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Ancient Monuments Laboratory
Report 71/98

BRUE VALLEY HOARD, SHAPWICK, GLASTONBURY, SOMERSET, REPORT ON GEOPHYSICAL SURVEY, 1998

P K Linford

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Summary

A geophysical survey was carried out at the request of Bob Croft, County Archaeologist for Somerset, after a hoard of over 9000 Roman silver coins was discovered in a field near Glastonbury. The results showed that an extensive building occupied the site, likely to have been a Roman courtyard villa. Further evidence for ditches and pits suggest that the area was intensively exploited in the Roman period and an additional network of broader ditches may have its origins in the prehistoric period.

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BRUE VALLEY HOARD, SHAPWICK, SOMERSET

Report on Geophysical Survey, October 1998.

Introduction

A geophysical survey was requested by the County Archaeologist for Somerset, Bob Croft, after a hoard of more than 9000 Roman silver coins was discovered near the village of Shapwick. The find was made by Martin and Kevin Elliot on 17/9/98, in a ploughed field owned by the family on the Nidons ridge, using metal detectors. The discovery was promptly reported, on the same day, to the County Museum in Taunton and a small exploratory excavation was made by R. Croft and R. Brunning and S. Minnit of the Somerset County Council Archaeology Section (SCCAS), starting on 21/9/98 and lasting for three days.

The excavation exposed a 3m by 3m area around the find spot (ST 42425 39512) and uncovered the remains of two wall foundations at c. 25cm below ground level. The first running approximately SE-NW was about 80cm wide and was interpreted as the outer wall of a building. The second foundation, orthogonal to the first was only 40-48cm wide and contained a 70cm gap, this was interpreted as an internal dividing wall the gap being a doorway. The hoard appeared to have been placed in the angle of these two walls on the south-west side. Additionally, the entire field was walked using a 5 metre grid in the week immediately before the geophysical survey and a number of Roman artifacts including additional coins were discovered. The Ancient Monuments Laboratory (AML) geophysical survey, which took place between the 19th and 23rd October 1998, was undertaken to complement this archaeological investigation and to help provide a context for the discovery.

The coin hoard was found 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 which might be expected to be highly conductive. Hence good electrical contrast would be expected between this and any resistive buried masonry. This soil has also been found to be responsive to magnetic survey, producing excellent results in a survey of a medieval settlement in the vicinity (Geophysical Survey Database, visits 660 and 665).

Method

Field Procedure

A grid of 30 metre squares was established over the area surrounding the spot where the hoard had been discovered using the same orientation as the grid used for the excavation and fieldwalking exercise mentioned above. The location of this grid is depicted in Figure 1, which also shows the position of the find spot (taken from a ranging rod left as a marker in the field) and the location of two permanent marker pegs in the north and west field boundaries. These latter were left by the AML survey team to record the positions of pegs used by the SCCAS team to establish the original site grid. The position of the AML survey grid relative to the above points and to the field boundaries was determined using an EDM.

All the numbered squares in Figure 1 were surveyed with a Geoscan FM36 fluxgate gradiometer according to the standard technique outlined in Annex 1, note 2. Additionally, bagged soil samples were also taken at the grid intersections on two orthogonal transects across the site for subsequent magnetic susceptibility analysis in the laboratory using a Bartington MS2 susceptibility bridge. The intersections from which these samples were taken are also indicated in Figure 1.

The 14 shaded squares in this figure were also surveyed using a Geoscan RM15 earth resistance meter and MPX15 multiplexer, using a mobile electrode separation of 0.5m. This was done according to the technique described in Annex 1, note 1 but, to improve resolution, readings were taken at 0.5m intervals along each traverse, traverses still being separated by 1.0m. Additionally, further improved resolution was achieved around the find spot (square 25), by surveying with traverses 0.5m apart, again using a reading interval of 0.5m. Furthermore, the MPX15 multiplexer was used to simultaneously recover a lower resolution survey over the same area with a 1.0m mobile electrode separation. The increased mobile electrode separation theoretically allows the resistance meter to sample anomalies at greater depth. This latter survey was measured at a reading interval and traverse separation of 1m over all squares except square 25 where the sample interval was reduced to 0.5m

Data Processing and Presentation

The magnetometer results were corrected for instrument heading errors by subtracting the median value of each traverse from all measurements on the traverse ("unbunching"). Additional processing with an adaptive thresholding median filter was applied to replace measurements of extreme magnitude with a local median ("despiking"). Such values are usually caused by modern, near surface, ferrous material and, if not removed, can skew the statistical distribution of the data set. Trace and greyscale plots of the magnetometer results after these modifications are depicted at 1:1000 scale in Plots 1 and 2 respectively. Note that in Plot 1, for ease of display of the traceplot, north is to the left rather than at the top of the plot.

The magnetic susceptibility measurements from the bagged samples are displayed in Figure 2 superimposed on the location plan. In this Figure the values are plotted as circles each centred on the point where the sample was taken from, the circle radius being proportional to the magnetic susceptibility of the sample. The measurement is also printed in text within each circle in units of $m^3Kg^{-1} \times 10^{-8}$.

The unprocessed resistivity measurements from both the 0.5m and 1.0m mobile electrode separation surveys are depicted in Plot 3 at 1:1000 scale in both trace and greyscale formats. Note that once again, for convenience, north is to the left in this plot. For each of the surveys, the data from all the squares other than square 25 was first interpolated to match the higher resolution of the latter square over the find spot.

To reduce the dynamic range of the data and bring out some of the additional detail visible on the computer screen the 0.5m electrode separation survey was processed to enhance features of narrow width using a variety of different methods. Three such enhanced versions of the data are depicted in Plot 4, a-c with an accompanying key describing the algorithms used. Details of these algorithms may be found in Pratt (1978, ch. 17)). Plot 4d, shows the result of treating the 1.0m mobile electrode survey as providing a regional background resistivity value and subtracting it from the 0.5m survey to enhance near surface features.

Finally, to accentuate some of the narrow linear features present in the 0.5m mobile electrode separation survey it was displayed as a shaded relief plot (Scollar *et al.* p512). Several different versions, with the illumination coming from different angles, are depicted in Plot 5. For this representation the data set was smoothed with an adaptive thresholding median filter prior to processing with the shadowing algorithm, to produce a less "noisy" output.

Results

The magnetometer survey

It is immediately clear from Plots 1 and 2 that soil conditions were favourable for magnetic survey and that a remarkable number of potential archaeological anomalies have been recorded. An interpretation diagram, superimposing these anomalies on a plan of the field boundaries, is presented at 1:1000 scale as Plot 6 and the figures in bold in square brackets in this text (eg: **[x]**) refer to numbered features in this plot.

Perhaps the most striking feature is the network of broad, ditch like, linear anomalies running throughout the entire area of the survey and highlighted in green in Plot 6. Scrutiny of trace Plot 1 shows that the fill of these features must be strongly magnetised, producing peak anomaly strengths varying between 8 and 12nT, with the highest magnitudes generally occurring slightly east of the centre of the survey area and towards the north-east corner. They are the broadest anomalies visible in Plot 2 and the causative features must vary in width from about 5m for the east-west ditch **[1]** in the centre of the plot, to 2.5m for those running out beyond the north and west of the survey area. They form a puzzling pattern, whilst trending linearly they are not all straight and some describe pronounced arcs. The most extreme example, being a reversed "S" shape, appears towards the west of the survey area **[2]**. Also in this area considerable bifurcation occurs and at [3] both the eastward heading branches inexplicably peter out after about 30 metres. Finally, there is a pronounced break in the broadest length of ditch at [4] and other features, described below, appear to trend towards this gap.

A second set of linear anomalies are also indicated in Plot 6 in blue, distinguished from the first by being narrower, straighter and having less strongly magnetised fills. The causative features must range from about 1.0 to 2.5 metres in width and the peak anomaly magnitudes vary from 2 to 6nT. It is notable that once again the strongest magnetisations occur slightly east of the centre of the survey area. At the other extreme of magnetisation, some of the weakest are marked with dashed lines in the interpretation plan, to indicate that their identification is tentative. The clearest and straightest of these linear anomalies occur in the centre of the survey area where they appear to form three sides of a sub-rectangular enclosure concentric around the find spot. The corners of these anomalies are markedly angular and in most places they appear to cut through the broader features described above. At [5] there appear to be two separate, parallel double ditch systems on different alignments. The northernmost of these links up with a less straight linear feature which runs south-southwest from the centre of the plot.

In the south-east corner of the survey area around [6] another group of these anomalies is apparent, not directly connected to those around the find spot. The strongest of these appears to form two sides of a rectangular enclosure which extends out of the survey area. The ninety degree corner in this anomaly is rounded rather than angular like the corners mentioned above. The area bounded by the feature is subdivided by a number of other linear anomalies on the same alignment but of varying strength. Also, some circular pit-like anomalies are apparent here and these have peak anomaly strengths of around 4nT suggesting a fairly well magnetised fill.

In addition to these positively magnetised linear anomalies, some negative anomalies can be discerned about 60 metres south of the find spot [7] and these have been emphasised in Plot 6 in red. Negative measurements indicate that the material causing the anomaly is less strongly magnetised than the surrounding soil and, although unusual, buried masonry (particularly limestone) can cause such artifacts. This interpretation is supported by the scale and the rectilinear layout of the anomalies at [7], suggesting that the wall footings of a stone building survive here.

A final set of linear anomalies are shown in grey in Plot 6 and these are characterised by a weakly magnetised fill, generally with a peak magnitude of 2nT or less and with less well defined edges suggestive of features created by natural processes. A number of these anomalies are distributed over the northern and western parts of the survey. It is possible that these have a similar origin to the features shown in green that were described above, but with less magnetic fills. However, just south of the centre of the survey, a pronounced cluster of these anomalies occurs running in a ninety degree arc between [4] and [7] appearing to coalesce as they approach the gap in the broad ditch-like feature noted at [4]. It is tempting to envisage these as trackways leading towards some gateway or crossing point, but complementary evidence from the resistivity survey (see below) may mitigate against this interpretation.

As well as the linear anomalies already described several amorphous areas of generally enhanced magnetic activity are indicated on Plot 6 with a blue stipple. These might be due to a number of causes but are likely to be the result of human activity. Scatters of fired ceramic fragments such as pottery and tiles can increase the level of magnetic noise detected by the magnetometers, as can burning which alters the magnetic mineralogy of the soil. Hence it might be hypothesised that these areas indicate foci for whatever processes were occurring at the site in antiquity and, indeed, they correlate well with the areas in which the fills of the linear features described above were noticed to be most strongly magnetised.

Finally a faint narrow but very straight linear anomaly has been indicated on Plot 6 with a yellow dashed line, running approximately east-west across almost the entire width of the survey area and towards the south of the survey area. From its appearance this is likely to represent a relatively modern feature such as service trench or old field boundary. No evidence of the latter was visible on the surface but Kevin Elliot indicated that the field had originally been subdivided by an east-west boundary and it is possible that this is what has been detected. Certainly no field drains are known to have been dug and its remoteness from any nearby habitation makes a service trench an unlikely explanation.

The magnetic susceptibility samples

The laboratory magnetic susceptibility measurements of the soil samples collected on two orthogonal transects across the site are depicted in Figure 2. By far the highest value, 80.8 $m^3Kg^{-1} \times 10^{-8}$, occurs where the two transects cross east of the centre of the survey area. Radiating out from this point in all four directions, the adjacent readings remain high, in the order of 40-50 $m^3Kg^{-1} \times 10^{-8}$. The susceptibilities begin to drop off to the north, south and west with increasing distance from the crossing point but remain high to the east. Taken in conjunction with the increased magnetisation of the ditch fills and the amorphous areas of increased magnetic disturbance noted above, these measurements suggest that the focus of some sort of industrial activity involving burning was situated in the area just east of the centre of the magnetometer survey, between **[4]** and **[2]**.

The resistivity survey

Study of Plot 4 indicates that the clayey soil of the site was indeed highly conductive with the modal background resistivity being around 20Ωm. A number of high resistance features have been detected owing to their strong contrast with this conductive background. An interpretation diagram at 1:1000 scale of the significant anomalies detected in the resistivity survey is shown in Plot 7b. The corresponding area from the magnetometer survey interpretation is included as Plot 7a for comparison.

The most pronounced features in the plots of the unprocessed survey results shown in Plot 4 are the concentric, arcing high resistance anomalies indicated in grey in Plot 7b. These do not appear to respect the alignments of any of the likely archaeological anomalies identified in either the magnetometer or resistivity surveys, so a natural explanation might be suggested. As the underlying geological composition is clay with some limestone, it is possible that these represent outcropping layers of electrically resistive limestone lias separated by bands of more conductive clay. It may be noted that, at the eastern end of the surveyed area, these correspond in position and alignment with the anomalies discerned in the magnetometer survey arcing between **[4]** and **[7]** and it is likely that these latter are a response to the same phenomenon.

It may be noted from Plots 3a and 4d that these layers clearly outcrop close to the surface and this has complicated the interpretation of some of the other high resistance masonry features described below which are also composed of the locally occurring stone and buried at a similar depth.

Also apparent in the shallower penetrating, 0.5m electrode separation measurements is a series of narrow, straight, high resistance anomalies forming a rectilinear pattern. These have been accentuated in Plots 4a-c and Plot 5 and indicated in red on Plot 7b (once again more tentative identifications have been denoted using a dashed line). Scrutiny of the enhanced plots of the data reveals distinct orthogonally disposed linear anomalies suggestive of masonry wall footings. Comparison of the survey results in the immediate vicinity of the find spot with the wall footings discovered in the SCCAS excavation confirms this conjecture as the two correlate well, even down to the break in the narrower east-west wall interpreted as an internal doorway. Thus, the survey indicates three ranges of buildings: a southern range which corresponds with the putative masonry features in the magnetometer survey at **[7]**; a western range overlying the find spot at **[8]**; and a possible, though less easily discerned northern range at **[9]**. It should be remarked that some of the possible footings indicated in this latter group may in fact be responses caused by outcropping limestone which, as noted above, is at similar depth and of the same composition.

Scrutiny of the deeper penetrating survey plotted in 3b, as well as Plot 4d which enhances shallow anomalies, suggests that the burial depth of these features varies across the site. They are closest to the surface towards the south of the survey area around **[7]**, perhaps explaining why the magnetometer also detected them here, and the overburden generally becomes deeper further north. The east-west anomalies indicated with dashed lines at **[9]** appear to be buried deepest but it is possible that some of the other features indicated with solid lines in this vicinity overly them.

The least distinct anomalies in the resistivity results are a number of low resistance linear anomalies characteristic of buried, infilled ditches. These tend only to be visible where they cross the high resistance anomalies thought to be caused by the outcropping limestone and are most easily discerned in the shaded relief plots shown in Plot 5. They have been depicted in blue in the interpretation Plot 7b. On comparison with Plot 7a, it is immediately apparent that these correspond in position with the linear anomalies detected in the magnetometer survey (also indicated in blue). Also, at the western edge of the survey area, a broad low resistance feature corresponds with one of the broader, strongly magnetised anomalies depicted in green in the magnetometer interpretation. This lends weight to the interpretation of the magnetometer anomalies as infilled ditches.

Discussion and Archaeological Interpretation

Plot 7c combines all the significant geophysical anomalies detected in either both surveys but omitting those anomalies thought likely to have a natural origin. This plan enables the full ditch complex revealed by the magnetometer survey to be compared with the masonry wall footings detected by the resistivity survey.

The masonry wall footings (red)

The resistivity survey, has detected a pattern of masonry wall footings in the vicinity of the find spot and this interpretation has been confirmed by the SCCAS excavation. Given the archaeological artefact evidence recovered, it is most likely that these represent the remains of a Roman villa with three ranges of buildings arranged around a courtyard. It can now be seen from the geophysical results that the doorway gap found in the internal wall immediately north of the hoard location was not centrally placed and that the room overlying it was, in fact, 5m wide. Through this doorway, the room to the north exhibited some faint evidence of internal features in the resistivity survey, perhaps a diamond shape at 45 degrees to the alignment of the walls. Without more detailed investigation it is not possible to conjecture what this might be.

It has not been possible to discern the shape of the northern range of buildings around **[9]** and what features are visible here suggest the superposition of two slightly different alignments. It is possible that the more tentatively identified dashed lines represent a separate, perhaps earlier, phase of construction from the anomalies marked with solid lines. Certainly they are detected most clearly in the deeper penetrating 1.0m electrode separation resistivity survey whilst the anomalies marked with solid lines are most prominent in the shallower 0.5m survey. It is notable that the former appear to correspond more closely to the alignment of the nearby ditches marked in blue.

Comparison of the two resistivity data sets, each sensitive to features at different depths, suggests that the footings of the southern range of buildings at **[7]** are closest to the surface, perhaps because of a shallower topsoil here. These are thus most likely to be at risk from plough damage, possibly accounting for the greater concentration of stone visible on the surface in this area

Finally, it should be noted that although the geophysical results agree well with the excavated evidence, the position of the find spot in relation to the nearby masonry footings in Plot 7c appears to be about 1.5m too far south. However, the find spot position was determined from EDM measurement of a ranging rod left in the field after the hoard discovery, so it is possible that the latter was moved out of the way during the excavation and was no longer at exactly the correct point when measured.

The narrower ditches (blue)

Both the magnetometer and resistivity surveys detected a network of narrow straight ditches surrounding the find spot. Given the presence of the Roman villa in their centre it is likely that they represent enclosure or defensive ditches associated with it. However, a number of different alignments are apparent and the northernmost of the two double ditch structures near **[5]** appears to cut through the southernmost building in the western range at **[8]**. A similar phenomenon occurs with the southern double ditch structure where both ditches run up to the southern range of buildings at **[7]**, then two of its principal walls appear to continue, overlying the ditches, on the same alignment. It is possible that the ditches had some function other than defence linked to the buildings that they cut, perhaps drainage. Nevertheless, it seems clear from such overlaps and variations of alignment that the site has seen differing phases of construction and expansion.

The second major cluster of these ditches at **[6]** in the south east of the magnetometer survey shown in Plot 6, may well represent the boundaries of a Roman field system. However, the rounded corner of the perimeter ditch and the evidence for extensive internal subdivision, allow entertainment of the conjecture that this represents the remains of a Roman fort. If the two parallel ditches running west to this perimeter at the extreme south of the survey area mark the position of the *via principia*, the resulting fort would enclose an area of only one hectare, smaller than any known fort. Nevertheless, an extended investigation of this area might establish the extent of this complex and determine the viability of this hypothesis.

The broad, well magnetised ditches (green)

The interpretation of these features is perhaps the most problematic as their apparently almost random paths throughout the survey area give them the appearance of being unplanned and suggest a natural origin. However, the explanation that springs most readily to mind, that they were watercourses, is confounded by the topography of the site. The very broad anomaly running east-west through Plot 7c passing just north of the find spot to the gap at **[4]** runs along the ridge of highest ground in the field rather than down its slopes which are north and south facing. It is also clear that the other ditches and masonry footings detected in the surveys do not respect their alignments but often cut through and apparently overlie them.

The highly magnetised nature of these features is also puzzling. Without further evidence a geological interpretation cannot be ruled out, but it seems more likely that the fill of the ditches at least is due to anthropogenic enhancement of the natural soil. Perhaps the most plausible conjecture is that they represent a prehistoric ditch system, which had fallen out of use by the time of the Roman occupation at the site and was gradually infilled during this period by soil enhanced by whatever industrial processes were then occurring.

Other anomalies

To aid intelligibility, the amorphous areas of generally increased magnetic activity have not been included in Plot 7c. However, with the benefit of comparison with the resistivity results it can now be seen that the three patches closest to the centre of the magnetometer survey area coincide with the ceramic scatters and human occupation of the villa buildings. The two patches to the north-east correspond with high magnetic susceptibility readings and the most strongly magnetised ditch fills in the magnetometer survey. Hence, it may be conjectured that an activity involving burning and capable of enhancing the natural magnetic mineralogy of the soil took place here. This might well have been an industrial activity associated with the occupation of the villa. However, an alternative explanation might be suggested by the scatter of reddened, burnt stone visible on the surface of the field. Testing with the magnetometer confirmed that these fragments had been exposed to temperatures high enough for them to acquire a thermoremanent magnetic field. It is thus possible that the villa, or a building associated with it, was destroyed by fire.

Conclusions

It would appear that, perhaps unusually for a hoard, the Brue Valley coins were hidden within a structure that was probably still extant when they were secreted. Indeed the geophysical results suggest a palimpsest of several phases of activity on the site during the Roman period. It is clear that the wall footings detected in the excavation represent the remains of an extensive series of Roman buildings, probably a courtyard villa, which underwent several phases of construction during its lifetime. It is also possible that industrial activities were taking place to the east of these buildings at some time in this period. Furthermore, the network of broader ditches extending throughout the survey area may indicate an earlier initial occupation of the site.

The survey results also suggest that many of the masonry remains are very near to the surface and this is confirmed by the excavation evidence which recorded an overburden of only 25cm over the exposed footings. In this regard, the southernmost range of buildings appear to be closest to the surface and thus perhaps most at risk from plough damage.

Surveyed by: A. David
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Dates: 19th-23rd October 1998

Report by: P. Linford

Date: 16th November 1998

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Enclosed Figures and plans

Annex 1: Notes on standard procedures

1) **Resistivity Survey:** Each 30 metre square is surveyed by making repeated parallel traverses across it, all aligned parallel to one pair of the square's edges, and each separated by a distance of 1 metre from the last; the first and last traverses being 0.5 metres from the nearest parallel square edge. Readings are taken along each traverse at 1 metre intervals, the first and last readings being 0.5 metres from the nearest square edge.

   Unless otherwise stated the measurements are made with a Geoscan RM15 earth resistance meter incorporating a built-in data logger, using the twin electrode configuration with a 0.5 metre mobile electrode separation. As it is usually only relative changes in resistivity that are of interest in archaeological prospecting, no attempt is made to correct these measurements for the geometry of the twin electrode array to produce an estimate of the true apparent resistivity. Thus, the readings presented in plots will be the actual values of earth resistance recorded by the meter, measured in Ohms (Ω). Where correction to apparent resistivity has been made, for comparison with other electrical prospecting techniques, the results are quoted in the units of apparent resistivity, Ohm-m (Ωm).

   Measurements are recorded digitally by the RM15 meter and subsequently transferred to a portable laptop computer for permanent storage and preliminary processing. Additional processing is performed on return to the Ancient Monuments Laboratory using desktop workstations.

2) **Magnetometer Survey:** Each 30 metre square is surveyed by making repeated parallel traverses across it, all parallel to that pair of square edges most closely aligned with the direction of magnetic North. Each traverse is separated by a distance of 1 metre from the last; the first and last traverses being 0.5 metre from the nearest parallel square edge. Readings are taken along each traverse at 0.25 metre intervals, the first and last readings being 0.125 metre from the nearest square edge.

   These traverses are walked in so called 'zig-zag' fashion, in which the direction of travel alternates between adjacent traverses to maximise survey speed. However, the magnetometer is always kept facing in the same direction, regardless of the direction of travel, to minimise heading error.

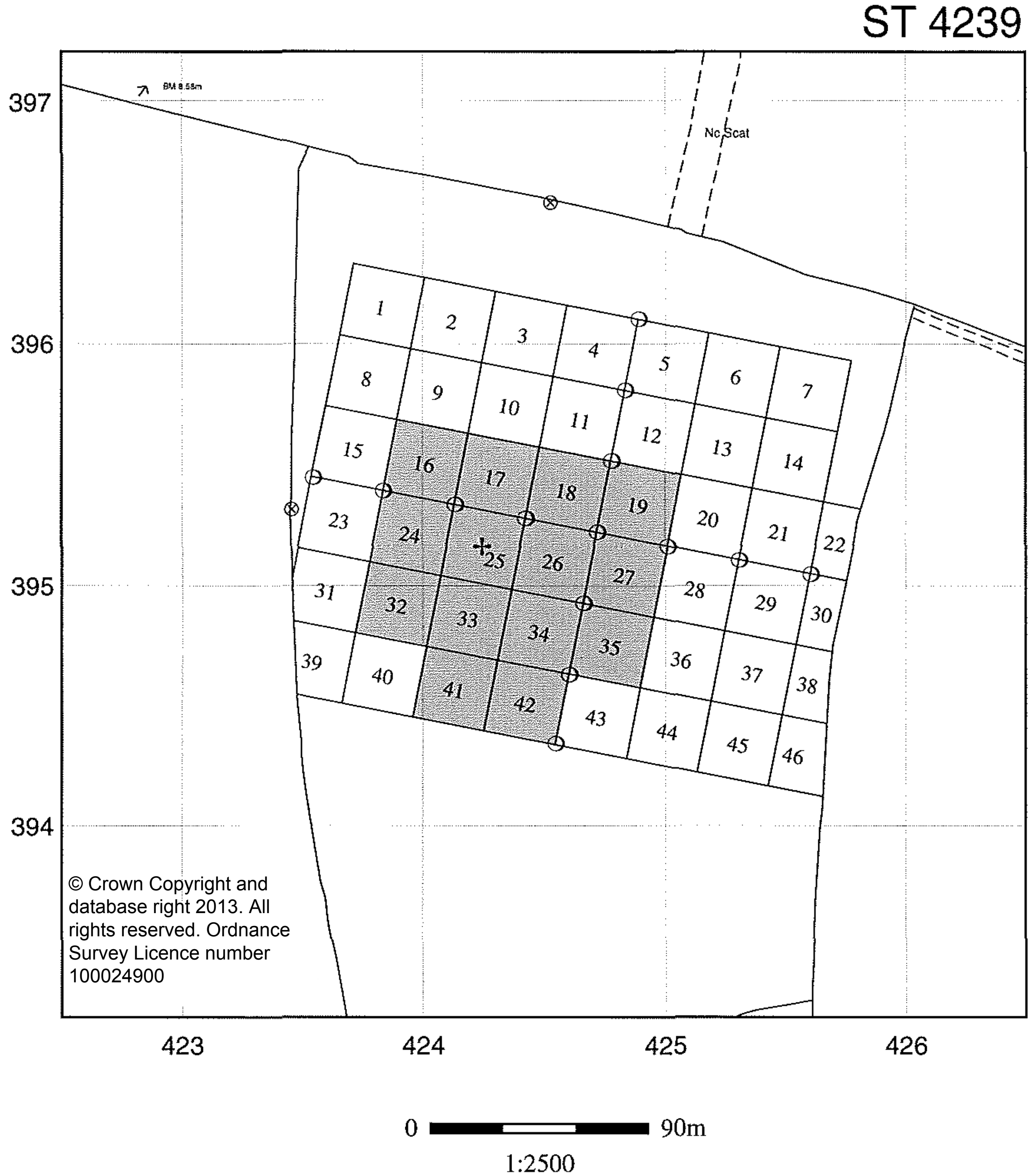
   Unless otherwise stated the measurements are made with a Geoscan FM36 fluxgate gradiometer which incorporates two vertically aligned fluxgates, one situated 0.5 metres above the other; the bottom fluxgate is carried at a height of approximately 0.2 metres above the ground surface. The FM36 incorporates a built-in data logger that records measurements digitally; these are subsequently transferred to a portable laptop computer for permanent storage and preliminary processing. Additional processing is performed on return to the Ancient Monuments Laboratory using desktop workstations.

It is the opinion of the manufacturer of the Geoscan instrument that two sensors placed 0.5 metres apart cannot produce a true estimate of vertical magnetic gradient unless the bottom sensor is far removed from the ground surface. Hence, when results are presented, the difference between the field intensity measured by the top and bottom sensors is quoted in units of nano-Tesla (nT) rather than in the units of magnetic gradient, nano-Tesla per metre (nT/m).

3) **Resistivity Profiling:** This technique measures the electrical resistivity of the subsurface in a similar manner to the standard resistivity mapping method outlined in note 1. However, instead of mapping changes in the near surface resistivity over an area, it produces a vertical section, illustrating how resistivity varies with increasing depth. This is possible because the resistivity meter becomes sensitive to more deeply buried anomalies as the separation between the measurement electrodes is increased. Hence, instead of using a single, fixed electrode separation as in resistivity mapping, readings are repeated over the same point with increasing separations to investigate the resistivity at greater depths. It should be noted that the relationship between electrode separation and depth sensitivity is complex so the vertical scale quoted for the section is only approximate. Furthermore, as depth of investigation increases the size of the smallest anomaly that can be resolved also increases.

Typically a line of 25 electrodes is laid out separated by 1 or 0.5 metre intervals. The resistivity of a vertical section is measured by selecting successive four electrode subsets at increasing separations and making a resistivity measurement with each. Several different schemes may be employed to determine which electrode subsets to use, of which the Wenner and Dipole-Dipole are typical examples. A Campus Geopulse earth resistance meter, with built in multiplexer, is used to make the measurements and the Campus Imager software is used to automate reading collection and construct a resistivity section from the results.

Figure 1) Brue Valley Hoard, Shapwick, Somerset, October 1998: Location of geophysical surveys.



Key

Grid surveyed with magnetometer only.

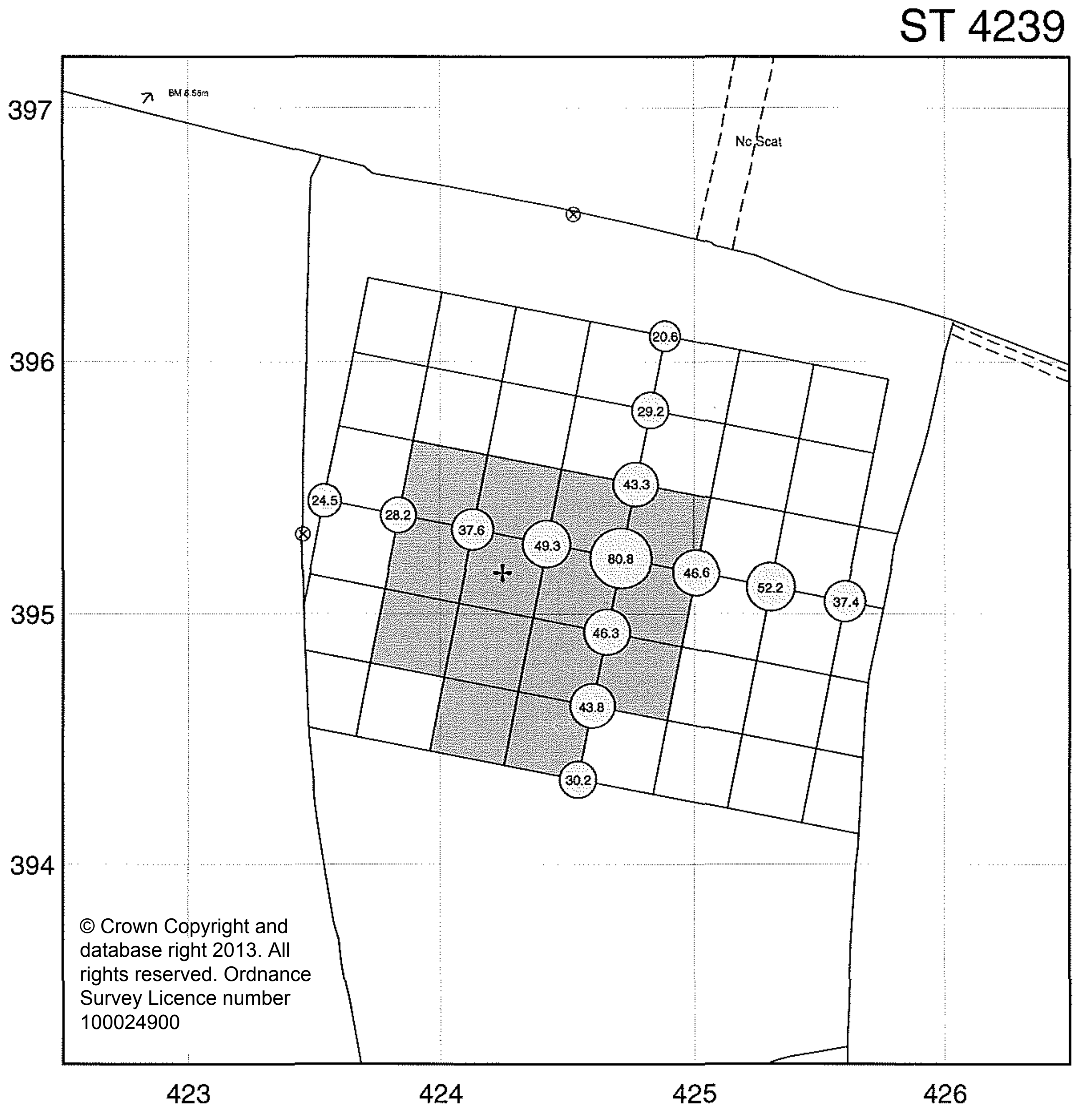
Grid surveyed with both magnetometer and resistivity meter.

✢ Location where coin hoard was discovered.

⊗ Location of AML permanent survey marker peg.

○ Grid intersection from which magnetic susceptibility samples were taken.

Figure 2) Brue Valley Hoard, Shapwick, Somerset, October 1998: Magnetic susceptibility measurements.



0 90m

1:2500

Key

Grid surveyed with magnetometer only.

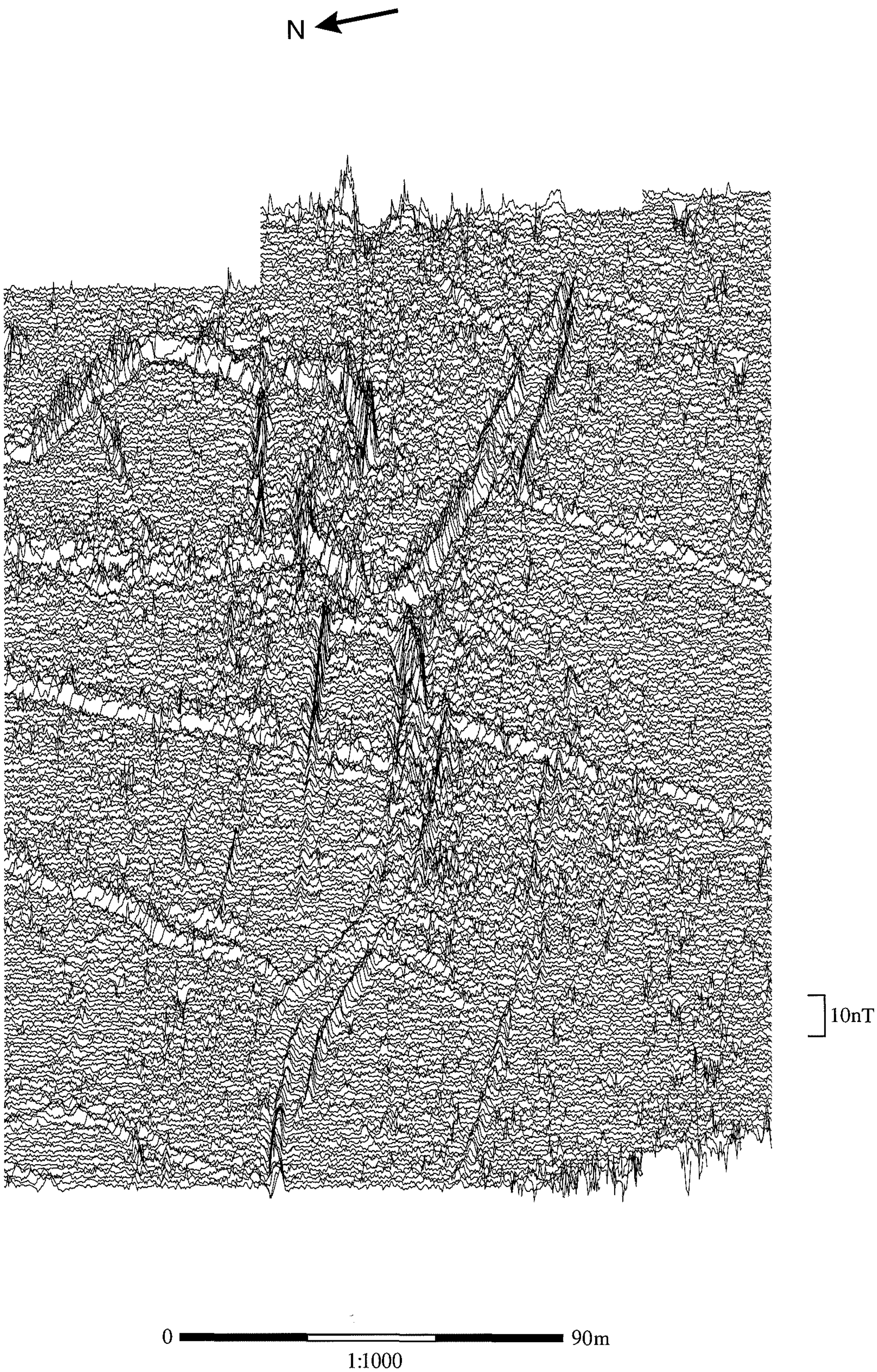
Grid surveyed with both magnetometer and resistivity meter.

✛ Location where coin hoard was discovered.

⊗ Location of AML permanent survey marker peg.

(24.5) Magnetic Susceptibility sample, where the area of the circle is proprtional to magnitude of the measurement. Figures are in units of: $m^3/kg \times 10^{-8}$

Plot 1) Brue Valley Hoard, Shapwick, Somerset, October 1998: Trace plot of magnetometer results.



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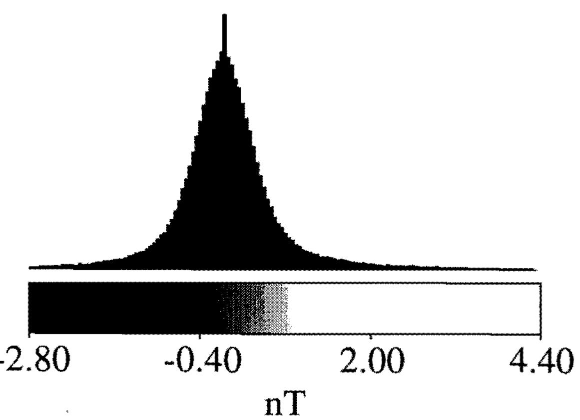
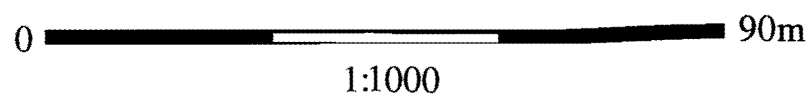
Plot 2) Brue Valley Hoard, Shapwick, Somerset, October 1998:
Linear greyscale plot of magnetometer results.





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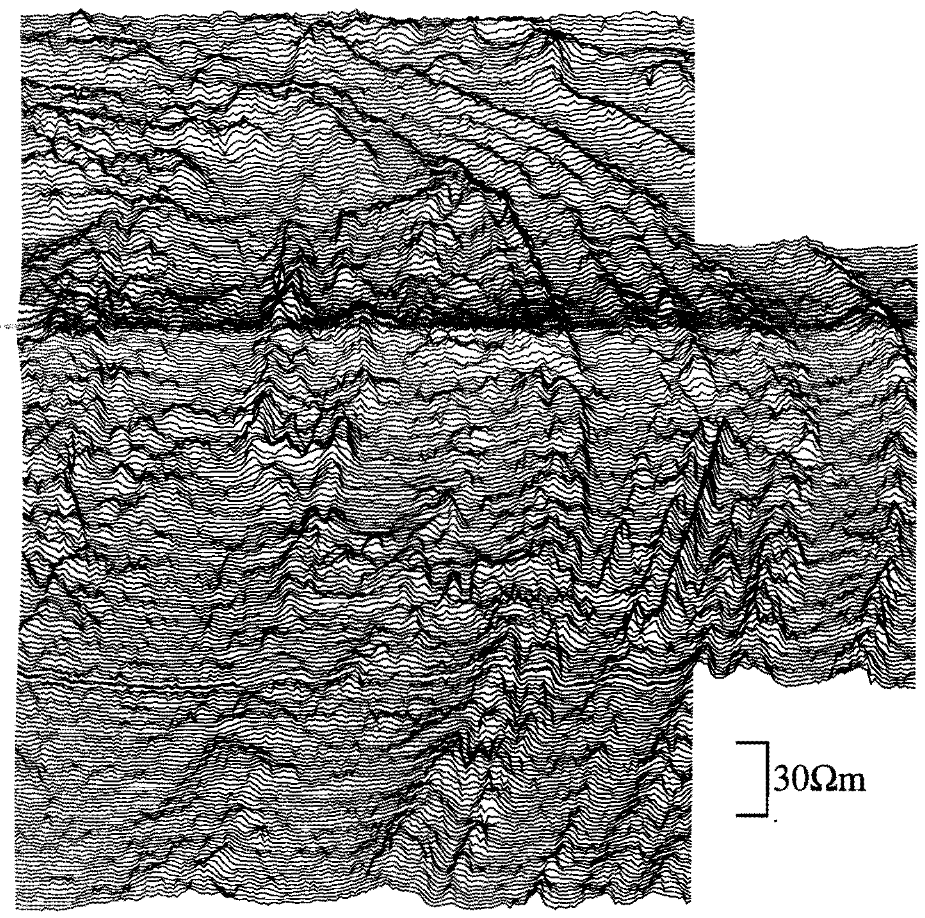
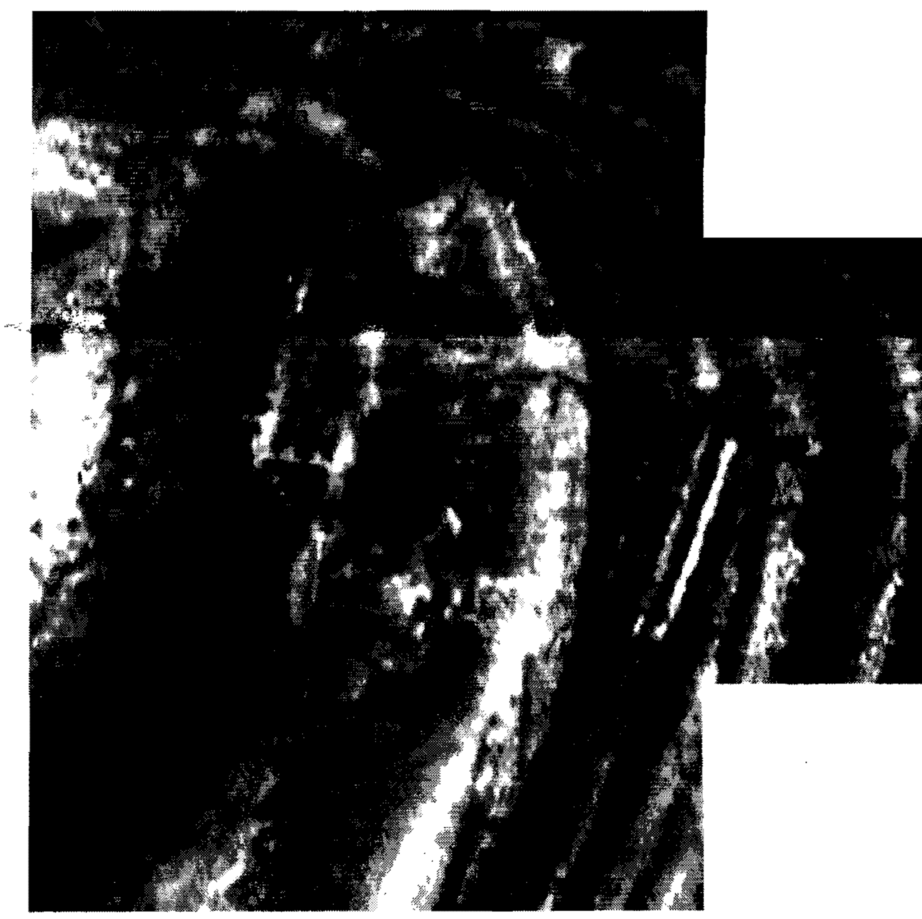
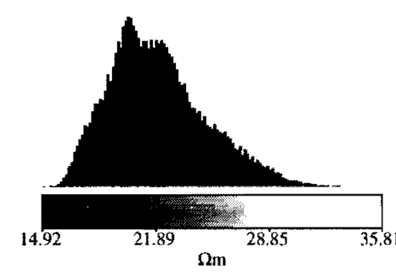
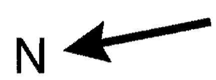
Plot 3) Brue Valley Hoard, Shapwick, Somerset, October 1998: Linear greyscale plot of magnetometer results.

a) Trace and linear greyscale plots of 0.5m electrode separation survey.

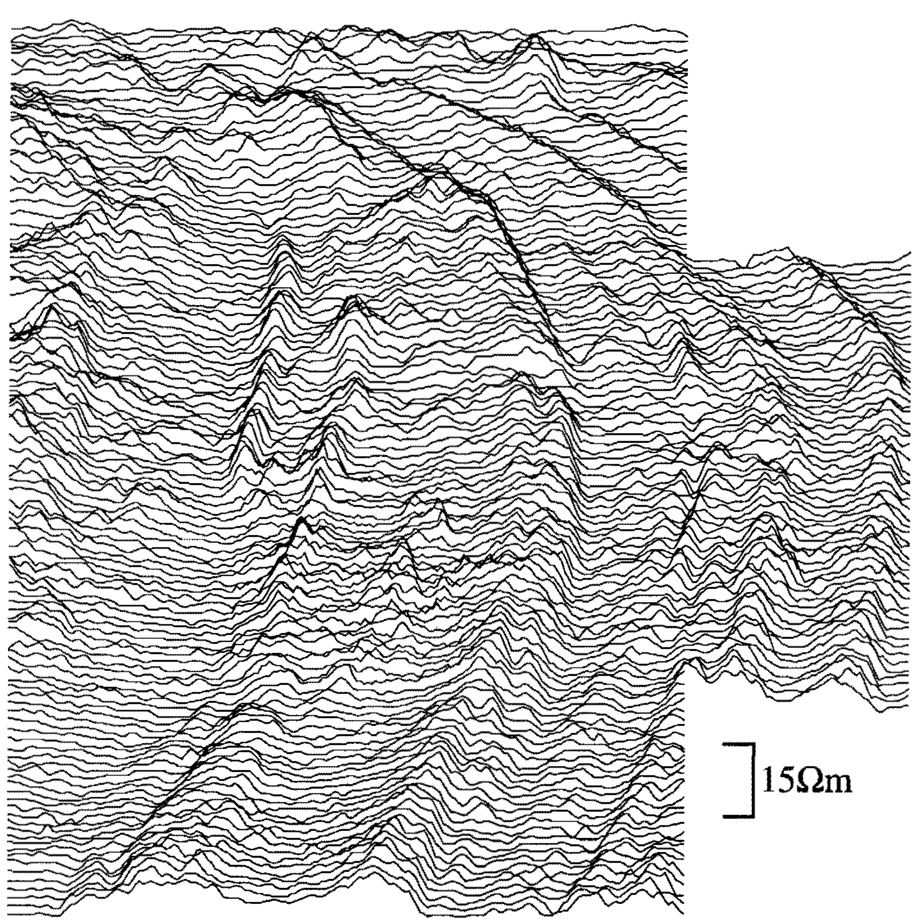


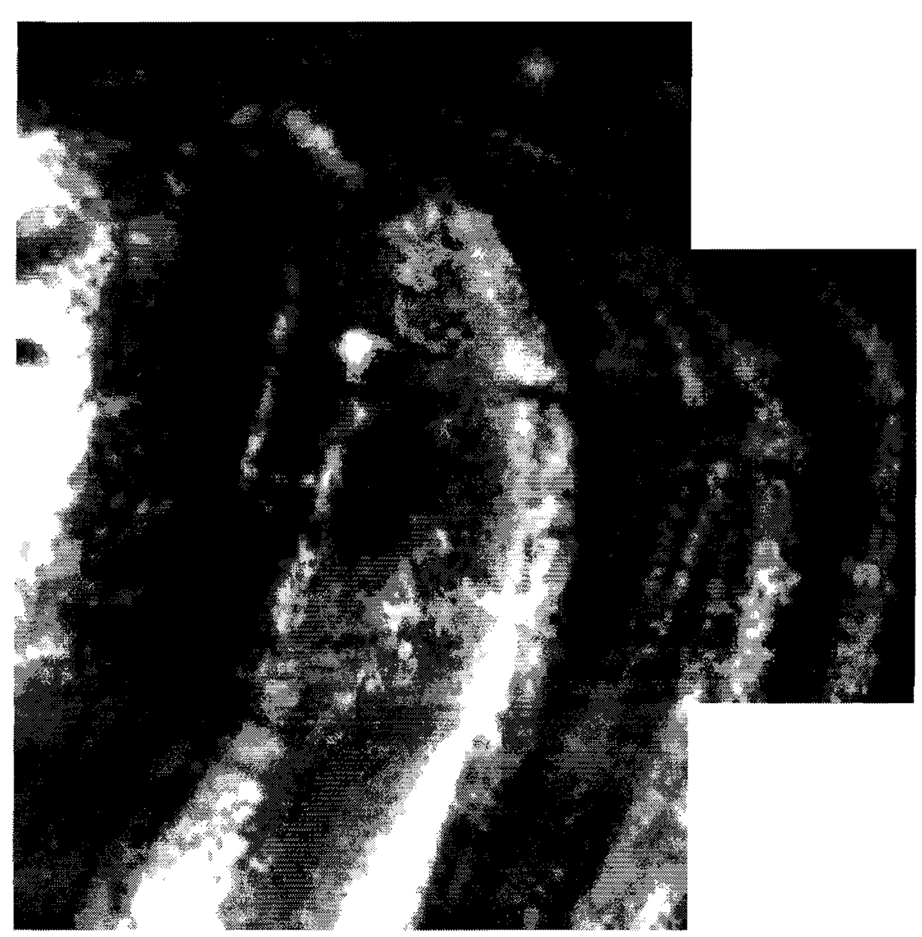


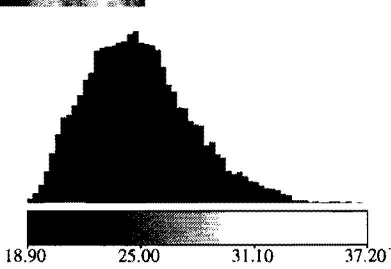


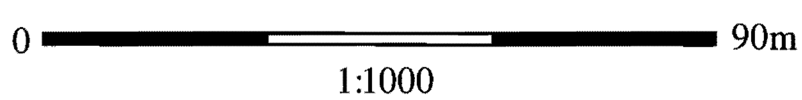


b) Trace and linear greyscale plots of 1.0m electrode separation survey.









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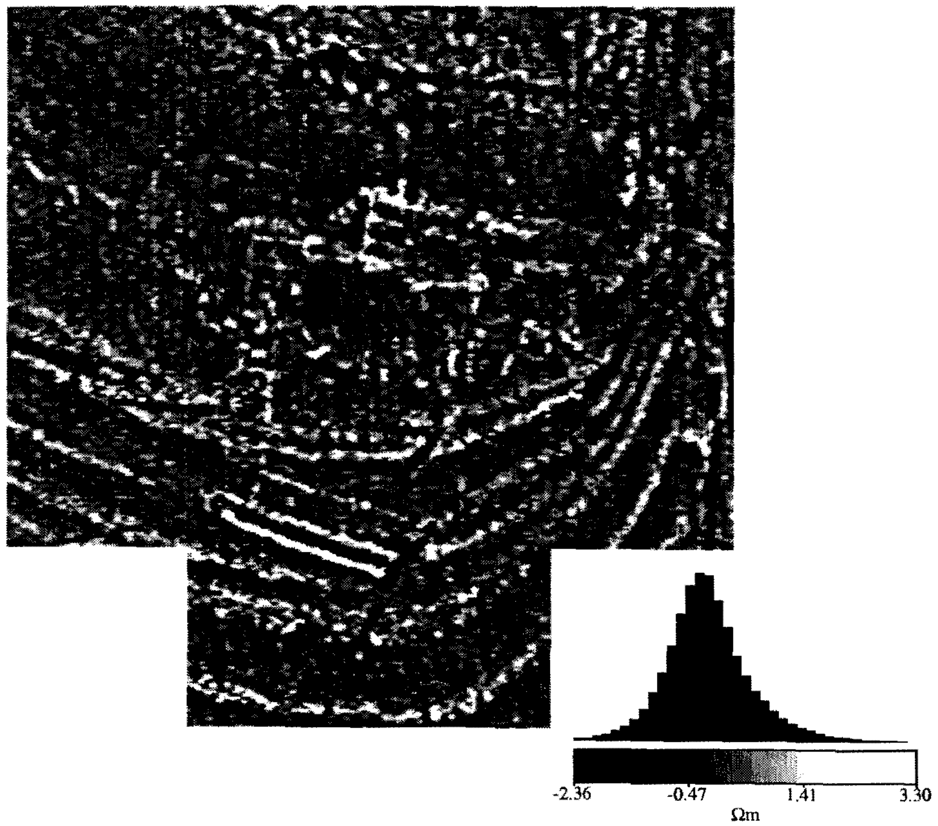
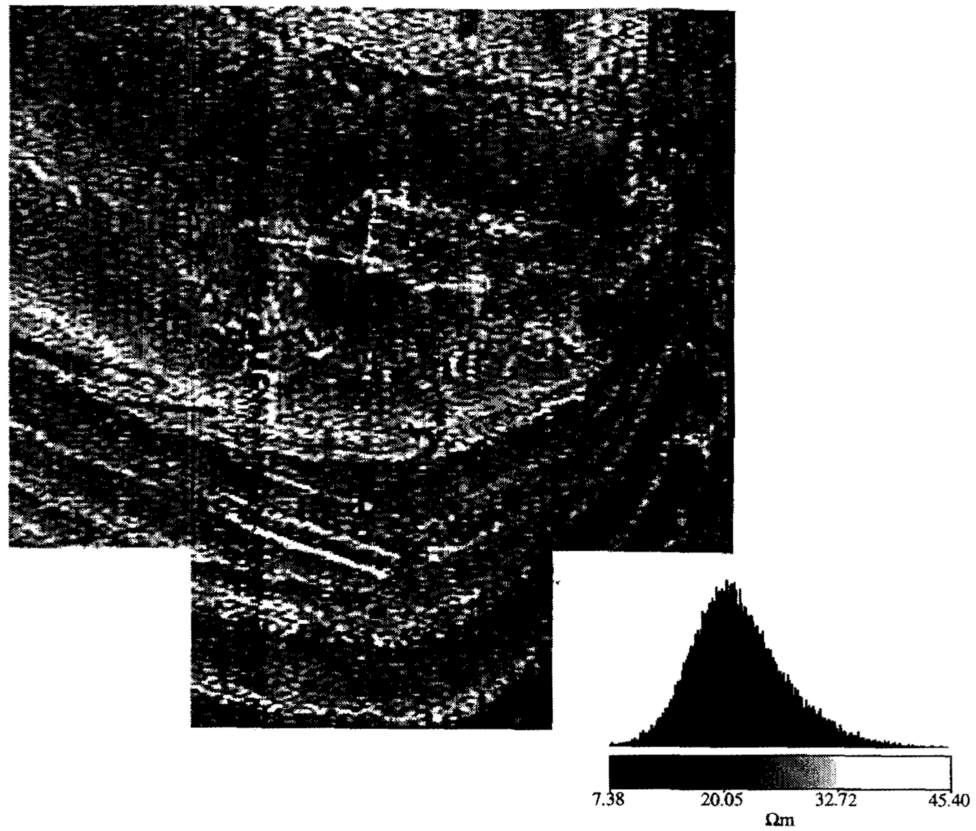
Plot 4) Brue Valley Hoard, Shapwick Somerset, October 1998: Linear greyscale plots of 0.5m mobile electrode separation resistivity data processed to enhance linear features.

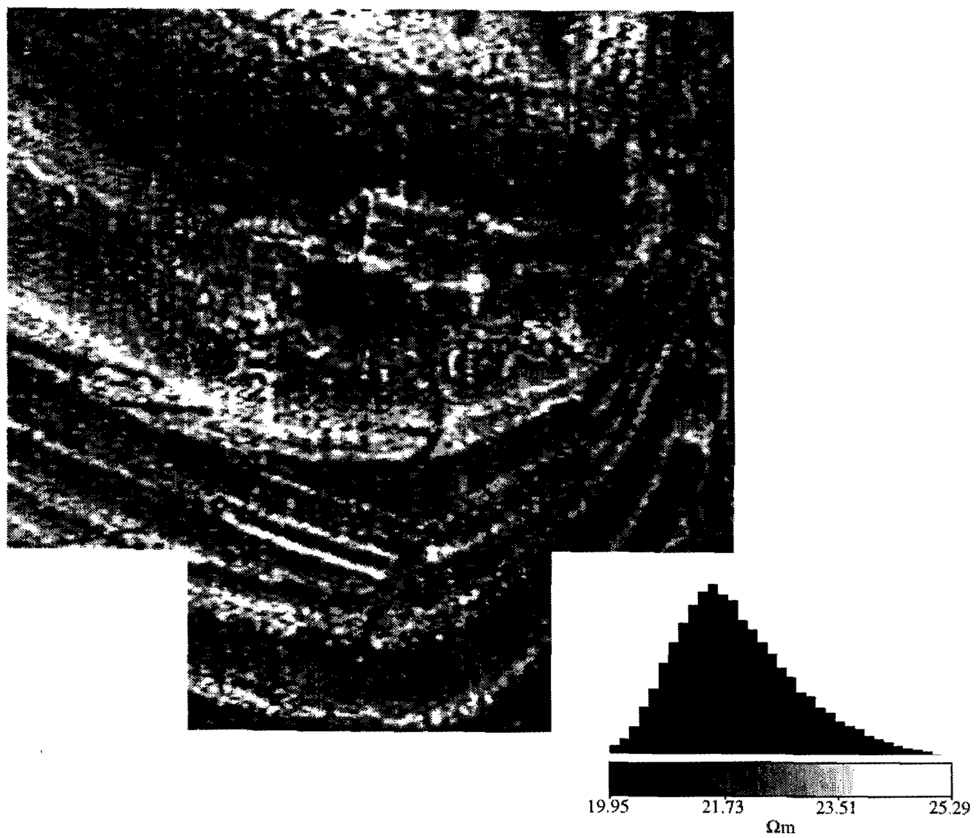
a)



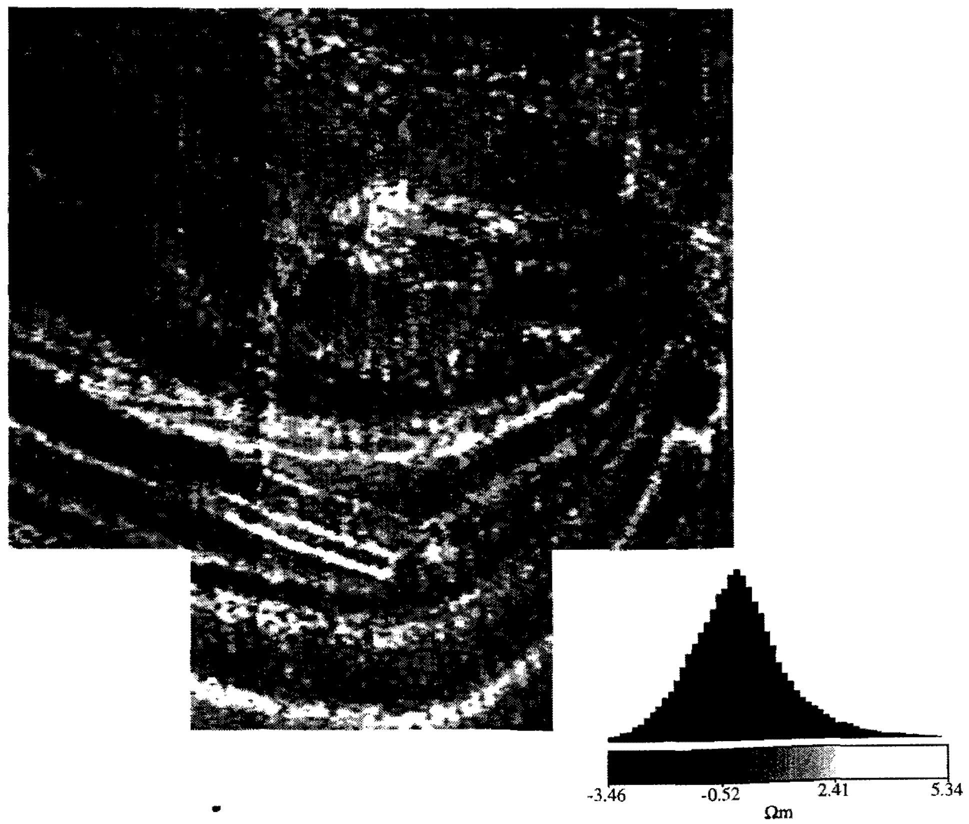
b)



c)



d)



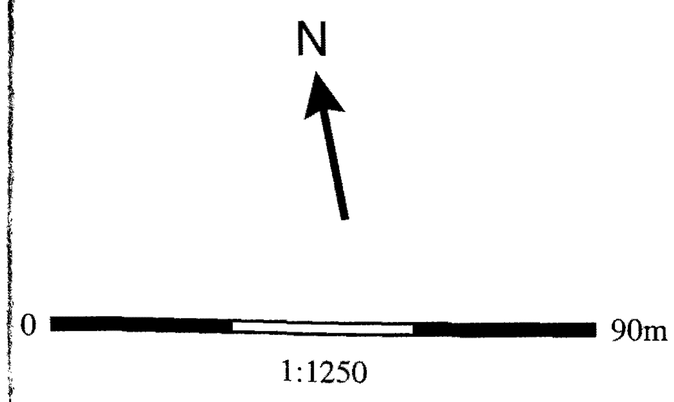
Key

a) Result after convolution with a 2m Gaussian high pass mask.

b) Result after contrast enhancement using the Wallis algorithm with window radius 1m and edge-to-background ratio 0.75.

c) Result after the addition of the output of convolution with a 3 by 3 laplacian edge detection mask to the original data.

d) Result of subtracting the apparent resistivities measured in the 1m electrode separation survey from those of the 0.5m survey to enhance near surface features.



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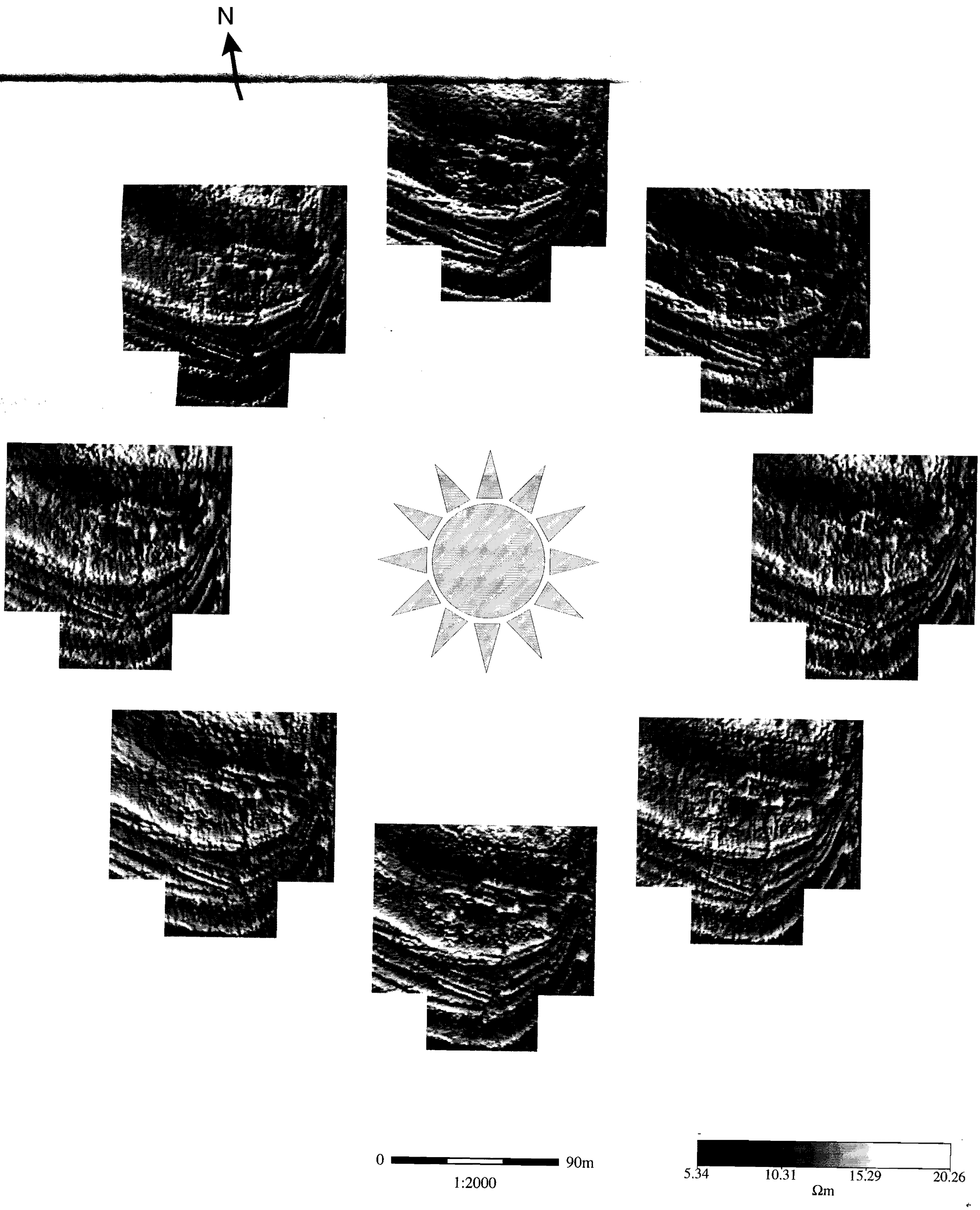
Plot 5) Brue Valley Hoard, Shapwick, Somerset, October 1998: Shaded relief plots of 0.5m mobile electrode separation resistivity data to enhance linear edges.

These plots were generated by equating the resistivity measurements with vertical relief, the higher the resistivity value the higher the assumed elevation at that point. This topagraphic surface can then be shaded as if illuminated by a low inclination light source which can be positioned at various azimuthal angles. Eight such shaded relief plots of the 0.5m mobile electrode separation survey are presented with azimuthal angles ranging from 0°to 360° in 45° increments. In each case the position of the plot relative to the sun at the centre of the page indicates the angle of illumination (ie: the topmost plot was illuminated from the south). The survey data set presented was pre-processed using an adaptive thresholding median filter to produce a smoother output.



Plot 6) Brue Valley Hoard, Shapwick, Somerset, October 1998: Interpretation plan of magnetometer results.

Key

- Broad linear anomaly with strongly magnetised fill.
- Positive magnetic anomaly, likely to be anthropogenic.
- Negative linear anomaly, likely to be anthropogenic.
- Very weakly positive magnetic anomaly, possibly caused by underlying geology.
- Tentative, linear, very weakly positive magnetic anomaly.
- Tentative area of anthropogenic, weak mangetic enhancement.
- Area of generally increased magnetic disturbance likely to be anthropogenic.
- Area of strong magnetic disturbance due to modern ferrous material.
- Narrow, weak, positive linear anomaly likely to represent old field boundary.
- Location referred to in text.
- Location where coin hoard was discovered.
- Location of AML permanent marker peg.

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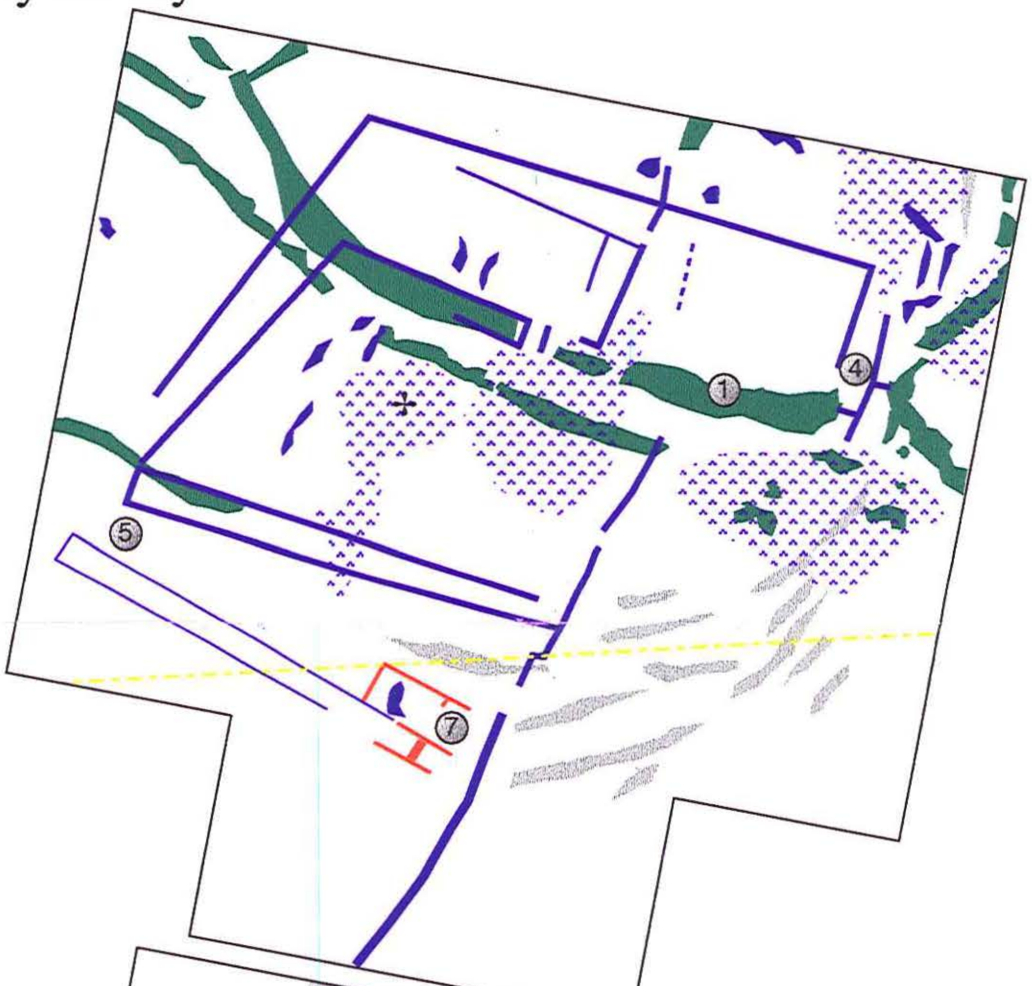
Plot 7) Brue Valley Hoard, Shapwick, Somerset, October 1998: Interpretation plans of the area covered by both magnetometer and resistivity survey.

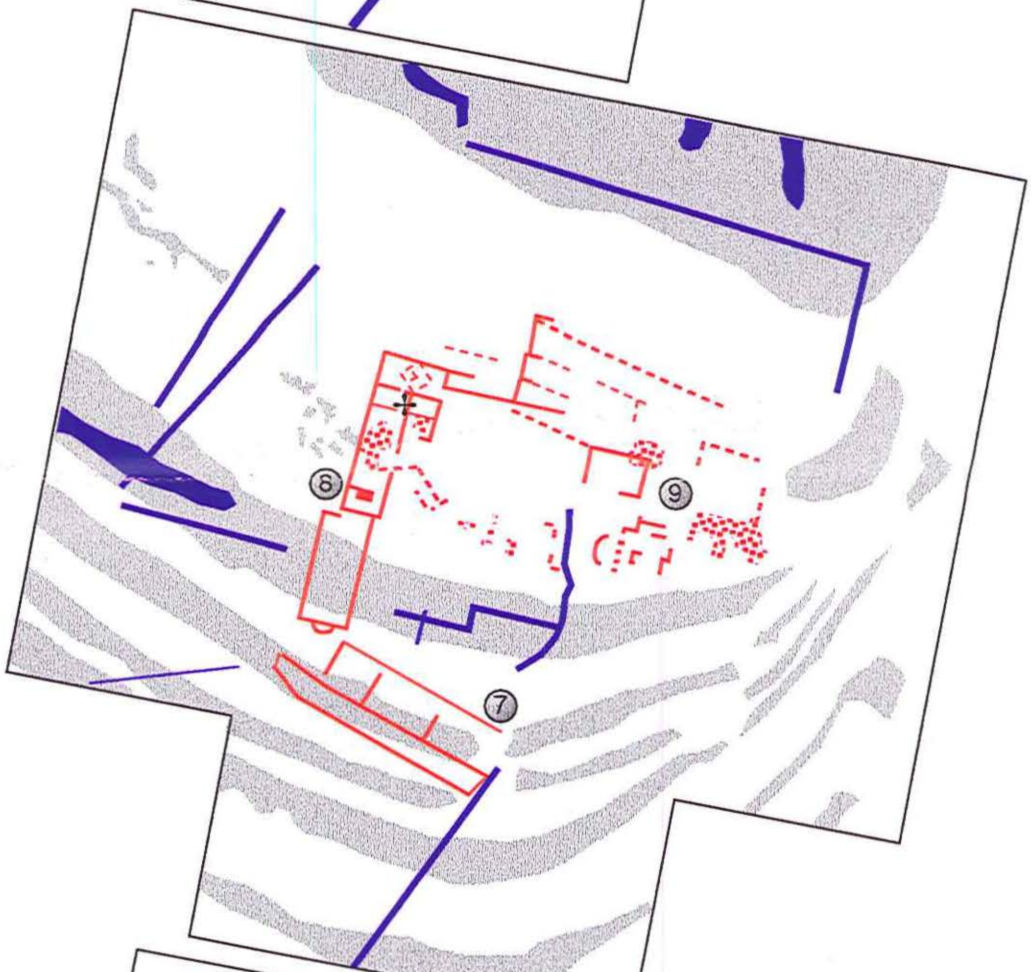
a) Interpretation of magnetometer survey.

- Broad linear anomaly with strongly magnetised fill.
- Positive magnetic anomaly, likely to be anthropogenic.
- Negative linear anomaly, likely to be anthropogenic.
- Very weakly positive magnetic anomaly, possibly caused by underlying geology.
- Tentative, linear, very weakly positive magnetic anomaly.
- Area of generally increased magnetic disturbance likely to be anthropogenic.
- Narrow, weak, positive linear anomaly likely to represent old field boundary.
- ① Location referred to in text.
- ✣ Location where coin hoard was discovered.



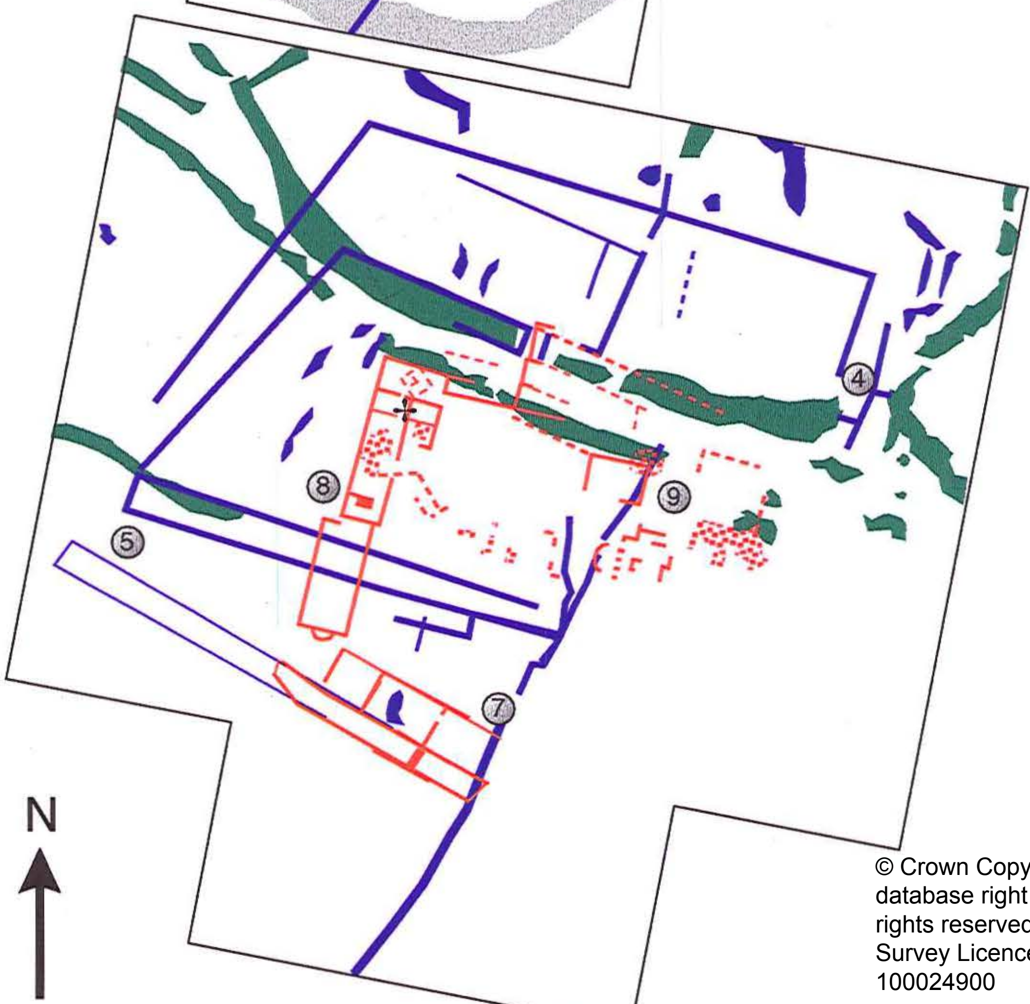
b) Interpretation of resistivity survey.

- Low resistivity linear anomaly likely to represent a ditch.
- High resistivity linear anomaly, likely to be caused by buried wall footing.
- Tentative, linear, high resistivity anomaly, possibly due to buried wall footing.
- Area of generally increased resistivity possibly caused by rubble spread.
- Arcing high resistivity anomaly, possibly caused by underlying geology.
- ⑦ Location referred to in text.
- ✣ Location where coin hoard was discovered.



c) Composite interpretation of probable causative archaeological features.

- Broad ditch with strongly magnetised fill, likely to have been caused by anthropogenic activity.
- Probable Roman boundary or defensive ditch.
- Tentative Roman ditch.
- Probable wall footing of Roman building.
- Possible rubble spread representing remains of Roman masonry.
- ④ Location referred to in text.
- ✣ Location where coin hoard was discovered.



0 — 90m

1:1000

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