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Ancient Monuments Laboratory
Report 95/97

CANSFORD QUARRY, CORNWALL, REPORT ON GEOPHYSICAL SURVEY, 1997

N T Linford

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Summary

A magnetometer survey was conducted at Cansford Quarry, Otterham, Cornwall, in response to a request from the Inspector of Ancient Monuments to investigate archaeological activity in the vicinity of three Bronze Age Barrows. Topographic anomalies over the site suggested the possibility of three additional monuments, but the survey failed to reveal any significant magnetic response in these areas. A pattern of intense linear anomalies dominated much of the survey area and is attributed to either a recent agricultural effect or to natural geological variation.

Author's address :-

Mr N T Linford
ENGLISH HERITAGE
23 Savile Row
London
W1X 1AB

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Report on geophysical survey, July 1997.

Introduction

A geophysical survey was requested by the Cornish Archaeological Unit, through the English Heritage Inspector for Ancient Monuments, to investigate archaeological activity associated with a group of three Bronze Age barrows immediately N of Cansford Quarry, Otterham, Cornwall (CO 922 a/b/c). Of the three extant monuments only the most northerly (922c) has escaped major modern interference as the other two barrows have been damaged by the construction of a concrete water reservoir (922b) and the encroachment of the expanding quarry workings (922a) respectively. The location of three additional barrows has been proposed in the western most field (Figure 1; Field 1, squares 1-20) based on the presence of slight topographic anomalies and it was hoped that geophysical survey would provide more definitive evidence of their nature.

The survey was extended to the E (Figure 1; Field 2, squares 21-34) to include an area of land on which extant planning permission exists for the possible expansion of the Quarry and also to the N (Figure 1; Field 3, square 35) to encompass barrow 922c to investigate the response to an unequivocal monument of this type at the site.

The site (centred on SX 168 932) is located on soils of the Halstow association (Soil Survey of England and Wales 1983) developed over a substrate of highly faulted Upper Carboniferous sandstone and shale of the Crackington formation (Institute of Geological Sciences 1969). At the time of the survey all three land parcels were down to pasture.

Method

Due to the frequent success of magnetometer surveys generally encountered over highly magnetic Cornish soils this technique was adopted as the primary investigative tool for the entire site. Separate 30m grids were established in each of the three fields (Figure 1) although the current Ordnance Survey 1:2500 map (incorporating revisions until 4/7/97) fails to account for the expansion of the quarry to both the N and W of the currently indicated workings. A more accurate indication of the current quarry boundary is shown by the greytone image of the magnetometer data superimposed over the OS map (Figure 2) as the survey was conducted to within 1m of the southern field boundaries.

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. Plan B2 shows a greytone image of the magnetometer data following frequency domain processing (Geosoft 1993) to remove specific linear anomalies dominating the results from fields 1 and 2 (decorrugation). In this case the data from each field was transformed to the Fourier domain and high-pass filtered to only pass frequencies on the order of the desired line separation (2m). A directional cosine filter was subsequently applied to this data to remove wavelengths of the desired orientation. A similar procedure was applied to the data from field 3 to gauge the effect of this procedure on survey data containing obvious archaeological anomalies.

Plan B1 provides a graphical summary identifying significant anomalies discussed in the following text.

Results

Modern interference

There is little evidence of modern interference to the survey results beyond the influence of the wire fencing along the southern boundary of fields 1 and 2. A number of additional near surface ferrous responses, due most probably to modern iron litter, are evident in field 3 (see Plan A2).

Archaeological anomalies

The most striking magnetic anomaly in the survey data is formed by a series of parallel linear responses **[1]** and **[2]** dominating the majority of fields 1 and 2. In each of these fields the anomalies are parallel to the EW field boundaries and are reminiscent of an agricultural cultivation pattern. However, the magnitude of their response ($\pm$30nT) and the fact that neither pattern extends over the entire field would suggest that a geological origin is equally likely. In this latter case the anomalies may well arise from different magnetic properties of the underlying highly faulted geological strata. The anomalies may also be explained by a combination of these two hypotheses with an outcrop of highly magnetic geology emphasising the effects of recent ploughing in localised areas of the site.

Two areas of additional anomalous response **[3]** and **[4]** are visible in field 1 and may well be caused by similar sources to those discussed above. However, **[3]** coincides with an area identified as a possible location for an additional barrow based on a slight topographic anomaly noted in the field (Peter Rose *pers comm*). The archaeological significance of **[3]** is difficult to ascertain due to this ambiguous magnetic response.

The circular magnetic anomaly revealed over the location of barrow 922c in field 3 demonstrates the distinctive response that may be expected from such monuments at this site. However, no similar responses are immediately evident in the raw data from fields 1 and 2 presented in Plan A.

Decorrugated data

Plan B2 illustrates the raw data following time domain processing to suppress the pattern of parallel linear anomalies **[1]** and **[2]**. Removal of these anomalies has considerably reduced the magnitude of the data for the entire site (*cf* inset greytone keys on Plan A1 and B2) but no additional significant responses have been revealed. Decorrugated data from field 3 appears to be slightly degraded when compared to the original raw results and it is therefore possible that more subtle anomalies may have been obscured by this process.

Conclusion

Magnetometer survey at this site has failed to produce convincing evidence for any significant archaeological activity in the vicinity of the three scheduled barrows. Interpretation has, however, been hampered by a curious pattern of intense linear anomalies possibly related to either a recent agricultural activity or the magnetic response of the complex underlying geology. Of the three areas indicated as possible additional barrow sites from topographic observations only one corresponds with an amorphous magnetic anomaly from which no conclusive interpretation can be drawn. Whilst an alternative geophysical technique, such as earth resistance survey, may produce more definitive results the circular magnetic anomaly recorded over barrow 922c confirms the suitability of magnetic survey at this site.

Surveyed by: M. Cole
T. Horsley (Bradford University)
N. Linford
P. Linford
A. Payne

Date of survey: 24-25/7/97

Reported by: N. Linford

Date of report: 17/10/97

Archaeometry Branch,
Ancient Monuments Laboratory,
English Heritage.

References

Geosoft, 1993, *MAGMAP 2-D frequency domain processing*, unpublished technical note, GEOSOFT Inc., Toronto, Canada.

Institute of Geological Sciences, 1969, *Geological Survey of Great Britain*, Sheet 322, Newquay - Solid and Drift.

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

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.

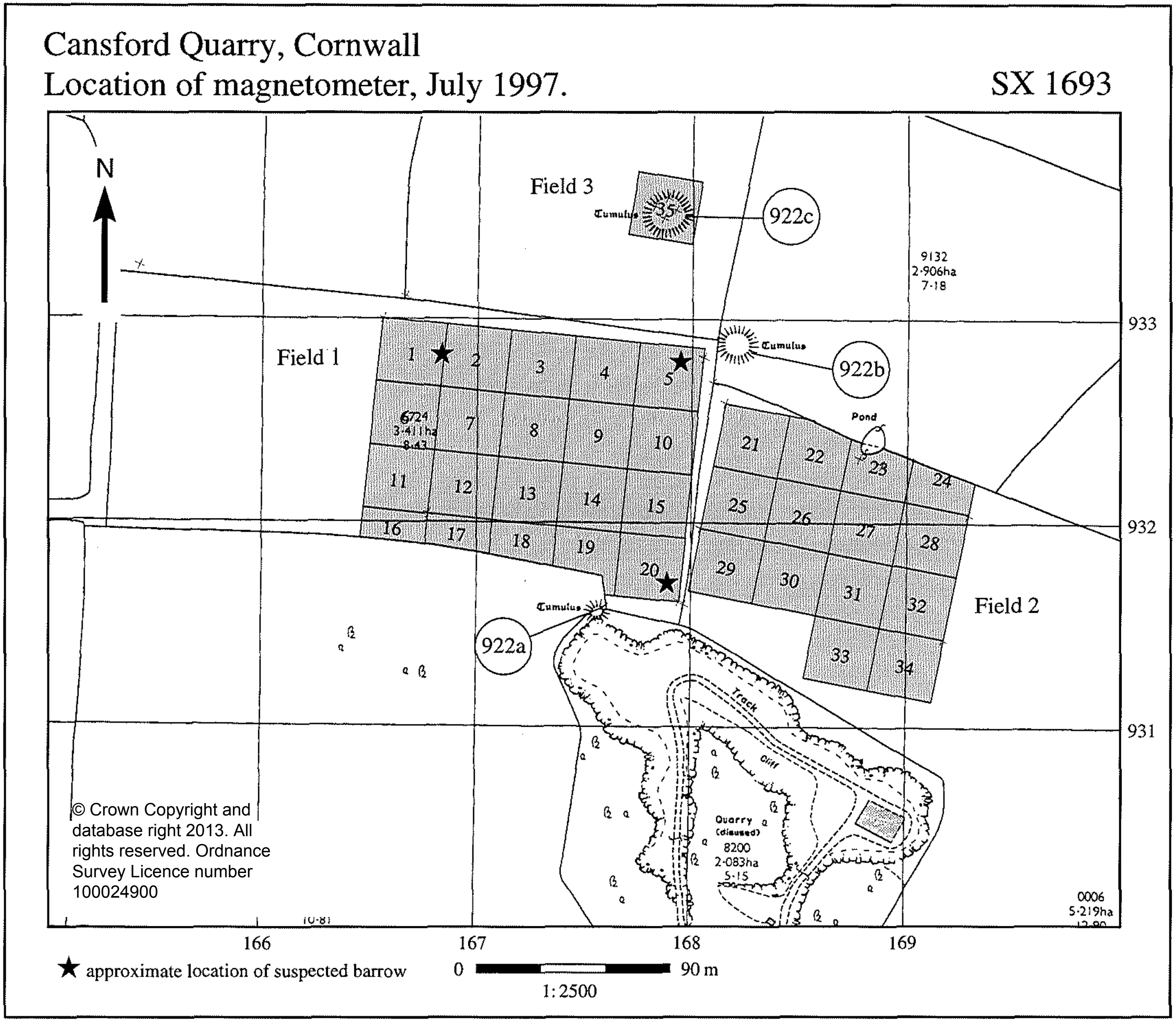

Figure 1; Cansford Quarry, Cornwall, *Location of geophysical survey July 1997.*

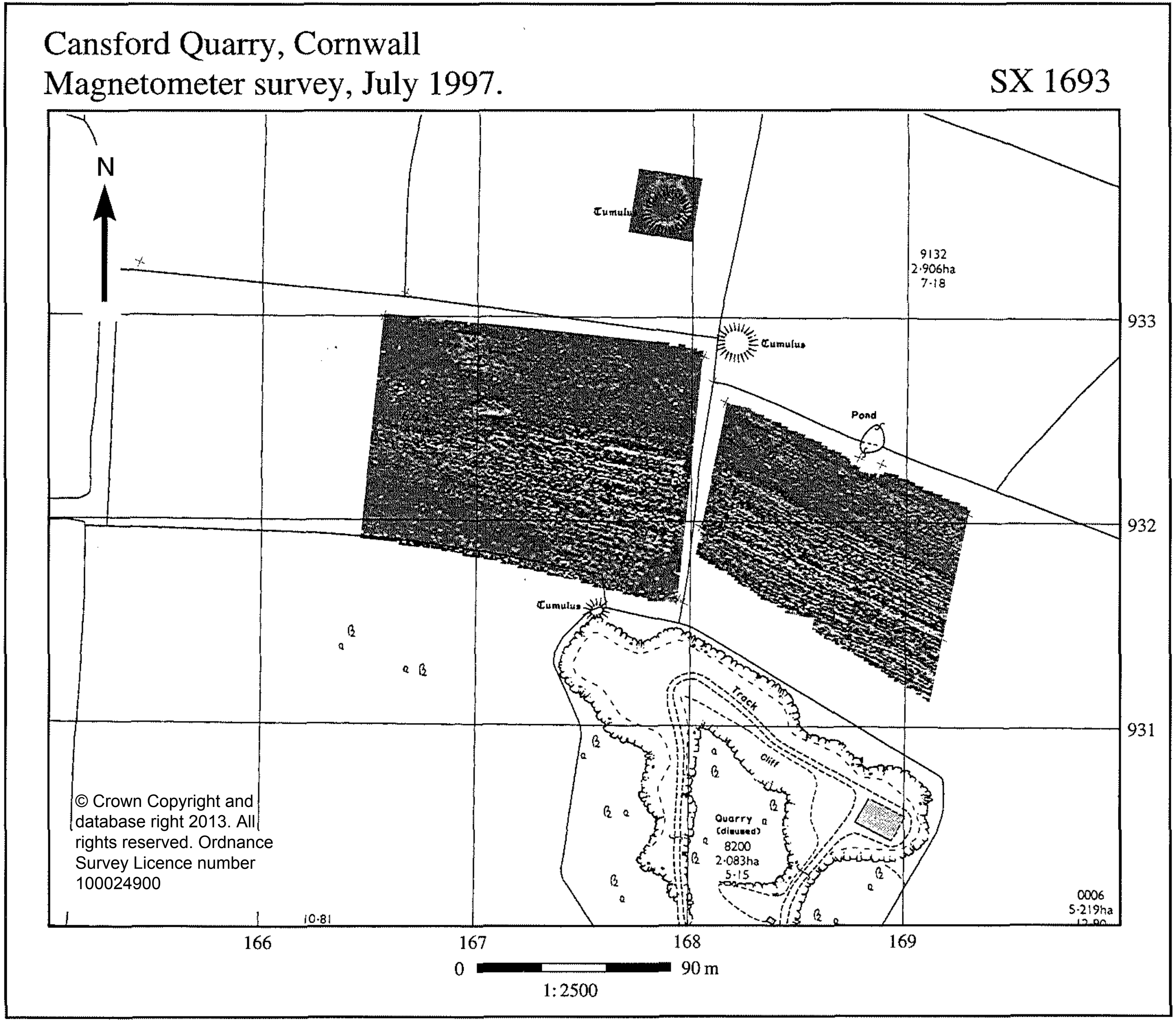

Figure 2; Cansford Quarry, Cornwall, *Greytone of raw magnetometer data superimposed over base OS map.*

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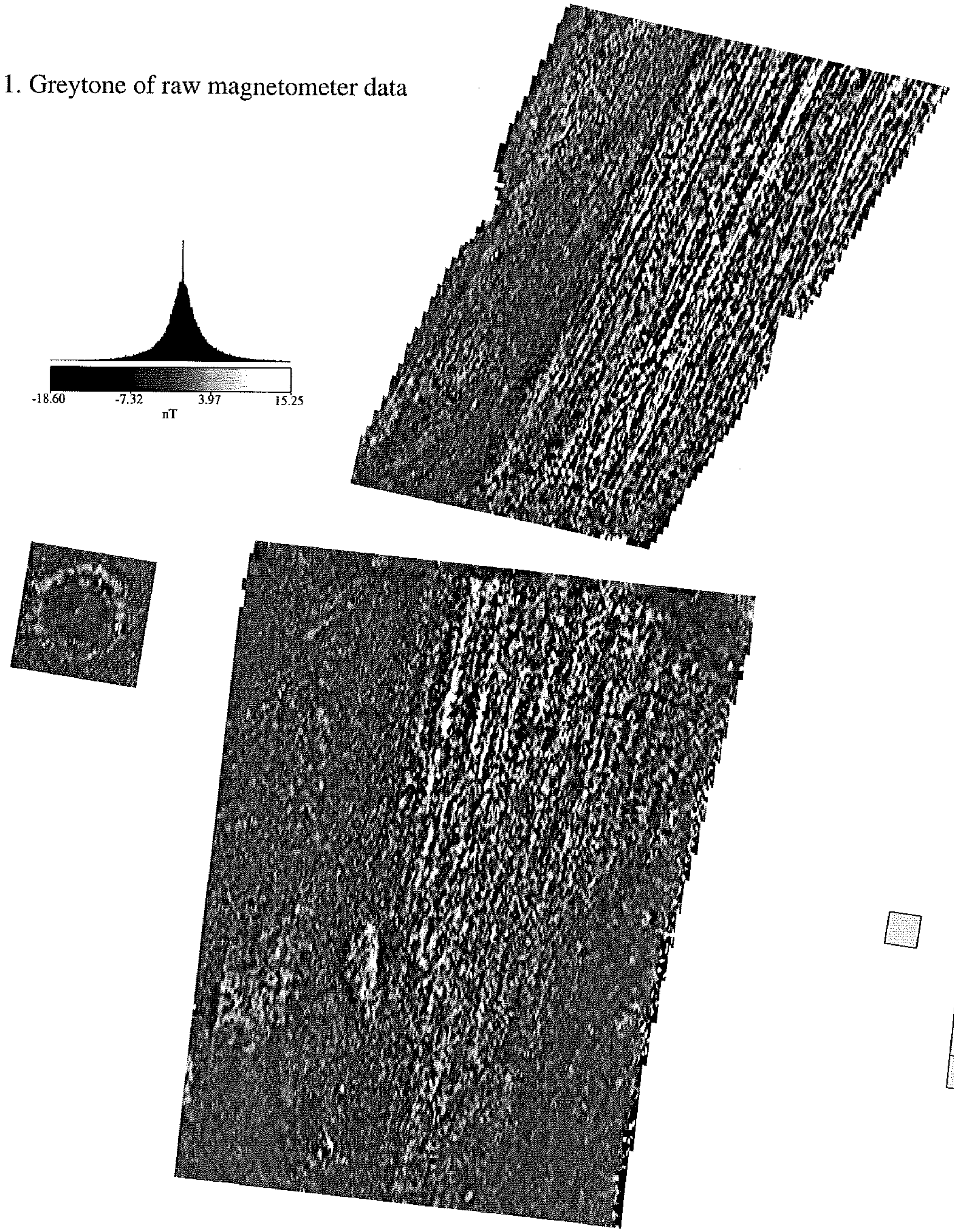
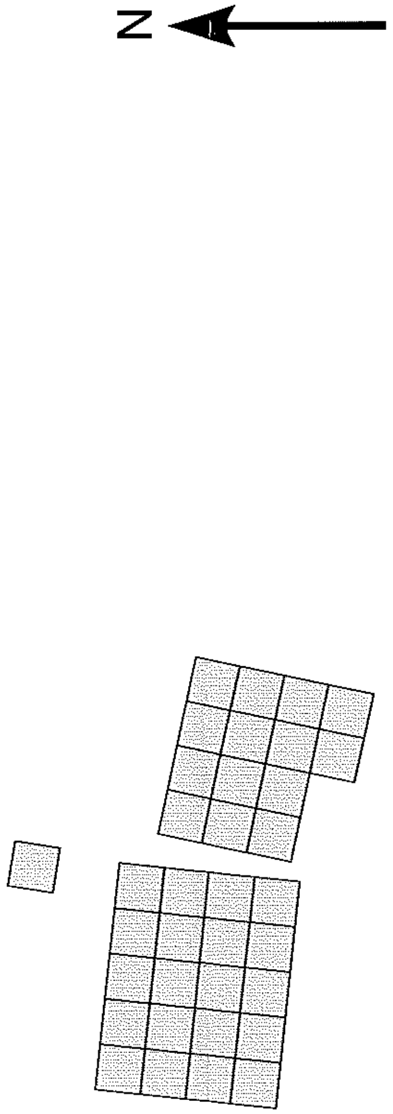
PLAN A

1. Greytone of raw magnetometer data





2. Traceplot of raw magnetometer data

0 90m
1:1250

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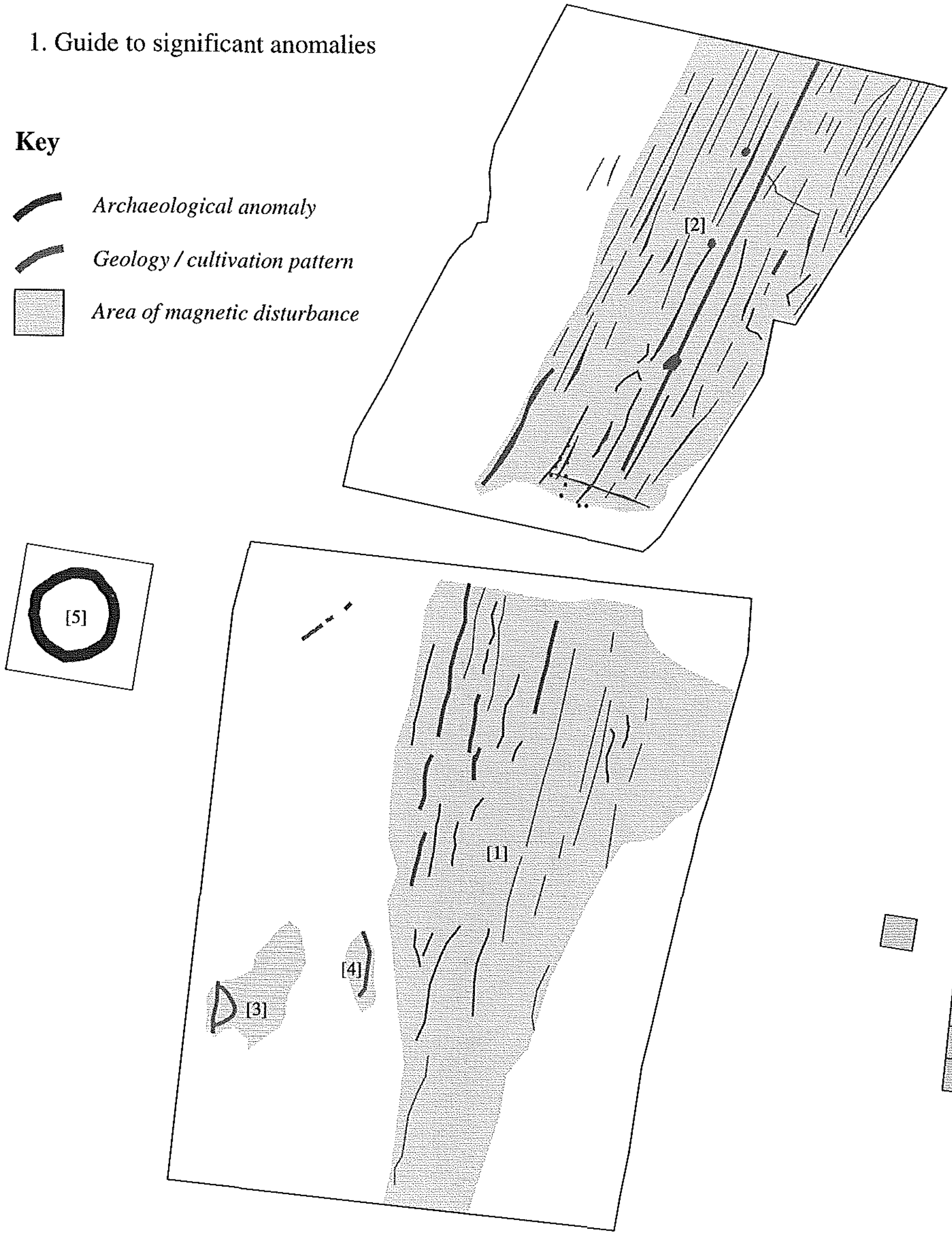
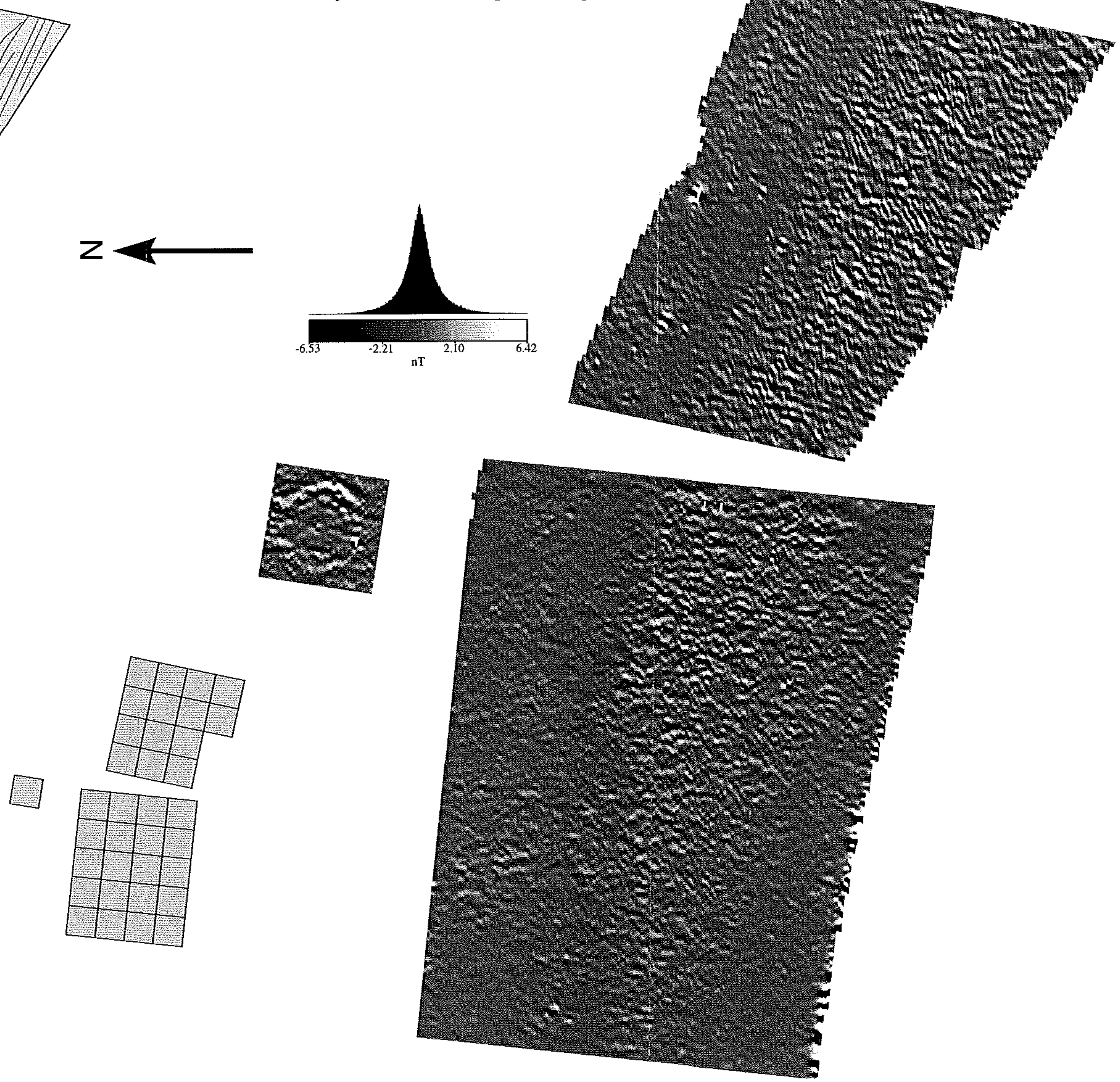
PLAN B

1. Guide to significant anomalies



2. Greytone of decorrugated magnetometer data



0 90m
1:1250

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