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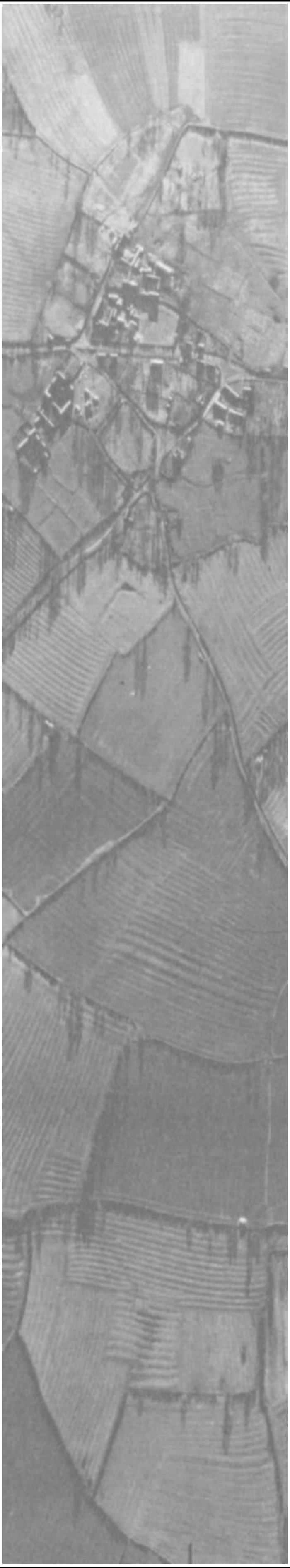

Land to the rear of 15 White Street
Easterton
Wiltshire

EARTH RESISTANCE & MAGNETOMETER SURVEY REPORT

for

Briony Clarke

Kerry Donaldson & David Sabin

July 2022

Ref. no. J922

ARCHAEOLOGICAL SURVEYS LTD

Land to the rear of 15 White Street
Easterton
Wiltshire

Earth Resistance & Magnetometer Survey Report

for

Briony Clarke

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Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

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Ordnance Survey Grid Reference – **SU 02183 54985**

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SUMMARY

A geophysical survey was carried out by Archaeological Surveys Ltd ahead of a proposed installation of a solar array at Easterton in Wiltshire. The results of the earth resistance survey revealed a high resistance linear anomaly, which lacked a clearly defined morphology. Zones of high resistance and low resistance appear to be associated with drier and more moisture retentive soils within the site. In the southern part of the site a zone of high resistance is associated with modern disturbance. The magnetometry data indicate the presence of a weakly positive linear anomaly, with other short, positive linear anomalies nearby; however, they are poorly defined. Linear anomalies within both the resistivity and magnetometry relate to former land divisions, with strip fields mapped in the early 19th century and allotment gardens in the early 20th century.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Briony Clarke to undertake an earth resistance (resistivity) and magnetometer survey of an area of land to the rear of Willoughby's, 15 White Street, Easterton, Wiltshire. A planning application has been made to Wiltshire Council (No:PL2022/02482) for the installation of 16 ground mounted solar panels in the paddock to the rear of the property and the survey has been carried out in order to provide information on the archaeological potential of the site.

1.1.2 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2022) and issued to the client prior to commencing the survey.

1.2 Survey objectives and techniques

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

1.2.2 As the site is small, located on the periphery of the medieval core of Easterton which could suggest the potential for buried structural remains, and also on Upper Greensand geology, which tends to be less than optimum for magnetometry, an earth resistance (resistivity) survey was considered the most appropriate technique for the site conditions in the first instance. A magnetometry survey was also undertaken to achieve a complimentary data set which can help with interpretation.

1.2.3 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 will 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 will be carried out to the Chartered Institute for Archaeologists (2014) (updated 2020) *Standard and Guidance for Archaeological Geophysical Survey.*

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.

1.4 Site location, description and survey conditions

1.4.1 The site lies between White Street and the B3098 High Street at Easterton in Wiltshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SU 02183 54985, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 0.3ha within an area of pasture and meadow to the rear of Willoughby's, 15 White Street, Easterton. The small pasture field forms the western part of the survey area which tends to slope down very gently towards the north west. It contained a small animal shelter in the north eastern corner and boundaries were mainly of wire fencing. The southern side of the field was very rough due to animal burrowing, but with some evidence for made ground and soil dumping. The meadow had been partly mown although the northern half contained long grass and saplings with ash from bonfires located near the north western corner, a small table and chairs was located in the southern part of the area. Land to the south east of the meadow had clearly been previously terraced for a tennis court and was unsuitable for survey.

1.4.3 The ground conditions across the site were generally considered to be favourable for the collection of geophysical data. Weather conditions during the survey were fine. Generally low levels of rainfall in the months prior to the resistivity survey were considered favourable for the location of subsurface anomalies, with damp conditions a few days before likely to prevent problems with contact resistance.

Plate 1: Area of pasture looking north west

Plate 2: Northern part of meadow area looking north east

1.5 Site history and archaeological potential

1.5.1 The site lies on the periphery of the medieval core of Easterton and north of the medieval core of Fiddington. The property, known as Willoughby's is a Grade II listed early 17th century house and the tithe map shows that the paddock/meadow area originally contained four long linear plots extending east south eastwards from the rear of the properties on the High Street to the west with reference to the site being allotment gardens in the first half of the 20th century.

1.6 Geology and soils

1.6.1 The underlying solid geology across the site is glauconitic sandstone from the Upper Greensand Formation (BGS, 2017).

1.6.2 The overlying soil across the survey area is from the Ardingdon association and is a typical argillic brown earth. It consists of a deep, well drained, fine and coarse loamy glauconitic soil (Soil Survey of England and Wales, 1983).

1.6.3 Magnetometry survey carried out across similar geology and soils has produced variable results as they are often associated with low magnetic contrast and low levels of magnetic susceptibility (Linford, Linford & Payne, 2013) (Hardwick & Payne, 2014). Therefore, due to the small area of survey, coupled with the proximity to the medieval core of the village, earth resistance survey was the primary technique as it is not dependant on the magnetic properties of the soil and underlying geology and may respond better to buried structural remains.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 The electrical resistance or resistivity of the soil depends upon moisture content and distribution. 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 although in certain conditions it may also produce a high resistance anomaly.

2.1.2 Localised variations in resistance are measured in ohms (Ω) which is the SI unit for electrical impedance or resistance. Additional details are set out in 2.2 below and within Appendix A.

2.1.3 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance (also known as thermoremanence) are factors associated with the formation of localised fields.

2.1.4 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.

2.1.5 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.

2.1.6 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). Additional details are set out in 2.2 below and within Appendix B.

2.2 Equipment configuration, data collection and survey detail

2.2.1 The earth resistance survey was carried out using a Geoscan Research Ltd RM85 resistance meter using a mobile twin probe array. The instrument contains a multiplexer that allows three mobile probes separated by 0.5m to be switch to record data at both 1m probe separation and 2 x 0.5m probe separation. The dataset from the 1m probe separation is recorded at 1m centres along traverses spaced at 1m; the data from the 0.5m probes effectively records at 1m centres along traverses spaced at 0.5m. The latter effectively improve the spacial resolution of the data, the former can provide stronger contrast at depth. The instrument was set to filter stray earth currents which can cause errors within the resistance measurements. The survey was carried out in a zig-zag fashion over grids 30m x 30m in size.

2.2.2 The survey grids were set out to the Ordnance Survey OSGB36 datum using a Leica GS10 RTK GNSS. The GNSS 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.

2.2.3 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 20Hz. 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 ±8000nT. They are linked to a Leica GS10 RTK GNSS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.

2.2.4 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.

2.2.5 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).

2.2.6 Fluxgate sensors are highly sensitive to temperature change and this manifests 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.

2.3 Data processing and presentation

2.3.1 Data logged by the RM85 resistance meter are downloaded and processed within Geoplot 4 software and TIF files are prepared. The main form of resistivity data display used in the report is the minimally processed greyscale raster graphic image. Minimal processing, including despiking to remove high contact resistance anomalies is applied as well as an interpolation of the processed data. Appendix D metadata sets out the data range and the processing sequence, with further details regarding the processing functions set out within Appendix C.

2.3.2 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.

2.3.3 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 the 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.

2.3.4 The minimally processed magnetic data are collected between limits of ±8000nT and clipped for display at ±10nT and also at ±3nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

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

2.3.6 For magnetometry data 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 2.3.3 and 2.3.4. 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.

2.3.7 The raster images are combined with base mapping using ProgeCAD Professional 2021 creating DWG (2018) 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.

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 geophysical 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 associated with magnetic debris	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. They often occur where there has been dumping or ground make-up and are related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, hearths and nail spreads from former wooden structures or rooves and may, therefore, be archaeologically significant. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc. Often a significant area around these features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically adjacent to strong magnetic sources. Buried services may produce characteristic multiple dipolar anomalies dependant upon their construction. Resistivity anomalies may be high or low and are clearly associated with extant modern features.

Table 1: List and description of interpretation categories

3.2 General assessment of survey results – resistivity

3.2.1 The earth resistance survey was carried out over approximately 0.3ha.

3.2.2 Resistance anomalies located can be generally classified as high and low resistance anomalies of uncertain origin, anomalies associated with land management, anomalies associated with ground disturbance and anomalies associated with modern land use. Anomalies located within each survey area have been numbered and will be outlined in 3.4 below.

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

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

3.3.2 A number of resistive 'spikes' were encountered across the site; however, they are not of sufficient density to adversely affect the dataset. The high resistance erroneous readings occur due to poor contact between the mobile probes and the ground surface probably relating to dry conditions or localised irregularities and soil disturbance. Processing effectively removes these responses and comparison is made between processed and unprocessed data to ensure that there are no detrimental effects on other anomalies.

3.3.3 High resistance ‘spikes’ and general noise is notably more visible in the 0.5m probe separation data due to increased variability of current flow in the near surface and the shallower response compared to the 1m probe separation. The variability probably relates to localised changes in moisture content and also to former and current land use that has caused superficial changes, such as compression or aeration of near surface soil relating to mowing, paths etc.

3.3.4 Generally the data demonstrate useful resistive contrast and numerous high and low resistance anomalies are present. The effect of the disturbed ground in the southern part of the site and moisture uptake and sheltering by vegetation is unclear with no distinct differences between the 0.5m and 1m probe separations.

3.4 List of anomalies – resistivity

Area centred on OS NGR 402183 154985, see Figs 03, 04, 06 & 07.

Anomalies of uncertain origin

(R1) – A cross-shaped high resistance linear response is located in the eastern part of the site. It may continue westwards as part of anomalies (R2). A high resistance response could be caused by a number of factors, which may include former structural remains; however, natural features and other anthropogenic features and activity could also be responsible for the anomaly.

(R2) – A small number of discrete and linear high resistance responses could be associated with (R1).

(R3) – The central part of the site contains large zones of high resistance response. This is situated on the crest of a ridge of high ground that extends through the site and it is possible that the response is to the underlying greensand geology which may be drier on the summit of the ridge.

(R4) – A discrete high resistance area is located in the north eastern corner of the site. Such a response could be caused by ground disturbance or make-up; however, its origin is uncertain.

(R5) – A band of low resistance can be seen in the eastern part of the site. It is possible that it relates to a more moisture retentive area within the underlying soil and geology.

(R6) – The western part of the site is generally low resistance and corresponds to a slightly westwards facing slope. It is likely that the response is to deeper and more moisture retentive soils on the slope.

Anomalies relating to ground disturbance

(R7) - An area of high resistance in the central southern part of the site corresponds to an area of disturbed ground.

Anomalies associated with land management

(R8) – Low resistance linear anomalies relate to former boundaries associated with either the formerly mapped strip fields or allotment gardens.

Anomalies with a modern origin

(R9) – A discrete low resistance response in the north eastern part of the survey area relates to the site of a modern bonfire.

3.5 General assessment of survey results - magnetometry

3.5.1 The detailed magnetic survey was carried out over approximately 0.3ha.

3.5.2 Magnetic anomalies located can be generally classified as positive linear anomalies of an uncertain origin, linear anomalies associated with land management, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects. Anomalies located within the survey area have been numbered and are described in 3.7 below.

3.6 Statement of data quality - magnetometry

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

3.6.2 The data demonstrate the presence of widespread magnetic debris probably related to spreads of burnt and ferrous material. It may be sufficiently strong and dense in some parts of the site to obscure more significant weak magnetic anomalies. Several linear anomalies possibly associated with the fill of former cut features are poorly visible within the data due to very low magnetic contrast, which is typical of the Upper Greensand Formation underlying this area.

3.7 List of anomalies – magnetometry

Area centred on OS NGR 402183 154985, see Figs 05 - 07.

Anomalies with an uncertain origin

(M1) – A weakly positive linear anomaly is located in the north western part of the site. It is possible that it relates to the fill of a former ditch-like feature.

(M2) – A small number of weakly positive, short linear anomalies can be seen towards the centre of the site. They have a general north north east to south south west orientation, parallel with the eastern and western boundaries; however, their origin is uncertain.

Anomalies associated with land management

(M3) – A number of negative linear anomalies, some with an association with magnetic debris appear to relate to former land divisions that have been mapped as strip fields on the 1840s tithe map.

Anomalies associated with magnetic debris

(M4) – A zone of magnetic debris along the southern edge of the site partially corresponds to anomaly (R7) and indicates that the disturbed ground probably contains modern material. Further magnetic debris is evident near the south eastern corner of the site.

(M5) – The site contains numerous and widespread strong, discrete, dipolar anomalies which are a response to ferrous and other magnetically thermoremnant objects, such as brick/tile, in the topsoil.

Anomalies with a modern origin

(M6) – Magnetic disturbance from ferrous material within and surrounding the site.

4 CONCLUSION

4.1.1 The geophysical survey comprised resistivity and magnetometry within the site. The results of the resistivity demonstrate the presence of a number of high and low resistance areas which may relate to differences in soil moisture caused by the topography and underlying subsoil or solid geology. High resistance linear anomalies are not well defined, and while such a response could suggest structural remains, more modern land use could also be responsible. Other anomalies appear to relate to modern ground disturbance and a bonfire. The magnetometry survey revealed a positive linear anomaly which could relate to a former ditch-like feature, although it is poorly defined. Other positive linear anomalies were short and lack a coherent morphology. Linear anomalies seen in both the resistivity and magnetometry data appear to relate to formerly mapped strip field boundaries.

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Appendix A – 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 B – 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 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.

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. Magnetic spikes can be caused iron objects on the surface or within the topsoil. Spikes in resistivity data are often related to poor electrical contact often associated with ground conditions. Despike can improve the appearance of data and remove extreme readings that may affect further processing.

Zero Median/Mean Traverse

The median (or mean) of data from 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 differences between the offset values of the gradiometer sensors. The process can remove archaeological features that run along a traverse but with the high resolution datasets created by the Sensys FGM650 sensors and the method of data collection this has not been a notable problem. In fact, the removal of offsets using software avoids carrying out a balancing procedure on site, which inevitably can never be done in magnetically clean conditions and results in improperly aligned fluxgate sensors and/or electronic adjustment values.

Appendix D – survey and data information

Raw resistivity
Mean = 11.01217
1 SD = 12.88567
3 SD = 38.65702
Minimum = -90.3
Maximum = 204.7
Dummy Value = 2047.5
SI, TI = 1 m, 1 m
Grid X, Y = 30 m, 30 m
Length, Width X, Y = 60m, 60m
Size X, Y = 60, 60
Processed resistivity
Mean = 30.05079
1 SD = 8.780943
3 SD = 26.34283
Minimum = 8.65
Maximum = 66.10779
Dummy Value = 2047.5
SI, TI = 0.5 m, 0.5 m
Grid X, Y = 30 m, 30 m
Length, Width X, Y = 60m, 60m
Size X, Y = 120, 120

Processed magnetometry
Instrument Type: Sensys DLMGPS
Units:
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 402139.92, 155020.92 m
Southeast corner: 402245.37, 154946.67 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Dimensions
Survey Size (meters): 105 m x 74.3 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 133200, Recorded: 133200

Stats
Max: 11.05
Min: -11.00
Std Dev: 5.09
Mean: -0.06
Median: 0.15
Composite Area: 0.78297 ha
Surveyed Area: 0.33935 ha
PROGRAM
Name: TerraSurveyorPre
Version: 3.0.36.24
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -10.00 to 10.00

Appendix E – digital archive

The main archive is held at the offices of Archaeological Surveys Ltd which allows for long-term storage including refreshing and migration of files so that they can be accessed for re-analysis in the future. The archive includes the raw and processed geophysical data, greyscale images, CAD, PDF figures and report text.

A PDF copy will be supplied to the Wiltshire Historic Environment Record. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

File type	Naming scheme	Description
Data	J922-res-0.5m-**[area number/name]**.cmp J922-res-1m-**[area number/name]-proc**.xcp J922-mag-**[area number/name]**.asc J922-mag-**[area number/name]**.xcp J922-mag-**[area number/name]**-proc.xcp	Raw data as Geoplot file Processed data as Geoplot file Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J922-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	J922-**[version number]**.dwg	CAD file in 2018 dwg format
Report	J922 report.odt	Report text in Open Office odt format

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 an uncertain origin			
AS-ABST MAG POS LINEAR UNCERTAIN		255,127,0	Line, polyline or polygon (solid)
AS-ABST RES HIGH LINEAR UNCERTAIN		153,133,76	Line, polyline or polygon (solid)
AS-ABST RES HIGH AREA UNCERTAIN		153,133,76	Polygon (net)
AS-ABST RES LOW LINEAR UNCERTAIN		127, 223, 255	Line, polyline or polygon (solid)
Anomalies relating to land management			
AS-ABST MAG BOUNDARY		127,0,0	Line, polyline or polygon (solid or cross hatched ANSI37)
Anomalies associated with magnetic debris			
AS-ABST MAG STRONG DIPOLAR		132, 132, 132	Solid donut, point or polygon (solid)
Anomalies with a modern origin			
AS-ABST MAG DISTURBANCE		132, 132, 132	Polygon (hatched ANSI31)

Table 3: CAD layering

Appendix G – copyright and intellectual property

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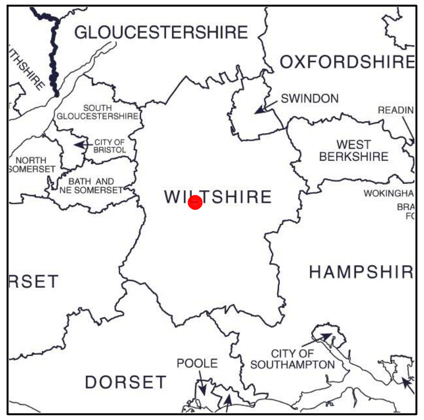
Easterton
Wiltshire

Map of survey area

N

Survey location



● Survey location

Site centred on OS NGR
SU 02183 54985

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 01

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Referencing information - earth resistance

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

Referencing information - magnetometry

Referencing grid to OSGB36 datum at 50m intervals

402150 155000

Survey tracks

Survey track start

Survey track stop

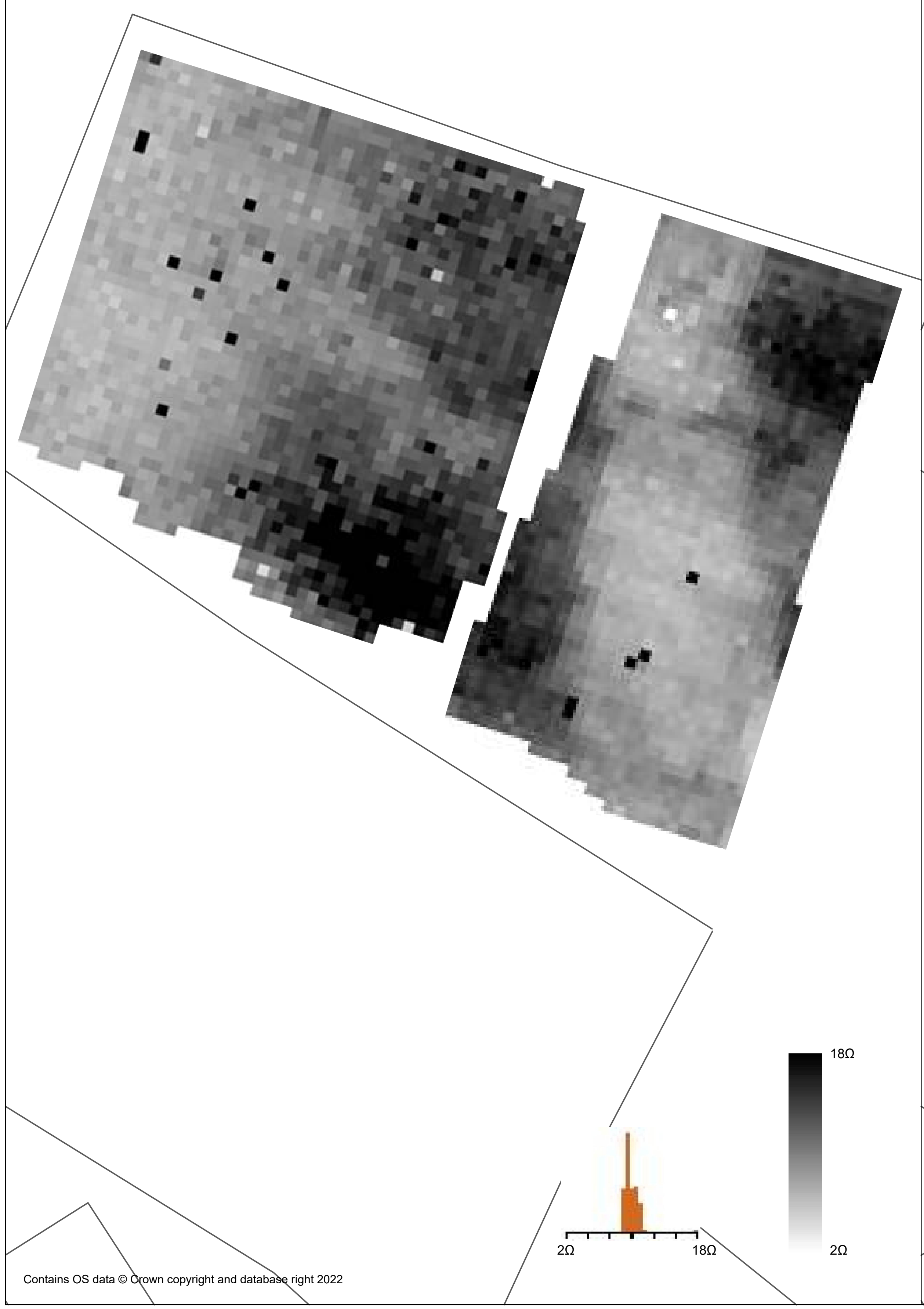
SCALE 1:1000

0m 10 20 30 40 50m

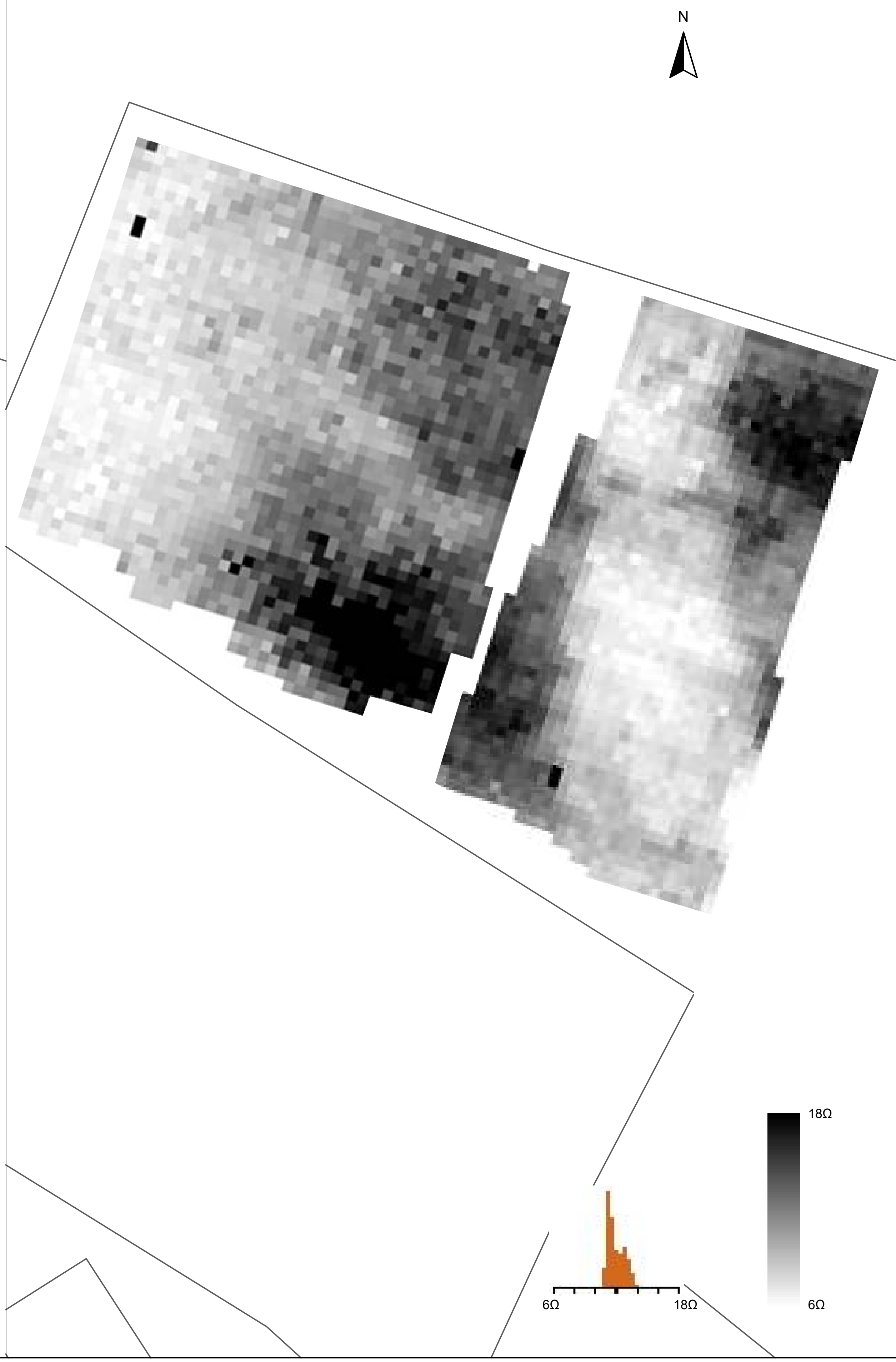
SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02

Greyscale plot of raw earth resistance data - 1m resolution



Greyscale plot of processed earth resistance data - 1m resolution



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Greyscale plot of raw and processed earth resistance data - 1m resolution

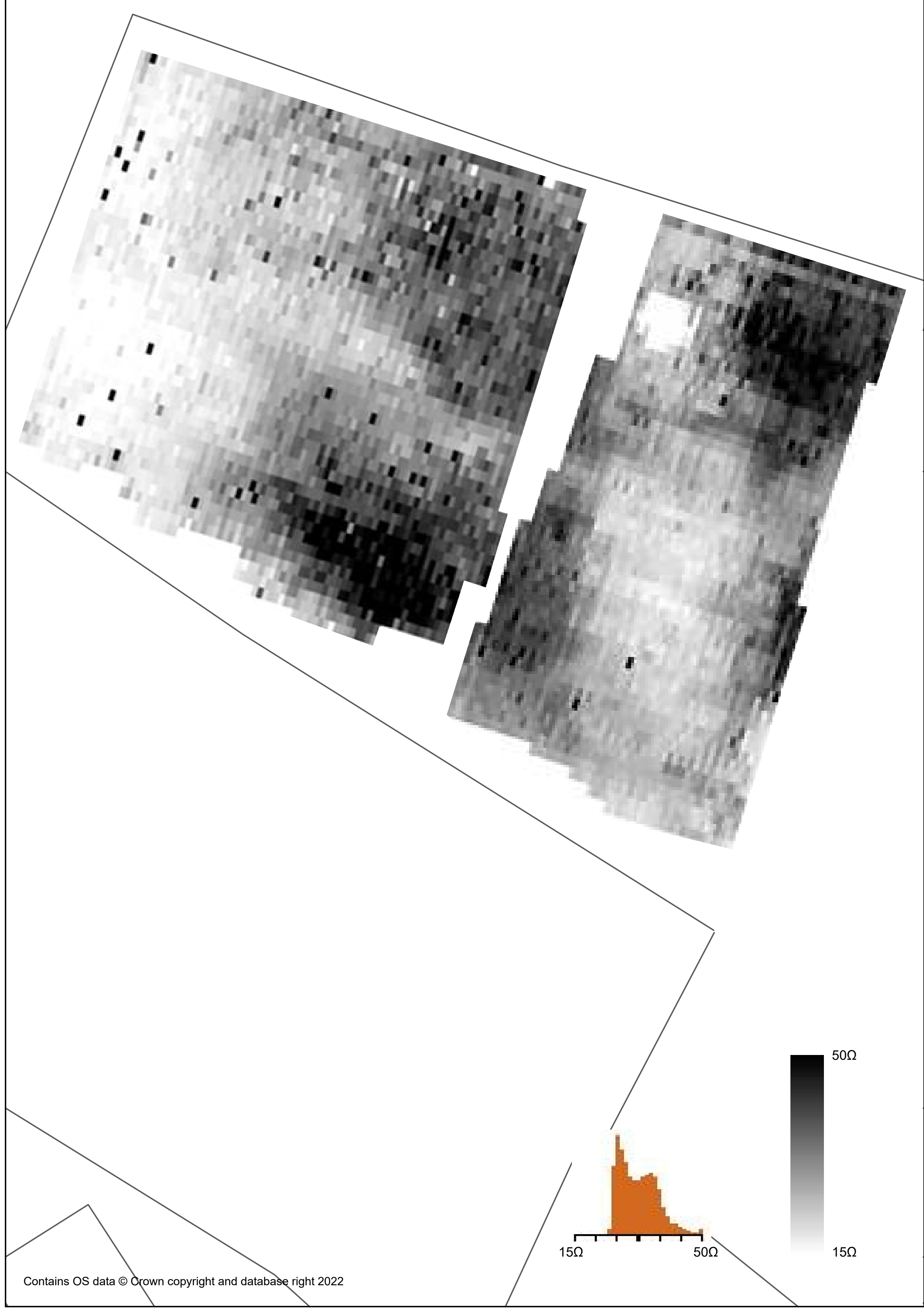
SCALE 1:500

0m 5 10 15 20 25m

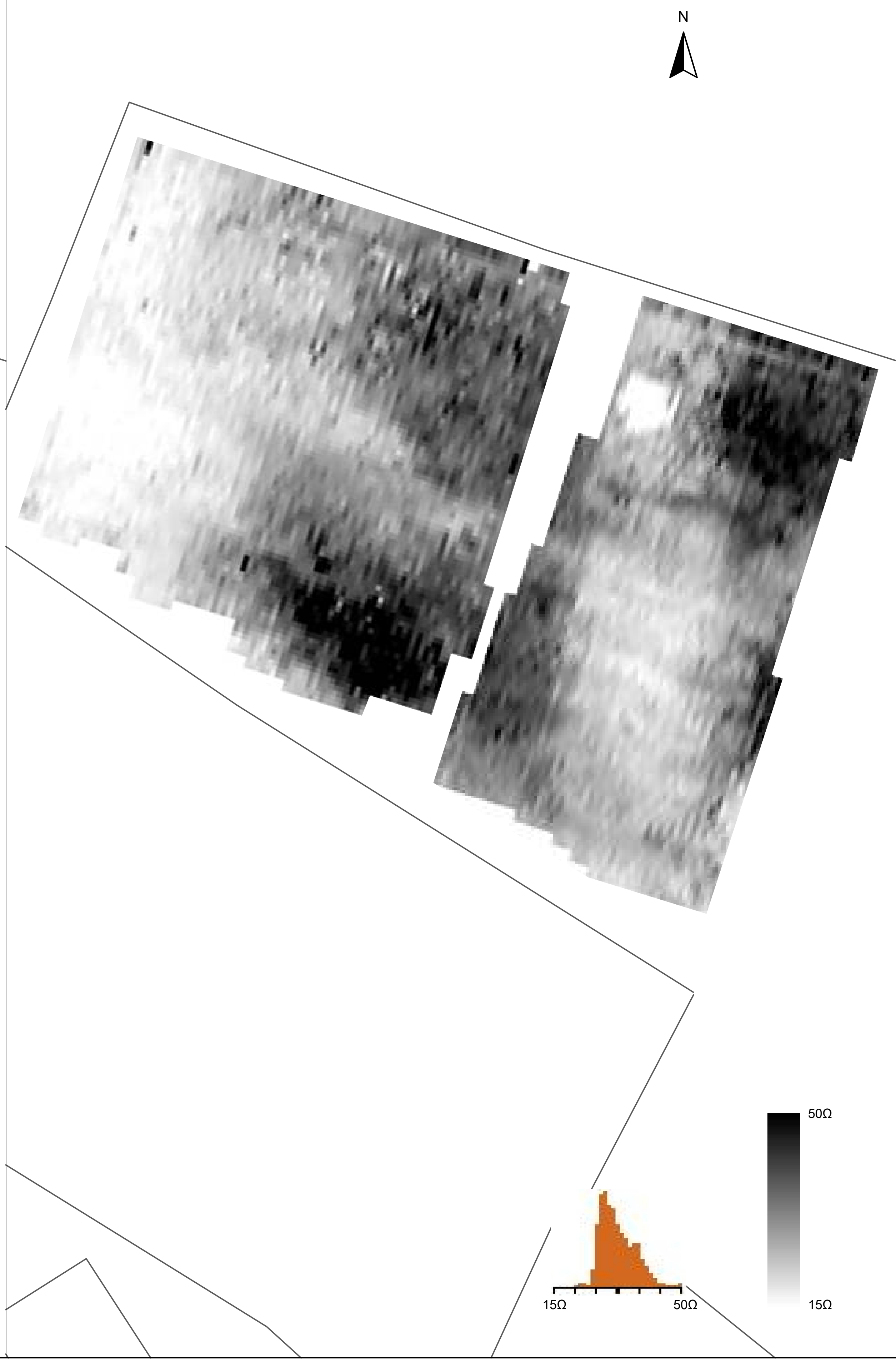
SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 03

Greyscale plot of raw earth resistance data - 0.5m resolution



Greyscale plot of processed earth resistance data - 0.5m resolution



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Greyscale plot of raw and processed earth resistance data - 0.5m resolution

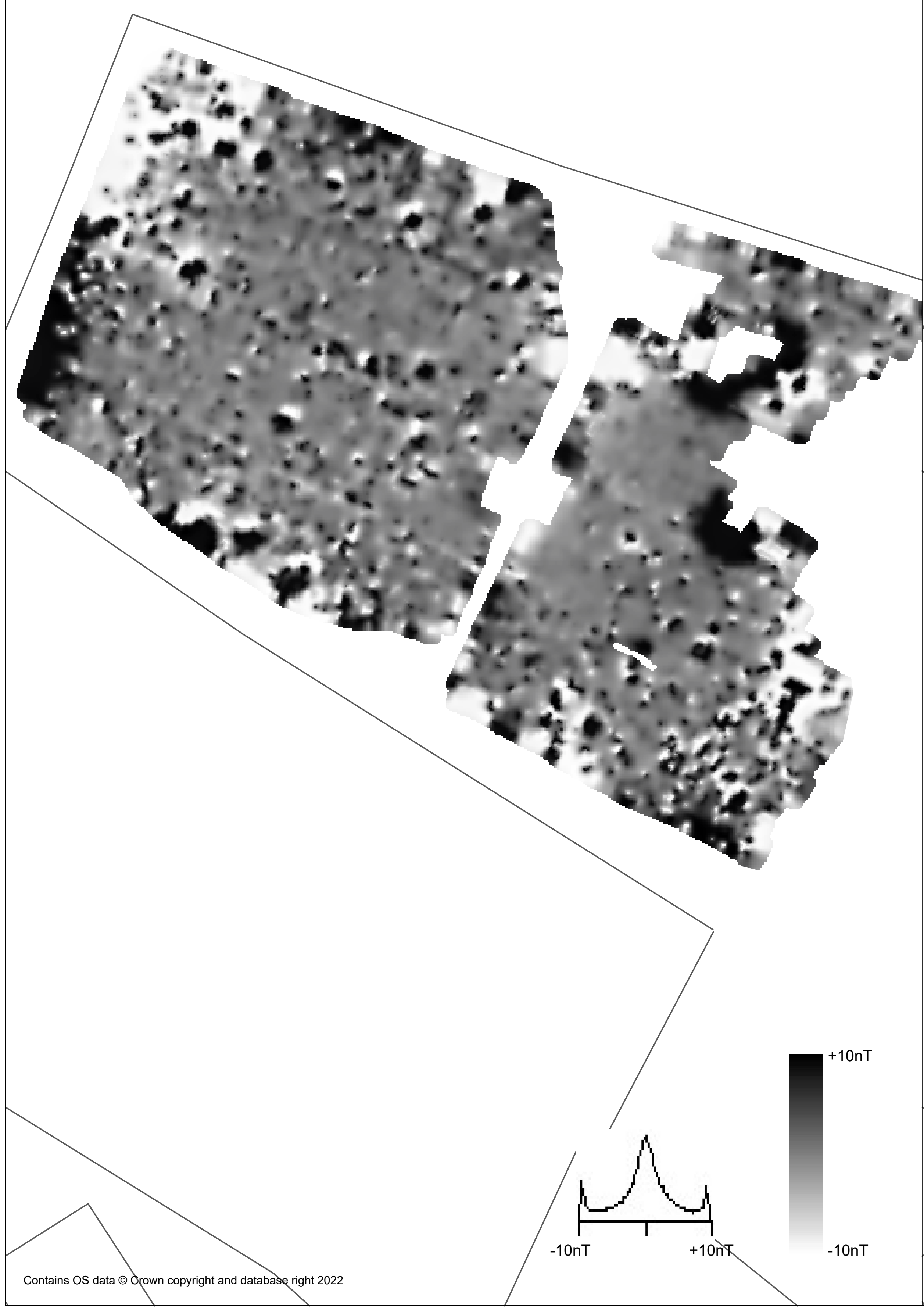
SCALE 1:500

0m 5 10 15 20 25m

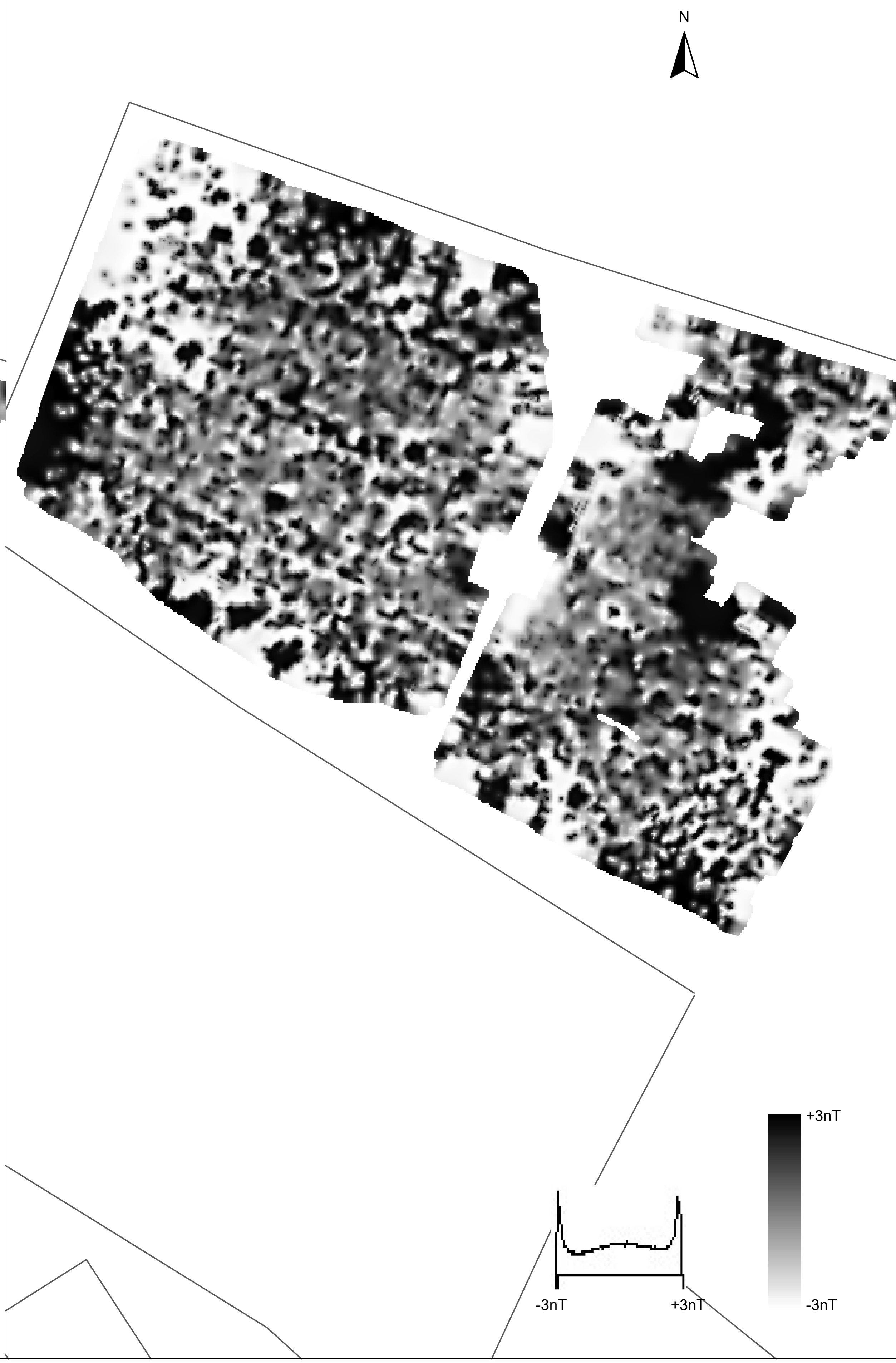
SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 04

Greyscale plot of minimally processesd magnetometer data clipped at ±10nT



Greyscale plot of minimally processesd magnetometer data clipped at ±3nT



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Greyscale plot of minimally processed magnetometer data

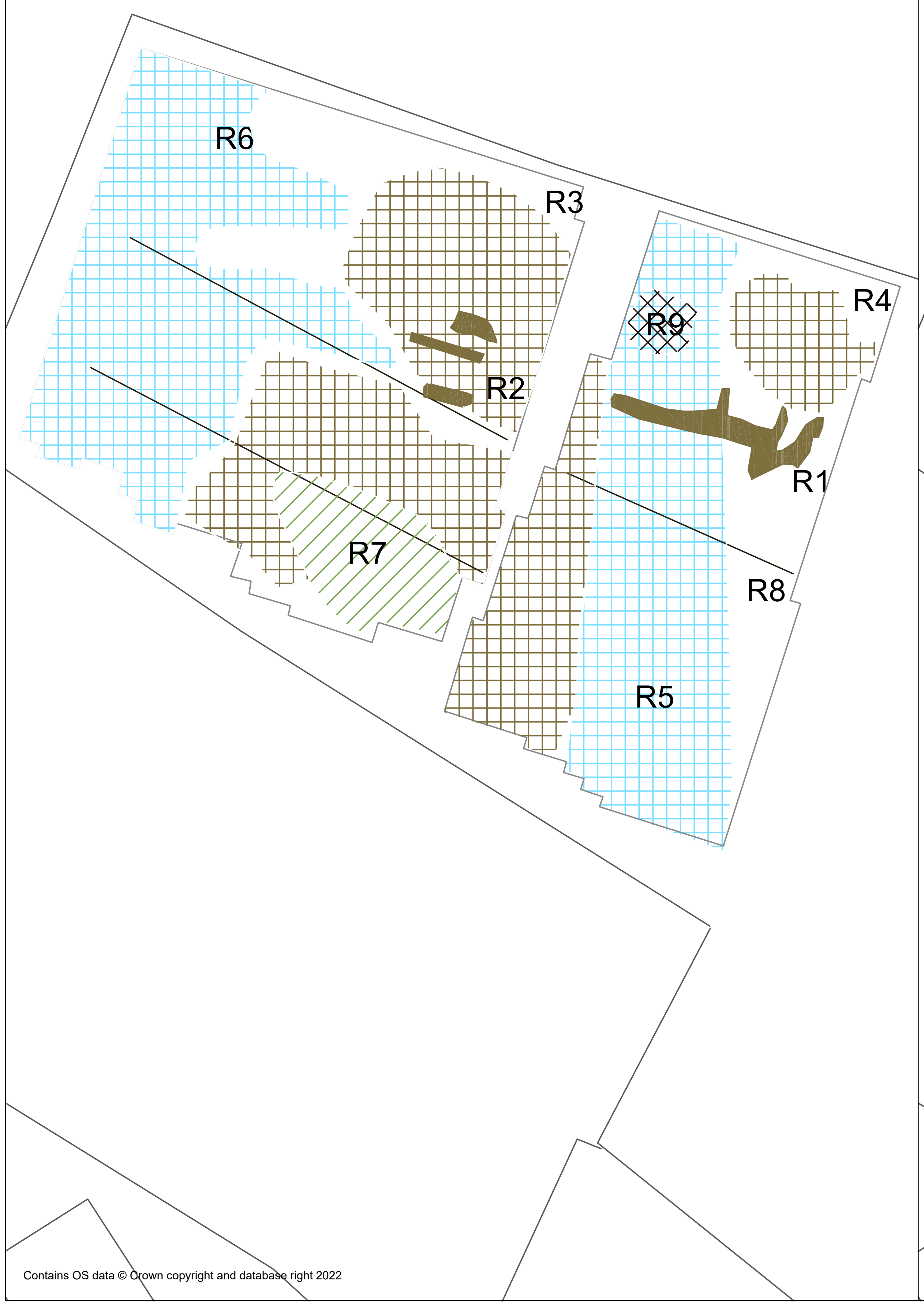
SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 05

Abstraction & interpretation of earth resistance anomalies



Abstraction & interpretation of magnetic anomalies

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Abstraction & interpretation of earth resistance & magnetic anomalies

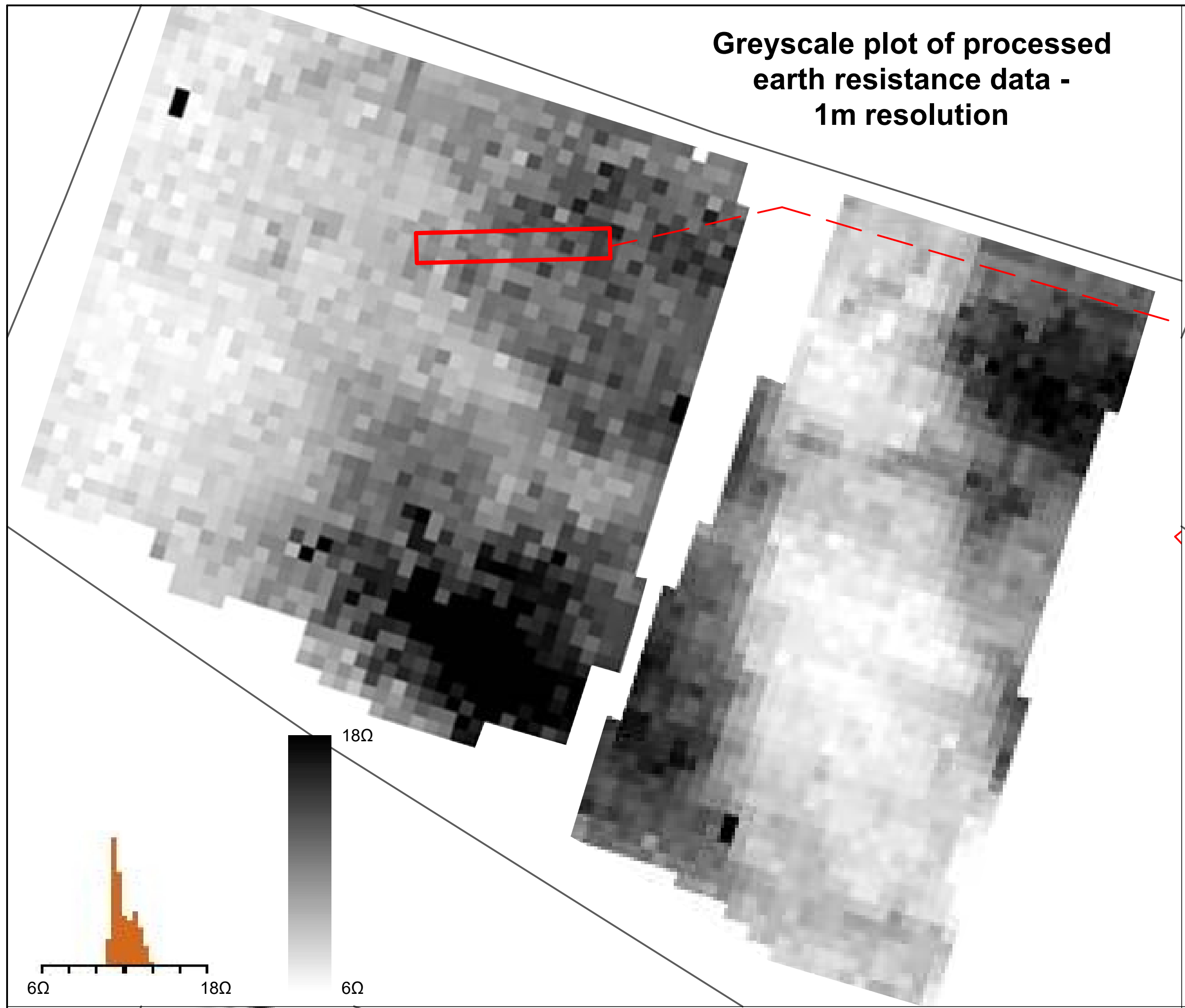
- High resistance linear anomaly - of uncertain origin
- Low resistance linear anomaly - former boundary
- High resistance anomaly - of uncertain origin
- Low resistance anomaly - of uncertain origin
- Low resistance anomaly - bonfire
- High resistance anomaly - associated with disturbed ground
- Positive linear anomaly - possible ditch-like feature
- Positive linear anomaly - possible former field boundary
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

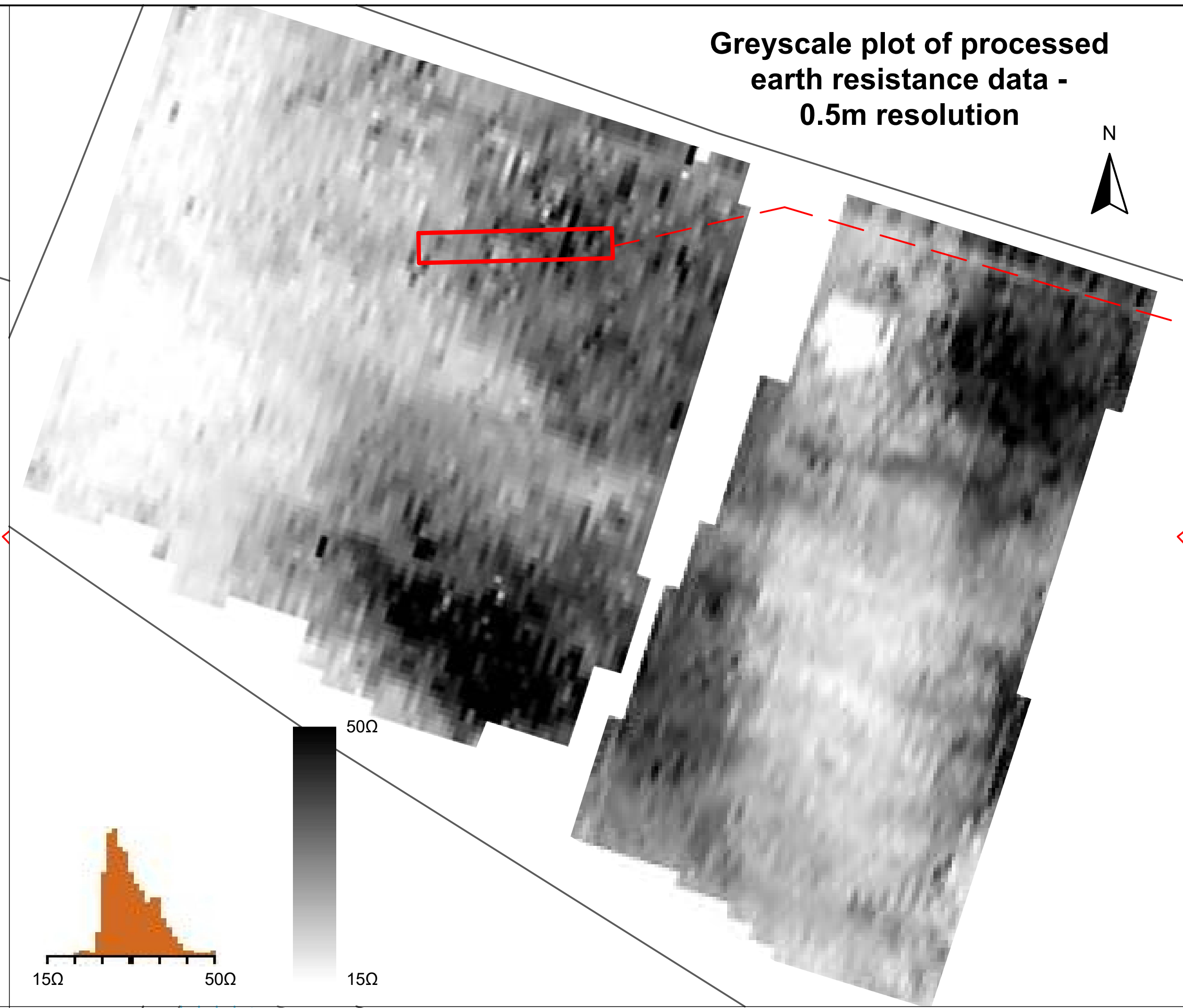
SCALE 1:500

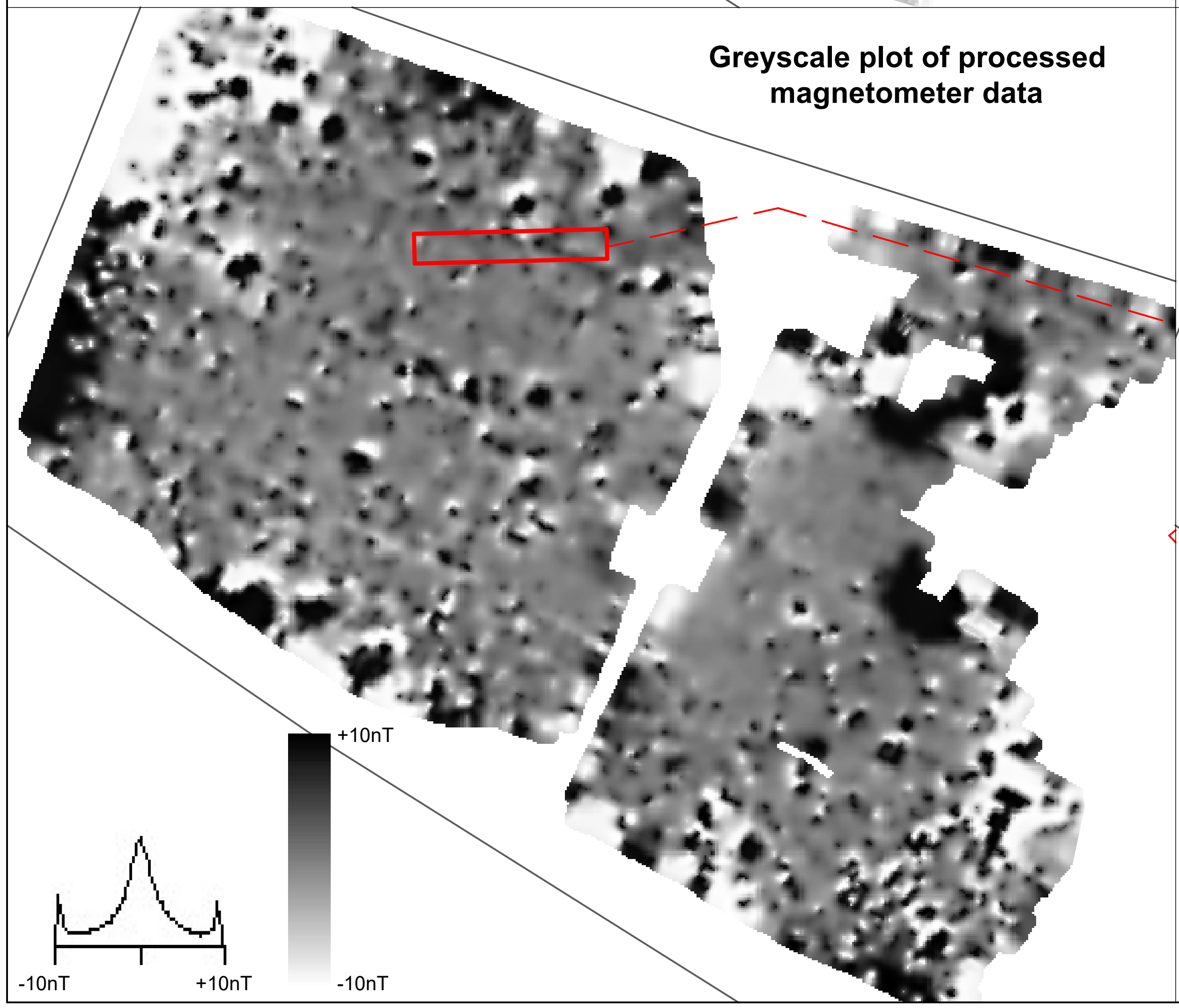
0m 5 10 15 20 25m

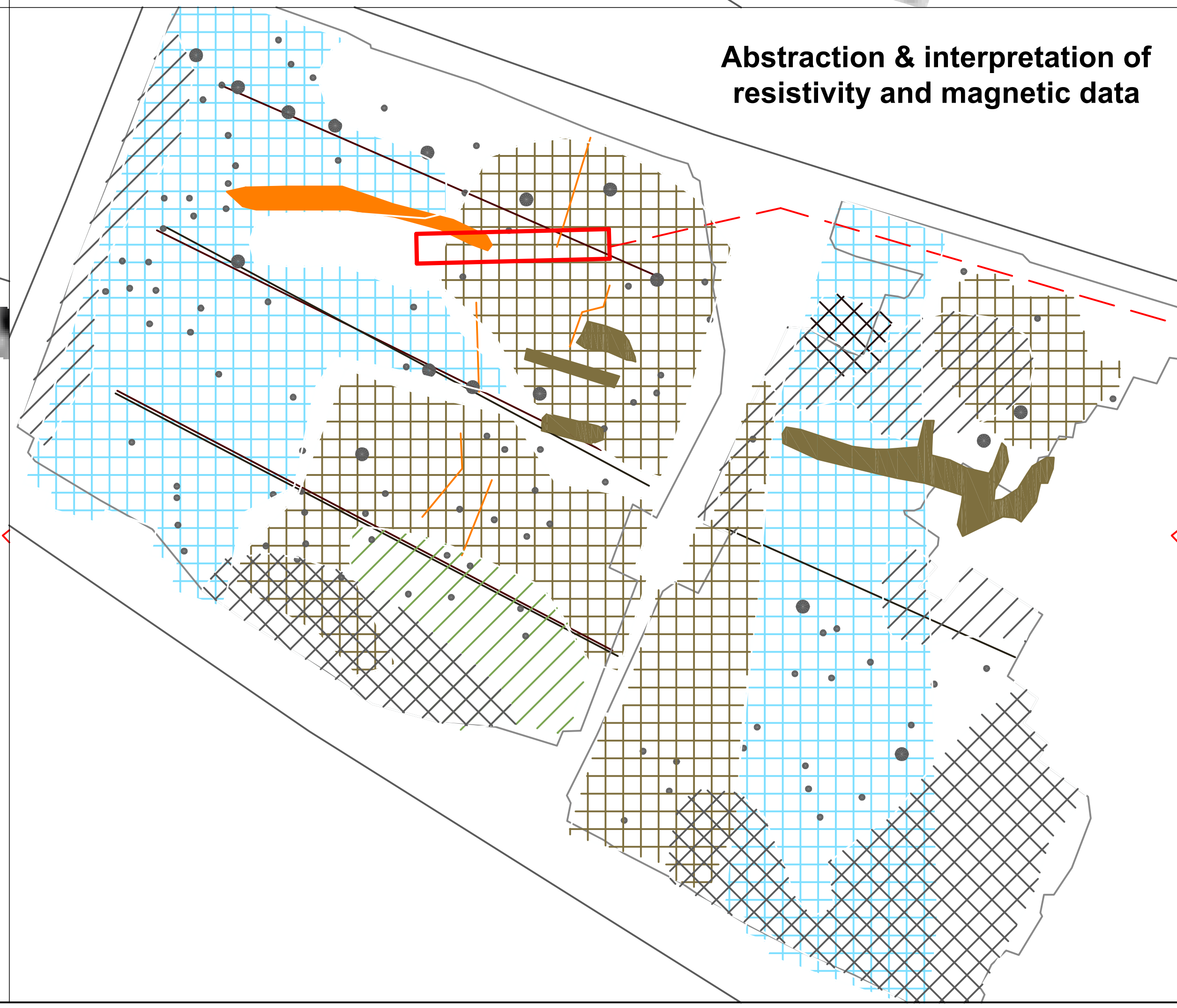
SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 06









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

- High resistance linear anomaly - of uncertain origin
- Low resistance linear anomaly - former boundary
- High resistance anomaly - of uncertain origin
- Low resistance anomaly - of uncertain origin
- Low resistance anomaly - bonfire
- High resistance anomaly - associated with disturbed ground
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - former boundary
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object
- Approximate location of solar panels and cable route

SCALE 1:500

0m 5 10 15 20 25m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 07