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Bridge Farm, Lopen, Somerset: Report on Geophysical Survey, November 2001.

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Summary

During the construction of a new access road at Bridge Farm at Lopen near Yeovil in Somerset, a substantial Roman mosaic was uncovered. Owing to the importance of the discovery, Somerset County Archaeological Unit began an immediate excavation on the site, which revealed the remains of a Roman villa. The Centre for Archaeology was requested to carry out a geophysical survey of the area surrounding the excavation to characterise the extent of the Roman site. The survey revealed a great deal of modern disturbance and few anomalies that could be ascribed an archaeological origin. Whilst one anomaly possibly indicative of a Roman building was detected, it appears that the geophysical techniques employed were not particularly responsive to archaeology under the prevailing soil and moisture conditions.

Keywords

Geophysics

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BRIDGE FARM, LOPEN, Somerset.

Report on geophysical survey, November 2001.

Introduction

During the construction of a new access road for heavy goods vehicles at Bridge Farm in Lopen near Yeovil in Somerset (ST 428 139), a substantial Roman mosaic was uncovered (Figure 1). Owing to the importance of the discovery, Somerset County Archaeological Unit began an immediate excavation on the site which revealed the remains of a Roman villa. The presence of such a large mosaic suggests that the villa was constructed by an individual of considerable wealth and might therefore be expected to be of substantial proportions. Hence, the Somerset County Archaeological Officer, Robert Croft, requested that the Centre for Archaeology carry out a geophysical survey of the area surrounding the excavation to characterise the extent of the Roman site.

Figure 1: The excavated Roman mosaic at Bridge Farm, Lopen.

In the post-medieval period a mill was constructed on the site of the present farm buildings, utilising the spring issues in the field to the southwest. Water was collected into a millpond and was then channelled through the mill to Lopen Brook down slope to the north. More recently, the issues have been piped into a buried conduit so that the field could be used as pasture.

The site at Bridge Farm lies on silty soil of the Curtisden association (Soil Survey of England and Wales 1983, 572i), described as having a slowly permeable subsoil prone to slight seasonal waterlogging. This soil is developed over Lower Jurassic Yeovil Sands to a depth of 38 to 64 metres (Institute of Geological Sciences 1946). At the time of the survey, all the surveyed fields were under grass. During the survey the weather began dry and sunny but showers of rain and hail developed leaving surface water that was slow to drain and formed standing puddles in the area immediately adjacent to the excavation.

Under these soil and weather conditions the immediate subsurface would be expected to be highly conductive and any resistive, non-porous subsurface features should produce strongly contrasting electrical anomalies. However, features such as infilled ditches that are detected electrically, because their higher porosity allows better moisture retention than the surrounding soil, may only produce detectable anomalies where local drainage conditions are favourable.

Method

A grid of 30 metre squares (Figure 2) was established over the site using a Trimble kinematic differential geographical positioning system. Two fields were identified as being of high priority for geophysical investigation and these were surveyed magnetically in their entirety using fluxgate gradiometers. Resistivity survey was targeted on the field containing the mosaic and the eastern half of the field to the south of the farm buildings, the latter area being chosen to cover the vicinity of the spring issues. As resistivity appeared to be the more successful of the two geophysical methods employed (see below), two further 30x30m resistivity grid squares were surveyed in a third field to the west of the mosaic, to test for features extending into this area from the other fields.

Resistivity survey

Resistivity measurements were made with a Geoscan RM15 meter, MPX15 multiplexer and PA5 probe array, using the Twin Electrode probe configuration. Readings were collected using the standard method outlined in note 1 of Annex 1, with measurements taken at 1.0m intervals with a mobile probe separation of 0.5m. Wings were added to the instrument frame to allow rapid data collection using the "parallel twin" configuration. This caused some striping in the raw data on alternate lines owing to the wet conditions during the survey. Water coating the frame allowed current leakage, which affected the left- and right-hand electrode pairs differentially. This resulted in a constant offset of about 2 Ohms being added to readings on alternate lines. The effect was removed by subtracting a constant value equal to this offset from every alternate line in each resistivity grid. The only other processing employed was an adaptive thresholding median filter (Pratt 1978, p330) to remove anomalous extreme values caused by contact resistance.

Plots of the resistivity survey are presented as both an X-Y traceplot and a linear greyscale, at a scale of 1:1250 in Plan A (1) and (2) respectively. Plan A (3) shows a linear greyscale of the data after a gaussian high-pass filter has been applied, to highlight anomalies less that 5m in width. Figure 3 depicts this same greyscale plot superimposed on the location plan.

Magnetometer survey

Magnetometer survey was conducted over the area indicated in Figure 1 using the standard method outlined in note 2 of Annex 1. Plots of the data set are presented as both an X-Y traceplot and a linear greytone, at a scale of 1:1250 in Plan B, (1) and (2) 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 compress extreme values with absolute magnitudes greater than 5nT using arctangent range compression (Scollar 1990, p504). This latter operation reduces the visually distracting effect of large spikes in the plot. Each traverse of the data presented in the greytone plot has been further enhanced using a one-dimensional Fourier filter, to suppress the systematic periodic component of the instrument noise and thus enhance extremely low magnitude features. The greytone data is also presented, superimposed on the location plan at 1:2500 scale in Figure 4.

Results

A graphical summary of the anomalies discussed in the following text, superimposed on the location plan, is provided in Figure 5.

Resistivity Survey

As expected, earth resistance readings were low, typically between 5 to 20 Ohms, equating to soil apparent resistivities between about 15 to 60 Ohm-m. However, despite concerns that low resistance features would not produce detectable anomalies under the conditions, a number of such anomalies are apparent in Plan A. In the field to the south of the farm buildings the most striking anomalies are two broad sub-rectangular areas of low resistance orientated approximately north-south [1]. These correspond with the position of the spring line and are likely to represent evidence for the millpond thought to have been located in this area. To the east of these anomalies, two linear, low resistance anomalies run towards the farm buildings on a line roughly parallel with the eastern field boundary. These almost certainly represent infilled ditch features but it is not possible to determine their function or age. However, their position and alignment might suggest that they are again associated with the milling activity on the site.

A broad curvilinear low resistance anomaly has been detected at [2]. The 1946 1:50,000 Ordnance Survey map of the area records a stream in this approximate position and it is likely that the earth resistance measurements are detecting the old stream bed. Further west, at [3], three low resistance anomalies have been detected, two of which are somewhat tentative. These are likely to be ditch features of anthropogenic origin but, as they do not form a recognisable pattern, it is not possible to estimate their age or function.

In the field in which the mosaic has been discovered, a linear low resistance anomaly can be seen running approximately east-west and continuing into the next field to the west. Unfortunately, the presence of a water company manhole and concrete marker noted at [5] confirm that this is the line of a cut for a water supply pipe rather than a Roman ditch feature.

At [6] immediately west of the silage clamp a linear, low resistance anomaly and some high resistance anomalies have been indicated. It is possible that these represent the remains of former buildings, possibly associated with the Roman occupation of the site. However, this area is used as a dump for agricultural equipment, some of which has been buried, so these anomalies could be caused by more recent disturbance. This point is illustrated by the rectangular low resistance anomaly marked to the north of the silage clamp. It was also detected by the magnetometer with a response characteristic of ferrous material and was confirmed by the farmer to be a large buried iron object.

At [7], another high resistance anomaly has been indicated which, given its proximity to the excavated mosaic, may represent the remains of Roman wall footings. Again some caution must be expressed as this area has been subject to a great deal of recent disturbance by earth moving machinery.

A rectangular anomaly has been detected at [8] consisting of concentric linear low and high resistance readings. The magnitude of the low resistance measurements tends to suggest a recent origin. However, it is also possible that the ditch-like response represents a robber trench, prehaps indicative of Roman wall footings. The position of this anomaly, on the bank of Lopen Brook at its closest approach to the known villa remains, might support the possibility that bathhouse remains are located here.

Magnetometer survey

The general background variation in measurements of the magnetic gradient has a standard deviation of only about $1nTm^{-1}$, which is comparable to the noise level of the instruments. This suggests that the magnetic susceptibility of the soil is generally low and, given the known history of occupation on the site, that its magnetic properties have not been dramatically altered by human activity.

However, very strong positive and negative gradients, typical of responses to ferrous material, are apparent near [1]. These begin in the centre of the spring line and form a curving line past [2] towards the stream in the western boundary of the field in which the mosaic is situated. Hence, these anomalies are likely to indicate the course of a pipeline dug into the field to drain the spring water. 40m south of [1] a similar line of strong gradient responses occurs, most likely also representing a recent ferrous pipe.

Near [2], two very faint linear anomalies of negative magnetic gradient have been indicated running approximately north-south. These could represent ditch features of any period but their alignment suggests that they might be field drains heading towards Lopen Brook. Further west, at [4], a number of discrete anomalies are apparent that could be caused by pits. Once again it is not possible to determine their age.

It is interesting to note that the magnetometer has not detected the possible ditch anomalies located by the resistivity survey at [3].

The magnetometer survey of the field containing the mosaic exhibits a high degree of disturbance caused by modern ferrous features. It has detected the buried ferrous object midway between [6] and [7] that appears as a low resistance anomaly in the resistivity survey. However, it has not detected any of the other resistance anomalies in this field, nor detected any other possible anomalies of archaeological origin. In particular it has not detected the ditch anomaly running through [5] suggesting that this is a recent feature containing a plastic pipe.

Conclusion

Geophysical survey has not identified any features at Bridge Farm that can definitely be ascribed a Roman origin despite the proximity of excavated Roman remains. This may in part be because the remains of the rest of the Roman buildings are located beneath the present farm buildings and thus inaccessible. Nevertheless, systems of enclosure ditches would have been expected surrounding the villa, yet these are not apparent in the geophysical results. The area around the farm has been subject to a lot of recent activity, including the piping of the water issuing from the springs to the south and the burial of old agricultural equipment. It is possible that this has destroyed less substantial Roman remains such as infilled ditches.

However, it is also possible that geophysical techniques are not responding to archaeological features on this site. The magnetometer did not detect any of the low resistance ditch anomalies indicated by the earth resistance survey. This suggests that backfilled ditches in the local soil may not exhibit sufficient contrast in magnetic susceptibility to be detectable.

The resistivity survey has been more successful at detecting ditch anomalies despite the generally wet soil. But it is possible that all these anomalies are caused by recent excavation and that fainter archaeological anomalies are not being detected due to the prevailing conditions of very low soil moisture deficit. The resistivity survey has been generally unsuccessful at detecting linear high resistance anomalies likely to have been caused by walls. Again this may be due to such features not exhibiting sufficient electrical contrast with the surrounding soil. Inspection of the exposed Roman wall footings revealed them to be composed of loosely packed porous stone rubble. The overall volumetric water content of these features may thus be little different from the surrounding soil, particularly when the soil moisture content is high.

In summary, geophysical survey has not detected extensive Roman remains at Bridge Farm and most of the anomalies that have been detected are likely to be of more recent origin. The most promising anomaly is that at [8] near Lopen Brook which is in close proximity to the excavated villa mosaic. However, there is evidence to suggest that geophysical techniques are not particularly responsive under the soil and moisture conditions prevalent at the site. Hence, the absence of geophysical evidence can not be interpreted as negating the possibility of further Roman remains being discovered in the vicinity.

Surveyed by: N Linford
P Linford

Date of survey: 5-9/11/2001

Reported by: N Linford & P Linford

Date of report: 14/11/2001

Archaeometry Branch,
English Heritage Centre for Archaeology.

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

List of enclosed figures

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 (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 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.

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.

BRIDGE FARM, LOPEN, SOMERSET
Location of geophysical survey, November 2001.

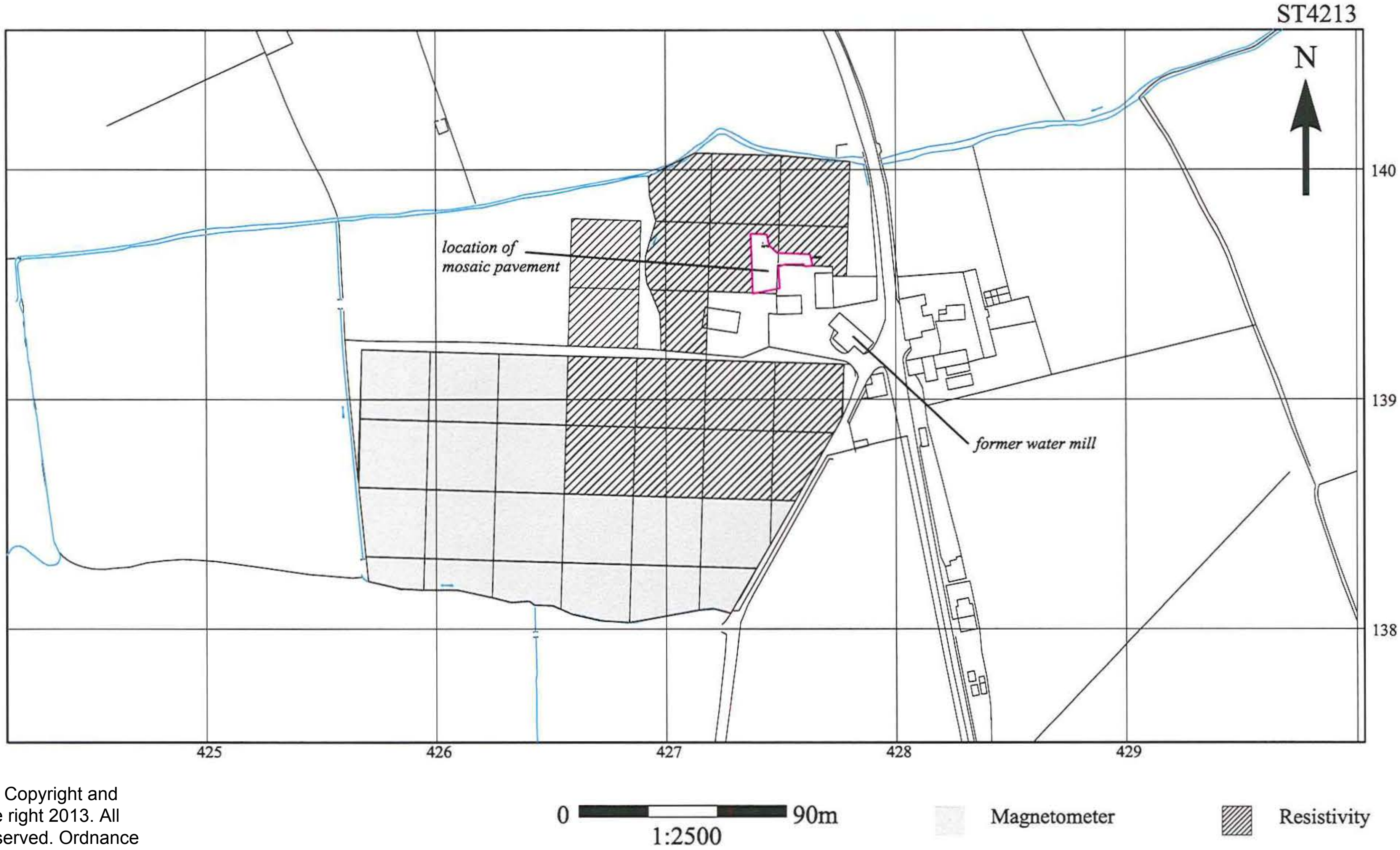


Figure 2; Bridge Farm, Lopen, *Location of the geophysical survey grids superimposed over the base OS map.*

BRIDGE FARM, LOPEN, SOMERSET
Location of resistivity survey, November 2001.

Figure 3; Bridge Farm, Lopen, *Greytone image of the resistivity data superimposed over the base OS map.*

BRIDGE FARM, LOPEN, SOMERSET
Location of magnetometer survey, November 2001.

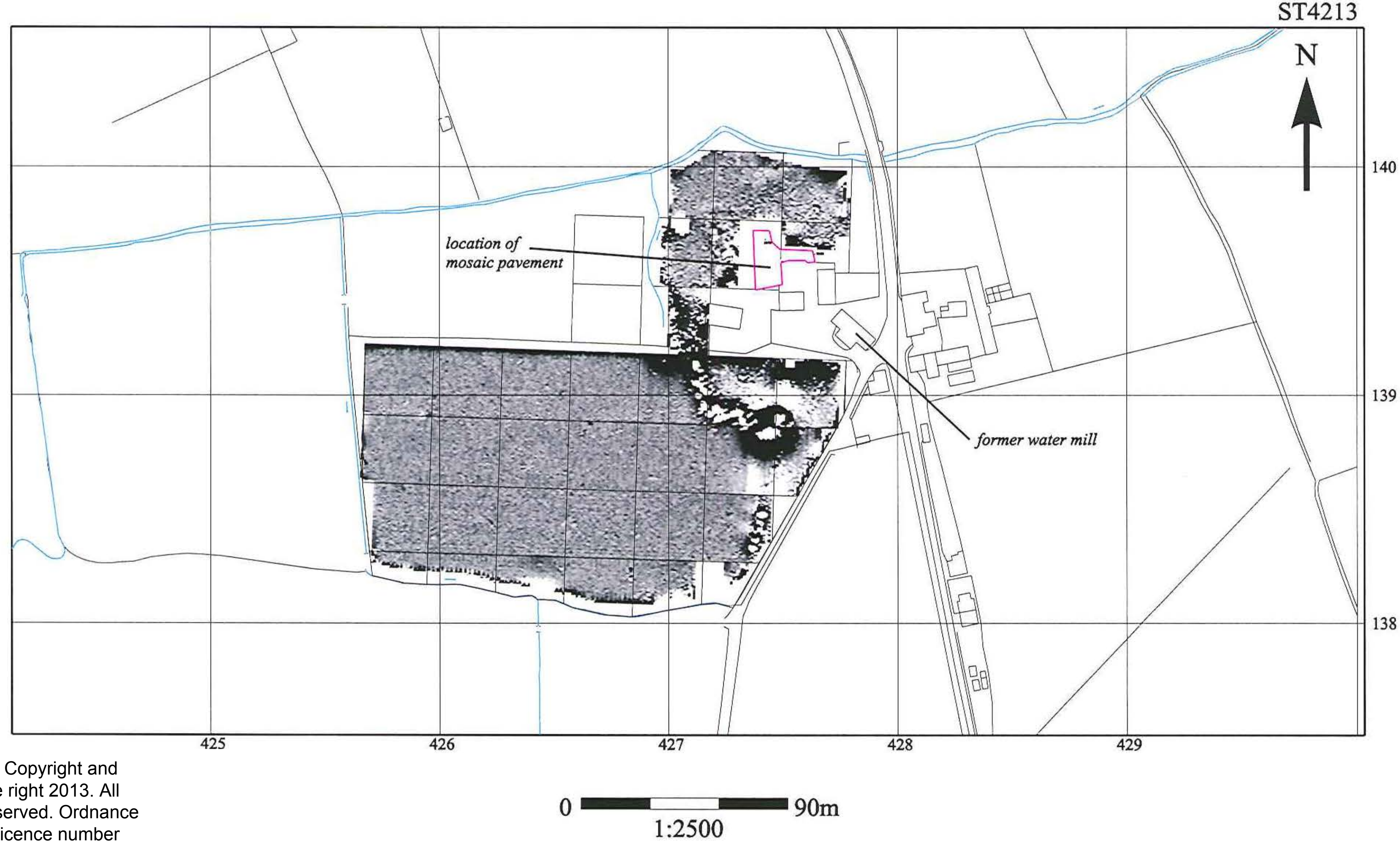
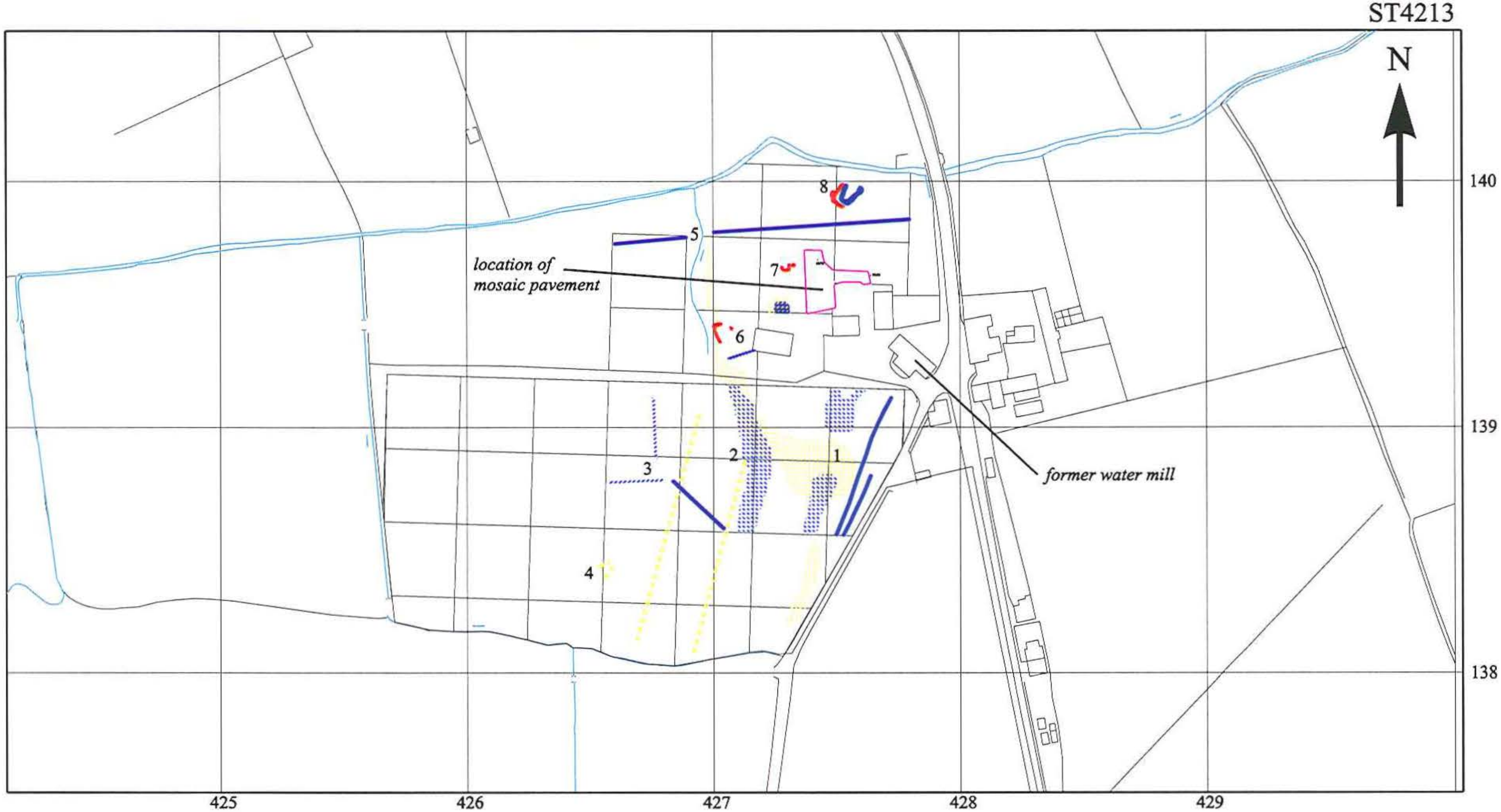


Figure 4; Bridge Farm, Lopen, *Greytone image of magnetometer data superimposed over base OS map.*

BRIDGE FARM, LOPEN, SOMERSET
Graphical summary of geophysical anomalies



0 90m
1:2500

magnetic disturbance
tentative magnetic anomaly
high resistance anomaly
low resistance anomaly
area of low resistance
tentative low resistance anomaly

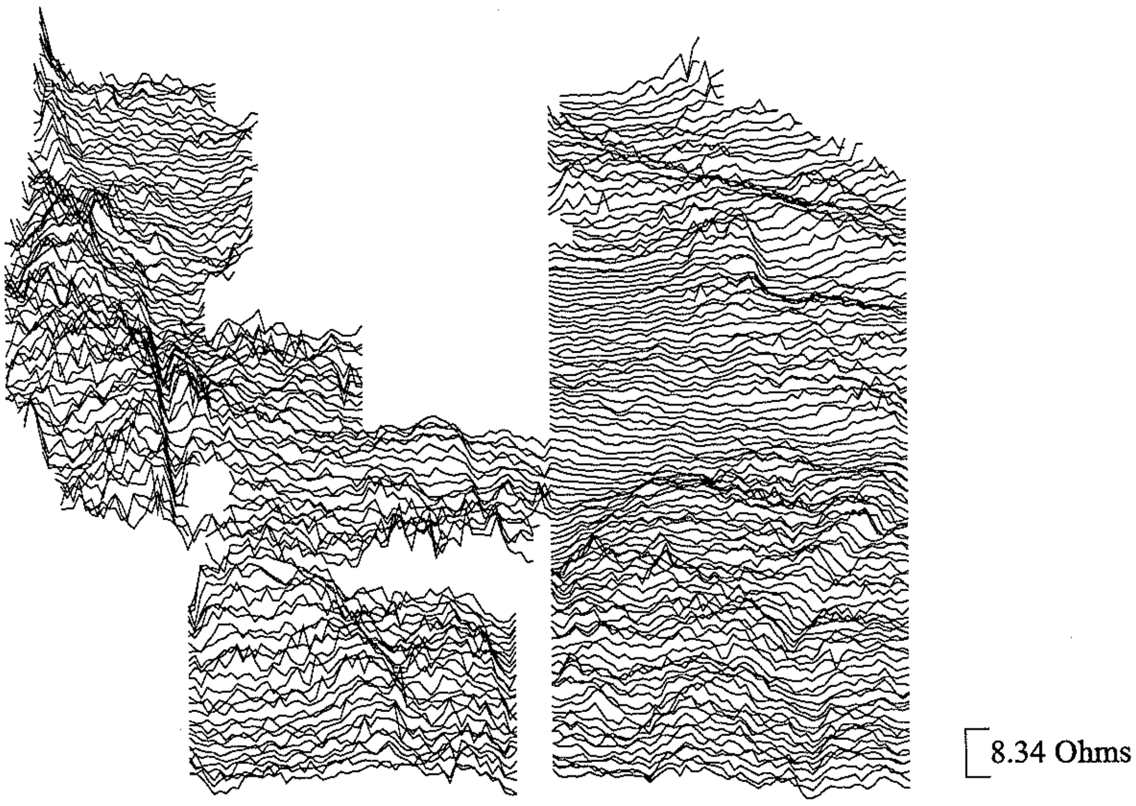
Figure 5; Bridge Farm, Lopen, *Graphical summary of geophysical anomalies superimposed over the base OS map.*

PLAN A

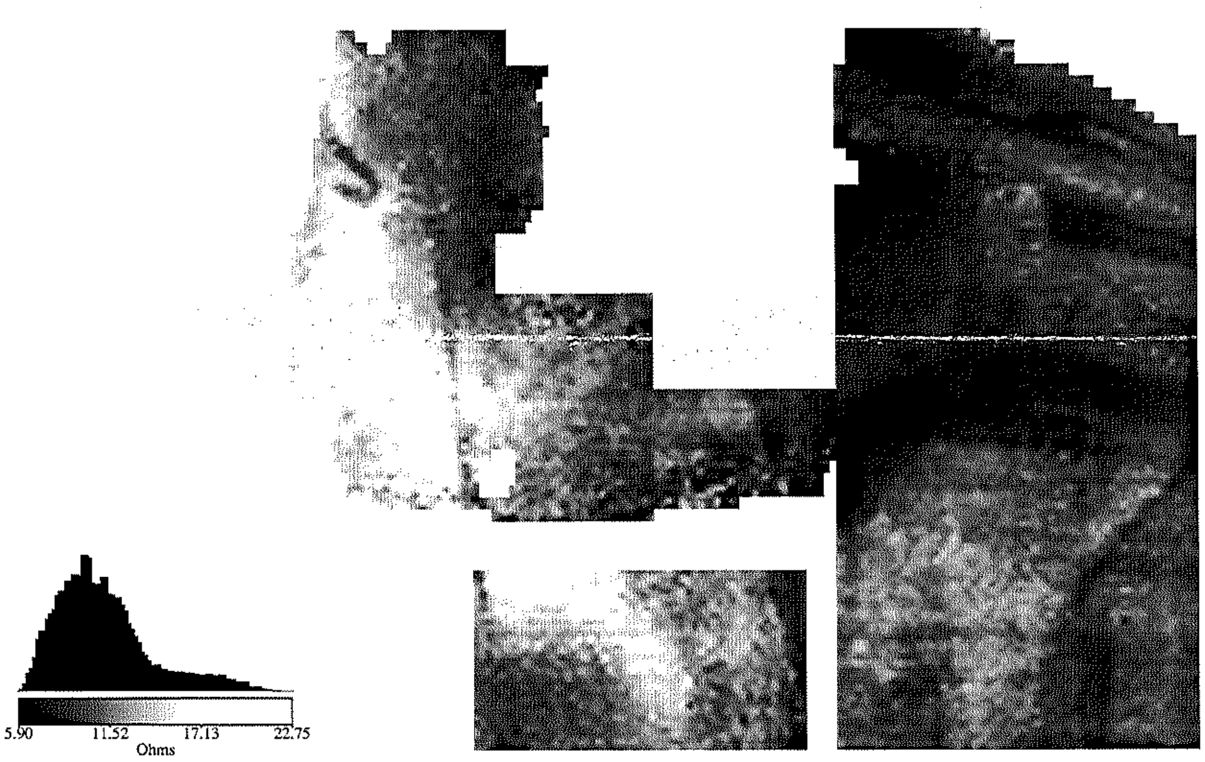
BRIDGE FARM, LOPEN, SOMERSET
Resistivity survey, November 2001.

N

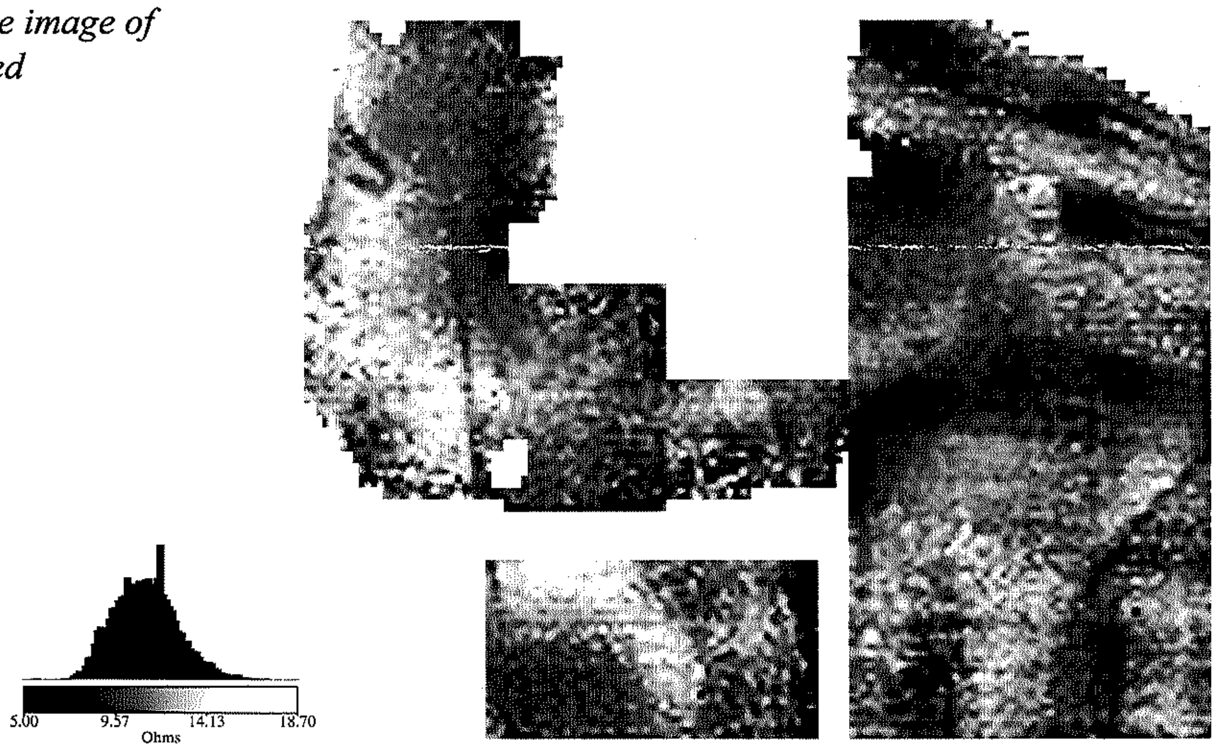
(1) Traceplot of raw data



(2) Greytone image of raw data



(3) Greytone image of enhanced



0 90m

1:1250

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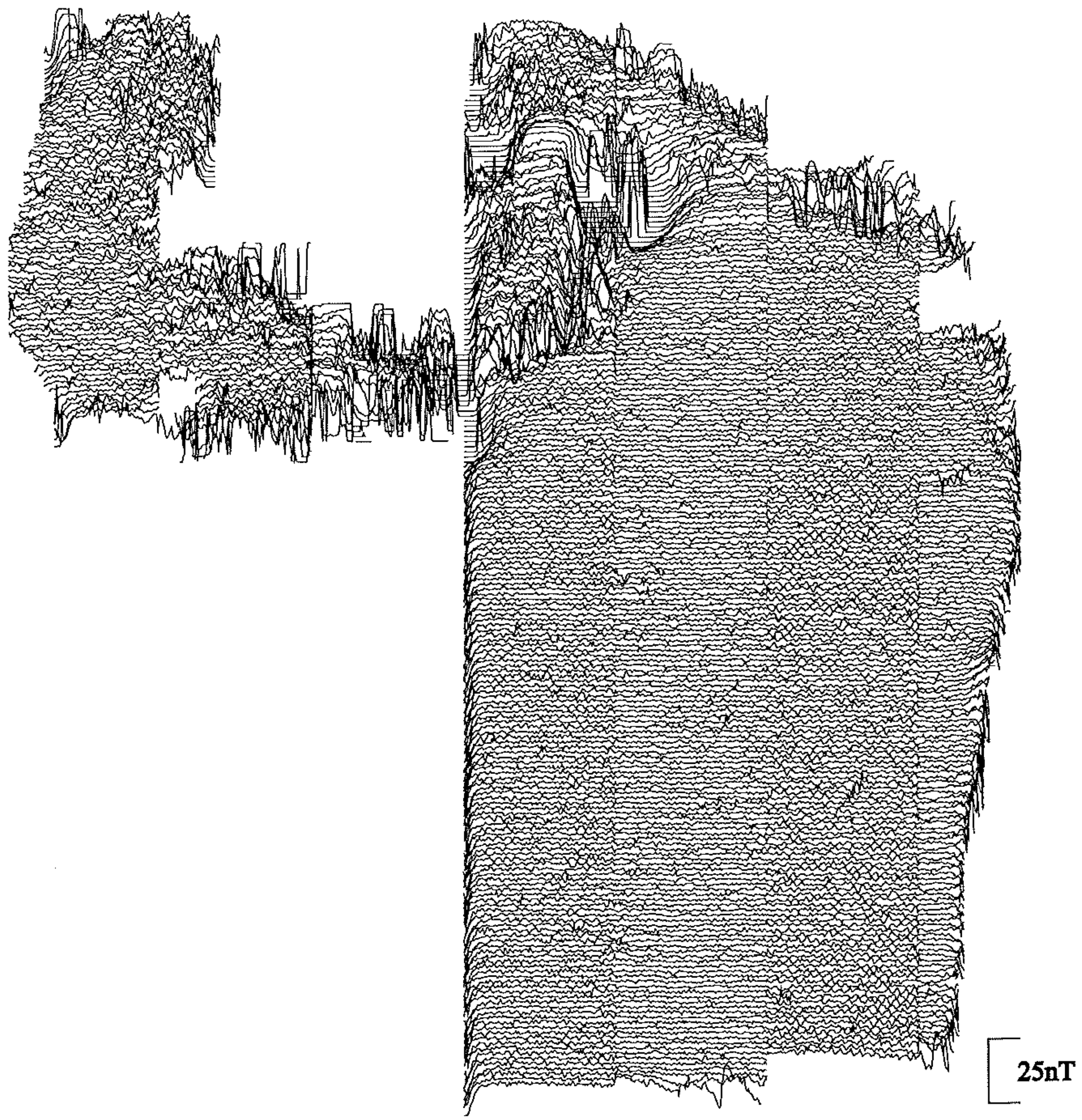
Fluxgate gradiometer survey, November 2001.

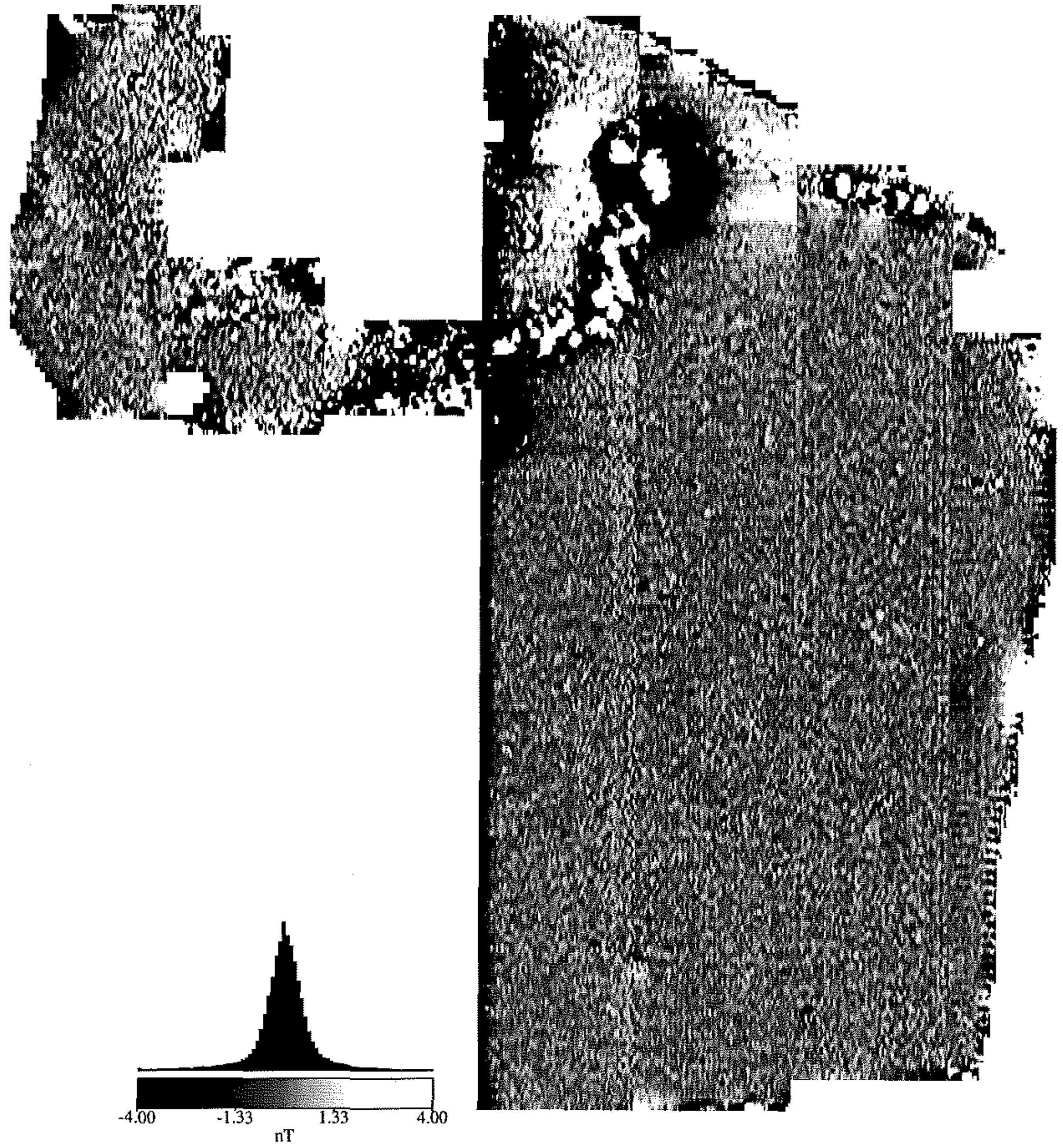
PLAN B

N ←

(1) Traceplot of data (extreme values attenuated)



(2) Linear greytone plot (processed to suppress systematic periodic noise)



0 — 90m

1:1250

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