GSB Prospection

GEOPHYSICAL SURVEY REPORT
2009/45

Litlington
Cambridgeshire

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Specialising in Shallow and Archaeological Geophysics

GSB Survey No. 2009/45

Litlington, Cambridgeshire

Time Team Series XVII Programme XII

NGR	TL 312 424
Location	Approximately 4 miles north west of Therfield and 6 miles south east of Potton
County	Cambridgeshire
District	South Cambridgeshire
Parish	Litlington CP
Topography	Generally flat with some extant earth works in Area 1
Current land-use	Pasture, stubble and rolled
Soils	The site soils belong to the Swaffham Prior group (511e) which consist of calcareous coarse and fine loamy soils over chalk rubble with deep non-calcareous loamy soils in places (SSEW 1983)
Geology[#]	Chalk with marl and thin flint beds (BGS Sheet 204)
Archaeology[#]	Between 1829 and 1841 antiquarian Reverend Clack excavated and recorded a substantial Roman Villa. All evidence of these excavations and the associated finds are now lost with the exception of a crude map which marks the location of the Villa site and a Roman cemetery that may be related.
Survey Methods	Fluxgate Gradiometer

Aims

The geophysical survey at Litlington was carried out as part of the broader research aims defined in the project design (Mower 2009). Specifically, the survey was undertaken to '*determine, as far as possible, the extent of sub-surface archaeological remains within the area of the site'* (Project Aim 3). The work forms part of a wider archaeological assessment being carried out by Channel 4's **Time Team**.

Summary of Results*

Magnetic survey over the suspected location of the villa building failed to record any anomalies which might be indicative of a substantial building; subsequent trial trenching confirmed the geophysical findings and pinpointed the Roman building(s) in gardens to the east. In the initial area of geophysical investigation a number of former field boundaries were detected, most of which were recorded on earlier map evidence; one previously unknown ditch was found by trenching to be Romano-British in date. In other survey areas, near to a recorded Roman cemetery, a large ditched enclosure of a pre-Roman date was discovered. Clusters of magnetic noise were seen to coincide with 19th century gravel extraction – though more burials were found. It seems unlikely that the magnetic anomalies were associated with the human remains.

Project Information

Project Co-ordinator: Dr J Gater
Project Assistants: J Adcock & E Wood
Date of Fieldwork: 29th September – 1st October 2009
Date of Report: 20th November 2009

[#] Taken from **Mower 2009**

Survey Specifications

Method

The survey grid was set out by **GSB Prospection Ltd**. using tapes 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 - Scanning (Appendix 1)	-	-	-	-
Magnetometer – Detailed (Appendix 1)	1m	0.25	Bartington Grad 601-2	2.65ha
Ground Penetrating Radar (GPR) (Appendix 1)	-	-	-	-
Ground Penetrating Radar (GPR) (Appendix 1)	-	-	-	-

Data Processing

	Magnetic	Resistance	GPR
Zero Mean Traverse	Y	-	-
Step Correction	Y	-	-
Interpolate	Y	-	-
Filter	N	-	-

Presentation of Results

Report Figures (Printed & Archive CD):	Location, data plots and interpretation diagram on base map (Figures 1-3).
Reference Figures (Archive CD):	Data plots at 1:500 for reference and analysis. (See List of Figures).
Plot Formats:	See Appendix 1: Technical Information, at end of report.

General Considerations

Conditions for survey were generally good. A 20m grid is missing from Area 1 due to the location of a trench and spoil. Unfortunately survey was not possible in the majority of back gardens due to their small size.

Resistance survey was not attempted due to the very dry nature of the ground and because it was not deemed appropriate due to the suspected depth of deposits thought to overlie the archaeological remains.

Experimental work with a MALA MIRA GPR system was carried out but this survey was not part of the *Time Team* evaluation.

Results of Survey

1. Magnetic Survey

Area 1

1.1 A number of parallel linear ditches have been located within this area. These are likely to represent former field divisions, some perhaps of medieval date – according to early mapping (S Ainsworth *pers comm.*). The easternmost ditch, which turns at its southern end, was evaluated by a small trench just outside of the survey area and found to be Romano-British in date.

1.2 Apart from the above linears, the magnetic results failed to show any archaeological type anomalies and certainly none of the responses (or 'noise') which have been found on numerous sites elsewhere and are normally associated with Roman villa buildings. Yet all the evidence from previous investigations into the location of the villa at Litlington suggested its presence was within this field. Trial trenching confirmed the results of the geophysics - that is, a lack of any structural remains – or even Romano-British artefacts in any sizeable quantities.

1.3 Along the northern limit of the dataset, large ferrous anomalies may be associated with Nissen Huts which are marked on a 1947 map.

Areas 2 and 3

1.4 These small areas were surveyed in an attempt to locate any buildings or features possibly associated with the villa, though due to their small size the results were inconclusive. Any interpretation was hindered by the presence of modern interferences such as pipes and fences.

Areas 4 and 5

1.5 To the south east of the postulated villa, antiquarian excavations carried out after small-scale gravel extraction, discovered a Roman walled cemetery referred to as 'Heaven's Walls'. Initially survey was carried out in Area 4 to try to find the cemetery and then as a final attempt in Area 5, to check possible map data errors. Although the *Time Team* trenches did eventually discover burials in Area 4 it is not thought that the magnetic anomalies were directly related; it is more likely that the anomalies reflect the ground disturbance associated with the old, back-filled gravel workings. As a consequence, a number of anomalies have been given the category of '*Uncertain*'. The geophysics failed to find any evidence for the walled enclosure.

1.6 Despite the lack of success in pinpointing the cemetery, the magnetic survey did identify a large, ditched enclosure thought to be Iron Age in date. There is also evidence for some form of trackway extending into the adjacent field (Area 4B).

2. Conclusions

2.1 Results from the magnetic survey were initially disappointing in the fact that they provided no evidence for the 'recorded' villa building being in its presumed location. Eventually Roman building remains were located in gardens to the east, which were too small to investigate geophysically. Survey work in and around the site of a Roman cemetery to the south east did identify a large, prehistoric enclosure - the full extent of which could not be determined in the time available.

List of Figures

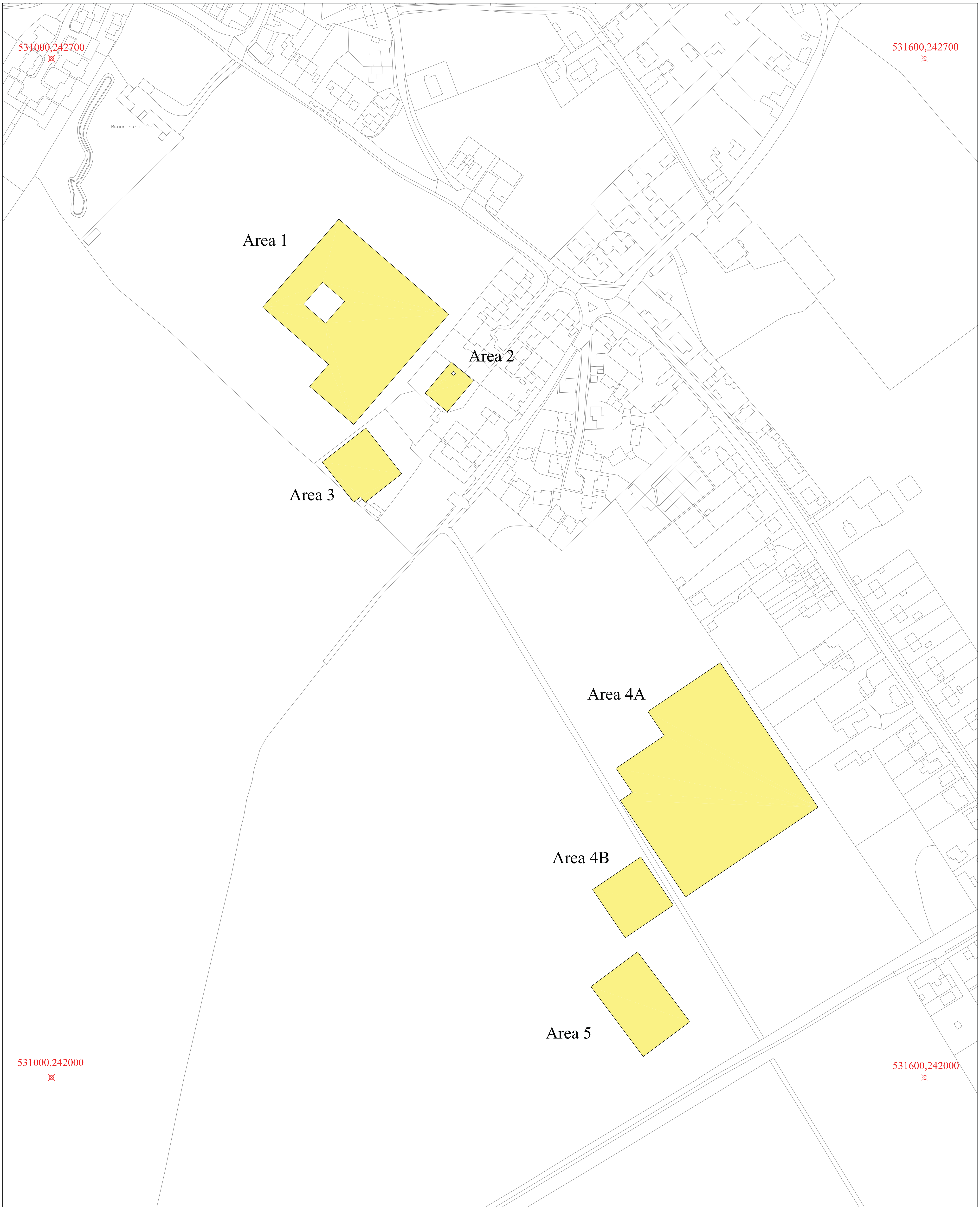
Report Figures

Reference Figures on CD

References

BGS Sheet 204 — *British Geological Survey Sheet 204: 1:50 000, Biggleswade.*

Mower J. 2009 — *Proposed Archaeological Evaluation, Litlington, Cambridgeshire*. Unpublished Project Design.



0 metres 100

Gradiometer Survey

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Location of Survey Areas

Figure 1

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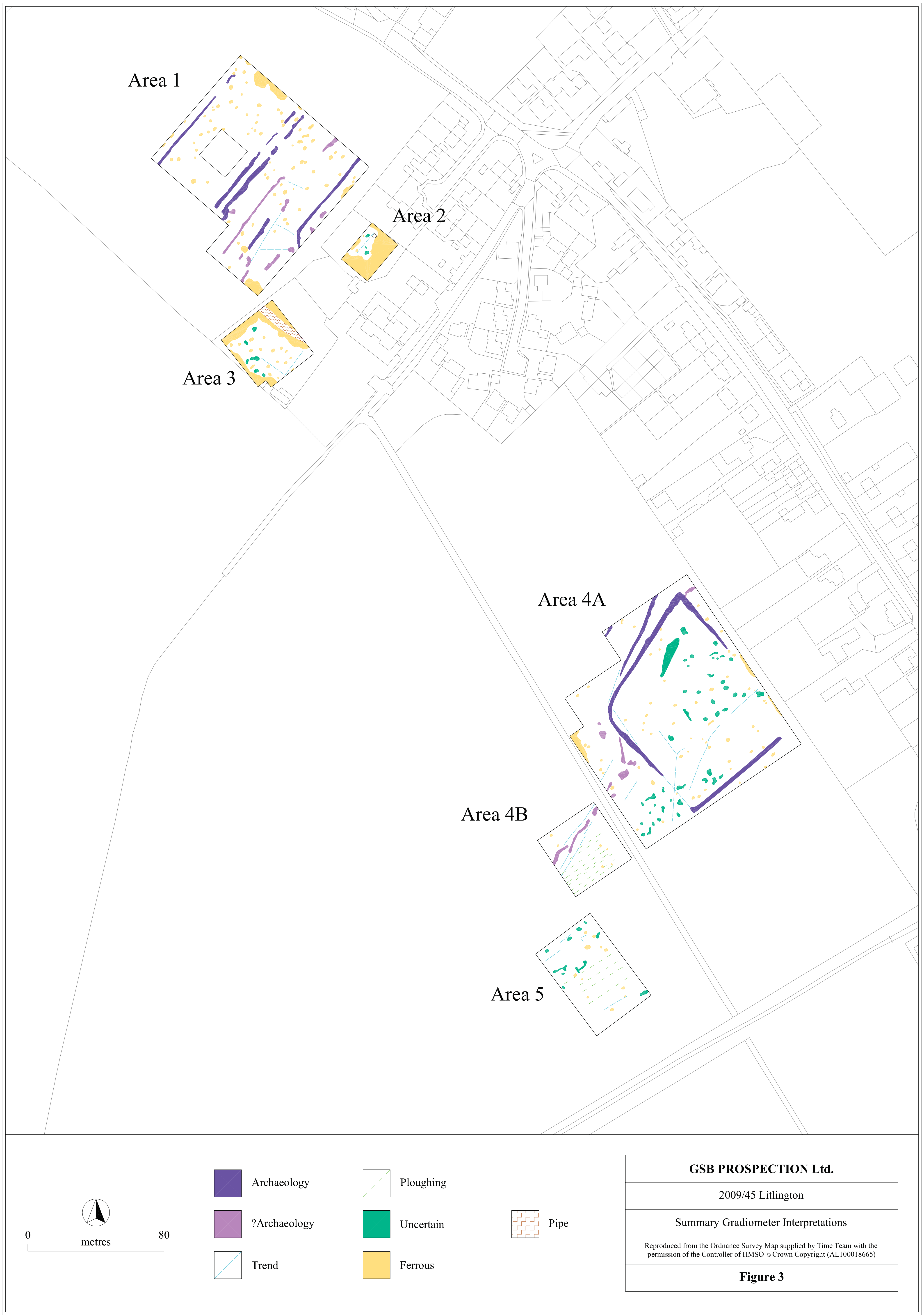
Summary Gradiometer Greyscales

Figure 2



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Summary Gradiometer Interpretations

Figure 3

Appendix 1: Technical Information

Instrumentation

Fluxgate Gradiometer: Geoscan FM36/256 and Bartington *Grad*601-2

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 offsets (typically converted to show approximate depth), thus simplifying the visualisation of how anomalies vary beneath the surface across a survey area.

Volume Plot

Rather than looking at discrete slices of data from the 3D volume, it is possible to strip away all reflections with intensity below a user-defined threshold, leaving just the strongest anomalies. This serves to create a rendered 3D model of the most substantial subsurface deposits which can then be rotated or enlarged/reduced to either animate the display or view it from any perspective.

Data Processing

Zero Mean Traverse	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.
Step Correction	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
Interpolation	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 *along* a traverse (the *x* axis) and/or *between* traverses (the *y* axis) and results in a smoother greyscale image.
Despike	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.
High Pass Filter	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.
GPR Filters	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

Tapes

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 *in-situ* for reference.

NOTE: 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.

Electronic Distance Measurers (EDM) / Total Stations (TST)

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.

NOTE: 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.

Global Positioning Systems (GPS)

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.

NOTE: 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

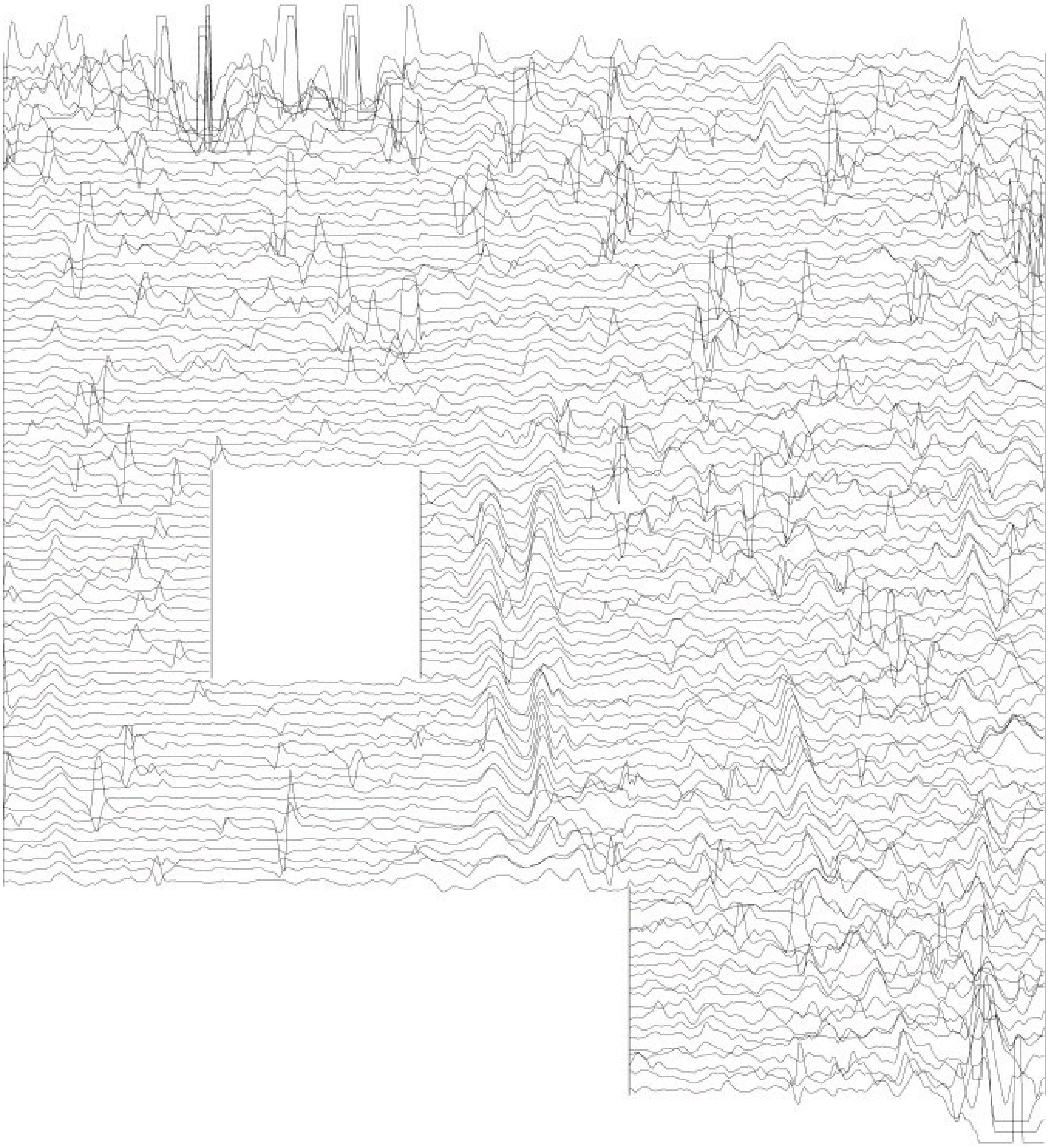
Archaeology	This term is used when the form, nature and pattern of the response are clearly or very probably archaeological These anomalies, whilst considered anthropogenic, could be of any age.
? Archaeology	The interpretation of such anomalies is often tentative, with the anomalies exhibiting either 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.
Areas of Increased Magnetic Response	These responses show no visual indications on the ground surface and are considered to have some archaeological potential.
Industrial	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.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e.g. palaeochannels or magnetic gravels.
? Natural	These are anomalies that are likely to be natural in origin i.e. geological or pedological.
Ridge and Furrow	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.
Ploughing Trend	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.
Uncertain Origin	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.
Trend	This is usually an ill-defined, weak, isolated or obscured linear anomaly of unknown cause or date.
Areas of Magnetic Disturbance	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.
Ferrous Response	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.

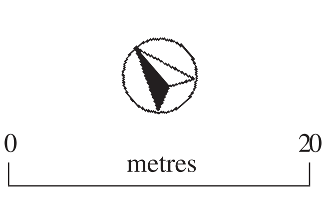
Resistance

Archaeology	High or low res responses are clearly or very probably archaeological These anomalies, whilst considered anthropogenic, could be of any age.
? Archaeology	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.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e.g. palaeochannels or magnetic gravels.
? Natural	These are anomalies that are likely to be natural in origin i.e. geological or pedological.
? Landscaping / topography	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.
Vegetation	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.
Trend	This is usually an ill-defined, weak, isolated or obscured linear anomaly of unknown cause or date.

GPR

Wall /Foundation/ /Vault /Culvert etc.	High amplitude anomaly definitions used when other evidence is available that supports a clear archaeological interpretation.
Archaeology	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.
? Archaeology	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.
Historic	Responses showing clear correlation with earlier map evidence.
?Historic	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.
Area of Anomalous Response	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'.
Natural	Anomalies relating to natural sub-surface features as indicated by documentary sources, local knowledge or evidence on the surface.
?Natural	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.
Trend	An ill defined, weak or isolated linear anomaly of unknown cause or date.
Modern	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.).
?Modern	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.
Surface	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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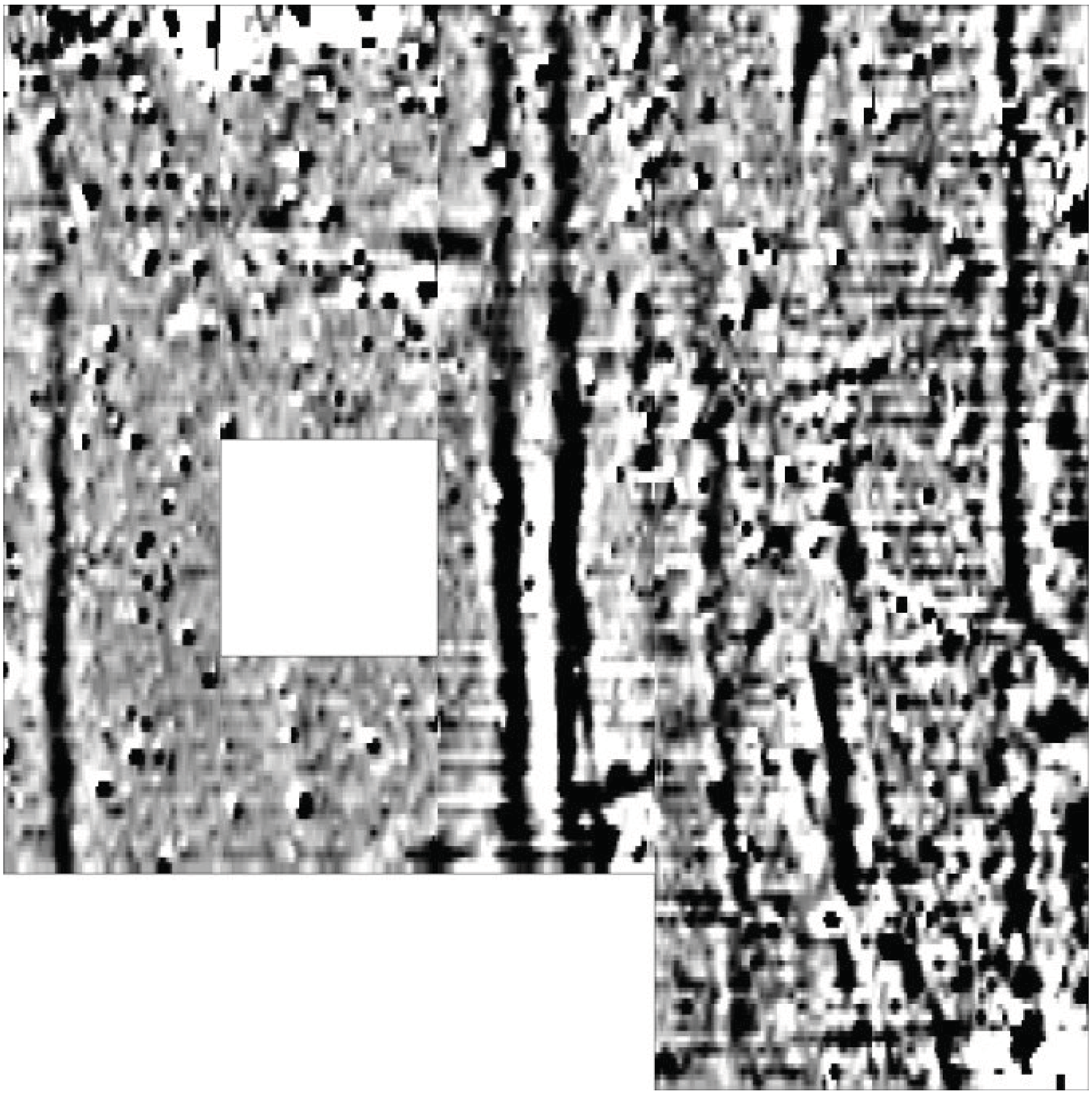
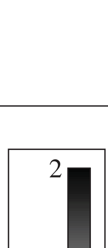
Magnetic Data - Area 1

Figure A1





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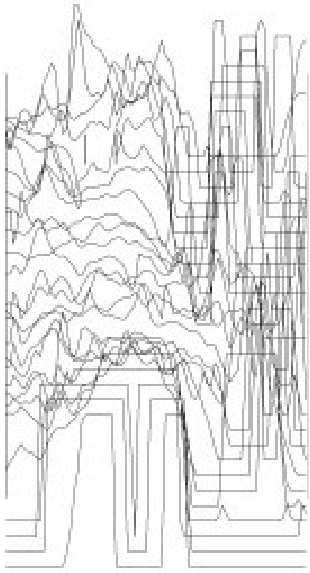
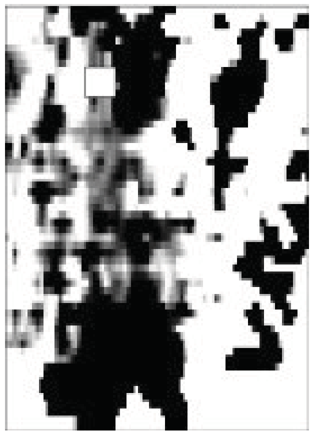
Magnetic Data - Area 1
Figure A2





0 metres 20

15 nT

2
nT
-1

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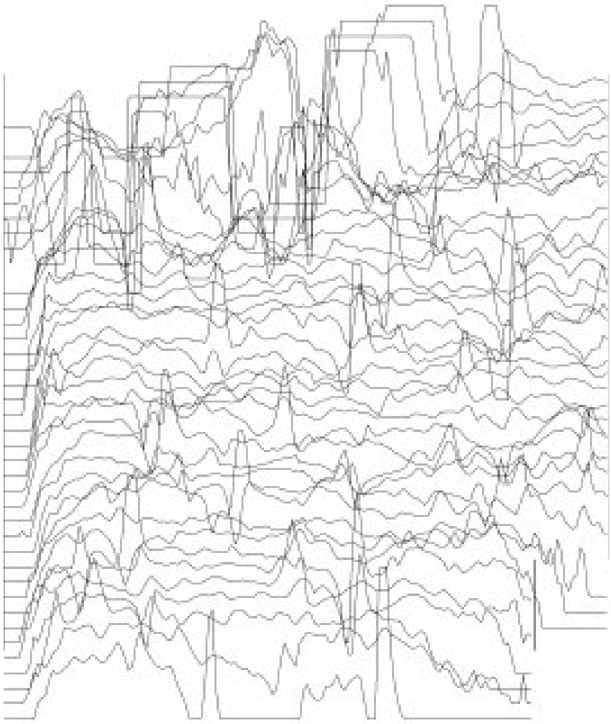
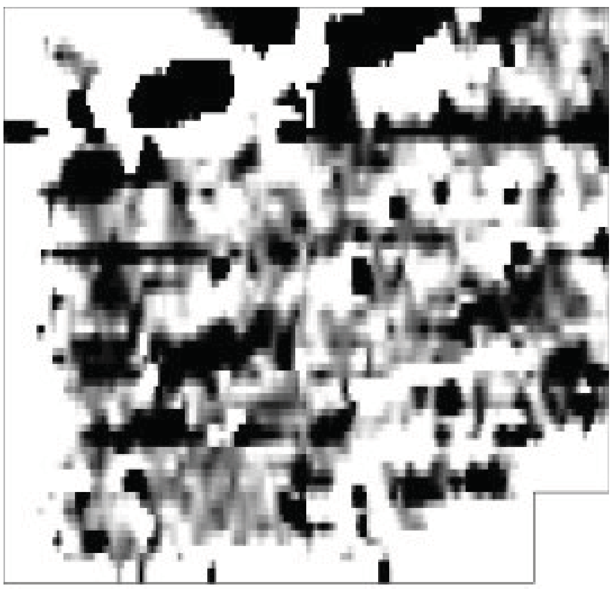
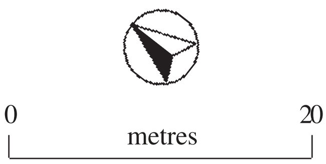
Magnetic Data - Area 2

Figure A3







15 nT

2
nT
-1

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Magnetic Data - Area 3

Figure A4

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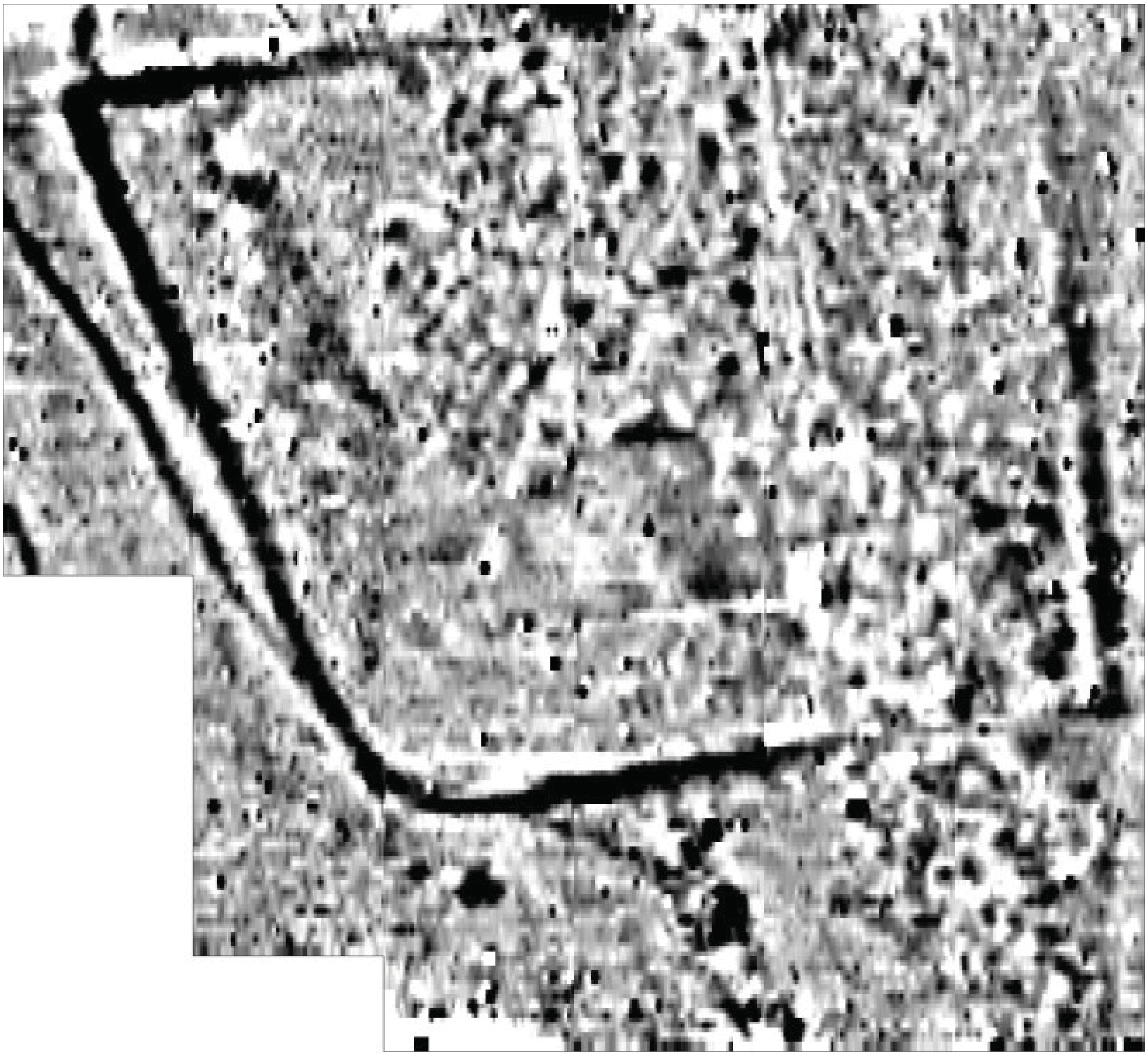
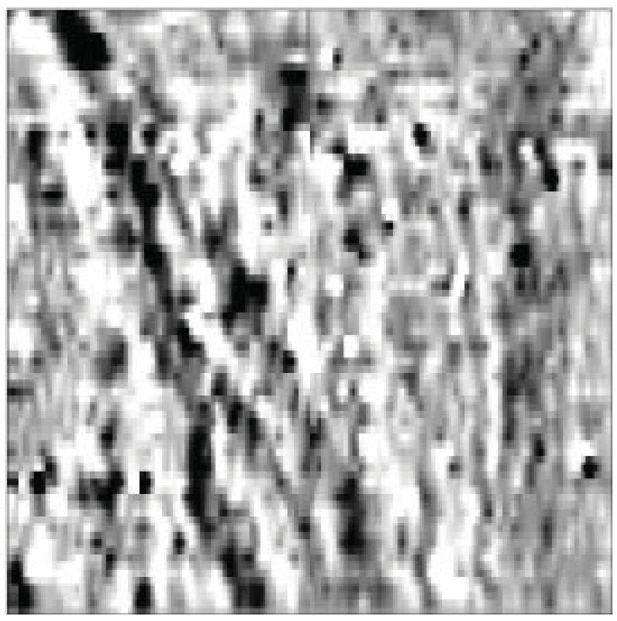
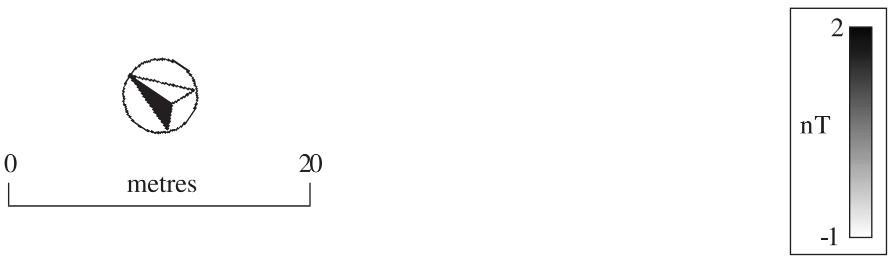
Magnetic Data - Area 4

Figure A5







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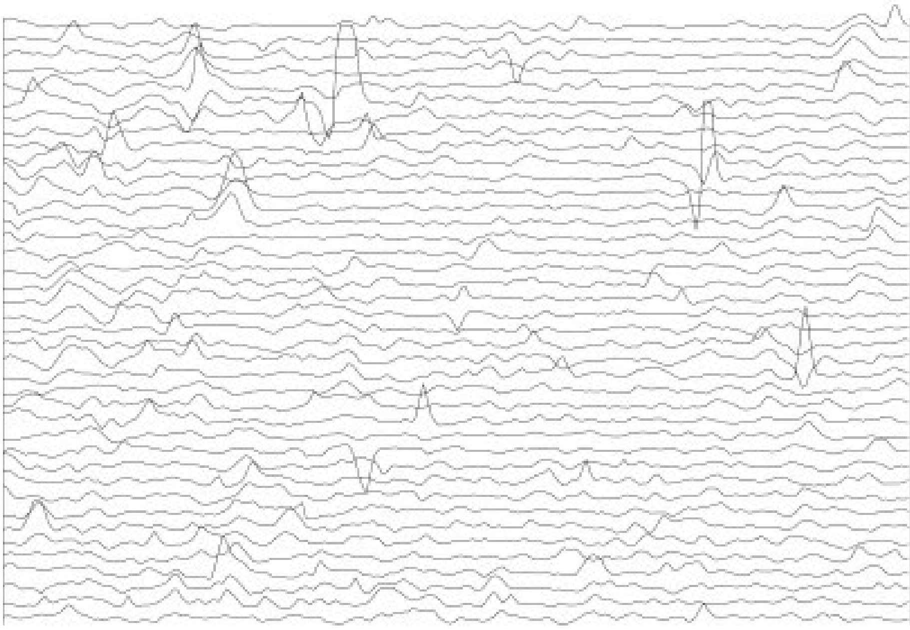
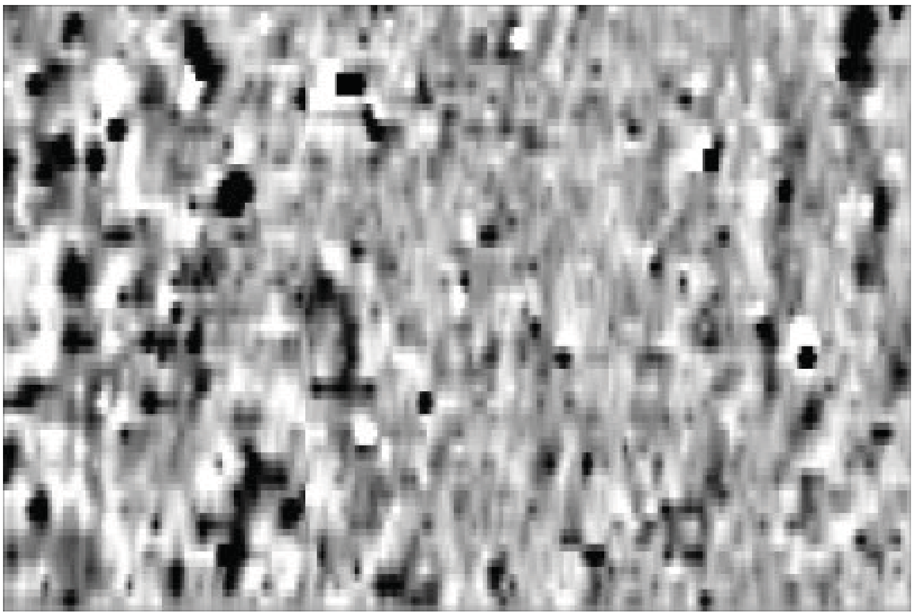
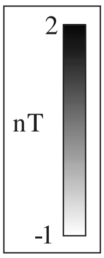
Magnetic Data - Area 4

Figure A6





0 metres 20



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Magnetic Data - Area 5
Figure A7