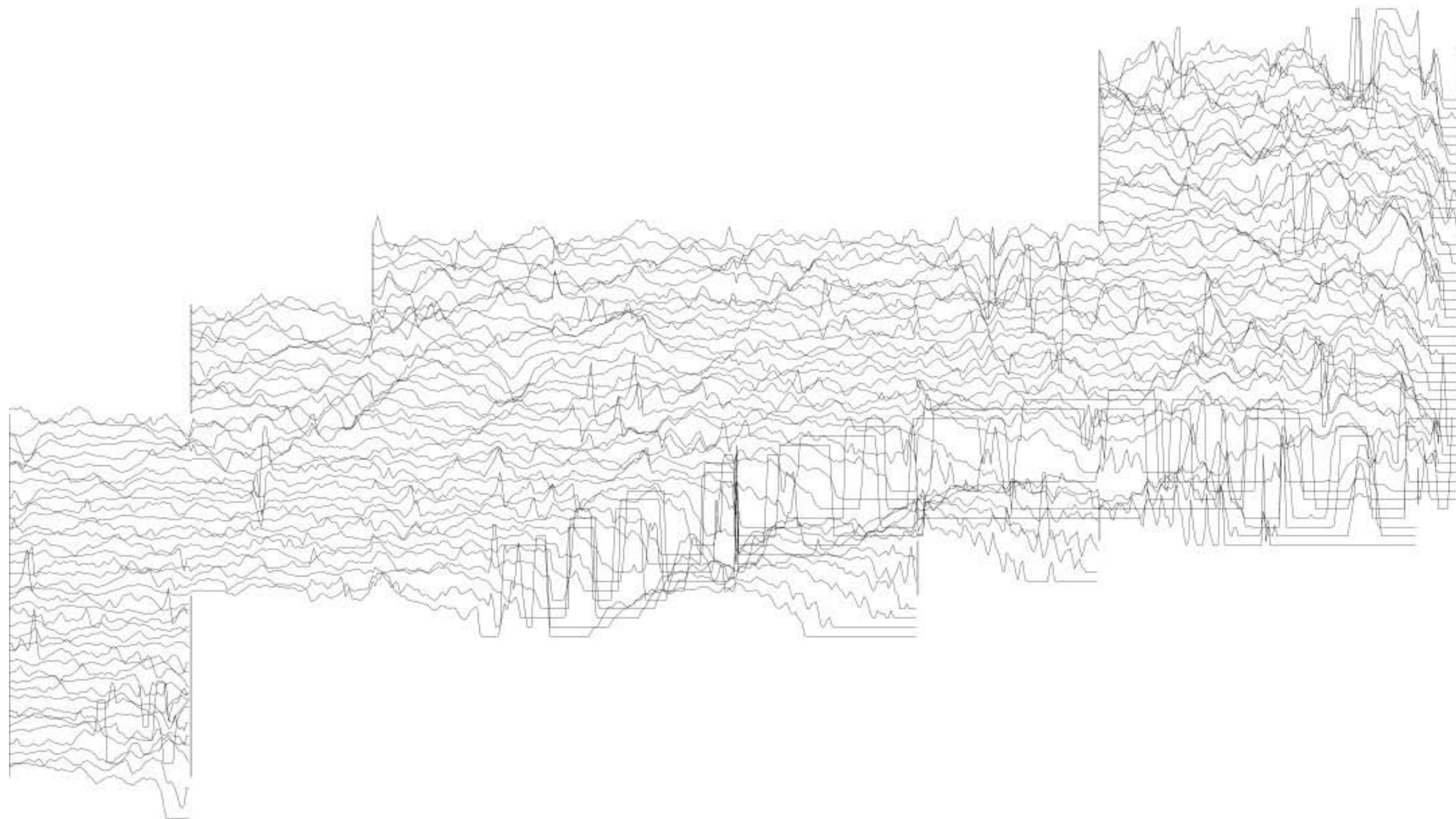
### Magnetic

<b>Archaeology</b>	This term is used when the form, nature and pattern of the response are clearly or very probably archaeological. These anomalies, whilst considered anthropogenic, could be of any age.
<b>? Archaeology</b>	The interpretation of such anomalies is often tentative, with the anomalies exhibiting either weak signal strength or forming incomplete archaeological patterns. They may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
<b>Areas of Increased Magnetic Response</b>	These responses show no visual indications on the ground surface and are considered to have some archaeological potential.
<b>Industrial</b>	Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal-working areas or hearths. It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies.
<b>Natural</b>	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e.g. palaeochannels or magnetic gravels.
<b>? Natural</b>	These are anomalies that are likely to be natural in origin i.e. geological or pedological.
<b>Ridge and Furrow</b>	These are regular and broad linear anomalies that are presumed to be the result of ancient cultivation. In some cases the response may be the result of modern activity.
<b>Ploughing Trend</b>	These are isolated or grouped linear responses. They are normally narrow and are presumed modern when aligned to current field boundaries or following present ploughing.
<b>Uncertain Origin</b>	Often, anomalies (both positive and negative) will be recorded which stand out from the background magnetic variation yet show little to suggest an exact origin. This may be because the characteristics and distribution of the responses straddle the categories of “?Archaeology” and “?Natural” or that they are simply of an unusual form.
<b>Trend</b>	This is usually an ill-defined, weak, isolated or obscured linear anomaly of unknown cause or date.
<b>Areas of Magnetic Disturbance</b>	These responses are commonly found in places where modern ferrous or fired materials are present e.g. brick rubble. They are presumed to be modern.
<b>Ferrous Response</b>	This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.

### Resistance

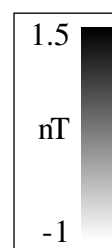
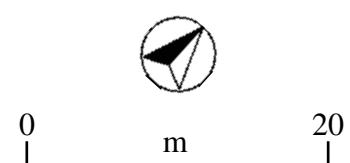
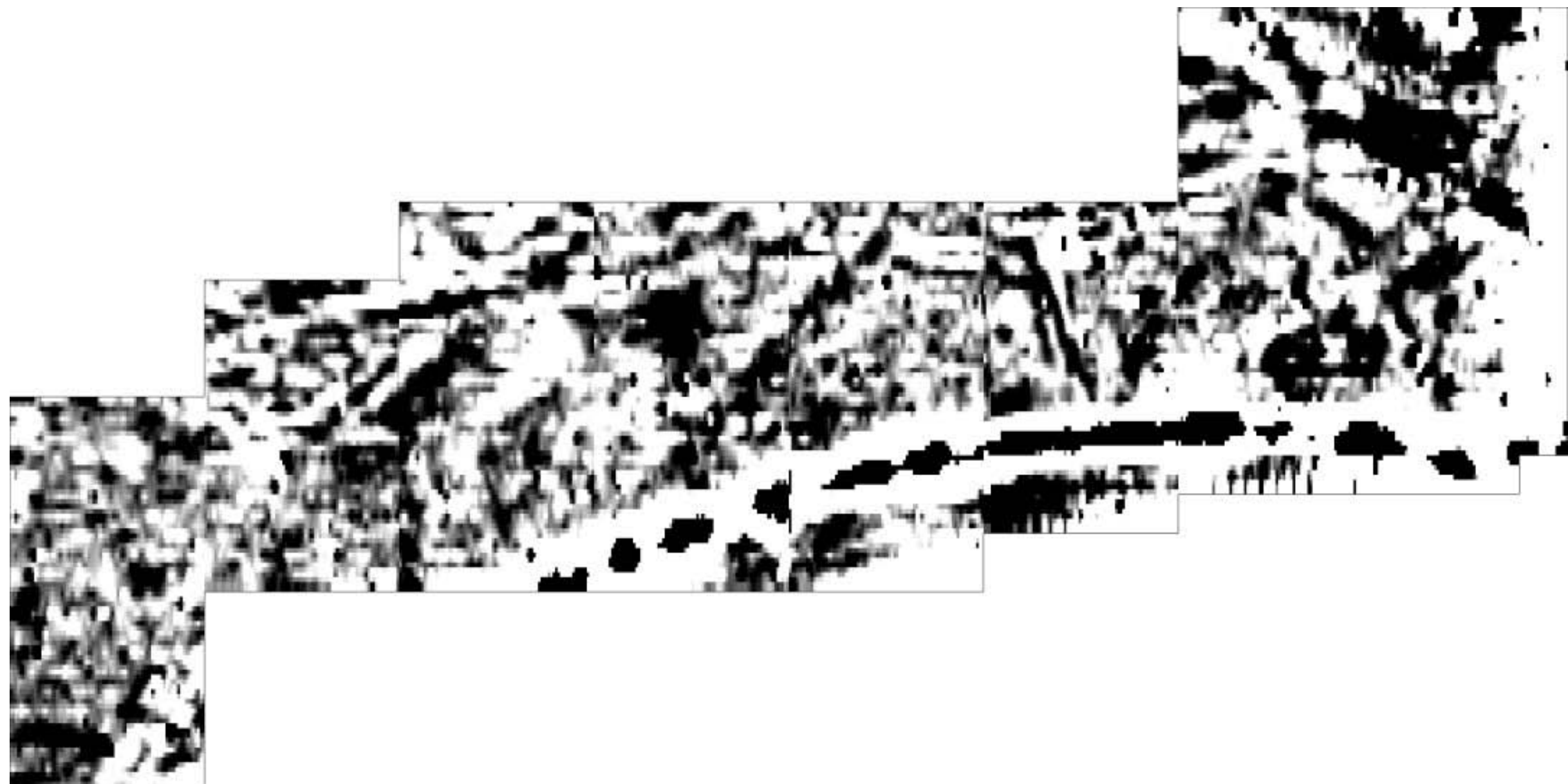
<b>Archaeology</b>	High or low res responses are clearly or very probably archaeological. These anomalies, whilst considered anthropogenic, could be of any age.
<b>? Archaeology</b>	The interpretation of such anomalies is often tentative, with the anomalies exhibiting either weak signal strength or forming incomplete archaeological patterns. They may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
<b>Natural</b>	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e.g. palaeochannels or magnetic gravels.
<b>? Natural</b>	These are anomalies that are likely to be natural in origin i.e. geological or pedological.
<b>? Landscaping / topography</b>	These are regular and broad linear anomalies that are presumed to be the result of ancient cultivation. In some cases the response may be the result of modern activity.
<b>Vegetation</b>	These are isolated or grouped linear responses. They are normally narrow and are presumed modern when aligned to current field boundaries or following present ploughing.
<b>Trend</b>	This is usually an ill-defined, weak, isolated or obscured linear anomaly of unknown cause or date.

<b>GPR</b>	
<b>Wall /Foundation/ /Vault /Culvert etc.</b>	High amplitude anomaly definitions used when other evidence is available that supports a clear archaeological interpretation.
<b>Archaeology</b>	Anomalies whose form, nature and pattern indicate archaeology but where little or no supporting evidence exists. If a more precise archaeological interpretation is possible, for example the responses appear to respect known local archaeology, then this will be indicated in the accompanying text. As low amplitude responses are less obvious features it is unlikely that they would have a definitive categorisation.
<b>? Archaeology</b>	When the anomaly could be archaeologically significant, given its discrete nature, but where the distribution of the responses is not clearly archaeological. Interpretation of such anomalies is often tentative, exhibiting either little contrast or forming incomplete archaeological patterns.
<b>Historic</b>	Responses showing clear correlation with earlier map evidence.
<b>?Historic</b>	Responses relating to features not directly recorded on earlier maps but which appear to respect features that are. May form patterns suggestive of formal gardens, landscaping or footpaths.
<b>Area of Anomalous Response</b>	An area in which the response levels are very slightly elevated or diminished with respect to the 'background'. Where no obvious surface features or documentary evidence can explain this spread of altered reflectivity it is assumed to denote some kind of disturbance, though the origins could be of any age and either anthropogenic or natural. Possible explanations are changes in subsurface composition and groundwater 'ponding'.
<b>Natural</b>	Anomalies relating to natural sub-surface features as indicated by documentary sources, local knowledge or evidence on the surface.
<b>?Natural</b>	Responses forming patterns akin to subsoil/geological variations either attenuating or reflecting greater amounts of energy. An archaeological origin such as rubble spreads or robbed out remains cannot be dismissed.
<b>Trend</b>	An ill defined, weak or isolated linear anomaly of unknown cause or date.
<b>Modern</b>	Reflections that indicate features such as services, rebar or modern cellars correlating with available evidence (maps, communications with the client, alignment of drain covers etc.).
<b>?Modern</b>	Reflections appearing to indicate buried services but where there is no supporting evidence. Also applies to responses which form patterns, or are at a depth which suggests a modern origin. An archaeological source cannot be completely dismissed.
<b>Surface</b>	Responses clearly due to surface discontinuities, the effects of which may be seen to 'ring' down through radargrams and so incorrectly appearing in the deeper time-slices.



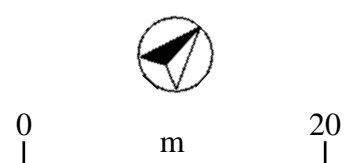
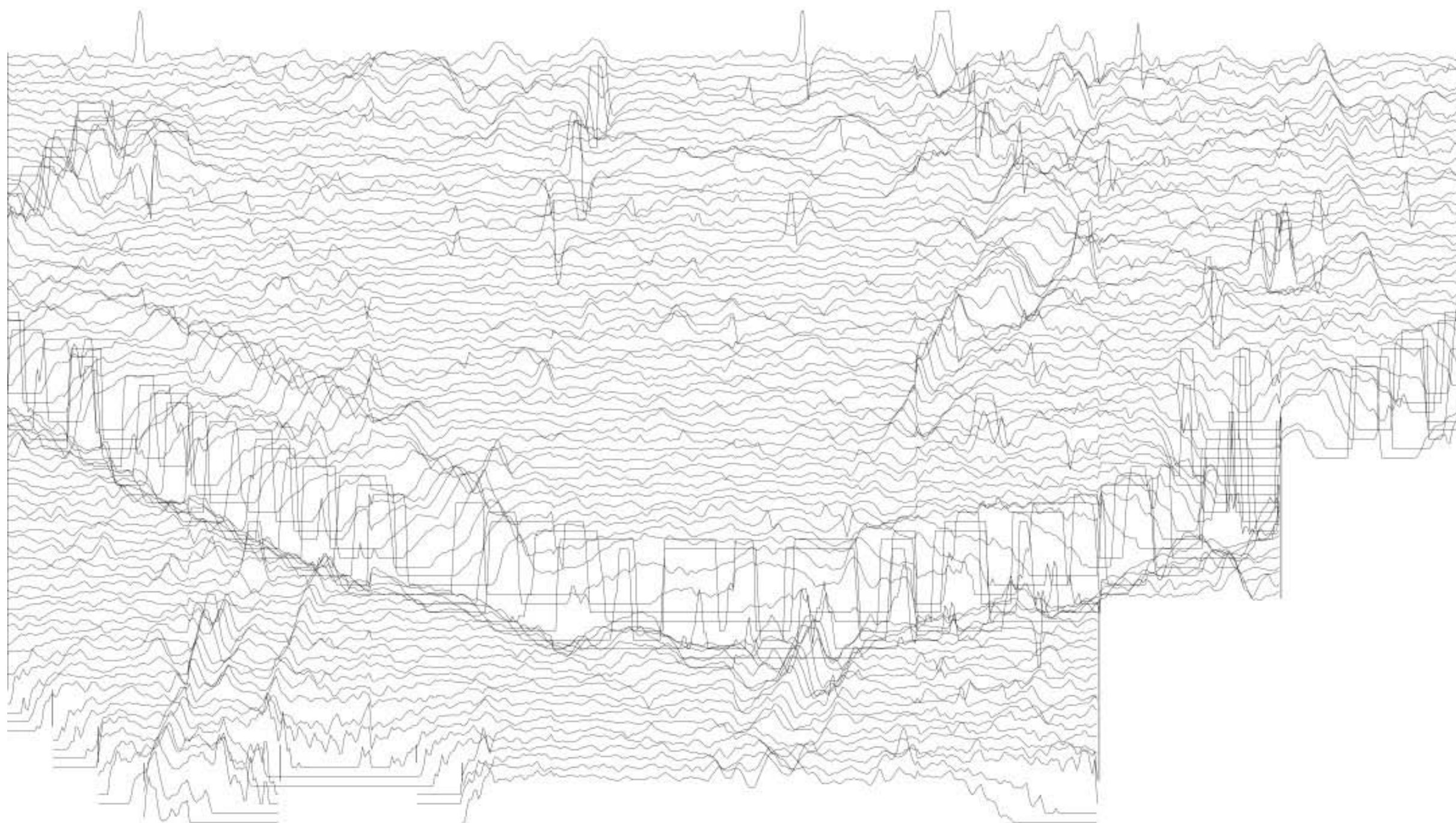
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<b>GSB Prospection Ltd.</b>
2008/27 Looe, Cornwall
Magnetic Data - Area 1A
<b>Figure A1</b>



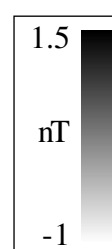
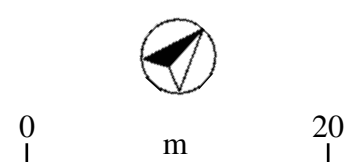
<b>GSB Prospection Ltd.</b>
2008/27 Looe, Cornwall
Magnetic Data - Area 1A
<b>Figure A2</b>





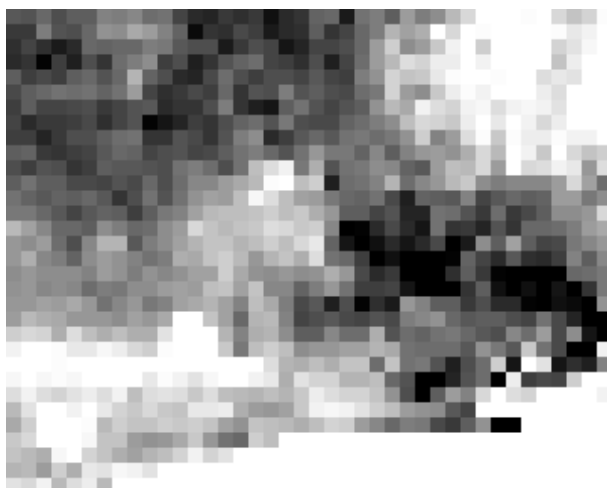
I 15 nT

<b>GSB Prospection Ltd.</b>
2008/27 Looe, Cornwall
Magnetic Data - Area 1B
<b>Figure A3</b>



GSB Prospection Ltd.
2008/27 Looe, Cornwall
Magnetic Data - Area 1B
Figure A4

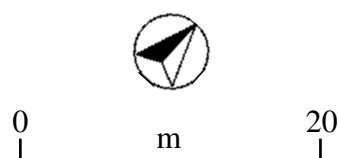
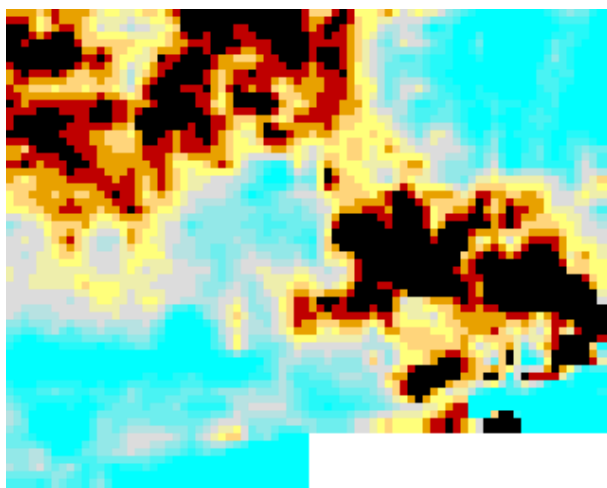
**Raw Data**



**Interpolated Data**

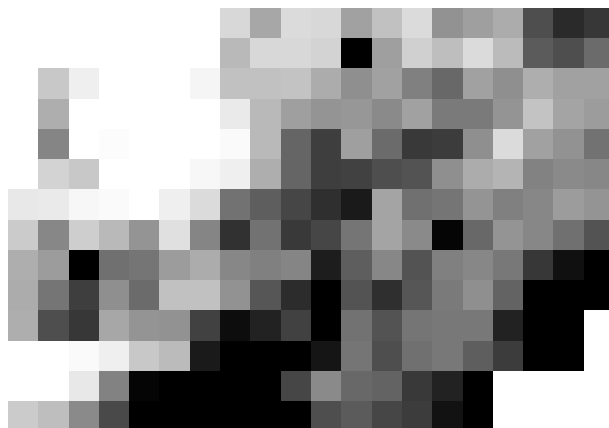


**Interpolated Data**



<b>GSB Prospection Ltd.</b>
2008/27 Looe, Cornwall
Resistance Data - Mainland
<b>Figure A5</b>

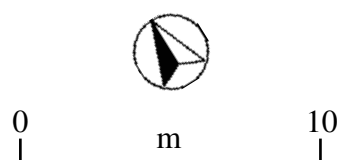
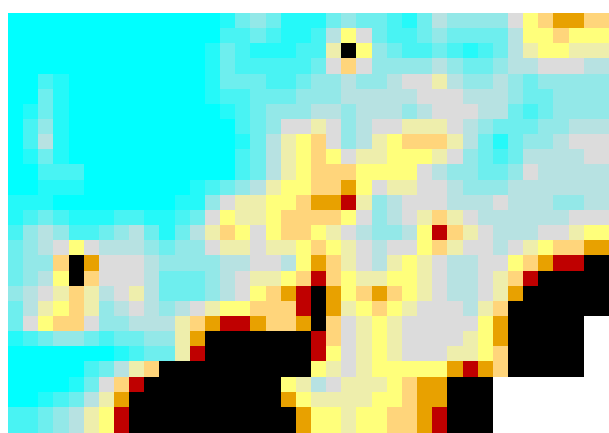
**Raw Data**



**Interpolated Data**



**Interpolated Data**



**GSB Prospection Ltd.**

2008/27 Looe, Cornwall

Resistance Data - Island

**Figure A6**