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NORTHBROOK FARM, SHAPWICK, SOMERSET

Report on Geophysical Survey, June 2002

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Summary

After a hoard of Roman coins was discovered at Shapwick in Somerset in 1998, archaeological investigations, including geophysical survey by the Ancient Monuments Laboratory, revealed the location to be the site of an extensive Roman villa. The original survey covered an area of some 4 ha around the find spot and a wealth of linear anomalies was detected which continued beyond the survey area. Hence, the present survey was intended to extend the previous magnetometer survey to cover the whole of the field in which the villa was discovered as well as the field to the east. The present work has identified the continuation of some major ditch anomalies to the north and identified the probable northern boundary to the site. Further anomalies likely to represent enclosure and boundary ditches have also been detected to the south and east. These diminish in spatial density and peak magnetic intensity with increasing distance from the villa site, suggesting that the location of the villa was the principal focus of Roman activity at the site.

Keywords

Geophysics

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Introduction

In September 1998, a hoard of over 9,000 Roman silver coins was discovered near the village of Shapwick in Somerset. The find was made by Martin and Kevin Elliot using metal detectors, in a ploughed field owned by the family on the Nidons ridge north of the village. At the request of Bob Croft, the Principal Archaeological Officer for Somerset County Council, the English Heritage Ancient Monuments Laboratory (EH AML) conducted a geophysical survey of the area surrounding the hoard's location in October 1998 (Linford 1998). This work complemented limited excavation and fieldwalking carried out by Somerset County Council Archaeology Section (SCCAS) to establish the context of the find. An analysis of the coin hoard and summary of this archaeological work has been reported by Abdy, Brunning and Webster (2001).

The excavation and geophysical evidence suggested that the hoard may originally have been buried beneath a floor within a Roman stone building forming part of a villa complex. The geophysical survey also identified a wealth of anomalies surrounding the central villa site indicating extensive activity in the vicinity. Although the geophysical investigation covered over 4 ha, some of the linear anomalies continued beyond the survey area. For this reason, SCCAS asked the Centre for Archaeology (CfA) to extend the geophysical survey to cover the remainder of the field in which the hoard was discovered as well as the adjacent field to the east. A return visit was made for this purpose between the 10th and 14th of June 2002.

The find spot (OS ST 424 395) is near the crest of a low ridge running approximately east-west across the field. To the north the land slopes gradually down to the peat moor in the valley of the river Brue, whilst to the south it descends towards the village of Shapwick. Geologically the site is situated on Jurassic Lower Lias which consists of clay with some limestone (Geological Survey of Great Britain 1973). The soil association, Evesham 1 (Soil Survey of England and Wales, 1983) is a well drained calcareous clayey soil. This soil has been found to be responsive to magnetic survey, producing excellent results both in the 1998 survey of the site and in a survey of a medieval settlement in the vicinity (Linford & Cole 1999).

Method

Field Procedure

A grid of 60m by 100m rectangles was established over the two fields using a Trimble kinematic geographical positioning system (GPS). It was intended that this grid should be orientated to coincide with the original survey grid established in 1998 and two permanent markers had been left in the field boundaries for that purpose. However, one of these markers had been uprooted by agricultural machinery in the interim and it was not possible to precisely re-establish the 1998 grid based upon only one surviving marker. For this reason the new survey grid was designed to ensure a significant area of overlap with the earlier work. Figure 1 shows the location of this grid as well as the position of the earlier survey and the permanent markers.

Each 60m by 100m rectangle was surveyed with a Scintrex Smartmag SM4G Caesium vapour magnetometer configured in horizontal gradient mode; the two sensors were separated by 1m. Traverses were walked parallel to the long axis of each rectangle and were separated by 2m, giving a 1m station interval in the north-south direction. Along each traverse measurements were taken every 0.2s giving an approximate station interval of 0.25m in the east-west direction.

Data Processing and Presentation

The magnetometer data was interpolated onto a regular 0.25m by 1m grid and corrected for instrument heading errors by subtracting a local median from each reading. The local median was calculated using a 1 dimensional window with a width of 31 readings aligned in the direction of the traverses walked in the field. The visually distracting effect of extreme values in the data was then reduced by applying hyperbolic tangent (tanh) range compression to the data (similar to the arctangent range compression used by Scollar *et al.* (1990) but using the tanh function). This operation was used to reduce the absolute magnitude of any reading with a value falling outside the range between –30 and +30nT. The results after these operations are depicted as a trace plot in Figure 3 at 1:1500 scale.

These same results are depicted, combined with the results from the 1998 magnetic survey as a greyscale plot in Figure 4 at 1:1500 scale. The greyscale plot is also depicted, superimposed on the Ordnance Survey map of the site in Figure 2 at 1:2500 scale.

It should be noted that the original magnetometer survey was carried out using fluxgate gradiometers which measure the vertical gradient of the vertical component of the ambient magnetic field. The results of the present survey were collected with an instrument that measures the total magnitude of the ambient field. It was thus necessary to transform the fluxgate survey results to total field measurements so that they could be matched with the data produced by the caesium magnetometer. This was achieved by applying the filter suggested by Tabbagh *et al*. (1997) to the Fourier transform of the fluxgate data set, then transforming from the vertical field component to the total field magnitude (Gunn 1975; Blakely 1996 p342). A 20m cutoff, high pass, Butterworth filter of order 8 (Gonzalez and Wintz, 1987 p181) was also applied to the data to suppress a regional component of low spatial frequency introduced by the transformation operation.

Figure 5 shows a colour scale plot of the same results after reduction to the pole (Baranov and Naudy 1964), again at 1:1500 scale. Reduction to the pole transforms the magnetic data set to that which would have been collected if the site had been located at the geomagnetic north pole: magnetic anomalies are located directly above their causative features. In the present instance it also corrects for the change in magnetic field direction (secular variation) that has occurred at Shapwick between the dates of the two magnetic surveys. The magnetic field directions at the time of each survey were estimated using the International Geomagnetic Reference Field (IGRF 2000). With the present data set the spatial adjustment made by the reduction to the pole operation appears to be minimal.

On combining the two magnetic data sets, comparison of the anomalies in the areas of overlap indicated that the new survey grid was approximately 3m west of that established in 1998. The fluxgate results have thus been shifted by 3m to allow them to be combined with the new results. In the regions of overlap between the two surveys, a weighted average of the corresponding reading from each data set has been substituted to reduce the distracting effect of a sharp transition.

Results

The most significant anomalies identified in the magnetometer survey have been illustrated in Figure 6, superimposed upon the Ordnance Survey 1:2500 map data for the area. In the text below, numbers in bold in square brackets refer to the numbered anomalies on this plan. For completeness, the anomalies identified in the 1998 fluxgate gradiometer survey have also been included in Figure 6. For discussion of these anomalies, the reader is referred to the report on this earlier work at the site (Linford 1998).

The area to the north of the 1998 survey

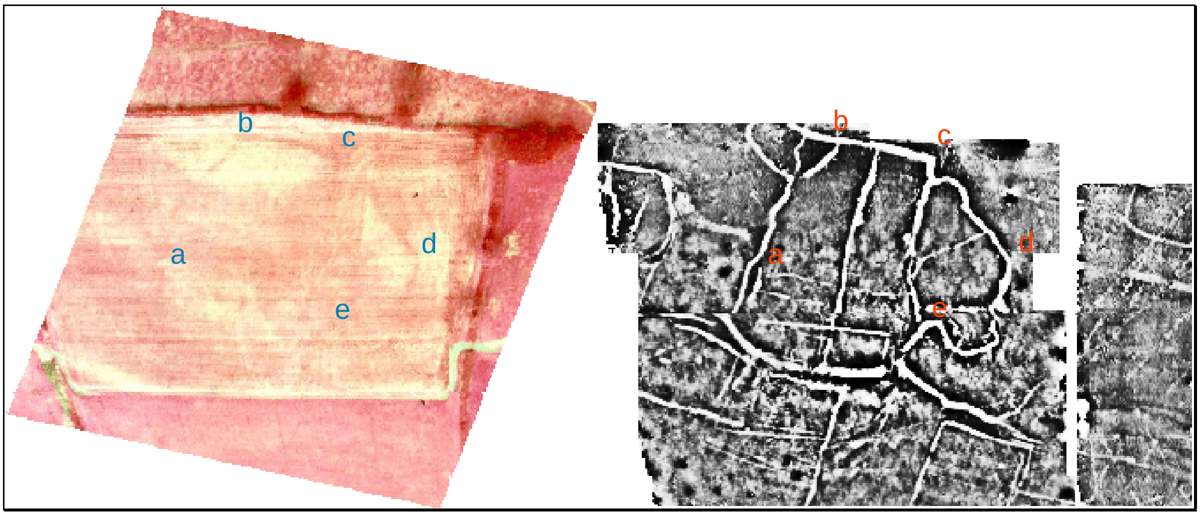

Plate 1; Rectified false colour infrared air photograph of the field where hoard was discovered (left), compared with the magnetometer survey of the same area (right). Labels a-e indicate corresponding features in the two images. As only one field corner is visible in the air photograph it has not been possible to rectify it onto map data for the area, so it has been rectified directly with the magnetometer survey. (Photograph source: Chris Webster, Somerset County Council).

Four linear anomalies some 10m wide and with a peak strength of about 15nT were detected in the 1998 survey running north out of the survey area. It was conjectured that these might represent ditches relating to a late Iron Age enclosure (Abdy *et al.* 2001). Their strongly magnetic fill may be due to enhancement by past burning activity or deposition of organic refuse that has modified the magnetic properties of the soil.

Since the earlier survey, an infrared air photograph has been discovered in the Somerset Levels project archive which shows a cropmark of a circular enclosure in the northern part of the field (Plate 1). It was speculated that the perimeter of the photographed enclosure might correspond with the outer two linear anomalies in the magnetic survey and that an extended survey would show them curving round to meet each other towards the north of the field. The new survey results reveal that all four anomalies do indeed terminate at the north of the field with a straight east-west linear anomaly apparently forming a northern boundary **[1]**.

At the western end of this linear anomaly at **[2]** some slightly narrower linear anomalies of similar magnitude appear to define a smaller, subsidiary enclosure. The magnetometer surveys have thus confirmed the broad identities of the infrared features (Plate 1, a-e), but have revealed much more of their true detail and complexity.

To the south, against the edge of one of the broad north-south linear anomalies, a discrete anomaly is apparent, possibly representing a pit **[3]**.

Part of a further enclosure can be seen at the western edge of the survey area **[4]**, possibly continuing beneath the hedge into the next field. There is evidence within it for putative linear subdivisions and pits as well as an interesting amorphous area of enhanced magnetisation at its eastern edge, at the point where its boundary is joined by another linear anomaly running east.

The area to the south of the 1998 survey

At the southern end of the 1998 survey, curvilinear bands caused by outcropping layers of the Lias geology were faintly visible and further banding has been detected in the extended survey **[5a]**. Similar banding is also visible in survey of the field to the east **[5b]**.

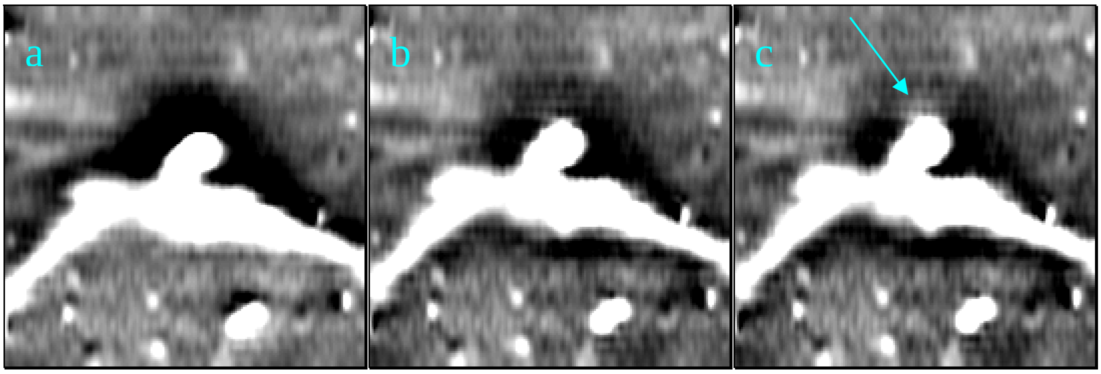

Plate 2, the anomaly at ***[6]****: a) as it appears in the survey; b) after reduction to pole using the present day geomagnetic field direction at Shapwick; c) after reduction to pole using the field direction prevailing in 224 AD [dec = 2.1°, inc = 57.2°] – note the indicated distortion [grey instead of black] to the north of the anomaly.*

Near **[5a]**, a linear anomaly possibly representing a boundary ditch runs south through this area and continues out of the survey area into the field to the south. Another similar linear anomaly forms a right angle at **[6].** This anomaly probably also represents a field boundary, enclosing the ground at the south of the extended survey area. Within this enclosed area at **[7]** a fainter linear anomaly of peak magnitude around 1nT subdivides a rectangular area and two anomalies that perhaps represents pits can be seen within it.

At the corner at **[6]**, an intense, discrete anomaly is apparent with a peak intensity of about 30nT and this may represent either a thermoremanent industrial feature, or a pit. The surveyed anomaly is depicted in Plate 2a. Also shown is the anomaly after reduction to the pole assuming magnetisation in the direction of the present geomagnetic field (2b) and assuming thermoremanent magnetisation in the direction of the field in 224 AD – the date when it is thought that the hoard was buried (2c). The positive part of the anomaly in Plate 2b (white) is well centred within the negative part (black). However, the distortion to the north of the anomaly in Plate 2c suggests that the field direction chosen for this latter reduction is not correct. These results indicate that, despite its intense peak magnitude, the anomaly at **[6]** is more likely to represent a pit filled with organic refuse than a Roman thermoremanent feature.

Where the putative field boundary ditch anomaly runs south-west from **[6]** to the southern end of the survey area, a number of discrete anomalies are apparent, possibly representing further pits. Faint linear anomalies may also be discerned perpendicular to the boundary ditch anomaly and these could represent the effects of ancient agriculture in this area.

At the south-eastern corner of the 1998 survey another apparent enclosure ditch anomaly was detected describing a right angle and extending out of the original survey area **[8]**. The corner of this linear feature was rounded, prompting speculative comparison with Roman military sites – perhaps the enclosure ditch was the perimeter of a small Roman fort or camp? The extension of the survey southwards reveals more of this enclosure and its overall shape is now less suggestive of a military construction and it is probably associated with farming activity linked to the Roman villa.

The new survey shows the enclosure to be subdivided by a number of internal, linear ditch-like anomalies to create a series of rectangular enclosures. It can also be seen that it extends into the modern field to the east, although the anomalies become fainter the further east they continue. A number of discrete anomalies have also been detected within it, possibly representing pits or industrial features. Perhaps the most intriguing anomaly within this enclosure is at **[9]** where the south-western corner appears to have been partitioned off by a further linear anomaly. The enclosed corner exhibits significant magnetic enhancement although it is not clear what this might represent. The southern side of the rectangular enclosure runs parallel to the linear anomaly running east from **[6],** separated by a distance of about 10m. This is suggestive of a trackway running approximately east-west and extending into the modern field to the east.

The field to the east of the 1998 survey

Some magnetic anomalies caused by recent agricultural practice are visible in the survey of this field. At **[10]** the two intense discrete anomalies adjacent to the field boundary are caused by a steel waterbutt in the hedge at this point. The herringbone pattern of parallel linear anomalies apparent throughout the field is also due to relatively recent field drains channelling water away from the Nidon ridge that runs approximately east-west through the centre of the field.

To the north, a linear anomaly some 3-5m wide defines a sub-rectangular enclosure **[11]**. This is on the same alignment as many of the anomalies conjectured to be enclosure ditches in the field to the west. Unfortunately, owing to magnetic noise at the northern edge of the survey, the northern side of the enclosure has not been clearly detected and it is possible that it extends into the field to the north.

South of this enclosure a broad linear anomaly some 10m wide, with a peak anomaly strength of 1-2nT runs east-west across the field. At its eastern end it appears to cross a north-south anomaly at **[12]**, getting weaker and narrower beyond the junction. Although of weaker magnitude than the linear anomalies in the field to the west it is likely to have a similar cause, perhaps representing an ancient field boundary ditch. It is clear that the fill of this ditch was disturbed when the field drainage system was inserted as it exhibits discontinuities at each point where one of the field drainage channels crosses it. Although narrower the north-south linear anomaly running through **[12]** is probably also a field boundary. It is interesting to note that it describes a dog-leg as it crosses the high point of the Nidon ridge just as the east and west boundaries of the modern field do.

Close by at **[13]** an intriguing group of four discrete circular anomalies is visible, measuring some 2-4m in diameter. Their peak anomaly strengths are about 4-5nT and it is possible that they are the response to pits.

Just south of **[10]** a network of faint linear anomalies may be discerned representing the continuation of the enclosure with corners at **[8]** and **[9]** in the field to the west. They get fainter as they continue east and their peak magnitude never exceeds 1-2nT. Further pit-like anomalies can be seen some 40m to the south.

At the southern end of the survey area the two parallel linear anomalies running east from **[9]** are visible, continuing to **[14]** where they cross the linear anomaly running south from **[12]**. As with the anomalies described in the preceding paragraph their peak magnitude becomes far less as they continue east into this field. At **[14]** there is an amorphous area of magnetic enhancement suggesting further possible activity at the junction.

It is notable that all the anomalies in the eastern field have lower peak anomaly strengths than those in the field containing the villa remains. Two possibilities may be advanced to account for this:

1. The fill of the anomalies to the west is more strongly magnetic owing to their closer proximity to the burning or depositional processes that enhanced the soil magnetic susceptibility in the past.

2. The anomalies are covered with a greater depth of overburden in the eastern field.

Topsoil magnetic susceptibility measurements made during the 1998 survey (see Linford 1998) did indicate that the area in the immediate vicinity of the villa had the highest values, with soil susceptibility dropping off with increasing distance from this focus of activity. This evidence tends to support the first possibility, but, without more extensive measurements on excavated features, it cannot be considered conclusive.

As a further test, the method of Cordell and Grauch (1982, 1895) was applied to the magnetometer survey data depicted in Figure 5. This involved processing the measured values with the Fourier domain pseudo-gravity transformation filter, then calculating the maximum horizontal gradient of the resulting data set. After this transformation, the maxima of positive anomalies are aligned directly above the edges of vertical-sided causative features and the width of the anomalies are proportional to the depths to the tops of the contacts. Hence, this transformation can give information about the position and depth of causative features. A modified version of the method of Blakely and Simpson (1986) was used to identify maxima points, and depth estimates were obtained for these using the half-widths of the anomalies (Roest and Pilkington 1993). The results of these analyses suggested that the depths to the contacts causing the anomalies were similar in both fields, further supporting the first possibility. In general these depths were between 0-0.5m below the surface. The main exception was the extremely intense, broad east-west ditch in the vicinity of the villa itself (detected in the 1998 fluxgate survey). This had a preponderance of depth estimates greater than 0.5m. However, this is more likely to be because the ditch is very deep rather than because it is covered by a greater thickness of overburden.

Conclusions

Extension of the 1998 magnetometer survey of the Roman villa site at Northbrook Farm has revealed a wealth of new magnetic anomalies likely to be archaeological in origin. However, the spatial density of such anomalies, as well as their peak magnitudes, tends to diminish with increasing distance from the villa remains discovered in 1998. This suggests that Roman activity on the site was focussed around the villa with the more remote linear anomalies representing ancillary enclosures associated with the Roman agricultural regime.

To the north of the 1998 survey, the new results have demonstrated that the magnetically intense ditch-like anomalies identified in the 1998 survey correlate with the enclosure detected on an infrared air photograph of the site found in the Somerset Levels archive. On the basis of excavated finds, this enclosure was postulated to relate to late Iron Age settlement at the site (Abdy *et al*. 2001). The extended survey appears to have defined the northern edge of the pre-Roman settlement, near the modern northern field boundary, as well as revealing many associated features not visible in the infrared photograph.

Continuation of the survey to the south, and into the field to the east, has revealed further anomalies associated with the linear anomaly at **[8]**. This was conjectured to represent an enclosure ditch but only one rounded, 90-degree corner was covered by the 1998 survey. A Roman military construction was tentatively suggested on the assumption that the visible anomaly represented one quarter of a symmetric rectilinear enclosure. The further information provided by the present survey shows that the feature is asymmetric in its overall form and it would thus be more consistent with Roman farming enclosures.

Whilst entirely new enclosures have been detected at **[2]**, **[4]** and **[11]**, the spatial density of archaeological anomalies diminishes to the north and east suggesting that the most important foci of Roman activity lie in the centre of the field originally surveyed in 1998. Interpretation of the geophysical anomalies could be enhanced, if further excavation were possible at the site. It would be of particular interest in this regard, to discover the functions and forms of the anomalies at **[6]** and **[9]**. It would also be informative to test some of the linear anomalies in the field to the east, such as that forming the enclosure at **[11]** and those crossing at **[12]**, to see if they are contemporary in date with the Roman occupation already identified and to confirm their function.

Surveyed by: N. Linford
P. Linford

Dates: 10th-14th June 2002

Report by: P. Linford
N. Linford

Date: 30th June 2002

Enclosed Figures and plans

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Figure 1) BRUE VALLEY, SHAPWICK, SOMERSET.
Location of Geophysical surveys, October 1998 and June 2002

ST4239

0 90m
1:2500

Fluxgate survey October 1998

Caesium survey June 2002

Figure 2) BRUE VALLEY, SHAPWICK, SOMERSET.
Location of magnetometer surveys, October 1998 and June 2002

ST4239

0 90m
1:2500

Figure 3) BRUE VALLEY, SHAPWICK, SOMERSET. Caesium magnetometer survey, June 2002.
Trace plot of data with extreme values suppressed.

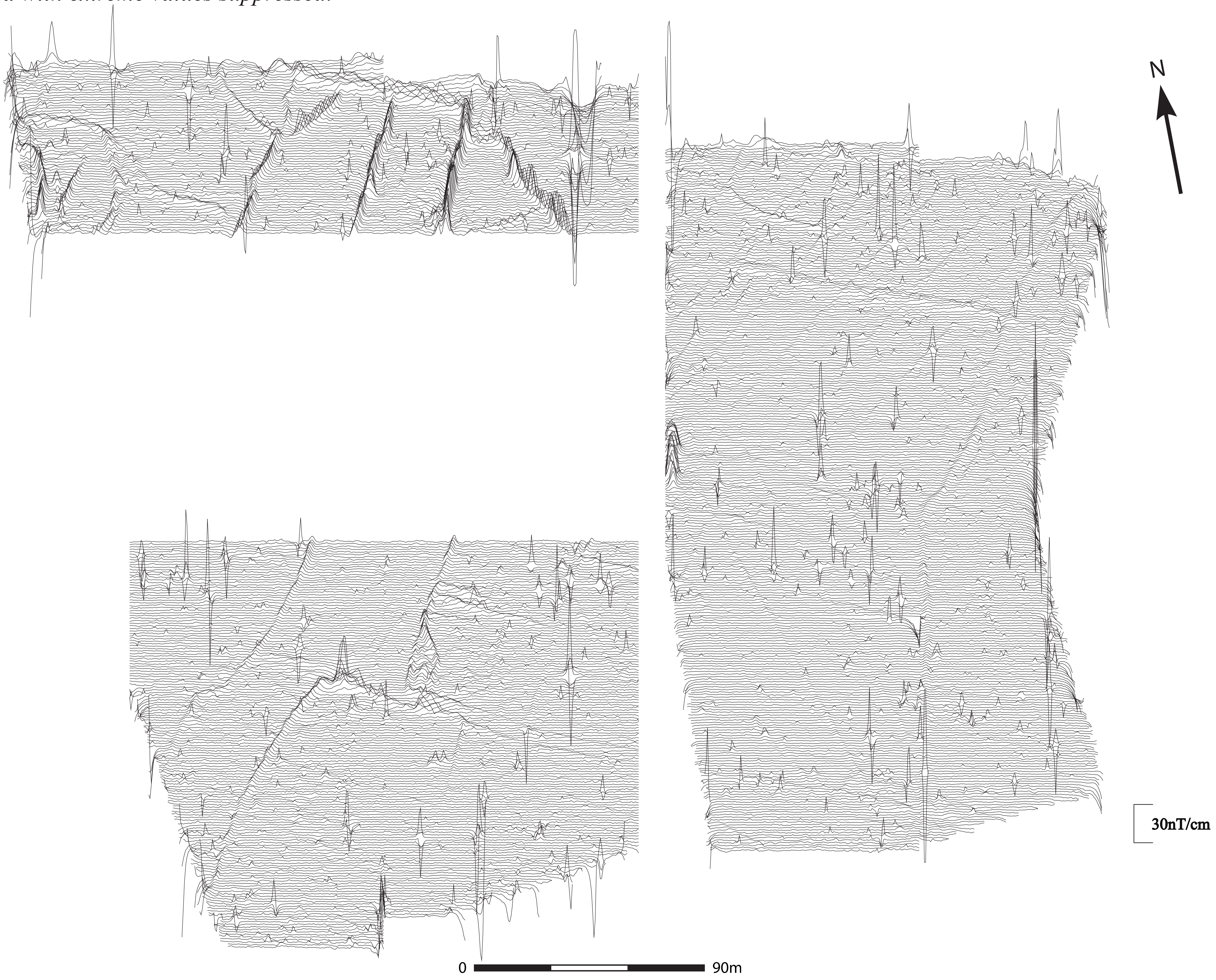

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Figure 4) BRUE VALLEY, SHAPWICK, SOMERSET. Caesium magnetometer survey, June 2002.

Linear greyscale plot of data between +/-1nT, incorporating transformed fluxgate gradiometer results from October 1998.

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Figure 5) BRUE VALLEY, SHAPWICK, SOMERSET. Caesium magnetometer survey, June 2002.
Linear colourscale plot of data between +/-1nT after reduction to pole, incorporating transformed fluxgate gradiometer results from October 1998.

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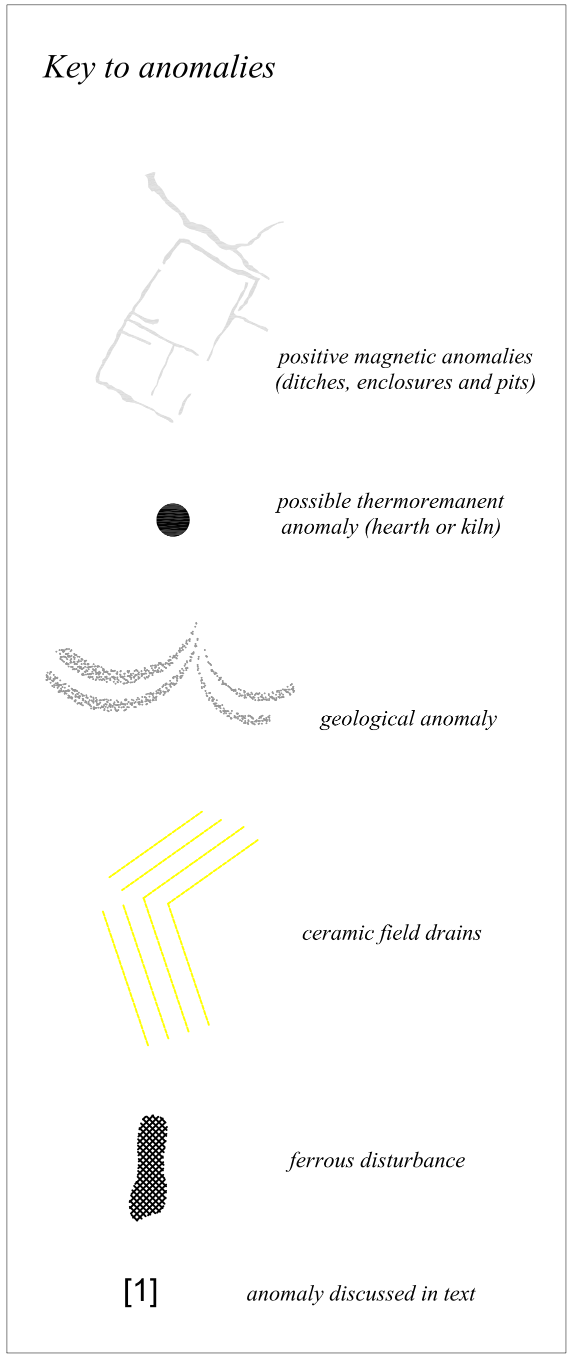
Figure 6) BRUE VALLEY, SHAPWICK, SOMERSET.
Graphical summary of significant anomalies



0 90m

1:2500