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Ancient Monuments Laboratory
Report 5/96

COCKS FARM ROMAN VILLA, ABINGER, SURREY. REPORT ON GEOPHYSICAL SURVEY, DECEMBER 1995

N Linford

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Summary

A limited magnetometer survey was conducted at Cocks Farm Roman villa to complement the resistivity and topsoil magnetic susceptibility results collected by the Surrey Archaeological Society. It was hoped that the application of geophysical techniques would augment the results of the society's recent excavations at this site. The magnetometer survey successfully detected a number of linear anomalies, although the quality of the data does not support a wholly conclusive interpretation. This report provides an interim summary of both the magnetometer and resistivity surveys prior to more detailed analysis of the data within the excavation report.

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COCKS FARM ROMAN VILLA, Abinger, Surrey.

Report on geophysical survey, 1995

Introduction

Following their recent excavation of the Cocks Farm Roman villa the Surrey Archaeological Society (SAS) has embarked upon a program of earth resistance and topsoil magnetic susceptibility survey over approximately 1 ha of agricultural land surrounding the monument. An additional magnetometer survey was requested from the AML to complement the other geophysical techniques deployed and provide further information to assist with the accurate protection and future management of the remains. This report provides an interim summary of both the magnetometer and resistivity surveys prior to the incorporation of the results within the excavation report.

The resistivity data was collected by Mr Steve Dyer on behalf of the SAS with the assistance of volunteers from the society. This data was kindly made available to the AML for comparison with the magnetometer survey in this report.

The site (NGR TQ 106 475) lies over Lower Greensand of the Hythe Beds (Geological Survey of Great Britain - sheet 285, 1949) and is of incidental interest to both naturalists and archaeologists alike, as it is believed to be the location of Charles Darwin's famous experiment to observe the natural deposition of topsoil through earth worm activity.

Method

Magnetometer survey

The magnetometer survey was conducted over all the numbered squares (Figure 1) previously established by the SAS using the standard method outlined in note 2 of Annex 1. The results of the magnetometer survey are plotted at 1:1000 scale in Plan A and Plan B. Plan A.1 shows a stacked trace plot of the raw data, the only correction to the measured values being to remove 'striping' between adjacent traverses; A.2 shows a linear greytone plot of the same data. The results of digital enhancement to remove the detrimental effects produced by soil noise and surface iron objects are presented as a stacked trace plot in Plan B.1 and as a linear greytone in Plan B.2. The enhancement employed was to 'despike' the data by filtering with a 2m by 2m thresholding median filter, then to slightly smooth it by low pass convolution with a 1.0m radius gaussian mask. Both stacked traceplots were truncated between +/- 500nT to improve the graphical representation of the data.

Earth resistance survey

In addition to covering the same squares as the magnetometer the resistivity survey was conducted over the fenced area of the villa itself and to the N of square 4 to meet the field boundary. Data was collected with a Geoscan RM15 resistivity meter utilising the twin-electrode configuration (note 1; Annex 1) with a mobile probe separation of 0.5m. Samples were collected at 0.5m intervals along parallel EW traverses separated by 1m. The raw data (Plan C.1) was digitally filtered with a contrast enhancing Wallis filter of radius 15m (Plan C.2) and de-corrugated with a directional cosine filter in the Fourier frequency domain (Plan C.3) to remove the distracting effect of recent plough furrows. Plan C.4 shows the latter data set after treatment with a directional edge detecting algorithm to enhance linear anomalies from a NE perspective.

Results *(numerals refer to significant anomalies identified on plan D)*

Magnetometer survey

General response

The survey contains a high degree of modern interference arising from ferrous material used in the perimeter fencing of the field and the more recent protection surrounding the site of the villa remains. This interference is evident as an intense, highly variable response impinging upon all extremities of the survey area apart from the E edge. The interior of the survey also contains a wide scatter of similar intense responses which may either be related to near-surface ferrous litter or, perhaps, to more significant iron artefacts in the topsoil.

Significant anomalies

Despite the interference noted above a number of significant anomalies are identifiable within the magnetometer data. The most striking of these are the two linear ditch-type anomalies (1) running orthogonal to each other that are seen to cross in square 11. The magnitude of response recorded by the magnetometer varies widely along the course of these two anomalies and approaches a maximum of approximately 2.5nT close to their intersection, fading to an almost imperceptible level at the S and E extremes. This variation may represent either a highly localised contrast in the magnetic properties of the sediment filling the ditches or a fluctuating depth of overburden as the survey descends to the site of the former villa.

The latter interpretation is partially refuted by the presence of the more intense arcuate anomaly (2) observed within squares 14/15 and the fainter ditch-type responses (3) in squares 15, 16 and 17. Precise interpretation of these anomalies is hampered by their fragmented nature and the limited extent of the survey area. However, it seems highly probable that they are related to activity at the Roman villa. One further linear anomaly (4) is seen to run EW through squares 8-10 and is of interest due to its negative response relative to the site average. Whilst anomalies of this type may represent the course of a buried non-magnetic structure (*eg* a wall footing or modern plastic pipe) the abrupt cessation of its course suggests a contemporary agricultural origin, such as an extant cultivation furrow.

Square 5 contains an intense anomaly (5) possibly associated with a thermoremanent feature such as a buried hearth or kiln, although, the magnitude of this response (>10nT) is perhaps a little weak to justify this interpretation. One possible explanation, supported by the fading linear anomaly (1) crossing squares 5-7 and the topography of the site, is that a localised increase in colluvial overburden has attenuated the response of magnetic features in this area.

A similar discrete anomaly (6) observed within square 17 appears indicative of a pit.

Examination of the reduced-scale magnetometer plot superimposed upon the OS base map (Figure 2) reveals a highly tentative circular anomaly (7) of diameter 15m within grid square 3. Close scrutiny of B.2 also provides evidence in support of this interpretation. However, the identification of this anomaly in the raw data (Plan A) is almost impossible due to the distracting effects of soil noise and near-surface iron litter.

<u>Resistivity survey</u>

General response

The earth resistance data (plan C1-4) is seen to vary considerably over the site with localised areas of high and low resistance apparently reflecting natural rather than archaeological features. Superimposed upon this response is a pattern of linear anomalies (8) associated with recent agricultural activity which is particularly evident in squares 8-10 where the double EW linear low resistance anomaly corresponds with the plough furrow identified in the magnetometer survey.

Significant anomalies

Square 13 contains a rectangular high resistance anomaly (9) over the location of the mosaic floor excavated by the SAS. Immediately W of this are a series of three linear low resistance anomalies (10) which are believed to be the continuation of sandstone wall footings observed within the excavation trench (S. Dyer *pers comm*). However, it should be noted that the low resistance response of these anomalies is indicative of a higher degree of moisture retention than that of the surrounding sediment. One of these anomalies is seen to continue N along the adjoining edge of squares 8 and 9 and *may* be an artificial effect of data processing.

A most tantalising circular low resistance anomaly (11) is just perceptible within square 15. However, the marginal nature of this response combined with its failure to be replicated in the magnetometer data defies anything more than the most tentative interpretation. Indeed, it is difficult to identify any further anomalies related to the villa itself, particularly, as the orientation of the Roman buildings apparently lies close to that of the distracting pattern of modern plough furrows.

Comparison with Magnetic data

Direct comparison with the magnetometer data indicates that only two of the magnetic anomalies are replicated within the resistivity survey: these are the plough furrow mentioned above (squares 8-10) and the linear anomaly in square 17. This latter anomaly (12) appears as a weak positive response in both data sets and is, perhaps, most likely to represent the course of a recent ceramic service with an inherent thermoremanant response.

The significance of the low resistance linear anomaly (13) adjoining the ploughing headland at (4) is difficult to ascertain, although it is replicated as a in the magnetic data as a negative response of lesser dimensions.

Conclusion

The limited magnetometer survey has detected a number of ditch-type anomalies and two discrete magnetic responses possibly indicative of a thermoremanent feature and a buried pit. However, there is no significant correlation between magnetic anomalies and the results of the resistivity survey conducted by the SAS over the same period of time. The failure of the resistivity method to detect anomalies corresponding to those of the magnetometer survey may, in part, be due to poor contrasts in soil moisture conditions caused by heavy rainfall during the winter months. It is understood that a more detailed seasonality study at the site is currently being performed (A. J. Clark *pers comm*) and it is hoped that this will encourage the repeat of the area resistivity survey under more favourable conditions.

Surveyed by: M Cole
N Linford
P Linford

Date of survey: 20/12/95

Reported by: N Linford

Date of report: 6/3/96

Archaeometry Branch,
Ancient Monuments Laboratory,
English Heritage.

Acknowledgements

The author wishes to acknowledge Tony Clark, Steve Dyer and the Surrey Archaeological Society volunteers for both their help in the field and for their most useful comments regarding the interpretation of the subsequent data sets. Special thanks is also due to the Corke family for granting access to their land and for the provision of the most welcome seasonal refreshments.

List of 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.

COCKS FARM, ABINGER, SURREY.
Location of magnetometer survey, December 1995.

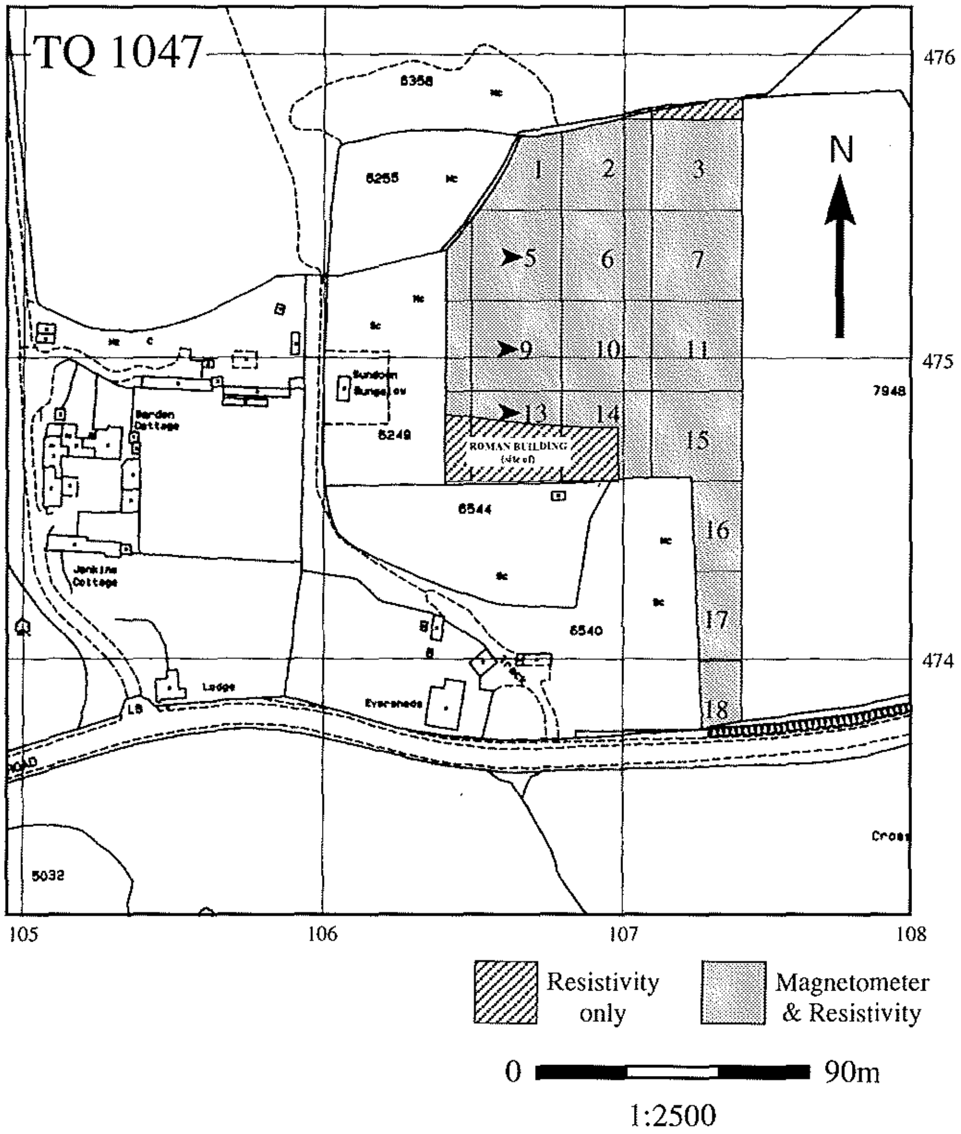

Figure 1; COCKS FARM, Location of magnetometer survey, December 1995.

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COCKS FARM, ABINGER, SURREY.
Location of magnetometer survey, December 1995.

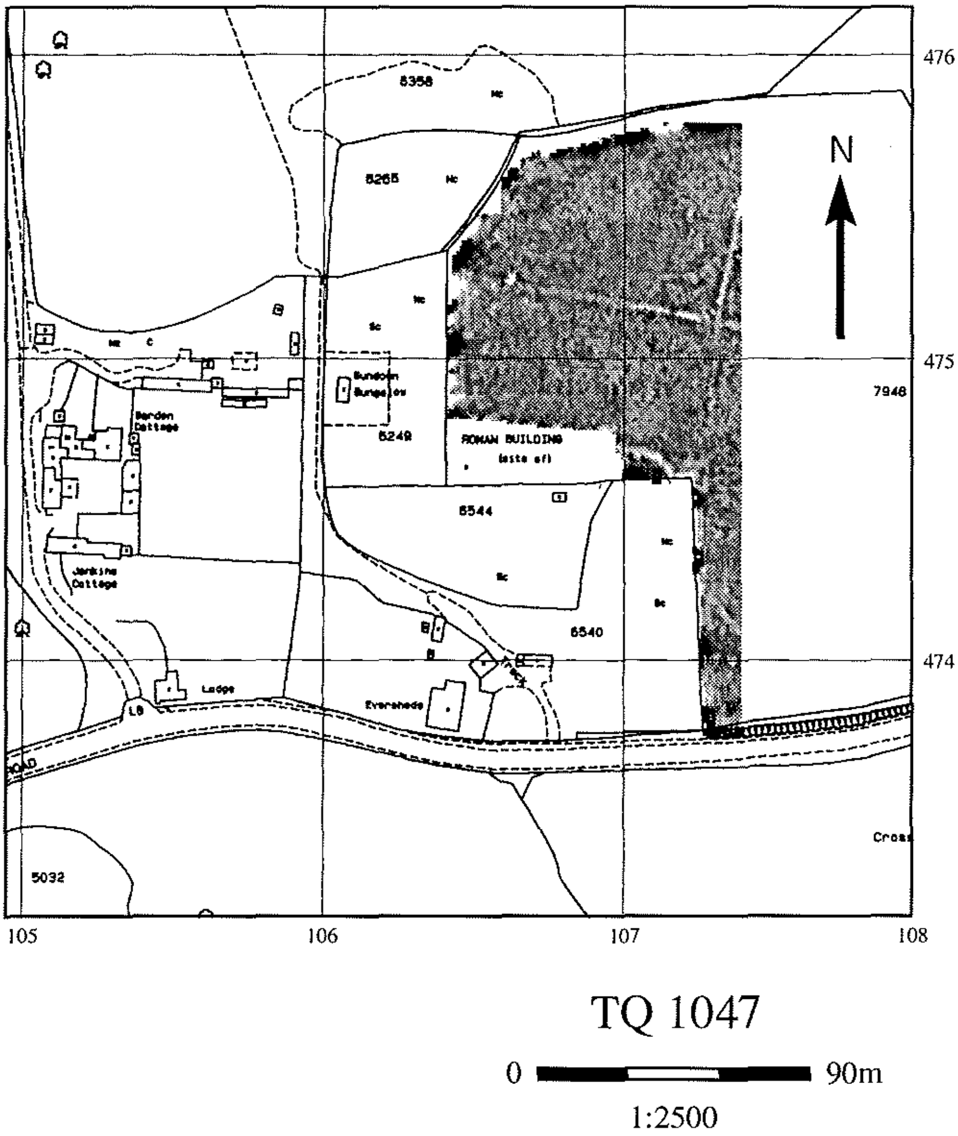

Figure 2; COCKS FARM, Greytone of magnetometer data superimposed over 1:2500 map.

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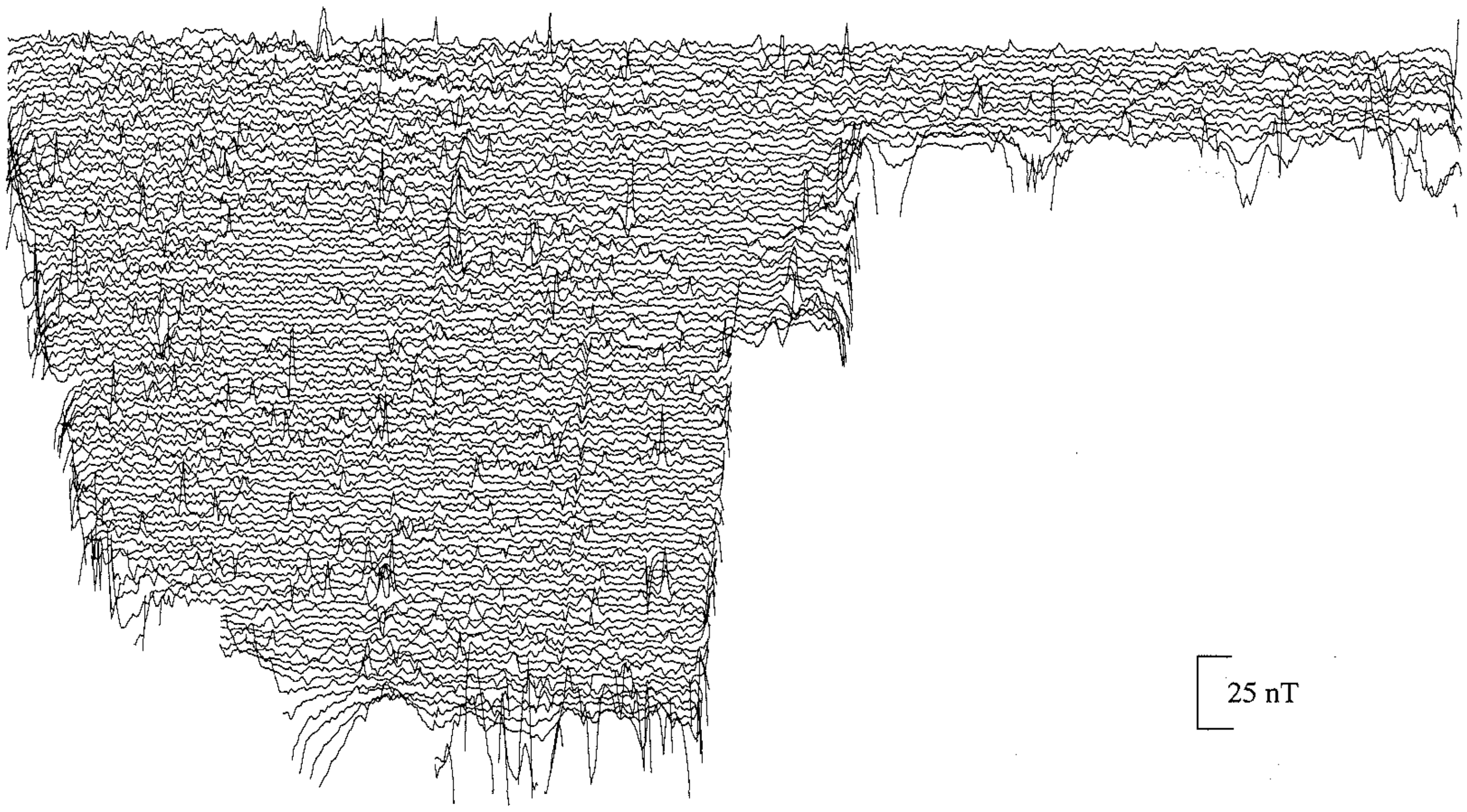
COCKS FARM, ABINGER, SURREY.
Magnetometer survey, December 1995.

PLAN A

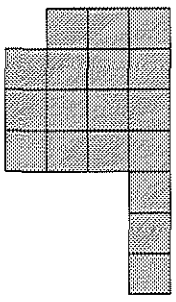
N

1. Traceplot raw data.



25 nT

2. Greytone raw data.



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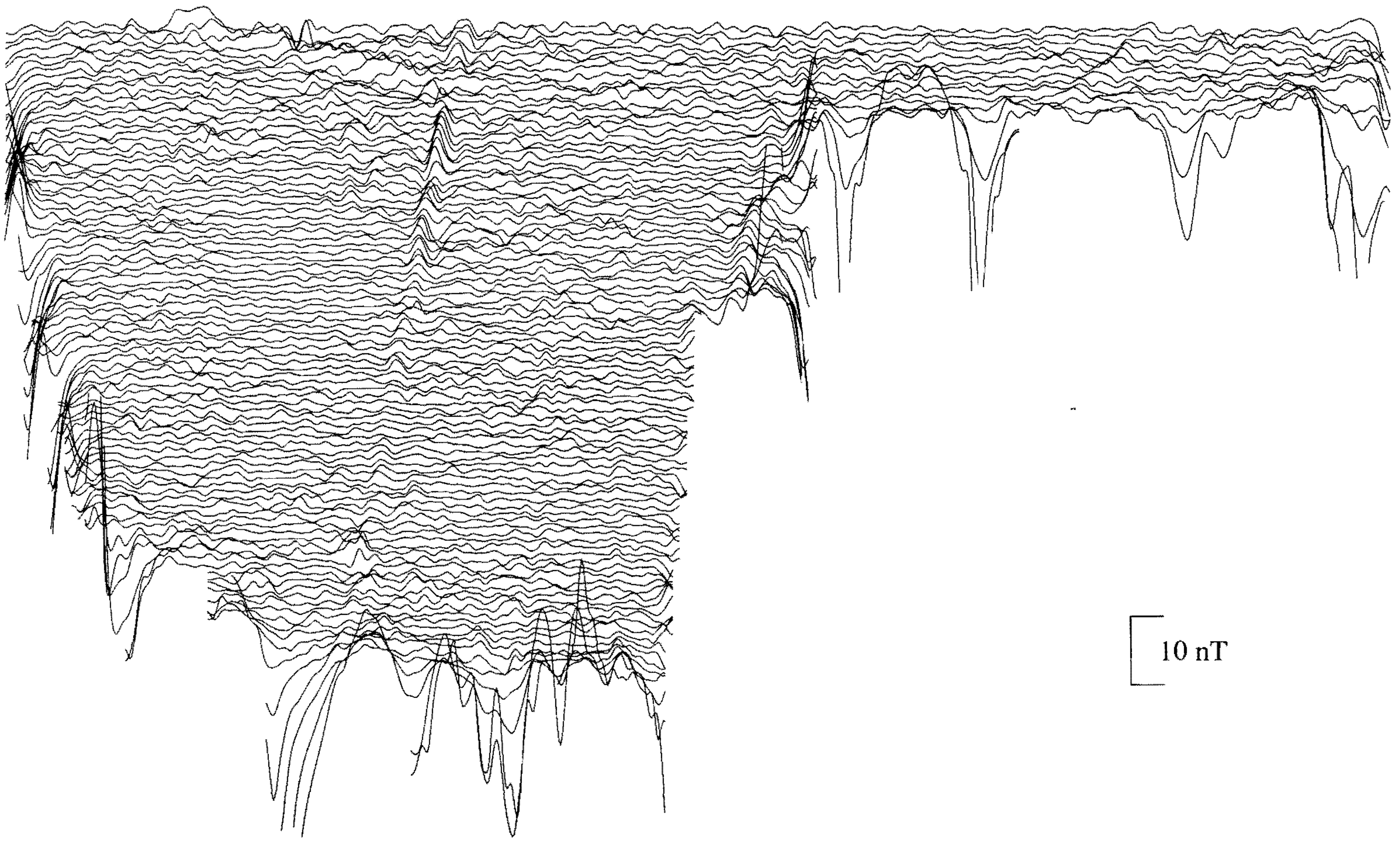
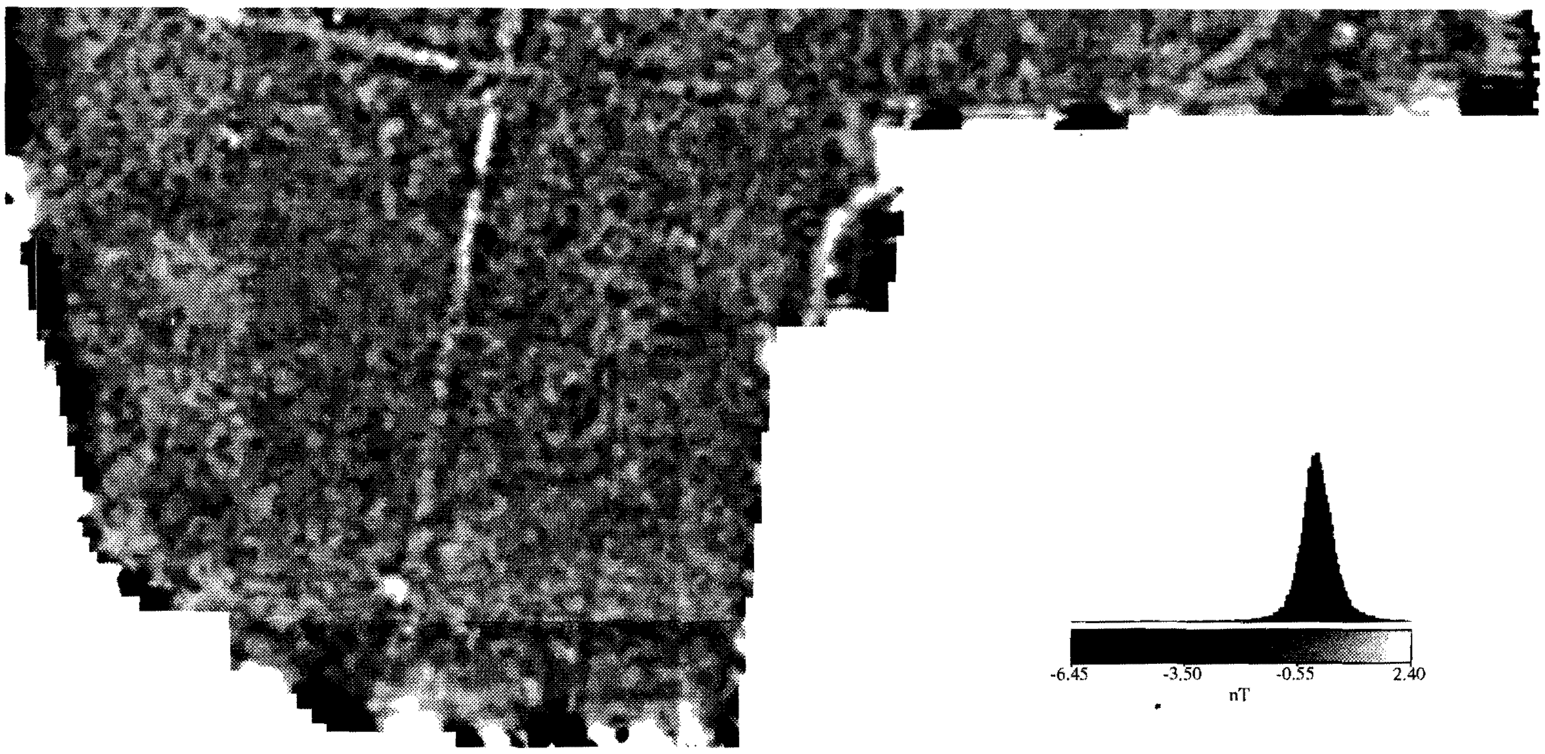
COCKS FARM, ABINGER, SURREY.
Magnetometer survey, December 1995.

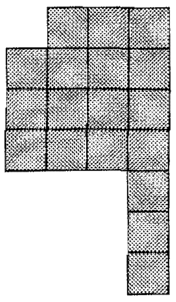
PLAN B

1. Traceplot smoothed data.



2. Greytone smoothed data.





0 90m

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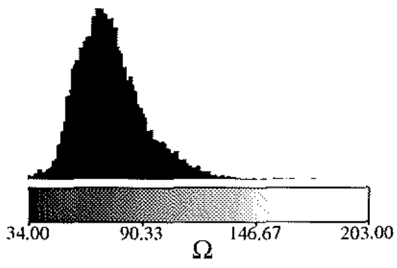
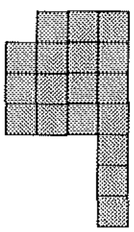
Ancient Monuments Laboratory 1996

COCKS FARM, ABINGER, SURREY.
Resistivity survey, December 1995.

PLAN C1

Greytone of raw data.





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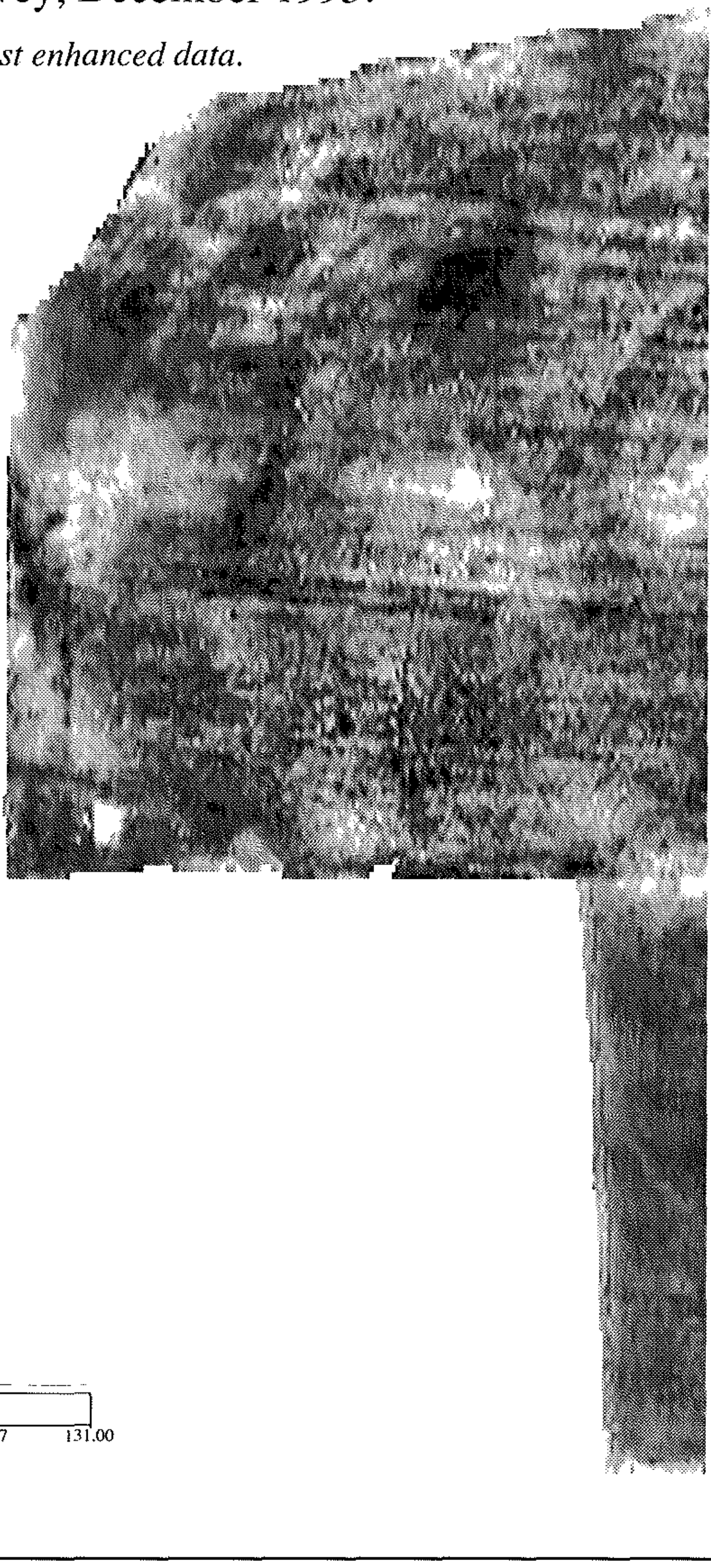
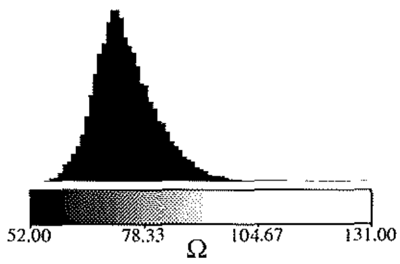
COCKS FARM, ABINGER, SURREY.

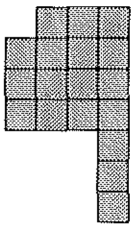
PLAN C2

Resistivity survey, December 1995.

Greytone of contrast enhanced data.







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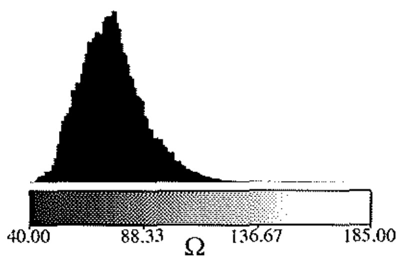
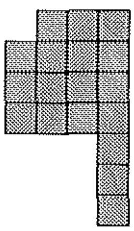
COCKS FARM, ABINGER, SURREY.
Resistivity survey, December 1995.

PLAN C3

Greytone of de-corrugated data.





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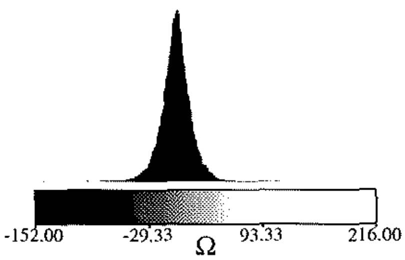
COCKS FARM, ABINGER, SURREY.

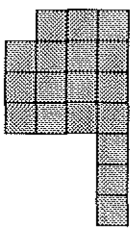
Resistivity survey, December 1995.

PLAN C4

Greytone of edge detected data.

N





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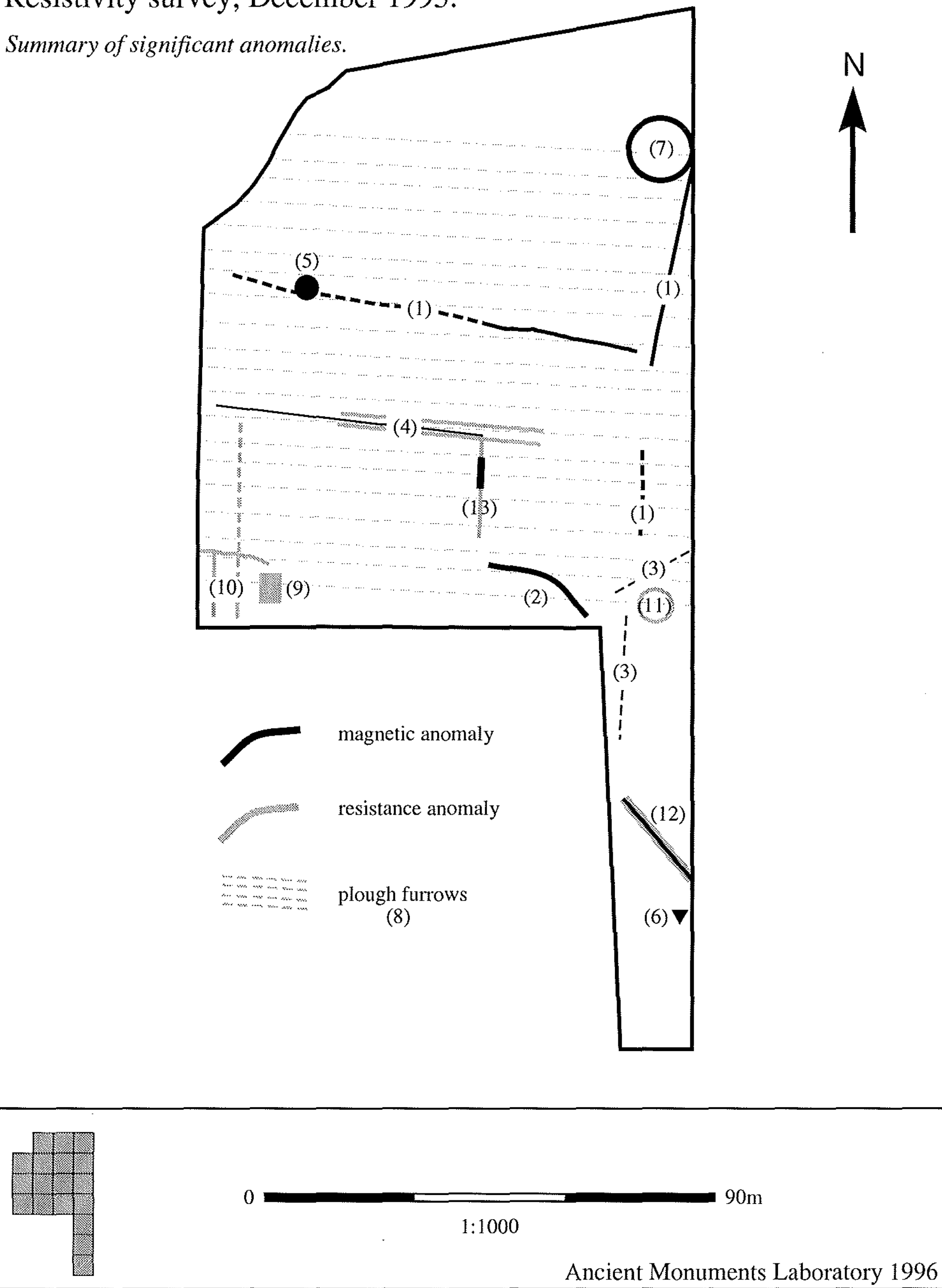
COCKS FARM, ABINGER, SURREY.

Resistivity survey, December 1995.

PLAN D

Summary of significant anomalies.



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