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**Sutton Hoo, Suffolk. Report on Geophysical Survey,
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Summary

Magnetometer surveys were carried out in the North Field west of the new visitors' centre at Sutton Hoo as well as the area immediately north of the Anglo-Saxon tumuli. The work was prompted by the recent discovery of Anglo-Saxon cremations and inhumations during the construction of the centre and the concern that the extents of both this new burial ground and the known area around the upstanding tumuli may not be accurately known. There was also interest in testing whether the newer generation of caesium vapour magnetometers might prove more sensitive to archaeological features than previous geophysical techniques employed at the site. Hence, both caesium and fluxgate instruments were used to carry out the surveys.

Keywords

Geophysics

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SUTTON HOO, Suffolk.

Report on geophysical survey, December 2001.

Introduction

Sutton Hoo in Suffolk is the site of one of the most spectacular archaeological discoveries in the British Isles. This was the excavation of an Anglo-Saxon ship burial inside one of a group of tumuli during the 1940s (Bruce Mitford 1975, 1978 and 1983). The site is now in the care of the National Trust who are undertaking works to improve public access. As part of this process a new visitors' centre has been constructed (TM 290 493) and, during archaeological evaluation prior to this work in 2000, a number of Saxon burials with rich grave goods were uncovered (Alberge 2001). This prompted interest in the possibility of more Anglo-Saxon remains in North Field, to the immediate west of the new building, as Saxon finds had previously been discovered there by metal detection and field walking (eg Mundell Mango *et al.* 1989). At the same time, a number of other areas in the vicinity were considered to merit further investigation. Principal amongst these was the area adjacent to, and immediately north of, the field containing the tumuli themselves where archaeological survey suggested that a further barrow might be present (Pattison 2000).

Hence, Professor Martin Carver of York University, who has guided archaeological research at Sutton Hoo for many years (Carver 1993 and 1998), asked the English Heritage Centre for Archaeology (CfA) to provide geophysical surveys of these areas. As part of this work the CfA were requested to test whether the newer generation of caesium vapour magnetometers might be more sensitive to buried archaeological remains at the site than the fluxgate gradiometer instruments that are more routinely employed for archaeological prospecting in the UK. The request for geophysical survey was supported by the English Heritage Inspector of Ancient Monuments for the region, Philip Walker.

Prior to the archaeological excavations in 2000, a number of other archaeological investigations have recently occurred associated with improvements to the site. Topographic and geophysical surveys have been carried out by Field Archaeology Specialists Ltd. (FAS) (Copp *et al.* 1997, Simpson 1999). Archaeological evaluation has been undertaken by Suffolk County Council Archaeological Service (SCCAS) (Abbott and Breen 1997, Abbott 1997). Also, the upstanding archaeology of the Sutton Hoo estate has been investigated and catalogued by the RCHME (Pattison 2000). These studies have helped to inform the present geophysical investigation.

Sutton Hoo lies on an area of glacial sand and gravel overlying Pliocene clays (British Geological Survey 1967, sheet 208). Soils are of the Newport 2 association which are deep well drained sandy often ferruginous soils (Soil Survey of England and Wales, 1983). Both of the areas surveyed were given over to rough grassland at the time of the survey, although they had been used for arable agriculture in the past.

Method

Grids of 30 metre squares were established in both the area adjacent to the tumuli and North Field using a Trimble kinematic differential geographical positioning system. The areas covered by these two grids are depicted in Figure 1.

Two types of magnetometer were available for the survey, a caesium vapour instrument that measures the total intensity of the ambient magnetic field and a fluxgate gradiometer that measures the vertical gradient of the vertical component of the ambient field. The former can potentially measure anomalies as small as 0.01nT but is less practical to use in confined areas and can be adversely affected by the strong magnetic gradients in the vicinity of large ferrous objects. The fluxgate gradiometers are less sensitive, but still capable of measuring gradients of the order of 0.5nT/m. Their configuration allows them to obtain meaningful measurements at smaller distances from large ferrous objects than the caesium instrument and their compact design makes them more practical to use in confined areas.

At Sutton Hoo it was found that the North Field, with the exception of the strip of land immediately west of the new visitors' centre, was open and relatively free of modern ferrous material, so this area was deemed most suitable for prospecting with a caesium vapour magnetometer. However, the areas adjacent to the tumuli and immediately to the west of the visitors' centre were partially covered with shrubs and subdivided by modern steel fencing. In view of the above considerations it was decided that a fluxgate gradiometer survey would be more suitable for these areas. To test whether there was any difference in the abilities of the two instruments to detect potentially archaeological anomalies in the sandy soils at Sutton Hoo, a 60m by 60m square area of the North Field caesium survey was resurveyed with the fluxgate gradiometer using the same traverses and sample intervals. The locations of the areas surveyed with each instrument are also shown in Figure 1.

The fluxgate gradiometer surveys

These were conducted using the standard method outlined in note 2 of Annex 1 with the exception that adjacent traverses were 0.5m apart. Traverses were laid out parallel to the grid axis closest to the north-south direction, except in the case of the 60m by 60m comparison square in the North Field where an east-west alignment was used for compatibility with the caesium survey.

The data from the area adjacent to the tumuli are presented as both an X-Y traceplot and a linear greytone, at a scale of 1:1250 in Figure 3, (a) and (b) respectively. In the traceplot, the only corrections made to the measured values were first to zero-mean each instrument traverse to remove heading errors and then to reduce extreme values using hyperbolic tangent range compression (similar to the arctangent range compression described by Scollar 1990, p504 but using the tanh function). This latter operation reduces the visually distracting effect of large spikes in the plot. The greytone data is also presented, superimposed on the location plan at 1:2500 scale in Figure 2.

The data from the area immediately west of the visitors' centre was processed in the same way as the above. However it was then transformed to the Fourier domain where filters were applied

that performed conversion to the vertical field component (Tabbagh *et al.* 1997) and transformation of the vertical field component to total field magnitude (Gunn 1975; Blakely 1996 p342). Owing to the effect of steep gradients caused by ferrous objects, a 5m radially symmetric Butterworth high pass filter was also applied (Gonzalez and Wintz, 1987 p181) before transformation back to the space domain. The resulting data set is effectively an estimate of the results that would have been obtained with a total field instrument, and is thus compatible with the caesium magnetometer survey. Hence this data was combined with that from the caesium survey and is plotted with it (see below).

The data from the 60m by 60m comparison area was also processed to zero the mean of each traverse and is depicted as a greytone plot at 1:1000 in Figure 5b. It was then transformed in the same way as the visitors' centre data set (except that the Butterworth high pass filter was not required), to produce the total field equivalent data set plotted in Figure 5c.

The caesium vapour magnetometer survey

This was carried out with a Scintrex Smartmag SM4G magnetometer with two caesium vapour sensors arranged 0.5m apart in the horizontal gradient configuration of the instrument. This allowed two traverses 0.5m apart to be surveyed simultaneously. The traverses were aligned with the east-west axis of the grid and measurements were taken at separations of 0.25m along each traverse.

The data was then processed by applying a one dimensional local median high pass filter with a 60m window width along each traverse, to suppress the effect of heading errors. Periodic effects in the data related to the instrument operator's stride length were also suppressed using a one dimensional Butterworth band-reject filter (Gonzalez and Wintz 1987 p199). Along the eastern edge of the survey the magnetometer was greatly affected by steep magnetic gradients caused by buried ferrous material relating to a rabbit fence, upstanding temporary fencing near the visitors' centre and agricultural equipment. A parabola was thus fitted to the affected portion of each traverse and subtracted from it to remove the high magnitude regional components caused by this ferrous material.

This data is presented as both an X-Y traceplot and a linear greytone, at a scale of 1:1250 in Figure 4, (a) and (b) respectively. In the traceplot the data has additionally been compressed using hyperbolic tangent range compression to reduce the visually distracting effect of large spikes in the plot. The greytone data is also presented, superimposed on the location plan at 1:2500 scale in Figure 2.

Additional processing applied to the magnetic data sets

Figure 6 presents the results of two additional Fourier filtering operations performed on the magnetic data that were used to assist in its interpretation. In this figure, (a) and (d) present the results from the two survey areas, exactly as plotted in Figure 2, for reference. The remaining figures present the results of two transformations on each of the two surveys. In both cases the fluxgate gradiometer data from the area adjacent to the tumuli was first transformed to total field data as outlined above for the area immediately west of the visitor's centre.

Figures (b) and (e) show the results of transforming the data using the Fourier domain reduction to pole operator (Baranov and Naudy 1964). This operator corrects for the regional angle of inclination of the earth's magnetic field and presents the survey as it would appear if the geomagnetic north pole had been situated directly beneath the site. In the UK the angle of inclination of the earth's field is approximately 67° resulting in magnetic features appearing as bipolar anomalies with a positive component offset slightly to the south of the causative feature and a smaller negative component to the north. However, at the pole the earth's field is vertical (ie: the angle of inclination = 90°) so anomalies are almost entirely positive and positioned directly over their causative features. This presentation can assist in the correct positioning of anomalies, however it can be seen that in the case of the Sutton Hoo magnetometer surveys the change in the positions of anomalies is minimal.

Figures 6 (c) and (f) show the results of processing the surveys with the Fourier domain pseudo-gravity transformation filter then calculating the maximum horizontal gradient of the resulting data set (Cordell and Grauch 1982, 1985). In this transformation of the data 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 on the data from plot 6(f) to identify points on the boundaries of anomalies and these were transferred directly to the CAD interpretation plan of Figure 7 to aid in tracing the boundaries of anomalies. Depth estimates were also obtained from this data set using the half-widths of the anomalies (Roest and Pilkington 1993). These estimates were used to classify the pit-like anomalies into those with depth estimates between 0.0-0.5m (near surface) and those with depth estimates typically greater than 0.75m (more deeply buried). This procedure produced less consistent estimates when applied to the transformed fluxgate data and so the depth classification was not applied to this data set.

Results

A graphical summary of the anomalies discussed in the following text, superimposed on the location plan, is provided in Figure 7.

(a) The North Field (Figures 4 and 7a)

The strongest magnetic anomalies in this area are the alternating lines of high magnitude positive (white in figure 4) and negative (black) responses due to buried pipes or cables identified in Figure 7a. One of these extends north-west from the new visitors' centre and it would be interesting to ascertain whether any archaeological discoveries were made when it was laid. Much of the area close to the visitors' centre is much affected by strong dipolar anomalies typically caused by near-surface ferrous objects. These are likely to be due to the construction work for the visitors' centre and render any weaker archaeological anomalies that might be present undetectable.

A number of parallel, closely spaced, linear negative anomalies are also visible in Figure 4 and inspection of the surface topography reveals these to be the response to modern agricultural activities in the field.

Towards the centre of the survey area a curving broad linear anomaly is visible, trending north west. This appears to be about 9m across with a peak magnitude of 8-10nT and has been indicated with a green hatch in Figure 7a. It corresponds in position with a gully that runs across the field and is visible in the FAS topographic survey (Copp *et al.* 1997, Figure 3). In the past this might have been the conduit for water to flow down into the nearby river Deben. The magnetic anomaly might thus represent an accumulation of magnetically enhanced alluvial sediment along the base of the gully.

A number of linear features detected by the magnetometers have also been indicated in yellow in Figure 7a. Given their width (~1.5m) and disposition these are likely to be caused by the remains of previous boundary ditches in the field. In the centre of the survey area two slightly narrower, short and irregular linear anomalies are also marked. These may be caused by the combined effects of smaller anomalies, such as pits (see below), or could even represent structural remains.

A striking aspect of the survey is the distribution of discrete positive magnetic anomalies across the whole of the survey area. These have diameters between about 1m and 5m across and peak anomaly strengths around 5-7nT. Similar anomalies have been observed at a site at Thurlby on Fenland gravel, caused by naturally occurring iron rich deposits (Cole 1995). Given the local soil chemistry, this explanation would also be plausible at Sutton Hoo. However, the peak strength of the Thurlby anomalies was ~50nT/m and their total field anomaly would be of a similar order of magnitude, much stronger than the Sutton Hoo anomalies. A second non-archaeological explanation is suggested by the SCCAS evaluations near the Coach House which indicated that re-landscaping had occurred at the time of its construction in the early 20th century (Abbott 1997, pages 5 and 15). Some of the pits noted in their evaluation, to the immediate south of the survey area, were interpreted as tree boles from plantings associated with this event.

Nevertheless, the south-eastern corner of the caesium magnetometer survey area is clearly an area of considerable archaeological importance. Pattison (2000) notes that the 7th century AD “Bromeswell Bucket” and a coin pendant of the emperor Honorius were discovered here (TM 2890 4934) as well as pottery of early and middle Saxon date. The tip of a Bronze Age spearhead was also discovered separately by a metal detector about 20m away (TM 2982 4933) and during the present survey work a quern stone was noted in the field boundary. This area is also only some 25m away from the location of the visitors’ centre beneath which wealthy Anglo Saxon burials were uncovered.

Hence, any anomalies present in this area should be scrutinised carefully before discounting an archaeological explanation. The shape and magnitude of these pit-like anomalies are not inconsistent with that produced by grave cuts or sunken-featured buildings and these causes cannot therefore be ruled out. However, there is no sign of any of the pits being surrounded by a ring ditch. Such burials were found during the excavations beneath the visitors’ centre and detection of ring ditches of similar diameter in the survey area would have significantly strengthened the interpretation of these anomalies as graves.

Further north, just south of the gully, a number of pit-like anomalies similar to those present in the rest of the field but apparently more deeply buried, have been marked. It is possible that these anomalies are caused by the same type of features as in the rest of the field but are covered with a deeper layer of soil that has accumulated in the gully. However, it is also possible that the difference in depth estimates does indicate some difference in the character of the causative features of these anomalies.

As mentioned above, an automated interpretation algorithm has been used to identify the boundaries of the pits and divide them into two depth classes ($\sim 0-0.5\text{m}$ below ground level shown in red in Figure 7 and $\geq 0.75\text{m}$ below ground level shown in magenta). The former category would be consistent with the SCCAS excavation results in 1997 where in trench 5 a prehistoric pit (0016) was discovered (Abbott, 1997 page 15). This was only 0.1m deep suggesting truncation caused by modern ploughing. In Figure 7a, only those pits where more than half the circumference could be identified by the algorithm are marked. As a consequence, many of the smaller anomalies visible in the survey have not been indicated. Nevertheless, it should be borne in mind that these smaller anomalies might also be of archaeological significance (hearths, smaller pits, etc). It should be noted too that the distribution of pits might be wider than indicated in Figure 7, especially where their responses may have been obscured by recent surface cultivation.

Two small ferrous responses have also been marked at the very southern edge of the survey. These would normally be discounted as modern objects, such as nails. However, given the archaeological context of the area, a cause due to more ancient artefacts cannot be discounted.

(b) The area adjacent to the tumuli (Figures 3 and 7b)

In this area also two very intense linear anomalies of alternating polarity are present, marked in blue in Figure 7b. These are likely to be caused by buried modern pipes or cables with a high iron content.

A number of areas of discrete near-surface ferrous response have also been indicated in light blue. Most of these, especially the larger areas, are likely to be caused by modern ferrous litter, some of which was visible on the surface of the field. However, given the proximity of this area to the Anglo-Saxon burial ground to the south, there is a remote possibility that the smaller anomalies could be caused by archaeological iron artefacts. Those towards the eastern side of the survey area would be the most likely candidates.

The survey is crossed by a number of linear positive anomalies about 1m wide and with peak magnitudes around 7.5nT/m and these have been indicated in solid yellow in Figure 7b. They are likely to be caused by infilled boundary ditches of archaeological origin, and seem likely to be a part of the prehistoric field system observed to the south and east (Pattison 2000, fig 5). A number of the ditches intersect in the centre of the survey area, perhaps suggesting this as a focus of activity. Other anomalies, similar in form but weaker, with peak magnitudes of only $2-3\text{nT/m}$, have been marked with a yellow hatch. The most intriguing of these is the broad curvilinear anomaly forming a half circle at the very northern edge of the survey area. Its magnitude is only just above the noise level of the survey, so any interpretation of its origin must be highly conjectural. However, it is possible that it represents an infilled ditch about $2-2.5\text{m}$ across. If this

were the case then the correlation in breadth and diameter to the ditches around the tumuli to the immediate south might be significant.

More pit-like anomalies have also been marked in red in this survey area. Once again it is possible that they represent a natural phenomenon as describe above. However, an archaeological origin cannot be ruled out given their apparent dimensions and proximity to the Anglo-Saxon burial ground. It is also interesting that they appear to cluster in the centre of the survey, in the same areas as the highest density of intersecting linear anomalies is observed.

Comparison of caesium and fluxgate magnetometer results (Figure 5)

The results of surveying a 60m by 60m square in the North Field with both instruments are presented in Figure 5 at 1:1000 scale. 5a and 5b show the caesium and fluxgate results respectively plotted with approximately equivalent greyscale parameters. Figure 5c shows the results of transforming the fluxgate gradiometer readings into the equivalent total field results. It can be seen that all the pit-like anomalies, the broad linear anomaly in the south west corner, the north-south trending linear anomaly in the north east and the north-south trending agricultural anomalies have all been detected by the fluxgate survey.

The main difference between the surveys presented in 5a and 5c is a variation in the regional background in the fluxgate survey which is not present in the caesium results. It is possible that this regional variation is not a real phenomenon but is an artefact of the techniques used to transform the data. In Figure 5d the results from 5c have been subtracted from 5a to show the residual anomalies. This figure indicates that the main differences are that the caesium magnetometer is more sensitive to the near-surface topography caused by recent agricultural activity and the regional trends in the transformed fluxgate survey just described. None of the potentially archaeological anomalies listed in the preceding section is visible in 5d indicating that both instruments had a similar magnitude of response to these anomalies.

The numerical correlation coefficient between the two data sets was calculated to be 0.23, which is surprisingly low given the good visual agreement between 5a and 5c. This is probably due to the regional background variation present in the transformed fluxgate results. Figure 5e, attempts to illustrate the correlation between the two data sets of 5a and 5c graphically. In this plot the caesium magnetometer readings have been plotted with varying intensities of orange and the transformed fluxgate results in varying intensities of blue. Where the two instruments agree, the two colours will sum to give a shade of grey. Where the caesium magnetometer gives a stronger positive response, orange will predominate. Where the fluxgate magnetometer gives a stronger response a shade of blue will result. Hence, if the results were perfectly correlated, the plot would appear as a greyscale plot exactly like 5a. Coloured areas indicate a disagreement between the two surveys. It can be seen that all the potentially archaeological anomalies do indeed show up in white, suggesting that they have been detected approximately equally by the two instruments. The only areas of colour are in the background between the anomalies confirming that this is where the discrepancies lie.

Conclusions

The present geophysical surveys have not identified any features at Sutton Hoo that can definitely be ascribed an Anglo-Saxon origin, despite their proximity to excavated remains. Nevertheless, linear anomalies possibly representing past boundary ditches have been detected in both of the areas surveyed. In the North Field these anomalies are straighter than those detected by FAS in their area E and associated with Iron Age or Romano-British enclosures (Copp *et al.* 1997). These were to the east of the present caesium survey near its north-eastern corner. Hence, the present survey does not suggest a continuation of that Iron Age system further west into North Field, despite Romano-British finds at the western edge of the field (Pattison, 2000 number 41).

A striking aspect of the magnetic surveys is the distribution of pit-like anomalies across the areas covered. Anomalies apparently similar in appearance are also present in some of the areas surveyed by FAS just south of the Coach House (Simpson 1999, areas G1 and G2, Figures CII and CIII). These are most prevalent in the North Field and might well have a natural origin associated with iron panning or former tree root boles. Their size and proximity to excavated Anglo-Saxon remains is suggestive, however, and the possibility that at least some of them represent further burials or sunken-featured buildings should not immediately be discounted. The sheer number of such anomalies seems to mitigate against such an interpretation but it has been conjectured that the cemeteries beneath the visitors' centre and in the tumuli field might represent the northern and southern ends of a single vast burial area (Hills 2000). In this case large numbers of burials might indeed be expected.

In the area adjacent to the tumuli, no anomaly was noted in the south western corner corresponding to Pattison's low semi-circular mound (TM 2882 4886, Pattison 2000, number 1). The survey in this area has suffered from the presence of near surface ferrous litter and it is possible that this masks any archaeological anomalies. However, an intriguing, apparently semi-circular, anomaly has been detected at the northern edge of this survey.

One of the aims of the survey was to see whether a caesium vapour magnetometer would be better able to detect archaeological remains in the sandy soils at Sutton Hoo than the fluxgate gradiometers more routinely employed for archaeological prospecting. The tests carried out suggest that, on the strength of the 60m by 60m area compared, the difference between the resolution of the two instruments is minimal and the caesium instrument was primarily more sensitive to near surface topographic effects. However, a larger area of comparison containing a broader range of magnetic anomalies will need to be tested before a definitive conclusion can be drawn. The ability to measure total field results has been of benefit in the interpretation of the precise position and burial depth of causative features and this aspect of caesium magnetometer survey deserves more attention and development in future.

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Annex 1: Notes on standard procedures

- 1) **Resistivity Survey:** Each 30 metre grid square is surveyed by making repeated parallel traverses across it, all aligned parallel to one pair of the grid 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 grid square edge. Readings are taken along each traverse at 1 metre intervals, the first and last readings being 0.5 metres from the nearest grid 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 (Ω m).

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 Centre for Archaeology using desktop workstations.

- 2) **Magnetometer Survey:** Each 30 metre grid square is surveyed by making repeated parallel traverses across it, all parallel to that pair of grid 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 grid 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 grid 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.

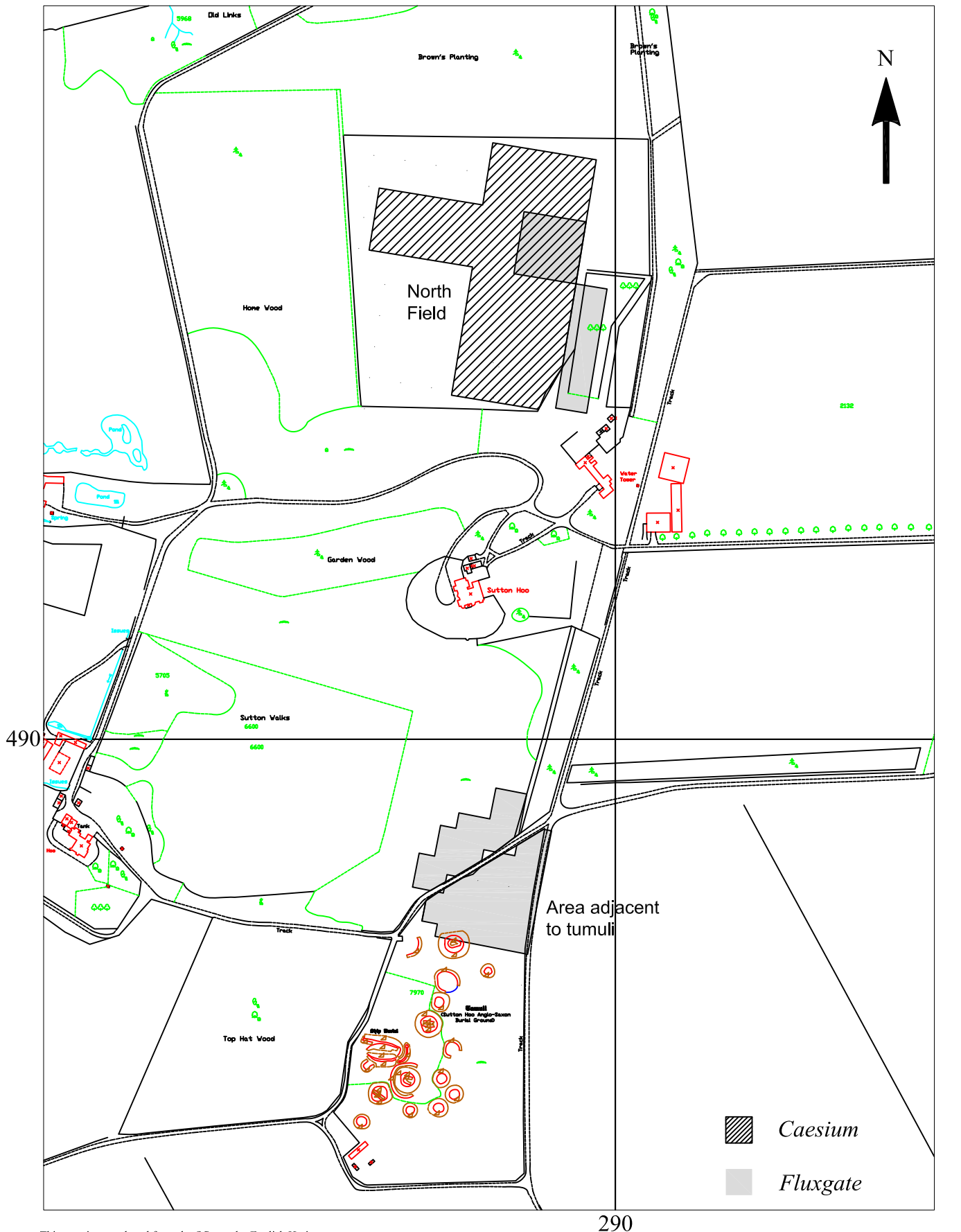
Unless otherwise stated the measurements are made with a Geoscan FM36 fluxgate gradiometer which incorporates two vertically aligned fluxgates, one situated 0.5 metres above the other; the bottom fluxgate is carried at a height of approximately 0.2 metres above the ground surface. The FM36 incorporates 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 Centre for Archaeology using desktop workstations.

- 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) SUTTON HOO, SUFFOLK
 Location of Geophysical surveys, December 2001

TM2949

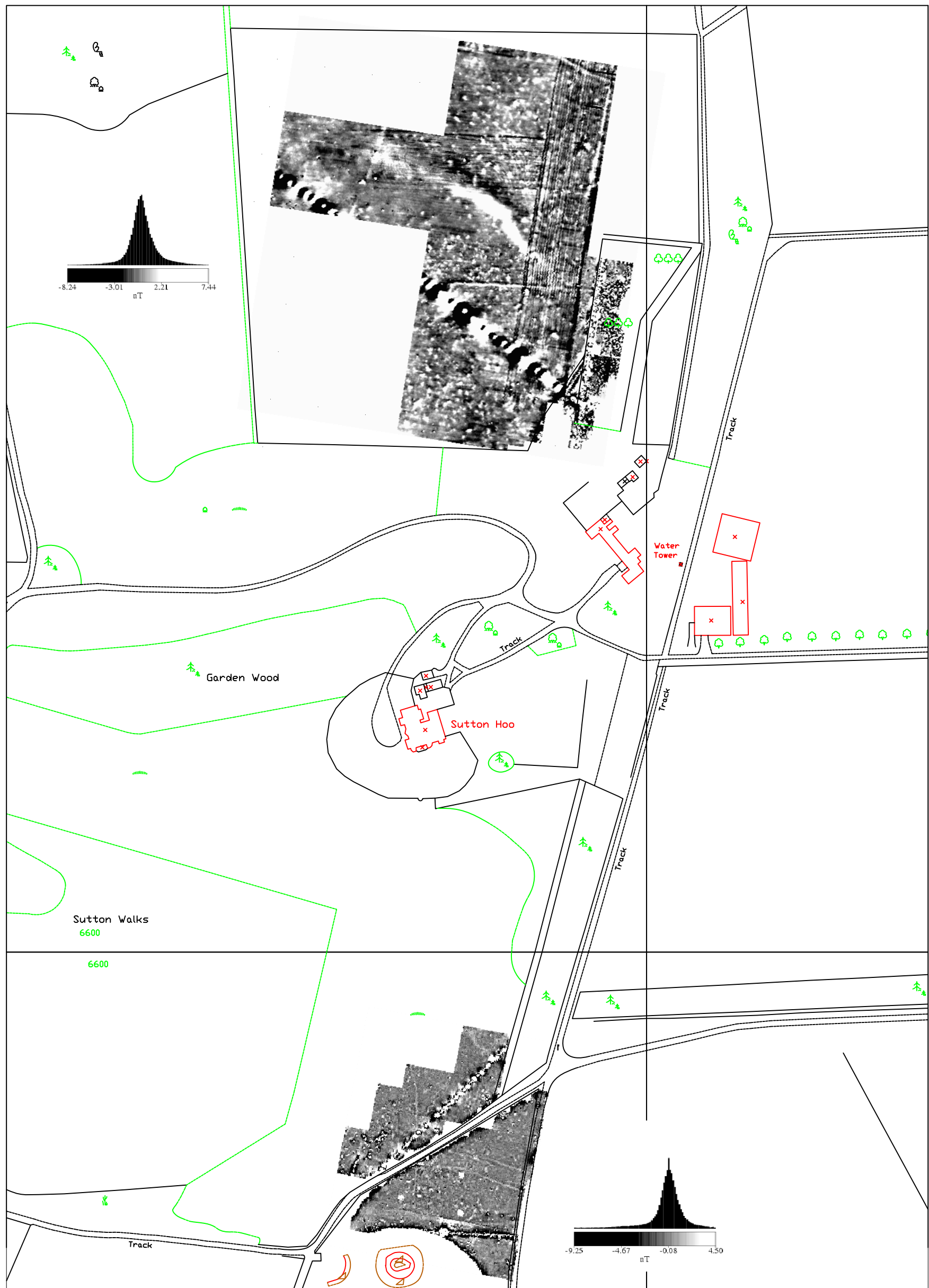


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Figure 2) SUTTON HOO, SUFFOLK

Location of Geophysical surveys, December 2001

TM2949



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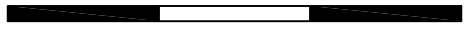
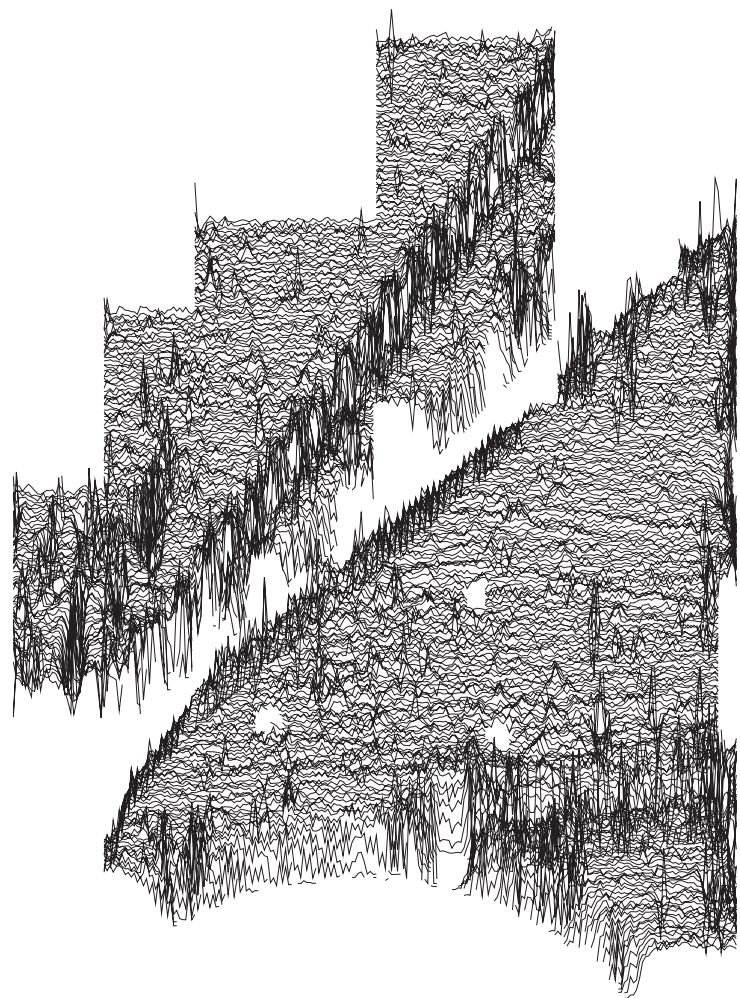
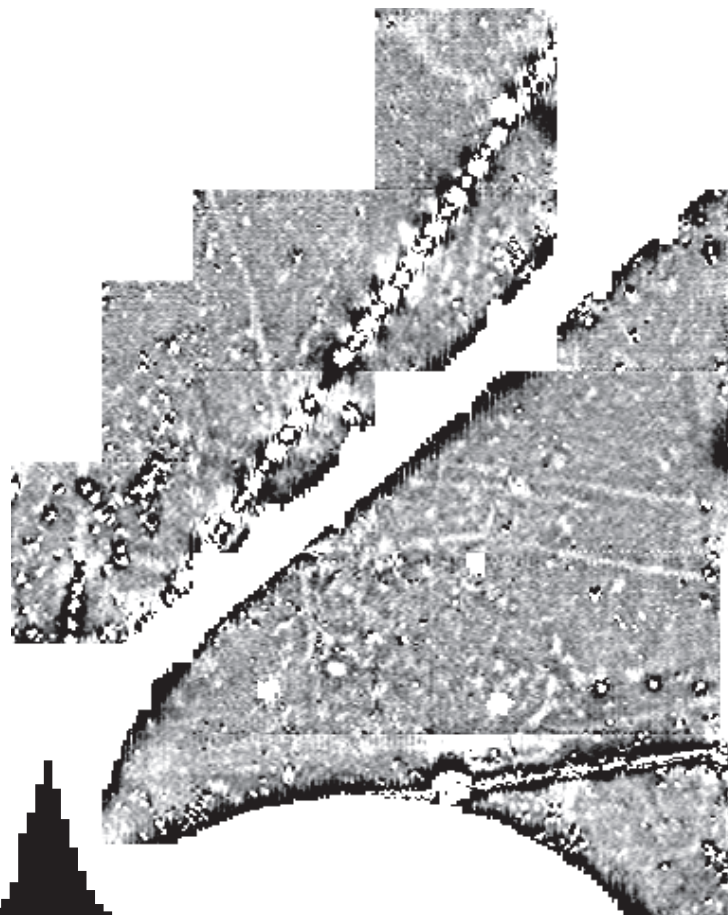
0  150m
1:2500

Figure 3) SUTTON HOO, SUFFOLK, Area adjacent to tumuli:
Fluxgate magnetometer survey, December 2001.

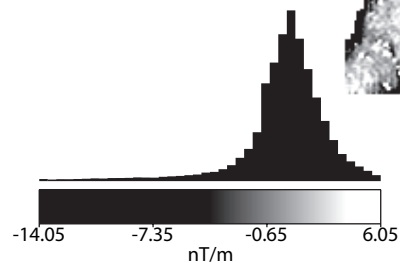
(a) Traceplot of data (extreme values suppressed)



(b) Linear greytone plot between ± 4 nT/m



50nT/m

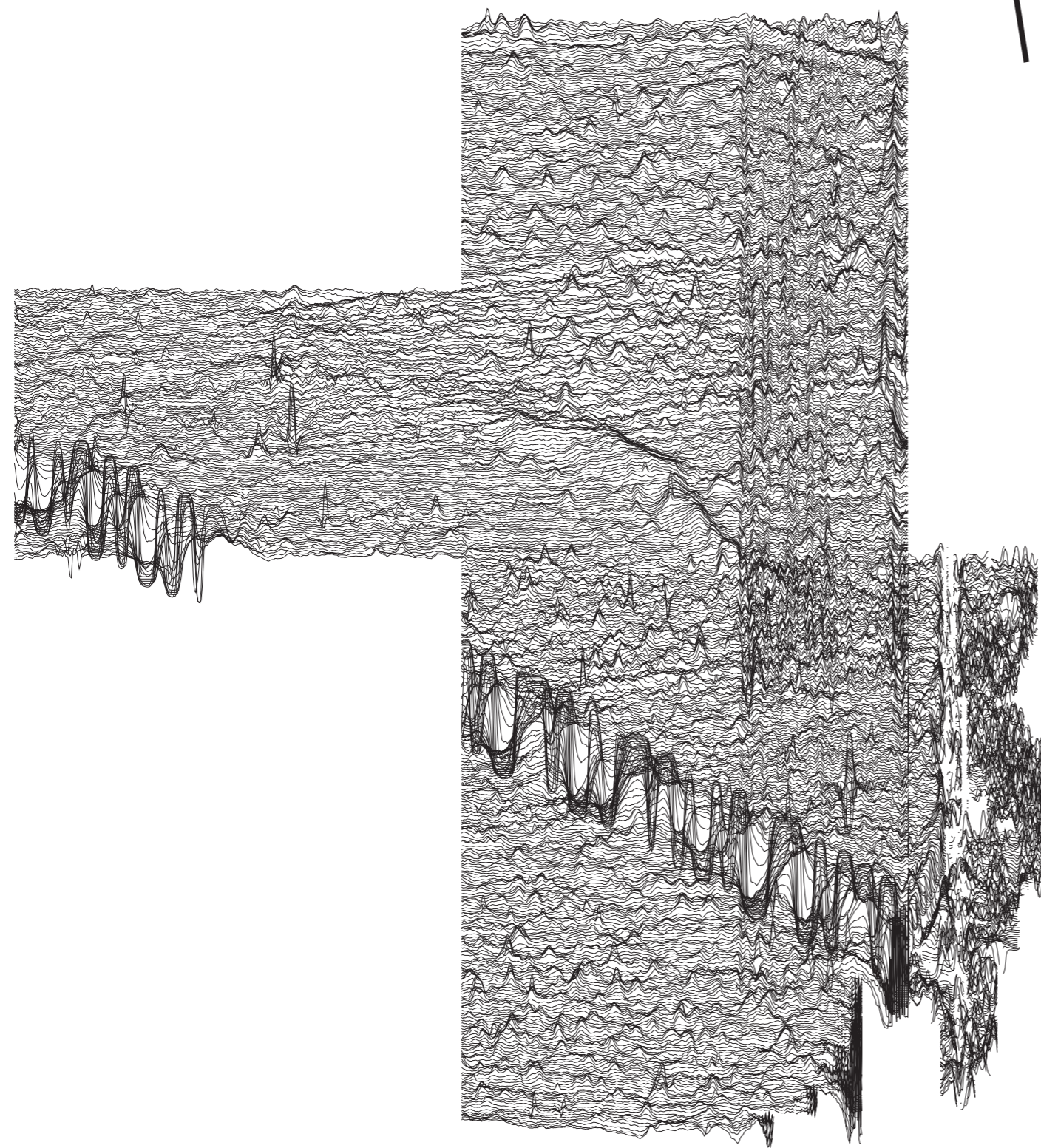


0 90m

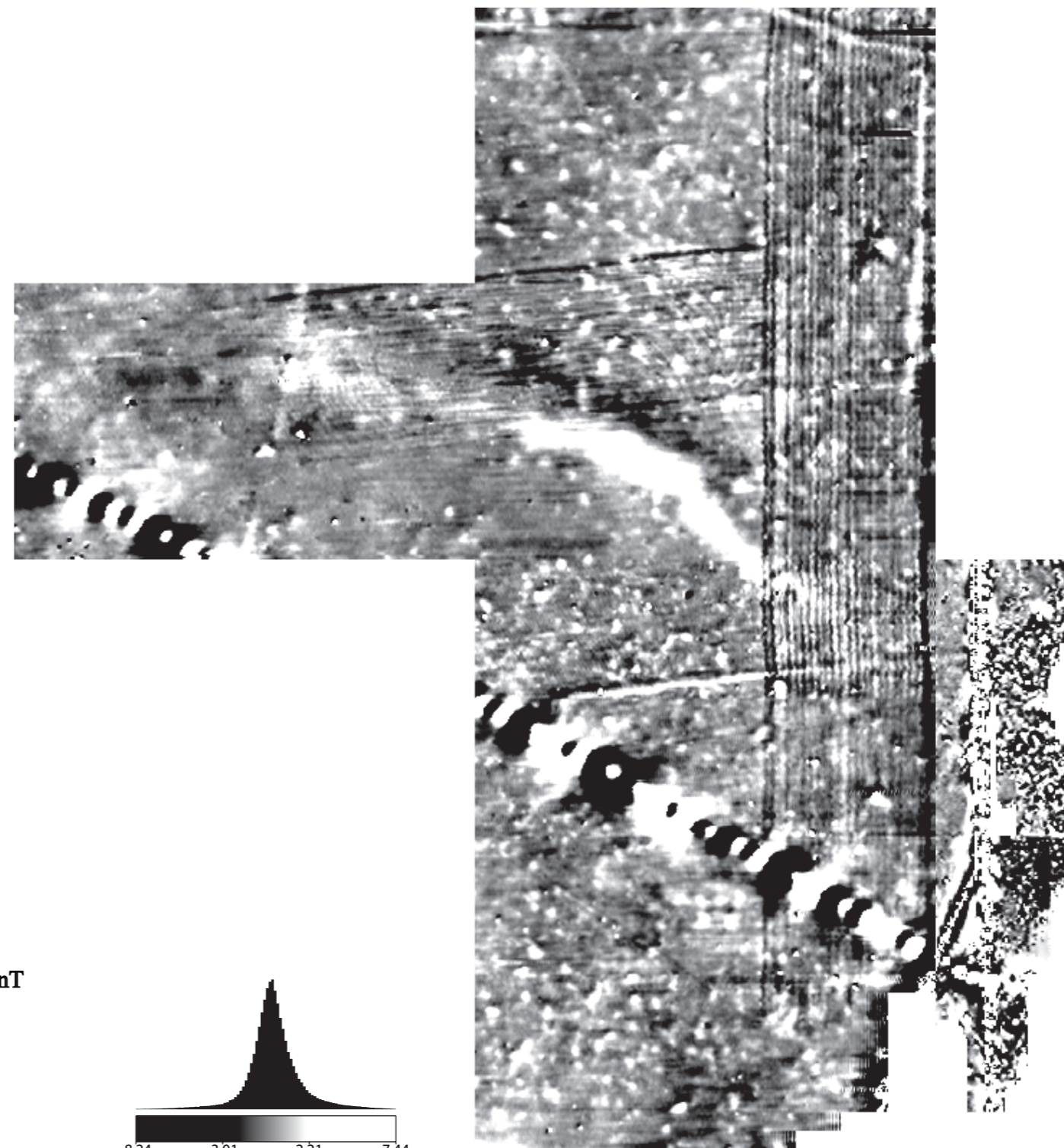
1:1250

Figure 4) SUTTON HOO, SUFFOLK, North Field:
Caesium and transformed fluxgate magnetometer surveys, December 2001.

(a) Traceplot of data (extreme values suppressed)



(b) Linear greytone plot between $\pm 2nT$



25nT

-8.24 -3.01 2.21 7.44
nT

0 90m

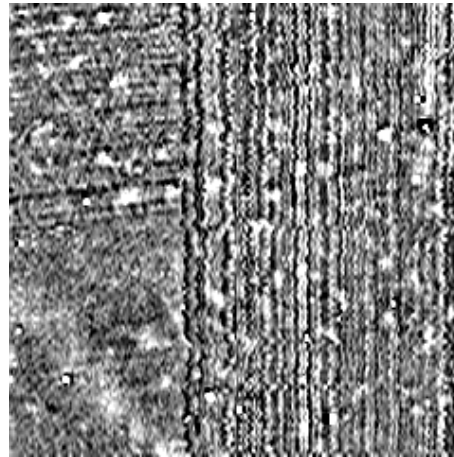
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Figure 5) SUTTON HOO, SUFFOLK, *Comparison of area surveyed with both caesium and fluxgate magnetometers [note that greyscale does not apply to (b) and (e)], December 2001.*

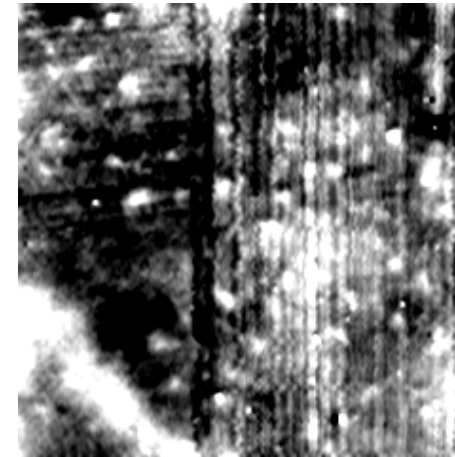
(a) Caesium survey (total field data).



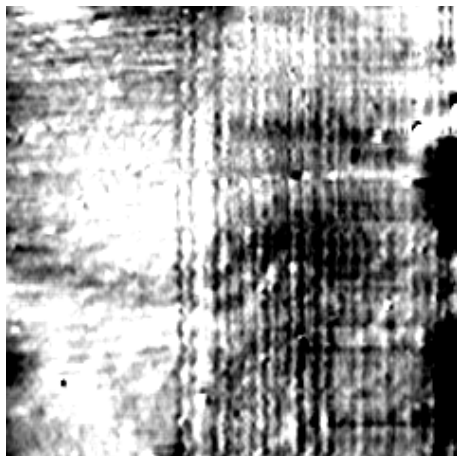
(b) Fluxgate gradiometer survey (plotted between +/-4nT/m).



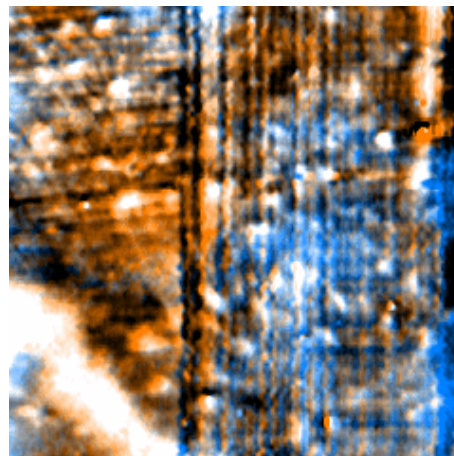
(c) Fluxgate data transformed to equivalent total field component.







(d) Residuals of Caesium total field data: (a) - (c).

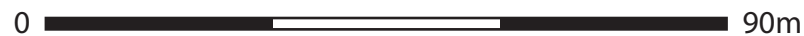
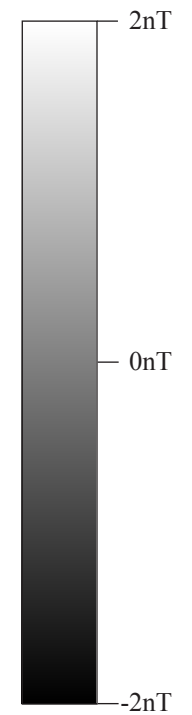


(e) Colour comparison of Caesium and transformed fluxgate data.



Key

-  Strongly negative in both caesium and transformed fluxgate surveys.
-  Strongly positive in both caesium and transformed fluxgate surveys.
-  Positive only in caesium survey.
-  Positive only in transformed fluxgate survey.

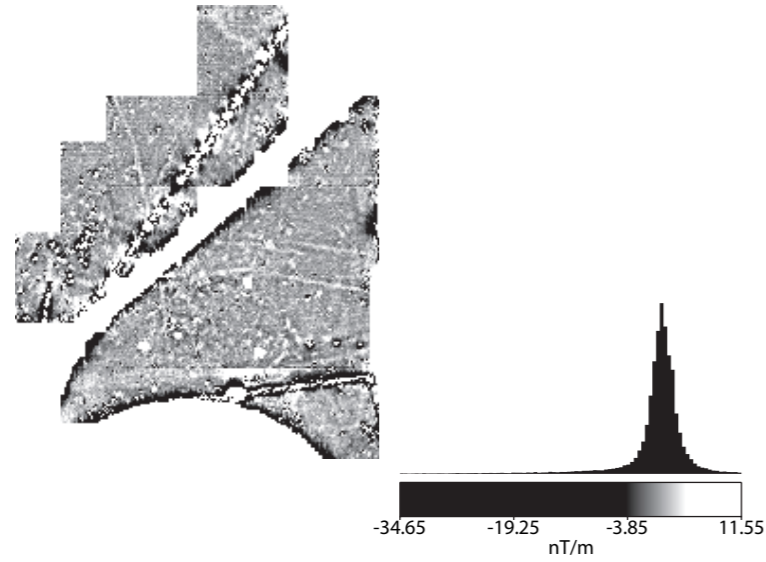


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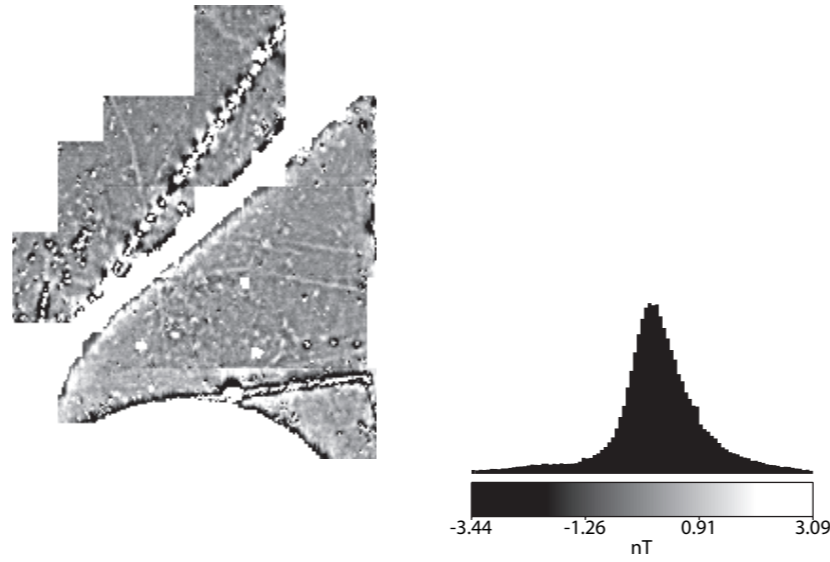
Figure 6) SUTTON HOO, SUFFOLK: *Data transformations of caesium and fluxgate magnetometer surveys from both the area adjacent to the tumuli and the North Field, December 2001.*



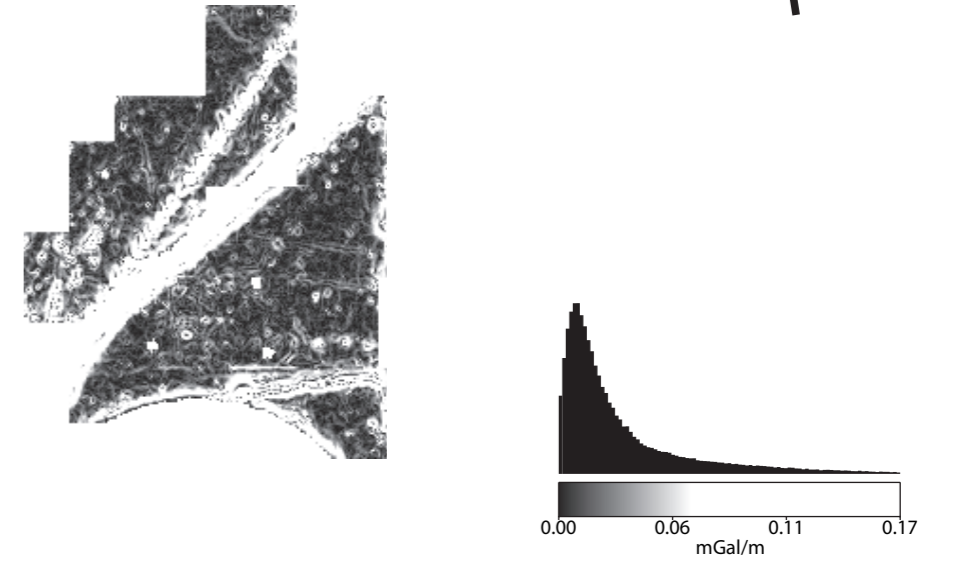
(a) Fluxgate survey from area adjacent to tumuli.



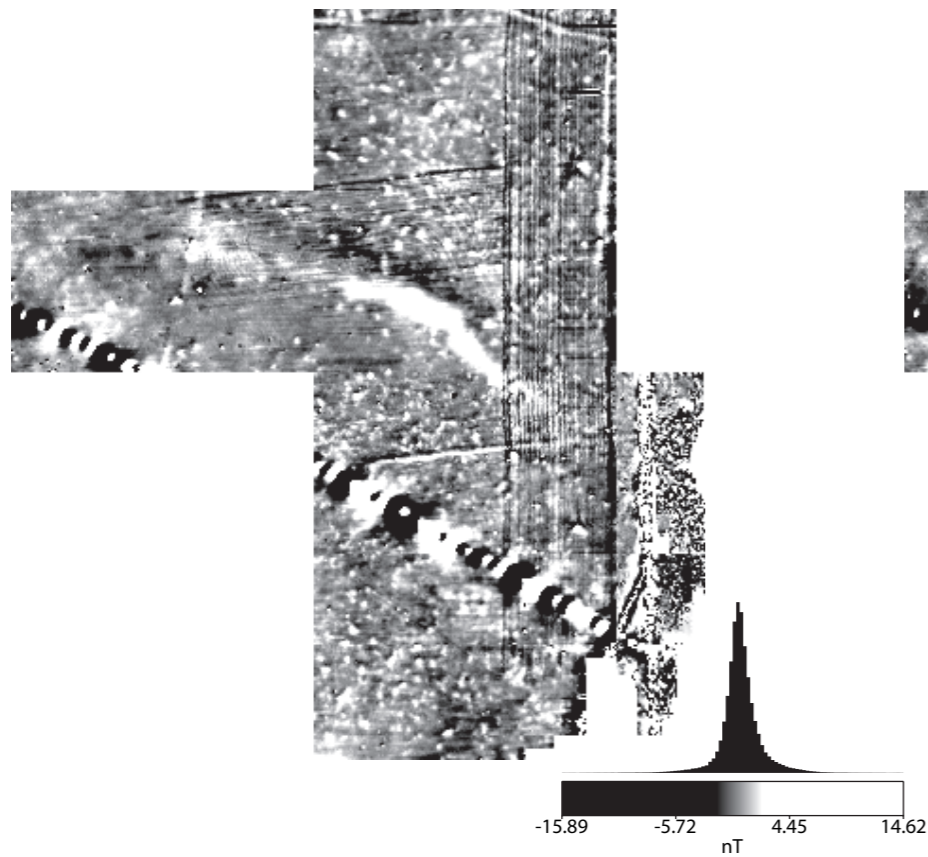
(b) Fluxgate survey from (a) after transformation to total field component and reduction to the pole.



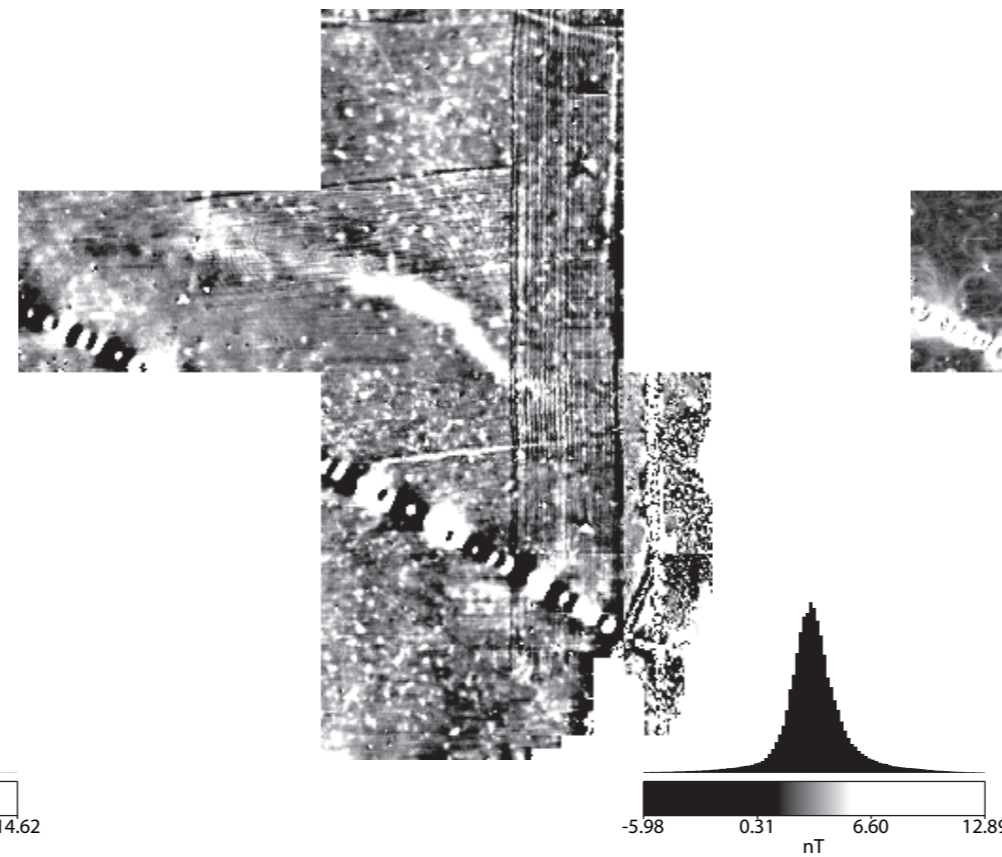
(c) Fluxgate survey from (a) after transformation to total field component and calculation of the horizontal gradient of the pseudogravity anomaly.



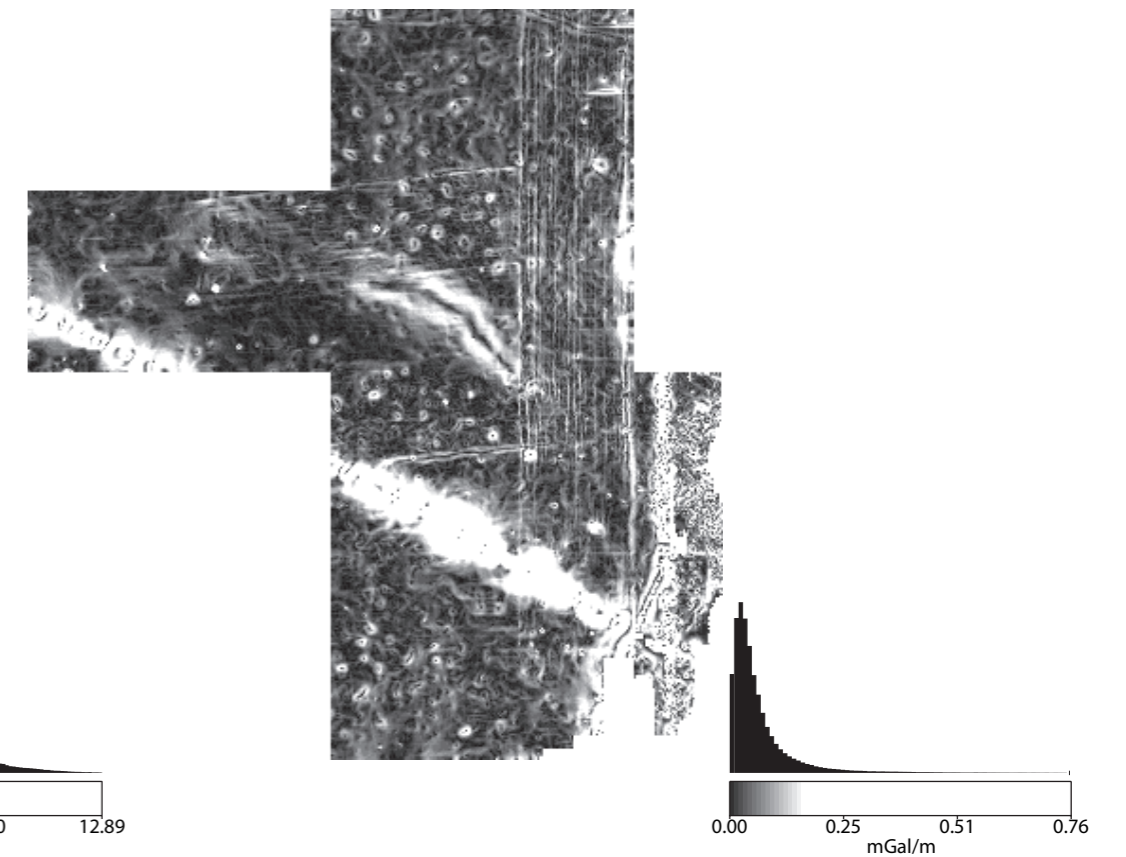
(d) Caesium survey from North Field combined with transformed fluxgate data from area next to the visitors' centre.



(e) Caesium survey from (d) after reduction to the pole.



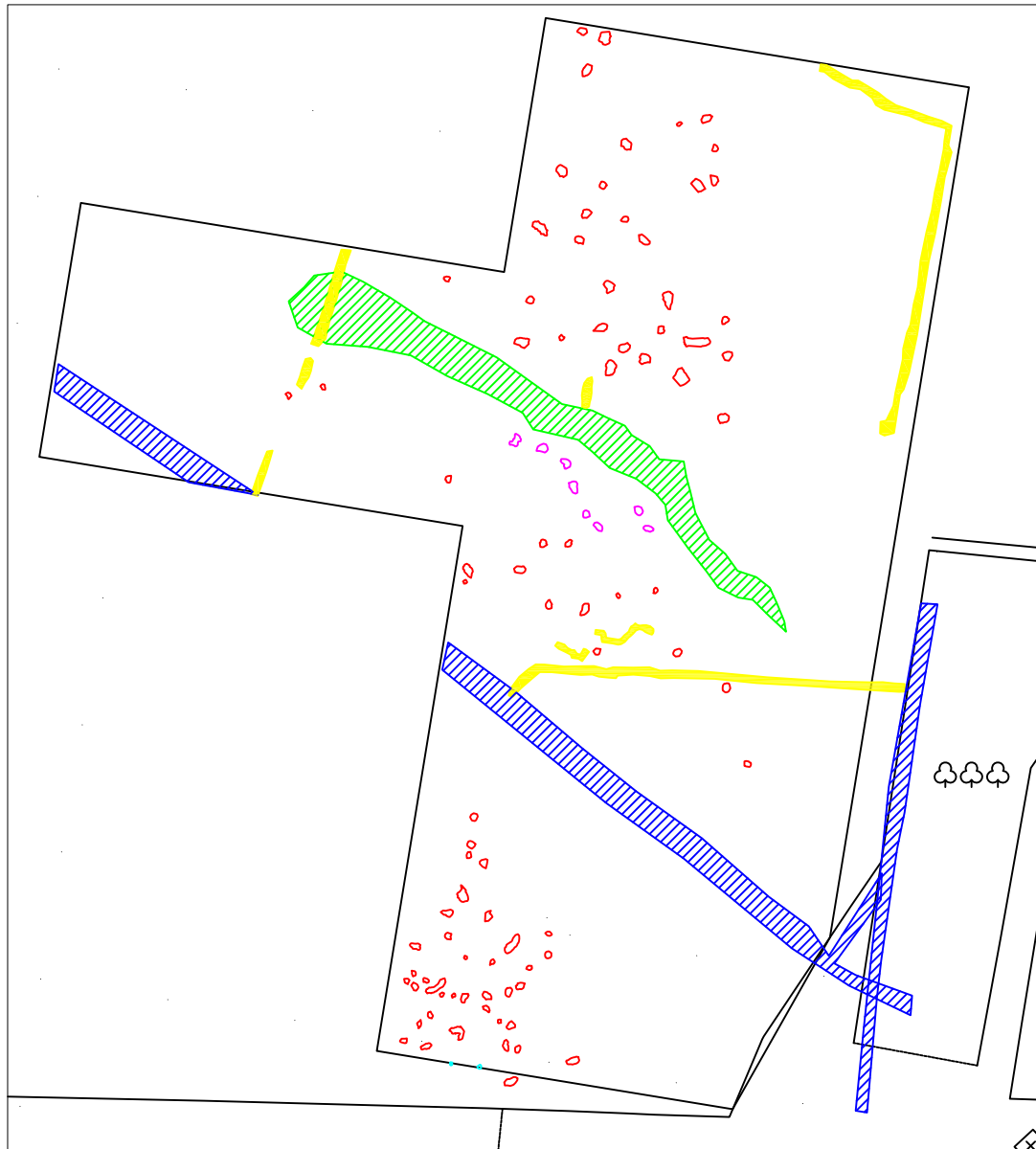
(f) Caesium survey from (d) after calculation of the horizontal gradient of the pseudogravity anomaly.



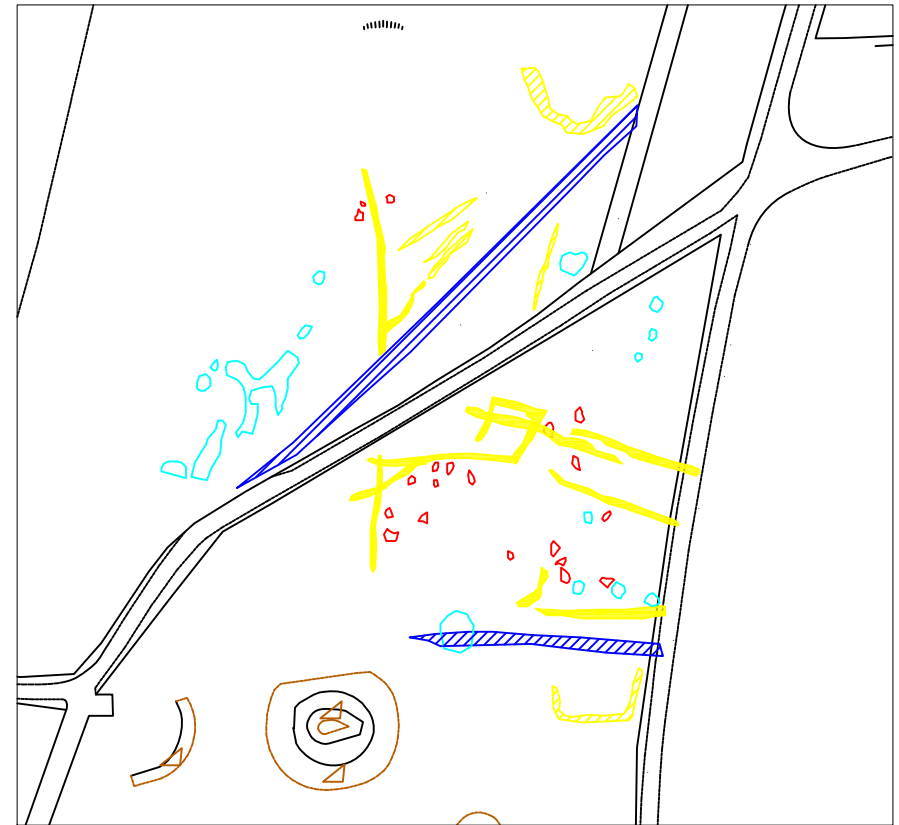
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Figure 7) SUTTON HOO, SUFFOLK: *Interpretation of Geophysical surveys, December 2001*







(a) North Field



(b) Area adjacent to tumuli



Key

- | | | | |
|---|---|---|---|
|  | Linear, ditch-like features (weaker anomalies shown hatched). |  | Pit like anomaly of possible archaeological significance. |
|  | Response to channel. |  | Deeper pit like anomaly. |
|  | Buried pipe or fence. |  | Near surface ferrous response. |