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REPORT ON THE GEOPHYSICAL SURVEY AT CALLESTICK VEOR, CORNWALL, REPORT ON THE GEOPHYSICAL SURVEY, 1997

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Summary

A magnetometer survey was conducted at Callestick Veor, Cornwall, in response to a request from the Cornwall Archaeological Unit to investigate archaeological activity in the vicinity of the known 'round' enclosure at the site. The specific aim of the survey was to provide a broader context for the limited geophysical survey and excavation results obtained from the W of the monument prior to the construction of the Engelly to Sevenstonemile section of the Cornwall Spine Water Main. Despite the interference caused by the presence of the water pipeline a wealth of significant magnetic anomalies were revealed. Whilst the majority of these anomalies are associated with the 'round' enclosure there is tentative evidence for the presence of further Bronze Age dwellings to the N of the monument.

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CALLESTICK VEOR ROUND, CORNWALL
Report on geophysical survey, July 1997.

Introduction

Prior to the construction of the Engelly to Sevenstonemile section of the Cornwall Spine Water Main a geophysical survey was conducted along the pipeline corridor immediately W of the known 'round' enclosure at Callestick Veor, Cornwall. This monument (SMR 19507) is still visible as a slightly raised circular bank bisected by a more recent field boundary separating two parcels of agricultural land. The results of this initial geophysical survey (Geophysical Surveys of Bradford 1995) revealed a number of significant ditch-type responses related to the round enclosure and a large pit-like anomaly, some 5m in diameter, in the northern half of the survey area. This latter anomaly was identified as the remains of a Bronze Age round house during subsequent excavation of the pipeline easement by the Cornwall Archaeological Unit (CAU).

Additional geophysical survey of the area beyond the pipeline corridor was requested by the CAU, through the English Heritage Inspector of Ancient Monuments, to provide a broader context for the interpretation of the limited evaluation results obtained during the construction of the water main. The specific aim of this survey was to investigate the area to the N of the monument and examine the possibility of more extensive Bronze Age activity predating the round enclosure.

The site (centred on SW 769 506) is located on well drained fine loamy soils of the Denbigh 2 association (Soil Survey of England and Wales 1983) developed over a substrate of Devonian Ladcock Beds or Grampound Grit (Institute of Geological Sciences 1974). At the time of the survey both land parcels contained a cut hay crop that was drying in the field prior to bailing.

Method

Due to the success of the initial magnetometer survey (Geophysical Surveys of Bradford 1995) it was this technique that was adopted to cover the extended area beyond the pipeline corridor. Figure 1 details the 30m grid established over the site and also shows the location of the initial magnetometer survey. Data was collected from each 30m grid square using a Geoscan FM36 fluxgate gradiometer along N-S traverses following the standard method outlined in note 2 of Annex 1.

Plan A shows a greytone image and X-Y traceplot of the magnetometer data after statistical processing of each survey line to provide a zero-centred mean. This process eliminates offsets between adjacent survey lines that may occur due to the directional sensitivity of fluxgate gradiometers when data is collected from alternate "zig-zag" traverses and considerably improves the presentation and interpretation of the resulting data. Unfortunately, when the survey data contains extreme values (e.g. due to the presence of a ferrous pipe) this algorithm may well result in a mismatch between affected areas of adjacent survey squares (as is evident across the line of the pipe in Plan A).

In addition, the data presented in the X-Y traceplot has been truncated to a range between ±50nT to remove the extreme response of the water main pipeline.

Results

Modern interference

The presence of the ferrous water main along the E edge of the survey has severely curtailed the identification of significant archaeological anomalies in this area. The course of the pipeline is visible as an intense positive anomaly (>204.7nT) **[1]** that has completely saturated the response of the magnetometer fluxgates when set to the 0.1nT resolution range. This phenomenon combined with zero-mean processing of individual survey lines (*see above*) accounts for the band of extreme positive readings running NS across the pipeline in squares 4, 8, 12, 16, 20, 24 and 26.

Of greater concern is the discrepancy in the course of the pipeline anomaly between squares 8 and 12. The anomaly in square 4 appears to be displaced to W of the linear course of the pipeline by approximately 6m. However, linear cultivation anomalies in square 7 (surveyed and downloaded from the same instrument as square 8) seem to be continuous with matching anomalies in adjacent squares 3 and 11. This suggests that the data from square 8 is correctly orientated and that either the anomaly reflects a real displacement in the linear course of the pipeline (unlikely) or loss of data due to a sporadic datalogger error in the instrument itself.

Two orientations of faint linear cultivation marks are also visible in the survey data. The first **[2]** is found only in the western field and consists of a closely spaced (~2m separation) pattern of weak positive anomalies running parallel to the course of the southern field boundary. The extensive nature of this pattern combined with the convenient orientation with regard to the current field boundaries suggests that these anomalies reflect recent mechanical agricultural practice. The second cultivation pattern **[3]** is found in both fields and consists of a less extensive more broadly spaced (~4m separation) pattern of anomalies. The orientation of **[3]** bares little relation to the present field boundaries and may well represent the remains of a more ancient agricultural regime. An additional linear anomaly **[4]** running parallel to the current field boundary N of squares 3 and 4 is most probably related to a recent ploughing headland.

Archaeological anomalies

The most significant archaeological anomalies are found in the southern half of the survey area and are related to the round enclosure. Anomaly **[5]** forms an extensive arcuate ditch encompassing the extant monument suggesting that the original round enclosure consisted of an outer defensive ditch with a raised internal bank (see Figure 2). A pattern of intense (>30nT) pit-type anomalies follows the inner radius of the enclosure ditch and these appear to be deliberately clustered in two main groups **[6]** and **[7]**. The function of these is difficult to ascertain although the intensity of their response suggests a considerable concentration of enhanced magnetic material. However, their position, apparently on or near the inner edge of the enclosure ditch, seems an unlikely location for contemporary features such as rubbish pits domestic or hearths - although it is possible that they could represent small-scale industrial features from a later phase of occupation. An alternative interpretation may be that they represent the remains of timber post-holes forming a palisade or other defensive structure similar to the post-hole features excavated within the inner enclosure ditch of the Penhale round (J. Nowakowski *pers. comm.*). The intense magnetism of these anomalies may indicate that the original timber features were destroyed by fire, thus creating a local concentration of magnetically enhanced burnt soil.

An entrance to the round enclosure may be proposed at the apparent break in the enclosure anomaly in square 22. This coincides with a discontinuity in the extant earthwork as well as the disposition of linear anomalies **[8]** and **[10]**. Unfortunately, there was insufficient time during this survey visit to cover the area immediately S of squares 21 and 22 that would have completed the circuit of ditch **[5]**.

Activity within the round enclosure itself is limited to a scatter of weak (~5nT) positive responses related to either small pits or short ditch sections. It is of interest to note that the modern cultivation anomaly **[2]** does not extend inside the enclosure through squares 18 and 22. As cultivation patterns generally arise due to variations in topsoil microtopography caused by ploughing the absence of such anomalies within the round enclosure suggests that recent ploughing has largely respected the monument.

A series of connecting ditch-type anomalies **[8]** apparently form an additional defensive structure encompassing the round enclosure. Other more fragmented anomalies **[9 - 12]** largely respect the two enclosure ditches **[5]** and **[8]** and may possibly represent field boundaries associated with the settlement. The pattern of ditches is similar to other examples of Cornish round settlements revealed through geophysical survey (e.g. David 1982 and Linford *in press*).

Anomaly **[9]** is of interest as it bisects a slightly less intense (~10nT) circular response **[13]** with a diameter of ~5m. This compares favourably with the dimensions of the large pit-type response encountered during the 1995 magnetometer survey (Geophysical surveys of Bradford 1995) and a similar anomaly revealed in the vicinity of the Penhale round (Linford 1994) - both of which were subsequently confirmed to be the remains of Bronze Age dwellings. Anomalies **[14]** and **[15]** demonstrate a similar response to **[13]** and may also represent such activity predating the round settlement. However, all three anomalies exhibit a much weaker magnitude of response than the round house revealed in the initial magnetometer survey (~10nT compared with ~30nT). Anomalies **[16]** and **[17]** again have similar dimensions and demonstrate a magnitude of response (~30nT) comparable to the round house feature. Whilst these latter two anomalies may therefore well be indicative of additional Bronze Age activity the possibility that they represent semi-industrial or settlement activity associated with a different phase of the site remains equally viable.

Conclusion

Despite the interference caused by the presence of the water main along the E edge of the survey area a number significant archaeological anomalies have been identified throughout the survey area. The results suggest that the 'round' consisted of a concentric outer ditch and inner bank surrounded by an additional polygonally-shaped enclosure. The entrance to the round would appear to be on the western side and a number of ditch-type anomalies are seen to respect the orientation of the enclosure. There is little evidence for substantial within the central round enclosure. Within the inner perimeter of the ditch there are a number of very distinct individual anomalies which may represent burnt structural remains, hearths or industrial features, possibly belonging to a later phase in the monuments occupation.

Further tentative evidence for activity predating the round settlement is suggested by a number of large pit-type anomalies concentrated to the N of the monument in the western field.

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Date of survey: 21-23/7/97

Reported by: N. Linford

Date of report: 28/8/97

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Soil Survey of England and Wales, 1983, *Soils of England and Wales*, Sheet 5, South West England.

Enclosed Figures and plans

Figure 1 Location of the geophysical surveys November 1995 and July 1997. (1:2500).

Figure 2 Greytone image of raw magnetometer data (July 1997) superimposed on the OS map. (1:2500).

Plan A (1) Greytone of raw magnetometer data, (2) X-Y traceplot of truncated magnetometer data and (3) summary of significant anomalies. (1:1250).

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.

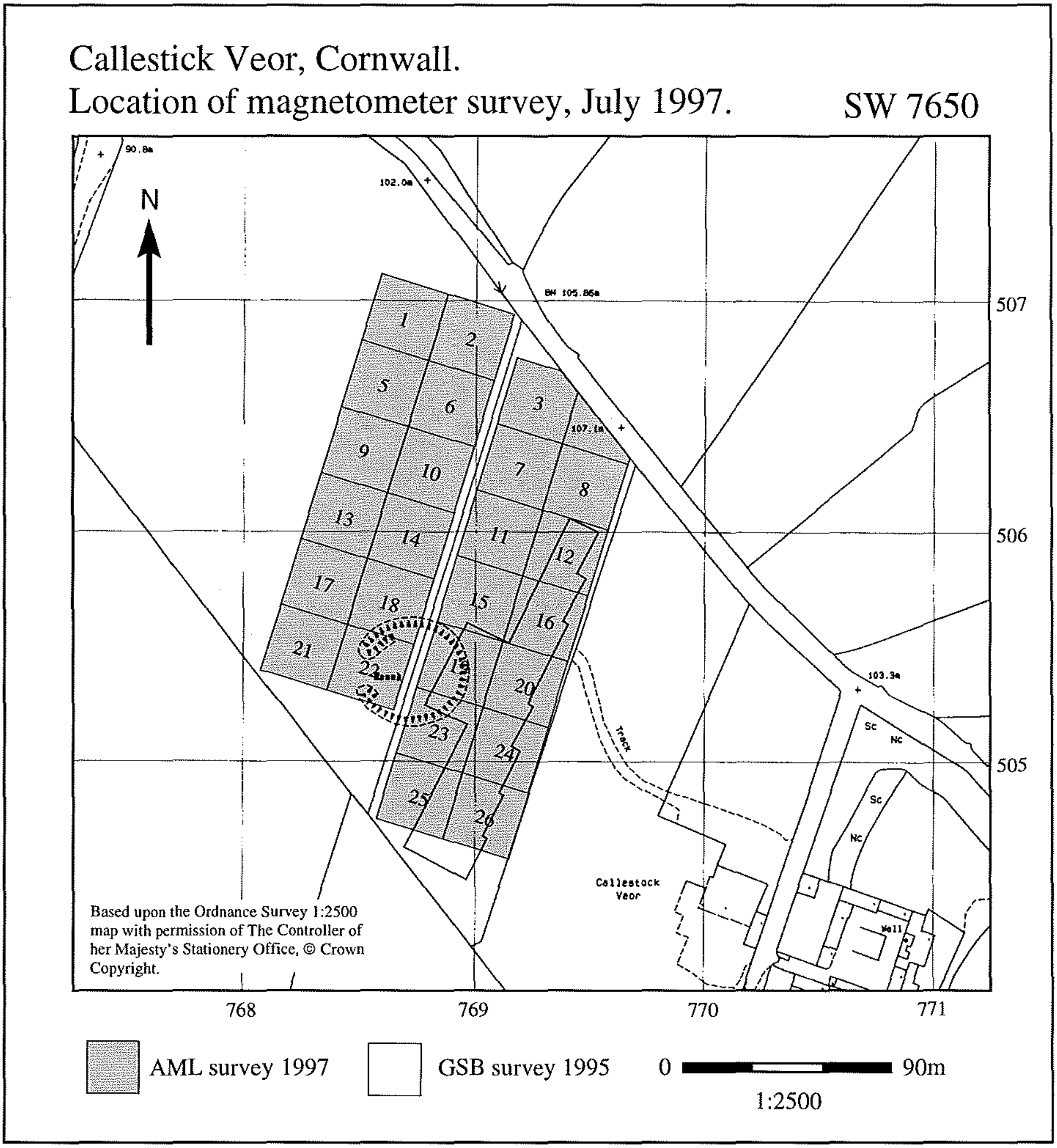


Figure 1; Callestick Veor, Cornwall, *Location of geophysical surveys November 1995 and July 1997.*

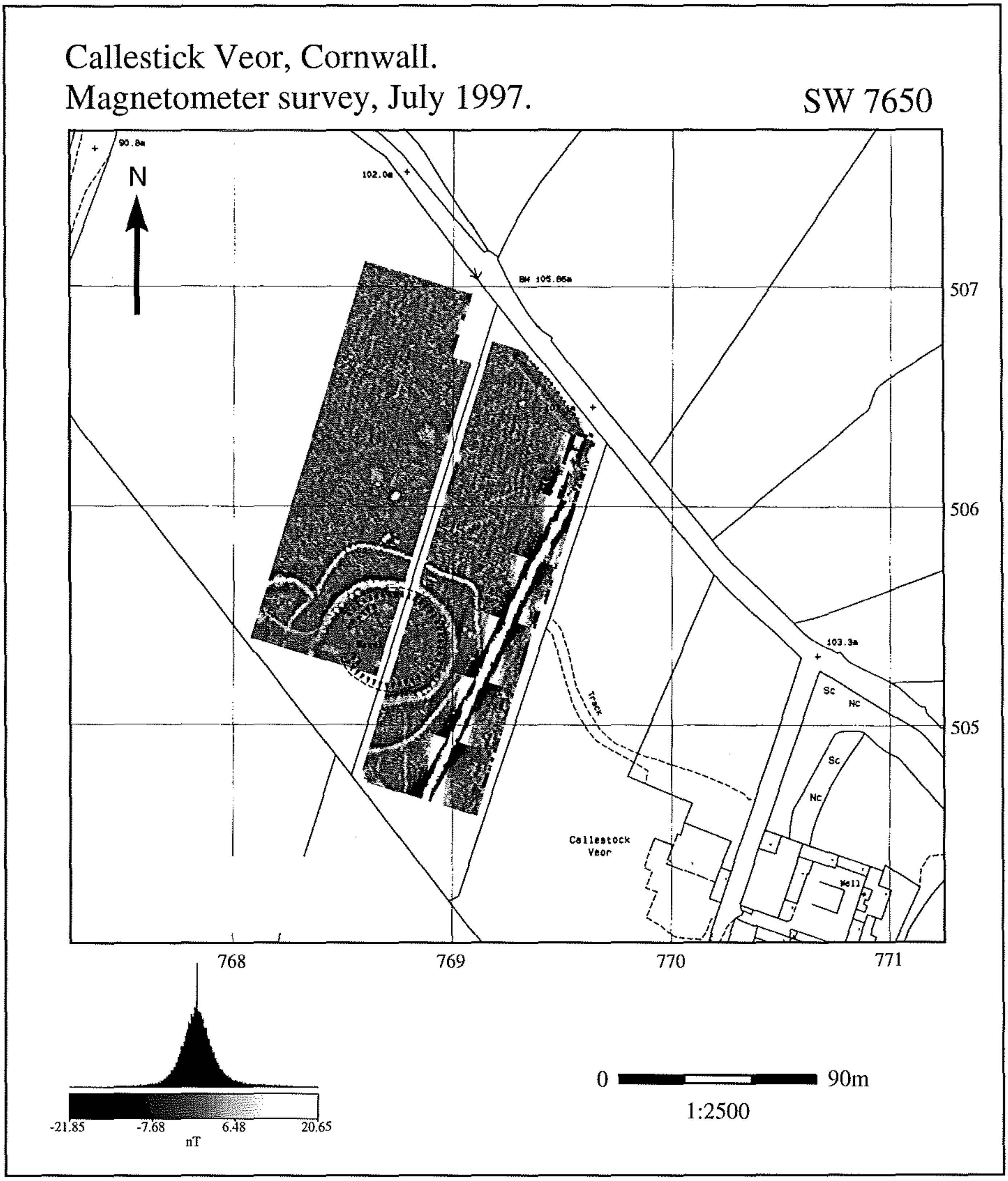
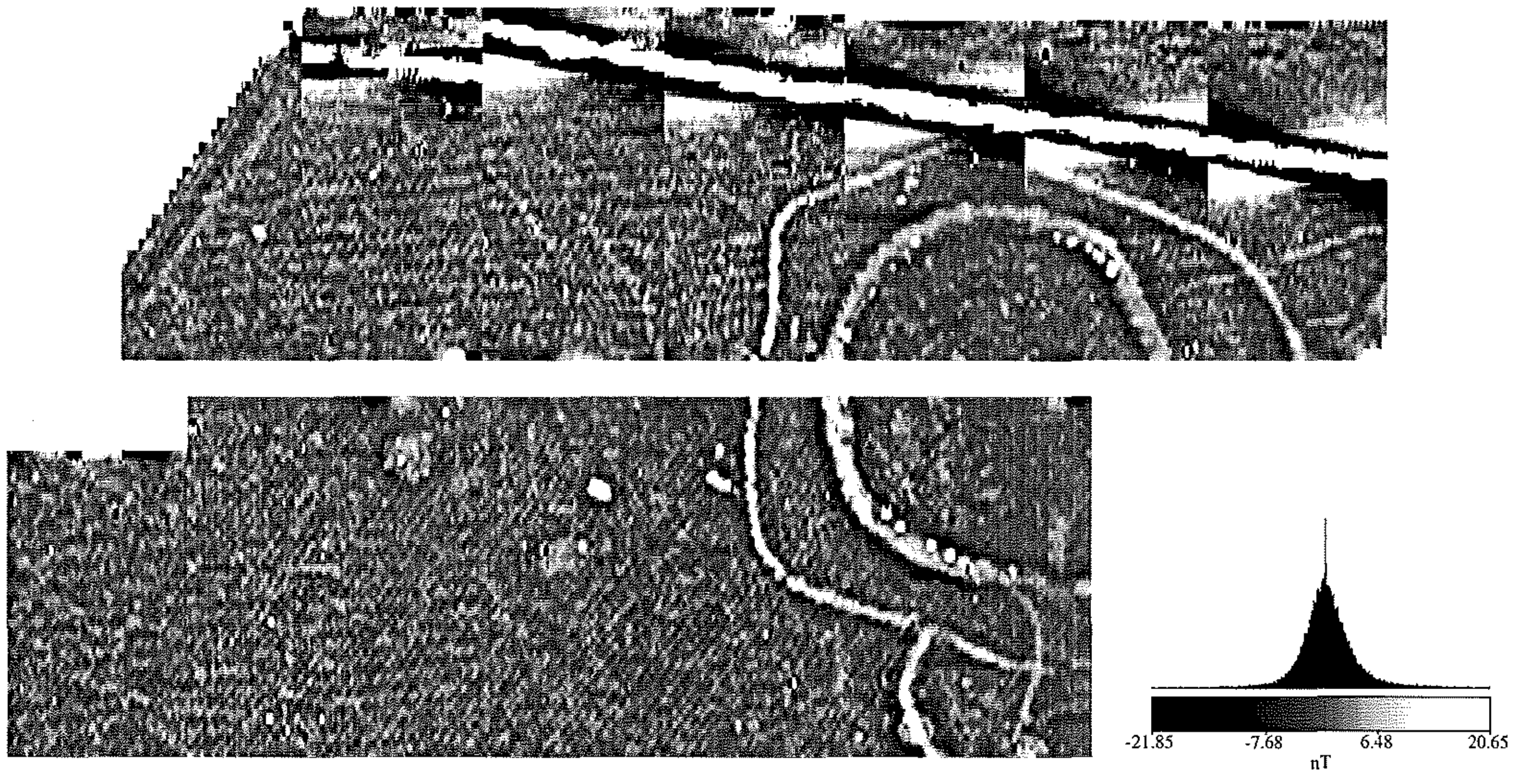


Figure 2; Callestick Veor, Cornwall, *Greytone image of raw magnetometer data superimposed on OS base map.*

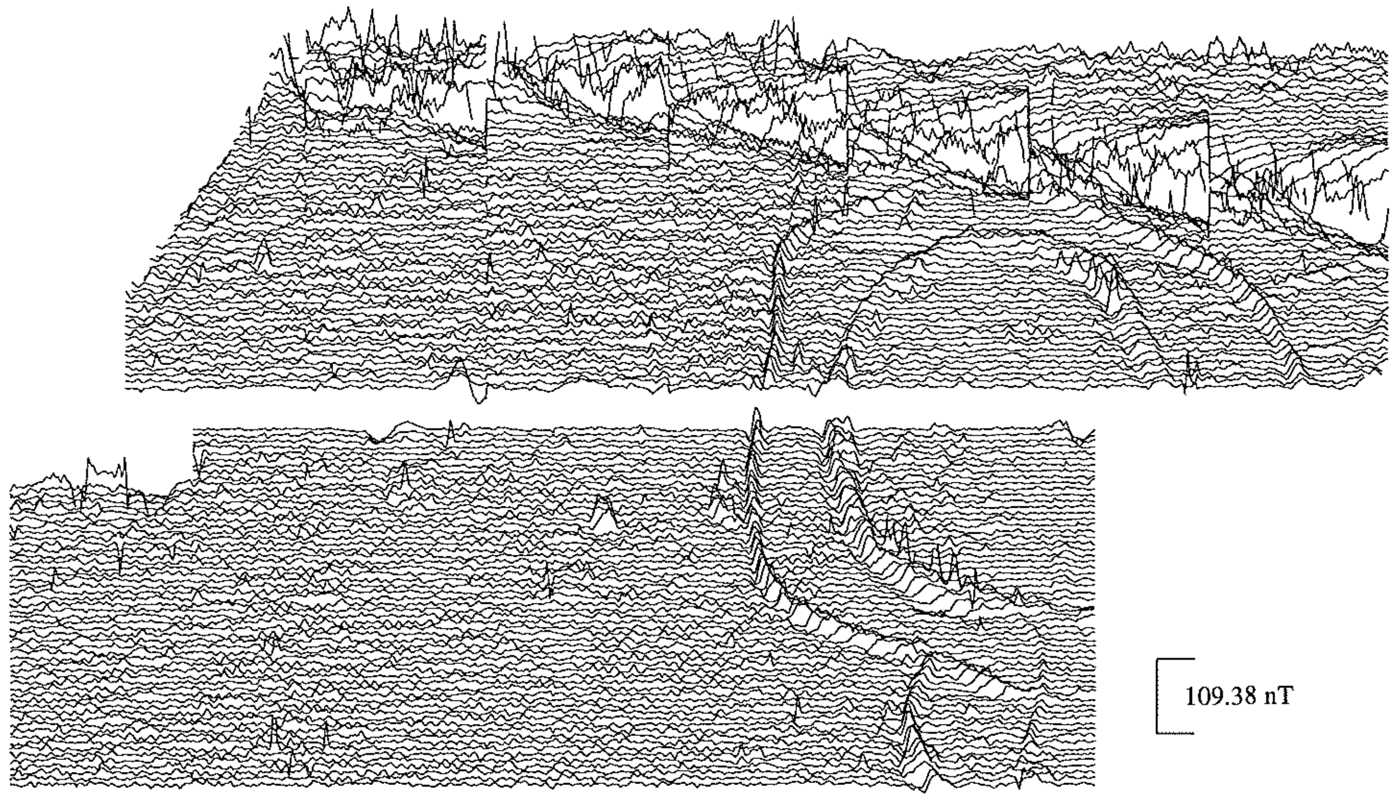
CALLESTICK VEOR ROUND, CORNWALL.
Magnetometer survey, July 1997.

PLAN A

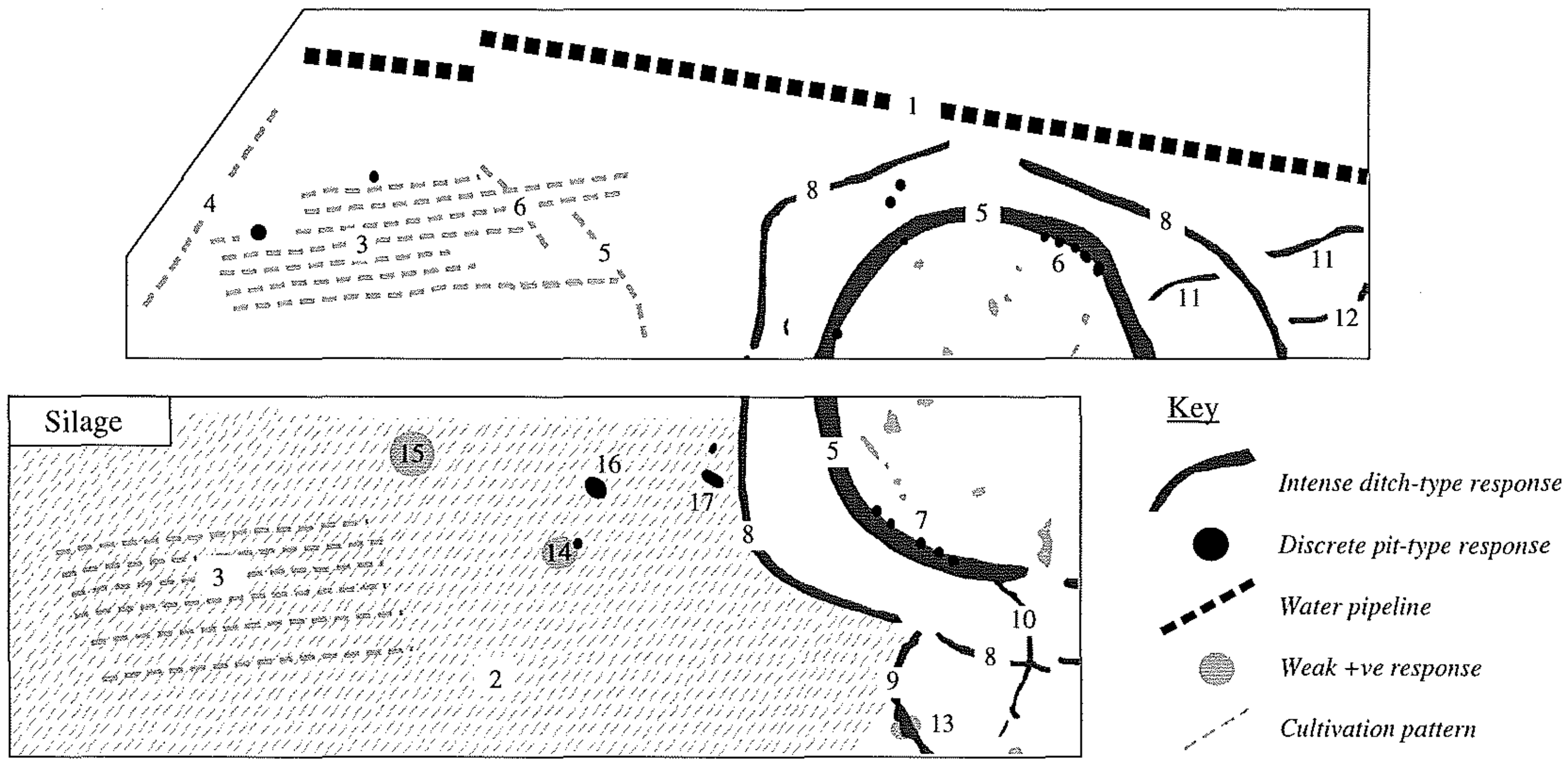
1. Greytone of raw magnetometer data

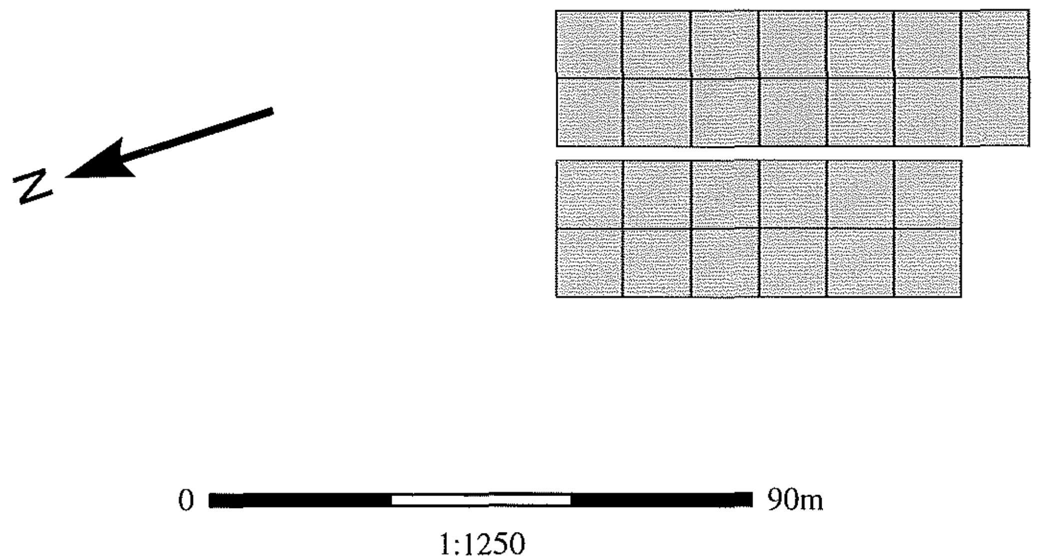


2. Traceplot of truncated magnetometer data.



3. Summary of significant anomalies.





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