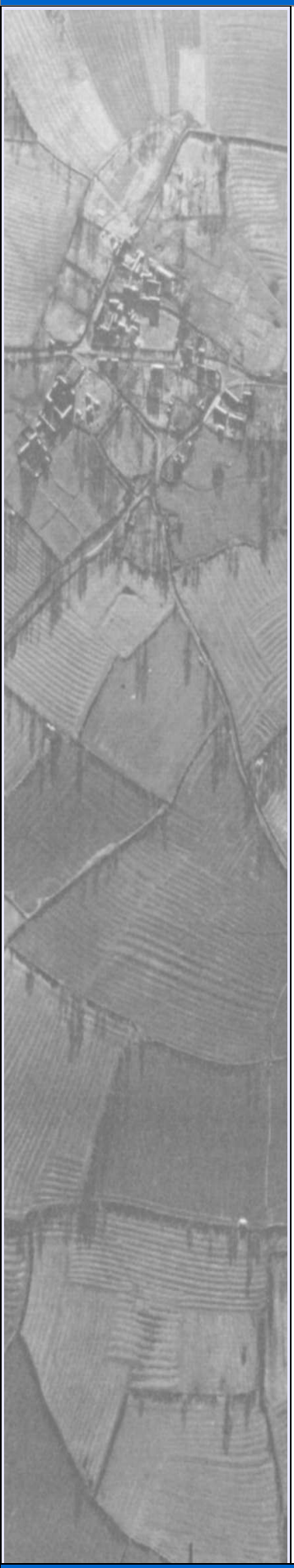

Land south of Newlyn Road
St Buryan
Cornwall

MAGNETOMETER & EARTH RESISTANCE SURVEY REPORT

for

Acquiro SW Ltd

Kerry Donaldson & David Sabin

December 2018

Ref. no. J770

ARCHAEOLOGICAL SURVEYS LTD

Land south of Newlyn Road
St Buryan
Cornwall

Magnetometer & Earth Resistance Survey Report

for

Acquiro SW Ltd

Fieldwork by David Sabin BSc (Hons) MCIfA
Report by Kerry Donaldson BSc (Hons)
Report checked by David Sabin
Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

Survey date – 22nd November 2018
Ordnance Survey Grid Reference – SW 41233 25814

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SUMMARY

A geophysical survey, comprising both magnetometry and resistivity, was undertaken within a single field on the north eastern edge of St Buryan, Cornwall. The results indicate the presence of two possible former field boundaries parallel with the existing eastern and southern boundaries. A number of pit-like responses have also been located, with several in linear groups.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Guy Kendall of GK Heritage, on behalf of Acquiro SW Ltd, to undertake a magnetometer and an earth resistance (resistivity) survey of an area of land at St Buryan, Cornwall. The site has been outlined for a proposed residential development and the survey forms part of an archaeological assessment.

1.1.2 The geophysical survey was requested by the Cornwall Council Historic Environment Planning (Archaeology) officer in relation to a planning application PA18/09367. The survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by GK Heritage which was approved by Sean Taylor for Cornwall Council prior to commencing the fieldwork.

1.2 Survey objectives and techniques

1.2.1 The objective of the survey was to use magnetometry and earth resistance survey (resistivity) to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site. The methodology is considered an efficient and effective approach to archaeological prospection.

1.2.2 Geophysical survey can provide useful information on the archaeological potential of a site; however, the outcome of any survey relies on a number of factors and as a consequence results can vary. The success in meeting the aims and objectives of a survey is, therefore, often impossible to predetermine.

1.3 Standards, guidance and recommendations for the use of this report

1.3.1 The survey and report generally follow the recommendations set out by: European Archaeological Council (2015) *Guidelines for the Use of Geophysics in Archaeology;* Institute for Archaeologists (2002) *The use of Geophysical Techniques in Archaeological Evaluations.* The work has been

carried out to the Chartered Institute for Archaeologists (2014) *Standard and Guidance for Archaeological Geophysical Survey.* Note: currently Historic England (2018) no longer support the guidelines set out in English Heritage (2008) *Geophysical survey in archaeological field evaluation* and there are currently no plans to update the document. As a consequence other sources of written guidance referring to this document may be out of date and/or contain unsupported information (e.g. Chartered Institute for Archaeologists, 2014).

1.3.2 Archaeological Surveys Ltd provide a detailed geophysical survey report and it is recommended that where possible the contents should be considered in full. The Summary provides a brief overview of the results with more detail available in the Discussion and/or Conclusion. The *List of anomalies* within the Results provides a detailed assessment of the anomalies within separate categories which can be useful in inferring a level of confidence to the interpretation. Quality and factors influencing the interpretation of anomalies is also set out within the results.

1.3.3 It is recommended that the full report should always be considered when using data and interpretation plots; where this is not possible, in the field for example, the abstraction and interpretation plots should retain their colour coding and be used with a corresponding legend.

1.3.4 Where targeting of anomalies by excavation is to be carried out, care should be taken to place trenches over solid lines or features visible on the abstraction and interpretation plots. Archaeological Surveys abstraction and interpretation avoids the use of dashed or dotted lines; broken or fragmented anomalies may well correspond closely with subsurface truncation.

1.4 Site location, description and survey conditions

1.4.1 The site is located to the south of Newlyn Road, on the north eastern edge of St Buryan in Cornwall. It is centred on Ordnance Survey National Grid Reference (OS NGR) SW 41233 25814, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 0.6ha within a single pasture field. The area is generally flat, although there is a slightly raised zone running centrally through the field with a north north west to south south east orientation. A residential area is located immediately to the south west and the boundaries are formed by Cornish hedges.

Plate 1: Survey area looking north west

1.4.3 The ground conditions across the site were considered to be favourable for the collection of geophysical survey data. Weather conditions during the survey were windy with light rain.

1.5 Site history and archaeological potential

1.5.1 The site does not contain any designated or undesignated heritage assets; however, there are a number of prehistoric standing stones and defended settlements recorded in the surrounding vicinity. St Buryan is believed to have medieval origins, possibly the site of a pre-Saxon or 6th century monastic establishment. The nearest scheduled monument is the Trevorrian medieval cross (Historic England List Entry no. 1004250) which exists as a cross base on its side built into the roadside hedge 150m to the north east of the site. The village expanded in the post medieval period and under the Historic Landscape Characterisation the field is indicated to lie within Modern Enclosed Land, which was mainly Anciently Enclosed Land or Post Medieval Enclosed Land whose field systems have been substantially altered by large-scale hedgerow removal in the 20th century. The western boundary is curving, and the boundaries are generally unaltered since the 1878 1st Edition Ordnance Survey map, with just the southern one inserted during the late 20th century.

1.5.2 Although there are a lack of heritage assets within the site, there is always potential for the survey to locate previously unrecorded buried archaeological features should they exist.

1.6 Geology and soils

1.6.1 The underlying geology is granite from the Land's End Intrusion (BGS, 2017).

The overlying soil across the site is from the Moretonhampstead association which is a typical brown podzolic soil and consists of a well drained, gritty, loamy soil with a humose surface horizon in places (Soil Survey of England and Wales, 1983).

1.6.2 Magnetometry carried out over similar geology and soils has produced variable results. Acidic podzolic soils can be subject to iron leaching and can be poorly drained which may produce less than optimum conditions for magnetometry. In addition, soils derived from granite may contain lower levels of iron than many other UK soils. However a soil sample was analysed for magnetic susceptibility values (see 3.3.3) and this indicated that the soils were good for magnetic survey.

1.6.3 Earth resistance survey may be effective at locating both former cut features and structural remains as strong resistive contrast can exist due to the relatively shallow depth of solid geology.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.

2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased, and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features, such as pits and ditches, may produce magnetic anomalies that can be mapped by magnetic prospection.

2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth, oven etc. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.

2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla, which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T).

2.1.5 The electrical resistance or resistivity of the soil depends upon the moisture content and distribution within the soil. Buried features such as walls can affect the moisture distribution and are usually more moisture resistant than other features such as the infill of a ditch. A stone wall will generally give a high resistance response and the

moisture retentive content of a ditch can give a low resistance response. Localised variations in resistance are measured in ohms (Ω) which is the SI unit for electrical impedance or resistance. Additional details are set out below and within Appendix B.

2.2 Equipment configuration, data collection and survey detail

2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5 fluxgate gradiometers (FGM650) spaced 0.5m apart with readings recorded at 20 Hz. The cart is pushed at walking speed and not towed. Each sensor is not zeroed in the field as the vertical axis alignment is precisely fixed leaving sensor offsets that are removed during data processing. The fixing of the vertical alignment ensures the sensors are not unduly influenced by localised magnetic fields and that the vertical component of a magnetic anomaly is measured. The gradiometers have a range of recording data between ±0.1nT and ±3,000nT. They are linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.

2.2.2 Due to the fixed offsets within the fluxgate sensors, as a result of the manufacturing and tensioning process, the survey data do not provide a visually useful dataset until a zero median traverse algorithm is applied. It is recognised that this has the potential to affect some anomalies detrimentally by removing linear features orientated parallel to survey transects. However, this has not been noted as a particular problem with the system due to the high resolution data collection, generally long length of traverses and variability within the magnetic characteristics of a linear anomaly.

2.2.3 Data are collected along a series of parallel survey transects to achieve 100% coverage of the surveyable land. The length of each transect is variable and relates to the size of the survey area and other factors including ground conditions. A visual display allows accurate placing of transects and helps maintain the correct separation between adjacent traverses. Data are not collected within fixed grids and data points are considered to be random even though the data are collected in a systematic manner covering all accessible areas (Aspinall, Gaffney and Schmidt, 2009).

2.2.4 Fluxgate sensors are highly sensitive to temperature change and this is manifest as drift during the course of a survey. This can be particularly noticeable during the morning as temperatures rise and the equipment warms or cools. Sensor drift within the course of a traverse will appear as a line trending from negative to positive after processing with a zero median traverse algorithm. To remove the potential for temperature drift data were collected after a 20 minute stabilisation period and traverses were limited to a time of generally <100s.

2.2.5 The earth resistance survey was carried out using Geoscan Research Ltd RM85 resistance meter using a mobile parallel twin probe array with a 0.5m electrode separation. Data were recorded at 1m intervals along traverses

separated by 1m within 30m grids with a zig-zag progression. The instrument was set to filter stray earth currents which can cause errors within the resistance measurements. Due to high background resistance, relating to shallow solid geology, instrument settings were a gain of x1 and current of 1mA.

2.2.6 The earth resistance survey grids were set out to the Ordnance Survey OSGB36 datum using a Leica GS10 RTK GPS. The GPS is used in conjunction with Leica's SmartNet service, where positional corrections are sent via a mobile telephone link. Positional accuracy of around 10 – 20mm is possible using the system.

2.3 Data processing and presentation

2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. The software effectively allocates a geographic position for each data point and can compensate for fixed offsets present within the FGM650 sensors. The offsets are positive or negative values present on all fluxgate gradiometer sensors. Some systems use manual or electronic balancing to effectively zero the sensors; however, this is a short term measure that is prone to drift through temperature changes and vibration and can easily be incorrectly set due to localised magnetic fields. The FGM650 sensors are very accurately aligned to the vertical magnetic gradient and are highly stable showing negligible drift on long traverses. The offset values are removed using TerraSurveyor software.

2.3.2 Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display within TerraSurveyor. The removal of offset values (compensation) of the sensors is also carried out in TerraSurveyor using a zero median traverse function. Data are then considered to be minimally processed. Note: without the zero median traverse function it is not possible to create a meaningful data plot as all sensors have a different offset value. Although a zero median traverse algorithm can remove anomalies aligned with the survey tracks, in practice this rarely occurs due to the use of long traverses, high resolution measurement and variability within the magnetic susceptibility of long linear features.

2.3.3 The minimally processed data are collected between limits of ±3000nT and clipped for display at ±10nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.4 Appendix D contains metadata concerning the survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix C for further information on processing.

2.3.5 A TIF file is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing (OSGB36 datum) when using GIS or CAD software. The main form of data display used in the report

is the minimally processed greyscale plot. With regard to the Sensys MXPDA, minimally processed data is considered by the manufacturer to be data that is compensated by SENSYS MAGNETO DLMGPS software, see 2.3.1 and 2.3.2. Note: traceplots are not considered to be appropriate as they do not provide an accurate or useful assessment of the magnetic anomalies due to very high density of data collection.

2.3.6 Data logged by the resistance meter are downloaded and processed within TerraSurveyor and Geoplot 4 software. Raw data are analysed and displayed within the report as well as processed data. Appendix C outlines the processing sequence with further information on processing set out within Appendix B. TIF files are prepared in TerraSurveyor for the earth resistance data. The main form of resistivity data display used in the report is the minimally processed greyscale plot. The processing applied within each survey area is outlined in Appendix D.

2.3.7 The raster images are combined with base mapping using ProgeCAD Professional 2016 creating DWG (2010) file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. The CAD plots are effectively georeferenced facilitating relocation of features using GPS, resection method, etc.

2.3.8 An abstraction and interpretation is also drawn and plotted for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.

2.3.9 A brief summary of each anomaly, with an appropriate reference number, is set out in list form within the results (Section 3) to allow a rapid and objective assessment of features within each survey area. Where further interpretation is possible, or where a number of possible origins should be considered, more subjective discussion is set out in Section 4.

2.3.10 A digital archive is produced with this report, see Appendix E below. The main archive is held at the offices of Archaeological Surveys Ltd, but the digital data will also be archived with the Archaeology Data Service.

3 RESULTS

3.1 Data interpretation

3.1.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, see Table 1.

Interpretation category	Description and origin of anomalies
Anomalies with an uncertain origin	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Morphology may be unclear or uncharacteristic and there may be a lack of additional supporting information.
Anomalies relating to land management	Anomalies are mainly linear and may be associated with the fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation. Land drains can appear in a classic herringbone pattern or as parallel linear anomalies.
Anomalies with an agricultural origin	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing. This category does not include agricultural features of early date or considered to be of archaeological potential (e.g. animal stockades, enclosures, farmsteads, etc).
Anomalies with a natural origin	Naturally formed features can produce variable anomalies that relate to the properties of the soil, subsoil and other drift or solid geologies. Anomalies may be amorphous, linear or curvilinear and may appear 'fluvial'or discrete; the latter are almost impossible to distinguish from pit-like anomalies with an anthropogenic origin. Fluvial, glacial and periglacial processes may be responsible for their formation within drift material and subsoil. Igneous and metamorphic activity can lead to magnetic anomalies within more solid geology.

Table 1: List and description of interpretation categories

3.2 General assessment of survey results - magnetometry

3.2.1 Magnetic anomalies located can be generally classified as anomalies associated with land management, positive and negative anomalies of an uncertain origin and linear anomalies of an agricultural origin. Anomalies located within the survey area have been numbered and are described in 3.4 below.

3.3 Statement of data quality - magnetometry

3.3.1 Data are considered representative of the magnetic anomalies present within the site. There are no significant defects within the dataset.

3.3.2 Despite initial concerns regarding the suitability of the soils and geology for magnetometry, the results demonstrate good magnetic contrast so that anomalies associated with cultivation are visible. On poor soils with weak

magnetic contrast this type of anomaly is often not visible. Other anomalies within the dataset appear to be associated with naturally formed features, and it may not be possible to confidently separate these from those with an anthropogenic origin.

3.3.3 To provide additional and supporting data for understanding the suitability of the site for magnetometry, a single topsoil sample was taken and mass specific magnetic susceptibility values were calculated for three sub-samples. Measurements were made using a Bartington MS2 with MS2B sensor. The average value (X_{lf}) obtained was 189.12 $10^{-8}m^3kg^{-1}$ with a frequency dependence (X_{FD}) of 10.8%. The X_{lf} value is high, much higher than anticipated from the geological and soil mapping of the area, the X_{FD} value also suggests a significant percentage of very small superparamagnetic grains that could relate to anthropogenic activity, such as burning. The measurements would infer very good conditions for magnetometry due to a topsoil contrasting strongly with a low magnetic susceptibility subsoil or solid geology.

3.4 List of anomalies – magnetometry

Area centred on OS NGR 141233 25814, see Figs 03 & 04.

Anomalies associated with land management

(1) - Two parallel positive linear anomalies extend along the length of the field, parallel with the eastern field boundary. The eastern anomaly extends the entire length, the western one can only be seen in the northern part of the site and becomes fragmented. This type of response is usually associated with a former field boundary feature.

(2) - Two parallel positive linear anomalies extend across the southern part of the site. They are parallel with the southern field boundary, but again this type of response generally relates to a former field boundary feature.

Anomalies with an uncertain origin

(3) - In the south eastern corner of the survey area are a number of discrete, positive responses, generally in linear groups. They appear to relate to pit-like features, but it is not possible to determine if they have archaeological potential.

(4) - A discrete, positive response is located towards the central part of the survey area. It appears pit-like, similar to anomalies (3), but its origin is uncertain.

(5) - The survey area contains a number of weakly positive linear and possible curvilinear responses, with a group towards the north western corner of the site. They do not have a coherent morphology, and it is possible that they relate to further natural features like anomalies (7).

(6) - A number of rectangular or sub-circular discrete negative responses can be seen within the site. They may be associated with former geotechnical pits.

Anomalies with a natural origin

(7) - Weakly positive amorphous responses in the north eastern part of the survey area appear to relate to naturally formed features.

Anomalies with an agricultural origin

(8) - The survey area contains several sets of parallel linear anomalies that relate to three different series of cultivation.

3.5 General assessment of survey results – resistivity

3.5.1 Resistance anomalies located can be generally classified as high resistance anomalies associated with land management and high resistance anomalies of uncertain origin. Anomalies located within each survey area have been numbered and will be outlined in 3.7 below.

3.6 Statement of data quality and other factors influencing the results - resistivity

3.6.1 Data are considered representative of the resistive anomalies present within the site. There are no significant defects within the dataset.

3.6.2 Numerous resistive 'spikes' were encountered across the site. The very high erroneous readings occur due to poor contact between the mobile probes and the ground surface. Although not unusual, contact problems may have been caused by concentrations of stone close to the surface. Processing effectively removes the high responses and comparison is made between processed and unprocessed data to ensure that there are no detrimental effects on other anomalies.

3.6.3 Generally the data demonstrate useful resistive contrast and several high and low resistance anomalies are present.

3.7 List of anomalies – resistivity

Area centred on OS NGR 141233 25814, see Fig 05.

Anomalies associated with land management

(9) - Two linear anomalies of relatively high resistance correspond to the linear ditches associated with the possible former field boundary located by magnetometry (1). They correspond to the eastern positive linear anomaly in the south and the

western positive linear anomaly in the north.

Anomalies of uncertain origin

(10) - Amorphous areas of high resistance are evident around the eastern and western edges of the survey area. It is not clear if they relate to more compacted ground or dumped material. The areas may be associated with drier ground adjacent to land boundaries and this may be caused by sheltering effects and moisture uptake by bushes etc.

4 CONCLUSION

4.1.1 The geophysical survey comprised magnetometry and resistivity as the magnetic characteristics of the soil and underlying geology were initially considered to be potentially poor for magnetic survey. However, the results demonstrate the presence of strongly contrasting magnetic anomalies that are indicative of very good conditions for magnetometry. Magnetic susceptibility measurement of a small soil sample indicated high values and add confidence in the results obtained by the survey.

4.1.2 The magnetometry results indicated the presence of two possible former field boundaries, parallel with the current eastern and southern boundaries. There was a corresponding high resistance linear response to one of the former boundary features.

4.1.3 A number of discrete positive responses have also been located during the magnetometry survey, with several appearing in linear groups; however, their origin is uncertain. Discrete negative responses may be associated with former geotechnical pits.

4.1.4 The earth resistance survey revealed high resistance zones around the eastern and western field margins. These are likely to have been caused by drier soil, possibly associated with compacted ground or dumped material, but could also relate to sheltering effects and moisture uptake by adjacent vegetation.

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Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material. Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field. Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried magnetic field. The difference between the two sensors will relate to the strength of the magnetic field created by the buried feature.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – basic principles of earth resistance survey (resistivity)

Earth resistance survey, commonly known as resistivity, relies on the variability of conduction of current through soil and the subsurface matrix. The variability relates to the distribution of moisture within different materials so that non-porous features, such as foundations, produce a relatively high resistance response and more moisture retentive soil, such as found within the fill of a former ditch, produces a low resistance measurement. The technique is, therefore, influenced by climatic factors although the success of a survey can be difficult to predict based on these alone. Soil type, ground use, vegetative cover and the nature of buried features and subsoil are all factors that will influence the outcome of a survey.

The technique involves inputting a small electrical current into the ground and measuring subtle variations to the current at regular intervals across an area. The current input and measurement requires a series of probes to be inserted into the ground and the configuration of these can influence the resolution of resistive anomalies and the depth of response. Research has demonstrated that the twin electrode configuration is one of the most useful for archaeological prospection. It requires a mobile frame with two electrodes separated usually by 0.5m and a pair of remote probes linked to the logging instrument using a long cable.

When using the twin probe configuration a useful reading interval for archaeological prospection across an area is 1m. Data are logged at 1m centres along traverses separated by 1m. Where areas contain known archaeological features 0.5m x 0.5m or 1m x 0.5 readings are considered more informative. Data collected by cart-based systems are typically at 0.25m centres along traverses separated by 1m.

Appendix C – data processing notes

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Edge Match

Calculates the mean of the 2 lines (rows or columns) of data either side of the edge to match. It then subtracts the difference between the means from all datapoints in the selected area.

High Pass Filter

Removes low frequency anomalies within the data that are not considered to be archaeologically significant and may be natural in origin. A window passes over the data, the mean of all the data within the window is subtracted from the centre value. The size of the window is adjusted as is the weighting which may be uniform or Gaussian.

Zero Median/Mean Traverse

The median (or mean) of each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise slight differences between the set-up and stability of gradiometer sensors and can remove striping. The process can remove archaeological features that run along a traverse so data analysis is also carried out prior its application.

Despike

Removal of data points that exceed the mean/median/threshold by selecting a window size of data points and replace by mean/median/threshold

Appendix D – survey and data information

Minimally processed magnetometer data

Filename: J770-mag-proc.xcp
Description: Imported as Composite from: J770-mag.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 141180.94, 25869.56 m
Southeast corner: 141284.44, 25760.51 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 190900
Dimensions
Composite Size (readings): 690 x 727
Survey Size (meters): 104 m x 109 m
Grid Size: 104 m x 109 m
X Interval: 0.15 m
Y Interval: 0.15 m
Stats
Max: 11.05
Min: -11.00
Std Dev: 2.88
Mean: 0.05
Median: -0.02
Composite Area: 1.1287 ha
Surveyed Area: 0.61561 ha
PROGRAM
Name: TerraSurveyor
Version: 3.0.23.0
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -10.00 to 10.00 nT

Raw earth resistance data

COMPOSITE
Path: C:\Business\Jobs\J770 St Buryan\Data\Res\comps\
Filename: J770-res-raw.xcp
Description: Imported as Composite from GeoPlot : Res
Instrument Type: Resist. (RM85)
Units: ohm
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 141181.51, 25844.78 m
Southeast corner: 141284.31, 25784.35 m
Collection Method: Zig zag
Dummy Value: 2047.5
Dimensions
Composite Size (readings): 90 x 150
Survey Size (meters): 90 m x 150 m
Grid Size: 30 m x 30 m
X Interval: 1 m
Y Interval: 1 m
Stats
Max: 216.49
Min: 110.50
Std Dev: 22.82
Mean: 154.01
Median: 146.00
Composite Area: 1.35 ha
Surveyed Area: 0.5924 ha
Processes: 2
1 Base Layer
2 Clip at 2.00 SD

Processed earth resistance data

Filename: J770-res-proc.xcp
Description: Imported as Composite from GeoPlot : Res
Stats
Max: 204.68
Min: 110.50
Std Dev: 21.24
Mean: 153.26
Median: 146.00
Processes: 3
1 Base Layer
2 Despike Threshold: 3 Window size: 9x9
3 Clip at 2.00 SD

Appendix E – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire. Data are backed-up onto an on-site data storage drive and at the earliest opportunity data are copied to CD ROM for storage on-site and off-site.

A printed copy of the report and a PDF copy will be supplied to the Cornwall Historic Environment Record. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS). The digital data will also be archived with the Archaeology Data Service.

File type	Naming scheme	Description
Data	J770_mag_raw.csv J770_mag_raw.xcp J770_mag_proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J770_mag_proc.tif J770_res_raw. tif J770_res_proc.tif	Image in TIF format
Drawing	J770_CAD.dwg	CAD file in 2010 dwg format
Report	J770 _St_Buryan_geophysical_survey_report.pdf	PDF report

Table 2: Archive metadata

Appendix F – CAD layers for abstraction and interpretation plots

The table below sets out Archaeological Surveys Ltd CAD layer names with associated colours and graphical content. Where CAD files are available layers may be extracted for further CAD/GIS use. Note: hatched polygon boundaries are contained within layers with the RGB colour code 254, 255, 255 (near white) in order to prevent their visibility.

Report sub-heading and associated CAD layer names	Colour with RGB index		Layer content
Anomalies with archaeological potential			
Anomalies with an uncertain origin			
AS-ABST MAG POS LINEAR UNCERTAIN		255,127,0	Line, polyline or polygon (solid)
AS-ABST MAG POS DISCRETE UNCERTAIN		255,127,0	Solid donut, point or polygon (solid)
AS-ABST RES HIGH AREA UNCERTAIN		153,133,76	Polygon (net)
Anomalies relating to land management			
AS-ABST MAG BOUNDARY		127,0,0	Line, polyline or polygon (solid or cross hatched ANSI37)
Anomalies with an agricultural origin			
AS-ABST MAG AGRICULTURAL		Green 0,255,0	Line or polyline
Anomalies associated with magnetic debris			
AS-ABST MAG STRONG DIPOLAR		132, 132, 132	Solid donut, point or polygon (solid)
Anomalies with a natural origin			
AS-ABST MAG NATURAL FEATURES		Yellow 255,255,0	Polygon (cross hatched ANSI37)

Table 3: CAD layering

Appendix G – copyright and intellectual property

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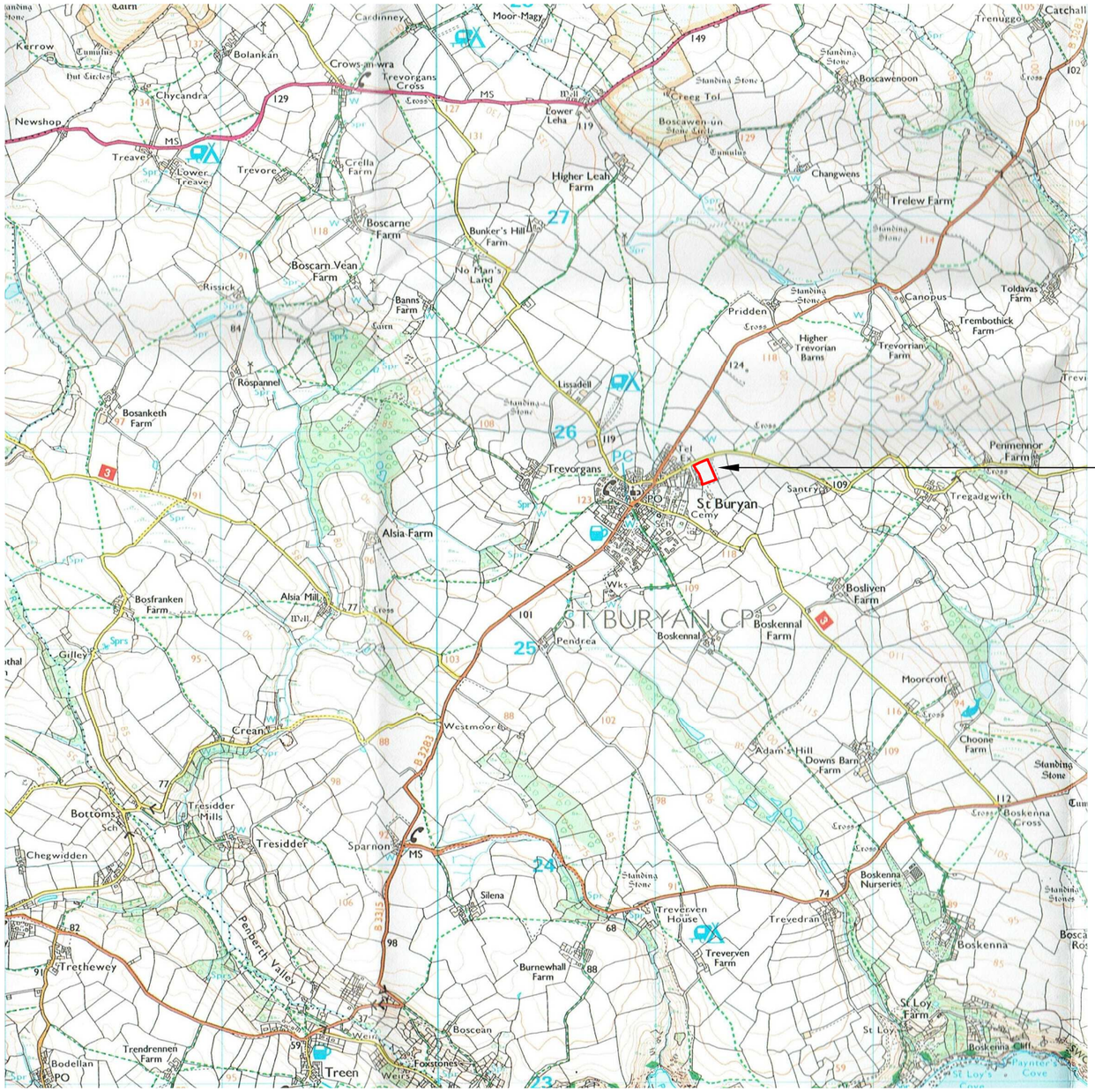
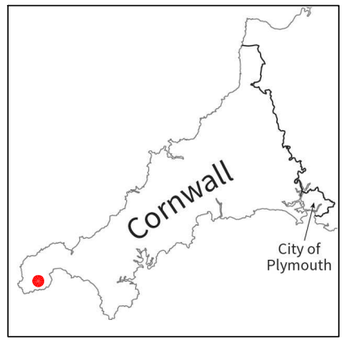


Survey location

Archaeological Surveys Ltd

Geophysical Survey
Land south of Newlyn Road
St Buryan
Cornwall

Map of survey area



Survey location

Site centred on OS NGR
SW 41233 25814

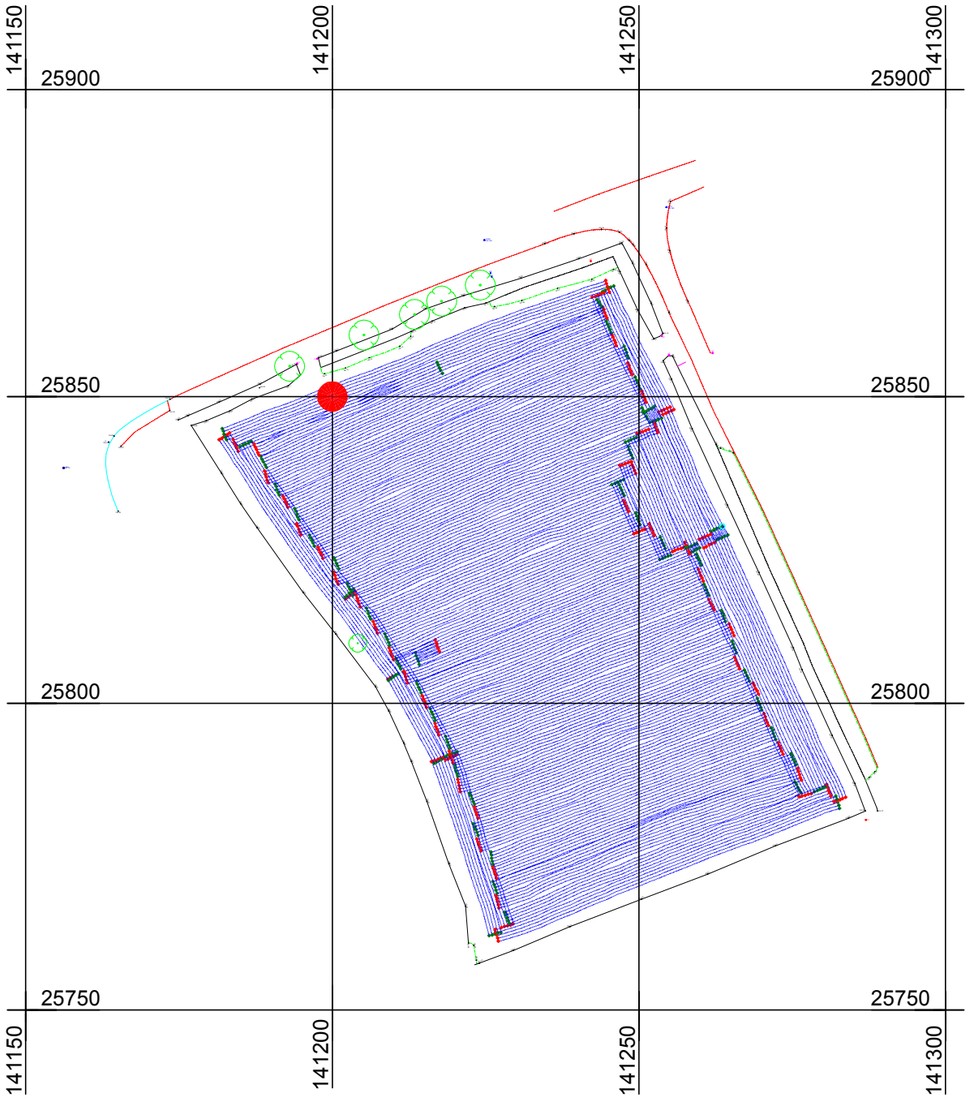
SCALE 1:25 000

0m 500m 1000m

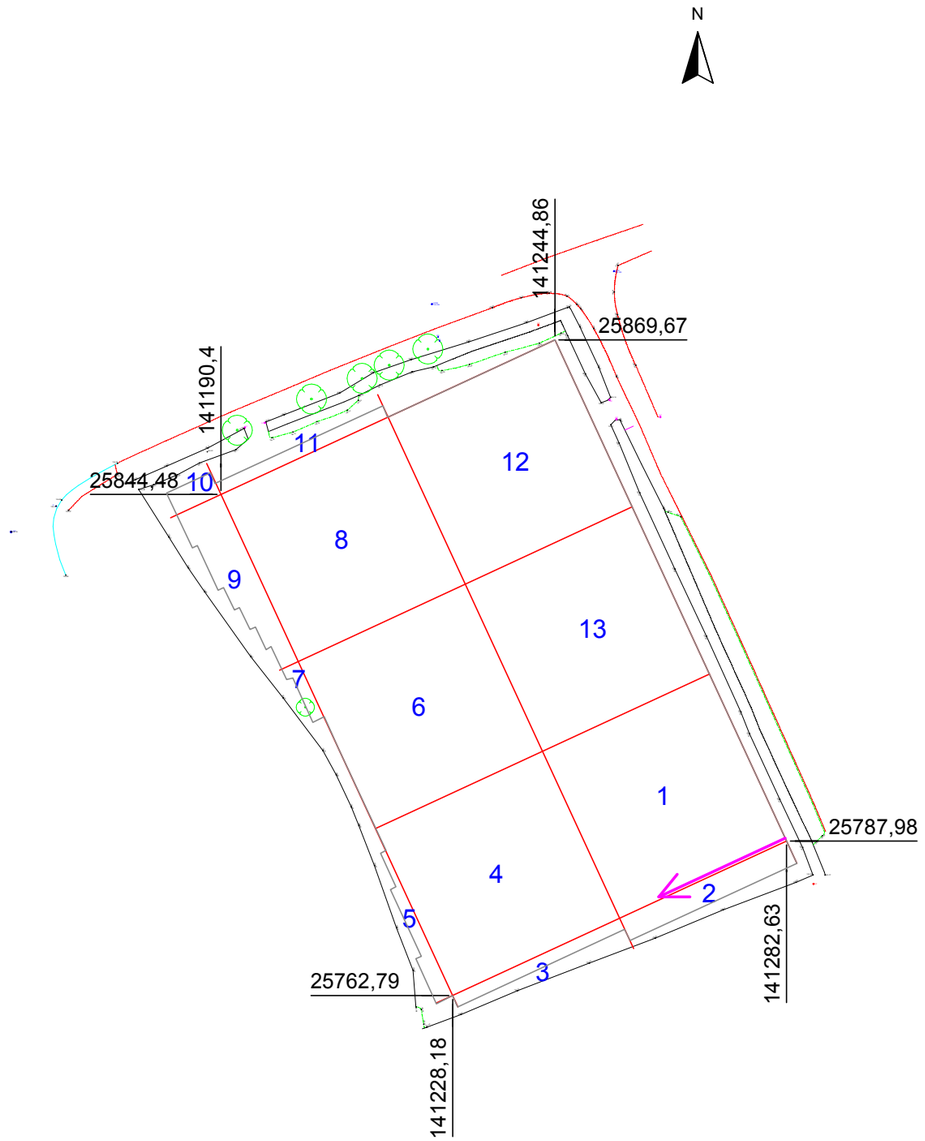
SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 01

Magnetometry survey tracks



Earth resistance grids



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Geophysical Survey
Land south of Newlyn Road
St Buryan
Cornwall

Referencing information

Magnetometry referencing grid to OSGB36 datum at 50m intervals. Data collected at 20Hz and georeferenced to ETRS89 zone 30 with conversion to OSGB36 using OSTN02

- 141200 25850
- Survey tracks
- Survey track start
- Survey track stop

Resistivity grid coordinates based on Ordnance Survey OSGB36 datum

Grids set out using RTK GPS with Leica SmartNet correction data RTCMv2 format OSTN02 transformation

Survey grid size = 30m

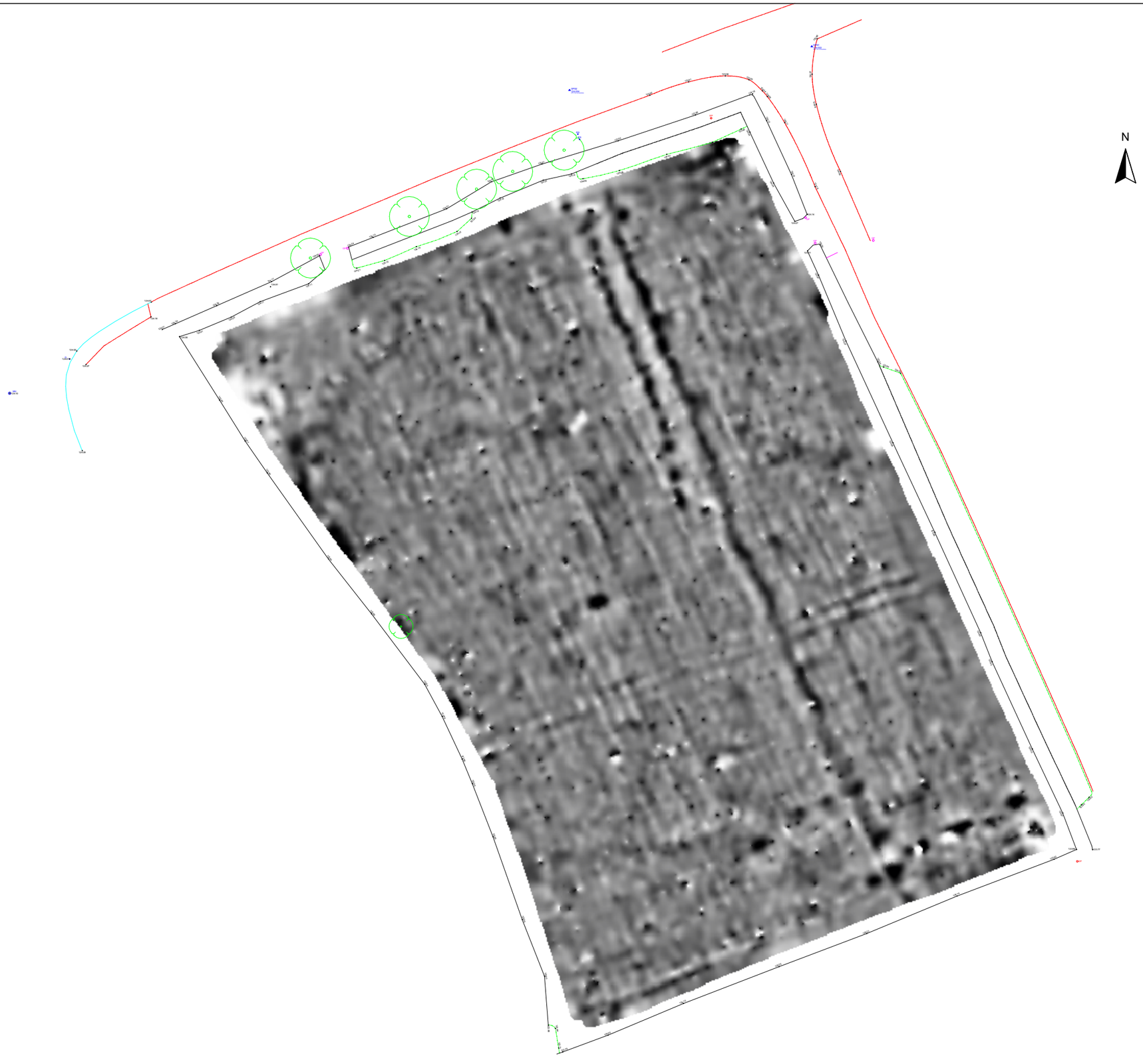
- Survey start and traverse direction
- 1 Grid reference number and filename

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02



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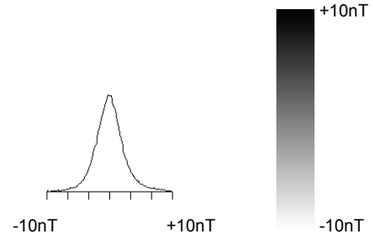
Greyscale plot of minimally processed magnetometer data



SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 03

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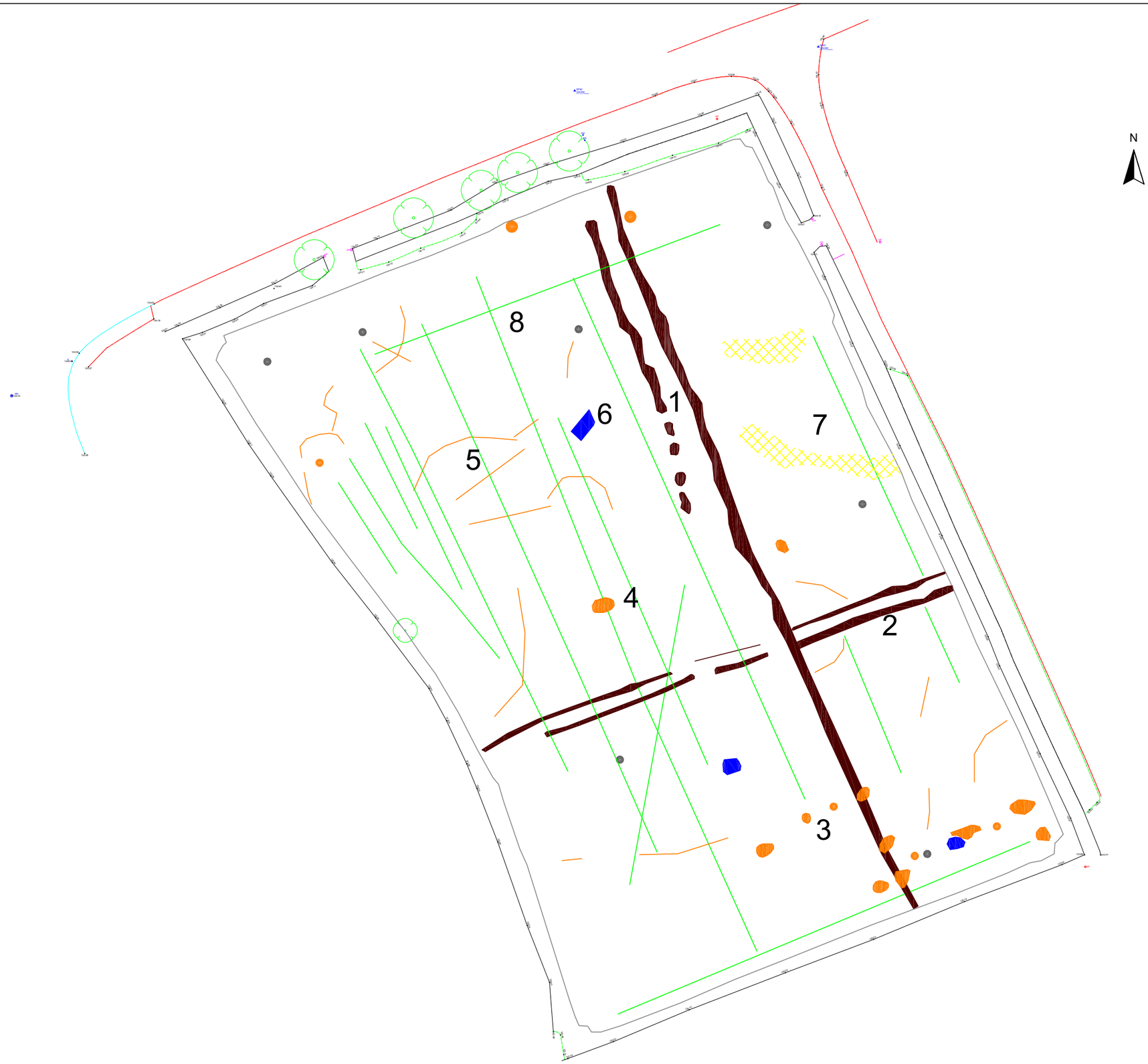
Cornwall

Abstraction and interpretation of magnetic anomalies



- Positive linear anomaly - possible former field boundary
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Discrete positive response - possible pit-like feature
- Discrete negative response - possibly associated with geotechnical pit
- Weakly positive magnetic response - of natural origin
- Strong dipolar anomaly - ferrous object

SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 04

Archaeological Surveys Ltd

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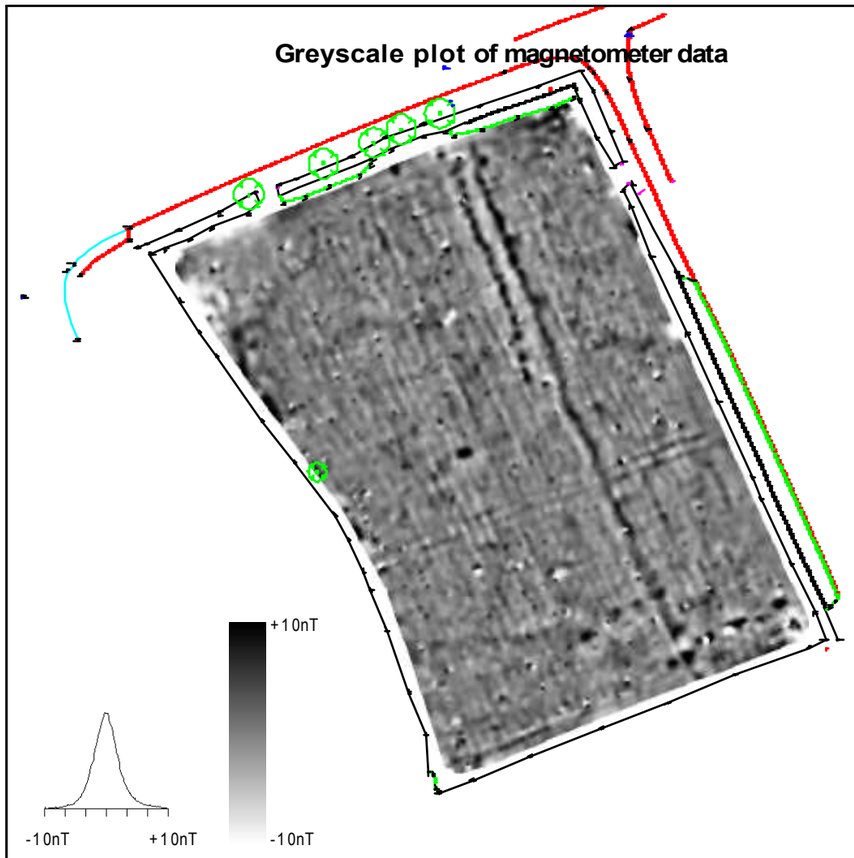
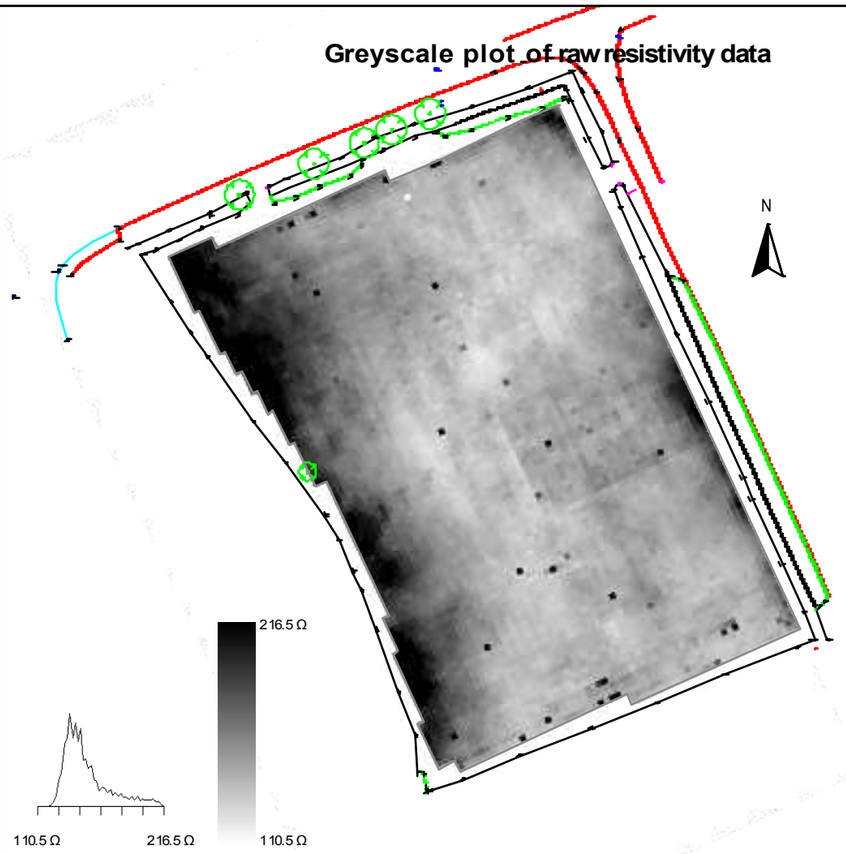
St Buryan
Cornwall

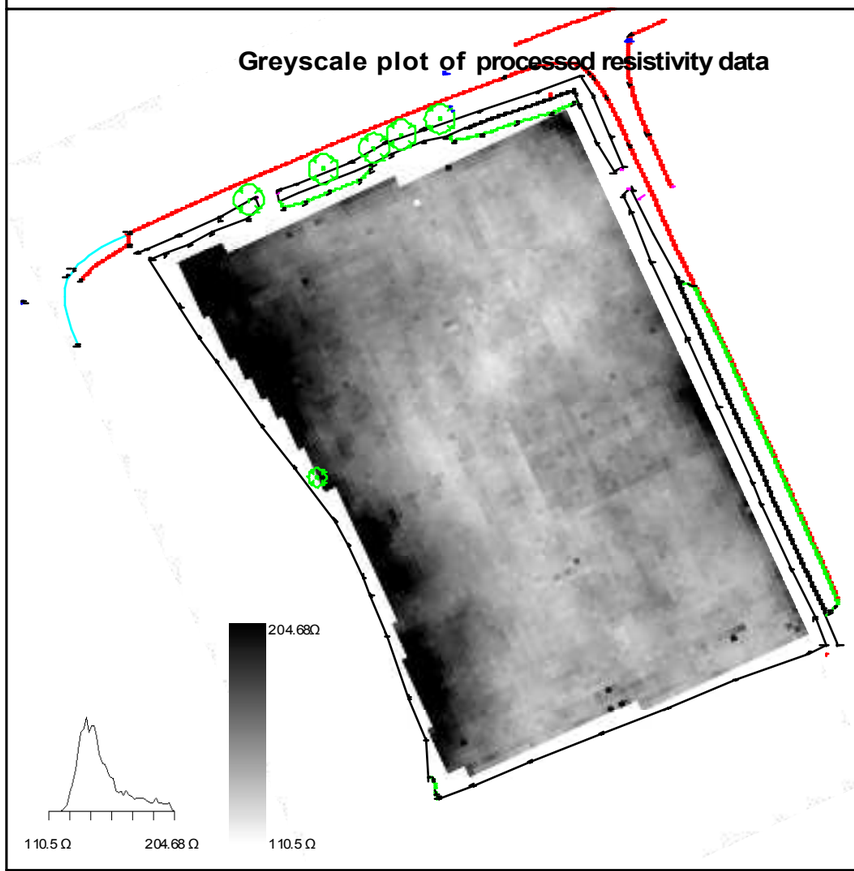
Greyscale plot of magnetometer data



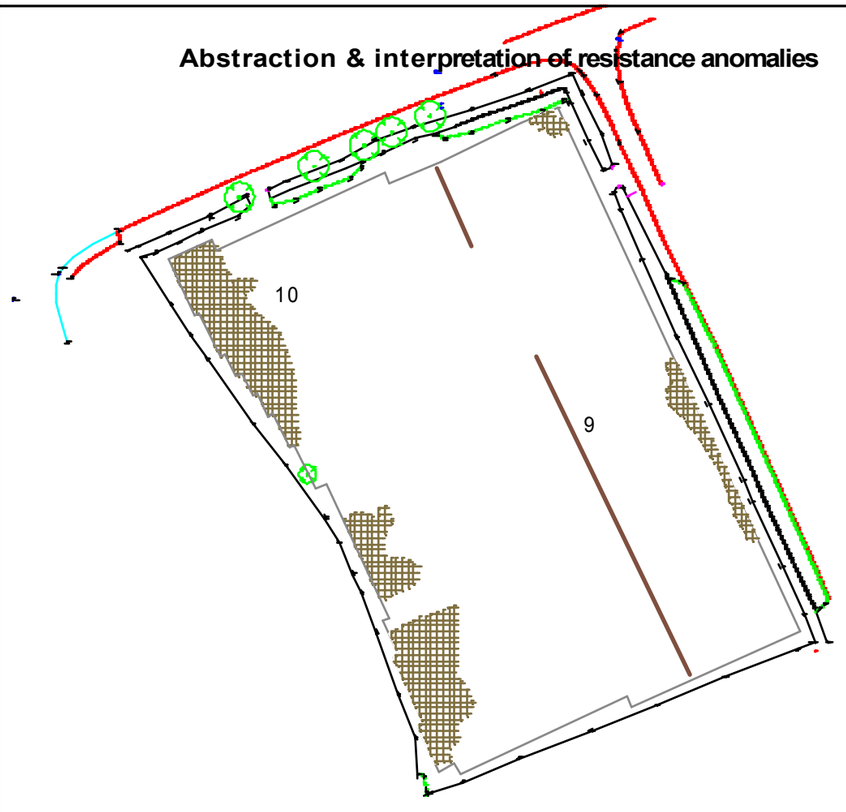
Greyscale plot of raw resistivity data



Greyscale plot of processed resistivity data



Abstraction & interpretation of resistance anomalies



Greyscale plot of magnetometer & resistivity data & abstraction & interpretation of resistance anomalies

High resistance linear anomaly - possible former field boundary

Area of high resistance - of uncertain origin

SCALE 1:1000

0m 10 20 30 40 50m

KTD	DJS	FIG 05