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Ancient Monuments Laboratory
Report 57/95

TRIAL GEOPHYSICAL SURVEY FOR THE HUMBER WETLANDS PROJECT AT ROSSINGTON BRIDGE, ROMAN CAMP, SOUTH YORKSHIRE. OCTOBER 1995

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Summary

A trial geophysical survey was carried out to assess part of a Roman vexillation camp near Rossington Bridge, South Yorks. Soil conditions at the site were found to be suitable for the magnetic detection of sub-surface features. The northern corner and the eastern side of the scheduled camp were located as well as other linear features of more uncertain interpretation within and around the Roman defences. Some of these other linear features suggest the presence of multiple activity on the site. Towards the centre of the camp several groups of probable pits were detected, one confirmed by augering.

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Report on Trial Geophysical Survey for the Humber Wetlands Project, October 1995

INTRODUCTION

A geophysical survey was carried out by the Ancient Monuments Laboratory (AML) over part of a Roman military site (SY 1044) in the Humberhead Levels near Rossington at the request of the Humber Wetlands Project (Van de Noort and Davies, 1993, 72-3). Aerial photographic and other evidence suggests that the site represents the remains of a temporary camp, rather than the more permanent type of Roman fort. The aims of this trial survey were to locate accurately the boundary ditch of the camp in the north-east part of the scheduled area, and to test for the presence of related internal and external features.

The site (centred on NGR SK 629 991) overlooks the floodplain of the river Torne to the north and occupies a slight plateau formed of sandy soils of the Wick 1 Association. The latter are developed on river terrace gravel deposits over Permian and Triassic sandstones (Soil Survey of England and Wales 1983, British Geological Survey 1979). The site straddles the modern B6463 (Sheep Bridge Lane), and the area to the east of the road, where the survey was carried out, is under cultivation. The land to the west of the road is mainly pasture.

METHOD

A grid of 30m x 30m squares rectilinear with the B6463 was established by Humber Wetlands Project staff roughly in the area containing the northern corner of the camp (see Figure 1). An area of approximately 2 hectares was surveyed with fluxgate magnetometers following the standard procedure of the AML (see Annex A, note 2). This technique was employed for its ability to detect rapidly the sort of archaeological features likely to occur in association with military occupation. It was hoped first to locate the boundary earthworks of the camp and then to extend the survey to trace part of its northern and eastern perimeter and to sample its interior. Fortunately the defences were quickly located but only a small proportion of the camp interior could be investigated in the limited time available.

The results of the magnetometer survey are presented in Figures 2-4. The raw processed data (after preliminary reduction of the effect of instrument drift and responses to iron) is shown as a traceplot in Figure 3a. A greyscale plot of the data (after enhancement by a 1m radius Gaussian low-pass filter to reduce superficial instrument and soil noise: Scollar *et al* 1986) is provided in Figures 2 and 3b. An interpretation is provided in Figure 4.

In support of the magnetometer survey, and as a possible aid to interpretation, the magnetic susceptibility (MS) of the topsoil was sampled over an area of approximately 3 hectares (see

Figure 5). Measurements were taken at 10m intervals using a Bartington Instruments field sensor (MS2D).

Soil samples were also retrieved from an augered core through a magnetic anomaly, suggestive of a pit, in the area of the survey nearest to the centre of the camp. Laboratory MS determinations were made on samples from this core and were compared with those for samples from a similar core taken from an area without anomalies (see Figures 4 and 6 and Table 1).

RESULTS

1. Magnetometer Survey (Figures 3 & 4)

Numerals in bold type refer to anomalies shown on the survey interpretation in Figure 4.

Although the magnetic contrast between archaeological features and the sandy soils of the site is relatively subdued, the survey has nevertheless recovered a considerable amount of information on archaeological features in the area.

Linear features

The boundary ditches of the scheduled camp are evident as two intermittently detected parallel linear anomalies (**1**) crossing the survey area diagonally from the south-east to the north-west. The response to these ditches becomes very muted in the middle part of the survey. This latter effect may be a caused by topography (ie localised soil build-up) or, alternatively, by the lack of adjacent settlement activity (and its associated magnetic enhancement of local soils). The correspondingly low MS values in the area recorded by the MS survey perhaps favour this latter explanation (see Figure 5).

In the north-west part of the survey, one of the four rounded corners of the scheduled camp has been located (**2**) where the ditches curve to the west. A very similar pair of ditches (**3**) can be seen to the north-east of (**1**) and may either define the course of a trackway (perhaps linking the camp to the Roman road, now the A638, 120m to the north), or may even be the edge of another separate camp. If the latter is indeed the case, it adds a major new element to the previously known site. Examples of such closely grouped Roman camps are fairly common in the north of England, for example on Haltwhistle Common near Hadrian's Wall, Northumberland (see Johnson, 1989, figure 25). Other linear anomalies (**4**) probably represent the ditches of field systems of uncertain relationship to the known camp. In general, these latter anomalies are difficult to interpret as a single system and are therefore probably the result of multi-period activity.

Occupation within the scheduled camp

In the southern part of the survey area, nearest to the centre of the known camp, a scatter of localised anomalies which may represent traces of internal occupation in the form of pits and burnt features has been detected. There may be two main concentrations of these: one (**5**) in grid squares 13, 14, 17 and 18 and another (**6**) in the far south-eastern corner of the survey. It is not possible to be clear whether these areas represent occupation associated with the

Roman camp or if they relate to a separate period. Their distribution corresponds approximately with a zone of increased topsoil MS (see Figure 5) the eastern edge of which is parallel to the eastern defensive ditches. The layout of the internal occupation features and the pattern of topsoil MS might thus have an element of consistency with the ground plan of the camp - although this link is far from certain. It will be necessary to extend both surveys to examine this trend further and to ascertain its true significance.

Augering confirmed that one of the localised anomalies (ROSS A) in the southern part of the survey area (see Figure 4.b) was generated by a pit. This was found to be buried approximately 0.4m below the modern land surface, cut 0.5m into the sand and gravel subsoil, and to contain a charcoal-rich sandy silt loam filling very different to the surrounding deposits (also augered for comparison). The maximum anomaly strength at a sensor height of around 0.6m above the top of the feature was approximately 25 nanotesla (nT). The MS results from this feature are discussed below.

2. Magnetic Susceptibility

Area survey (Figure 5)

Perhaps the most noticeable influence of MS, as displayed in Figure 5, has been to subdue the magnetic response to features in the central and eastern part of the survey area - especially over the camp ditches, as referred to above. It must be uncertain as to whether or not the level of archaeological activity detected elsewhere in the survey area is maintained within this zone of low MS, perhaps protected under a greater soil depth. Conversely, the low MS and poor magnetic response could indicate that erosion may have been more severe in this area. Soil type and solid geology do not themselves appear to vary significantly over the survey area and are therefore unlikely to account for the contrast seen in the plot (Figure 5).

The higher MS values in the south-western part of the survey area, occurring within the scheduled camp, might be taken to indicate a higher level of archaeological activity there.

Laboratory measurements on augered soil samples (Table 1 and Figure 6)

Standardised mass specific magnetic susceptibility readings were obtained in the laboratory from soil samples retrieved by augering in the south-east area of the survey, within the region of high topsoil MS referred to above (see METHOD and Table 1). Low frequency MS values for the topsoil range from 64.3 to 88.9 $m^3Kg^{-1} \times 10^{-8}$ (6 samples) with an average of 73.1, providing a contrast with the lower readings of 56.6 and 58.2 obtained from the sandy gravel subsoil sampled at the bottom of the two auger holes. The good contrast between these values (MS of topsoil approximately 20% higher than subsoil) explains the satisfactory magnetic response of silted features such as ditches.

Soil from the pit fill produced MS values ranging from 147.6 to 437.1 (5 samples) with an average of 244.5 explaining the strong response of this feature to the magnetometer survey. Many of the other discrete anomalies in this central area are likely to have originated from similar features.

CONCLUSIONS

This survey has demonstrated that magnetometry is capable of defining the outlines of the scheduled camp and has also located features within its interior, one of which has been confirmed by augering to be a substantial pit. Linear and other features have been mapped elsewhere on the site, but it is uncertain at this stage whether or not these relate to further military activity. The form of one group of anomalies does however hint at the presence of a second camp lying to the east of the previously known site - a suspicion that would be worth exploring further.

Surveyed by : M Cole and A Payne 5-6th October 1995

Reported by : Andrew Payne 12th October 1995

ARCHAEOMETRY BRANCH, Ancient Monuments Laboratory

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LIST OF FIGURES

TABLE. 1.

Laboratory measured magnetic susceptibility data from sub-surface soil samples obtained by augering from : a selected discrete magnetic anomaly - ROSS A (max 25 nT, at normal sensor height) and from an adjacent area 5m to the east (ROSS B) where the magnetic field gradient was average for the site suggesting relatively undisturbed ground. See Figure 4.b. and 6 for the location of the auger profiles.

Sample reference	Description	Sample mass (g)	κ_{LF} 100cc	χ_{LF} m^3kg^{-1} x 10^{-8}
ROSS A	profile through localised anomaly of 25 nT strength			
depth : 0 - 20cm	dark brown sandy topsoil	198.9	143	71.9
20 - 30cm	"	167.1	124	74.2
30 - 40cm	"	187.8	167	88.9
40 - 50cm	lighter brown sandy silt loam with dark (charcoal?) flecks	137.6	362	263.1
50 - 60cm	"	183.7	378	205.8
60 - 70cm	"	220.1	962	437.1
70 - 80cm	"	179.9	304	169.0
80 - 90cm	bottom of feature	227.0	335	147.6
90 + cm	natural subsoil	104.2	59	56.6
ROSS B	profile through topsoil and natural subsoil			
depth : 0 - 20cm	darker sandy topsoil	217.4	156	71.8
20 - 30cm	darker sandy topsoil	150.9	97	64.3
30 - 40cm	transition from A to B horizon (sand becoming lighter in colour)	192.1	130	67.7
40 - 50cm	lighter sand above gravel	206.0	120	58.2

100 gram mass specific measurements using Bartington Instruments MS1 magnetic susceptibility meter and MS2B bench sensor.

ANNEX A : 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. For a 1m reading density, each traverse is 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. In the case of a reading density of 0.5m instead of the usual 1.0m, the intervals are reduced to 0.5m and 0.25m respectively.

   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 metre 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 0.5m apart do not produce a true measure of vertical magnetic gradient. 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).

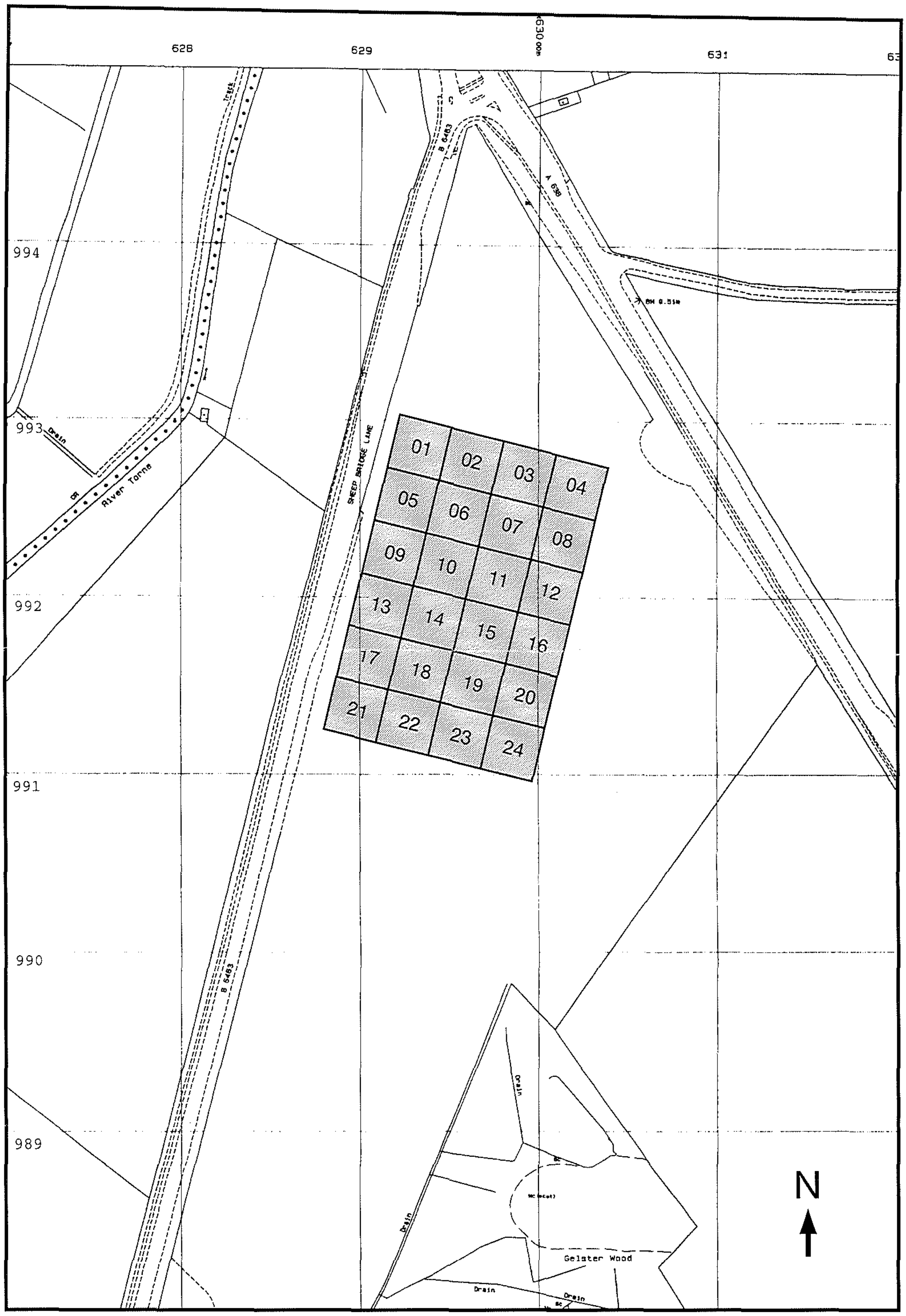
3) **Resistivity Profiling:** This technique measures the electrical resistivity of the subsurface in a similar manner to the standard resistivity mapping method outlined in note 1. However, instead of mapping changes in the near surface resistivity over an area, it produces a vertical section, illustrating 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 lateral 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.

ROSSINGTON BRIDGE ROMAN CAMP, S YORKS

Provisional Location of Magnetometer Survey, Oct 1995



Scale

0 50 150m

30m grid squares

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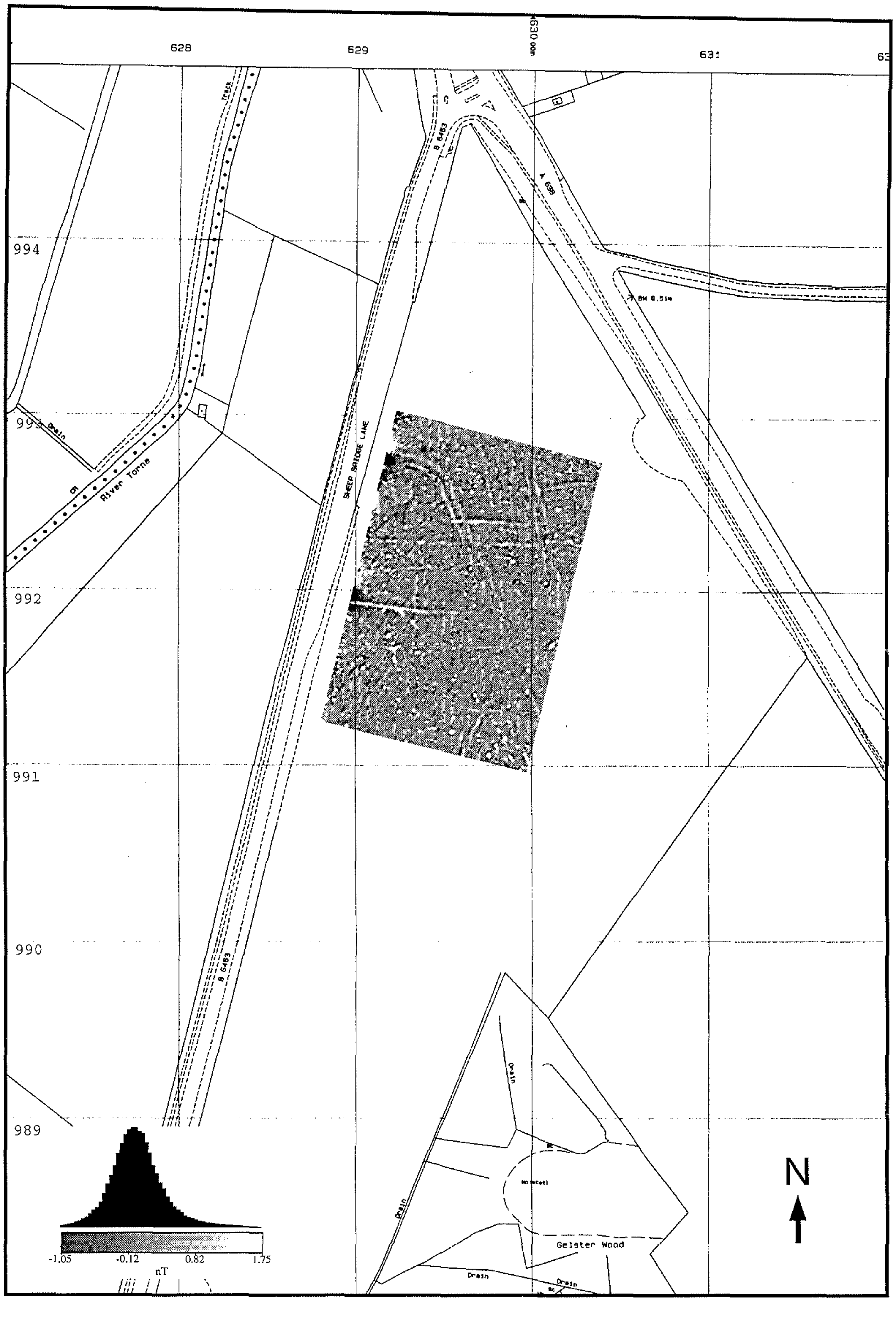
ROSSINGTON BRIDGE ROMAN CAMP, S YORKS

Figure. 2.

Provisional Location of Magnetometer Survey, Oct 1995



Scale

0 50 150m

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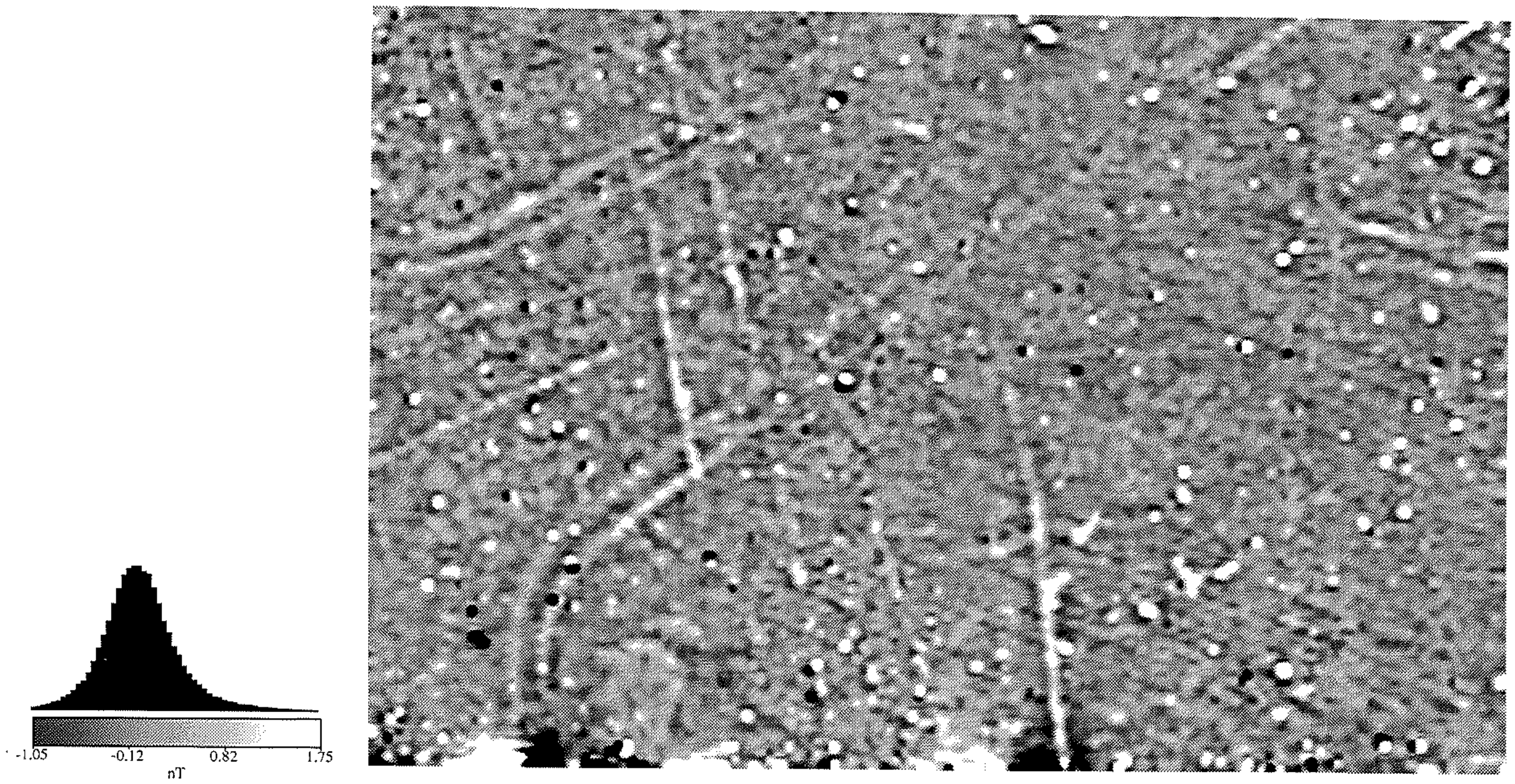
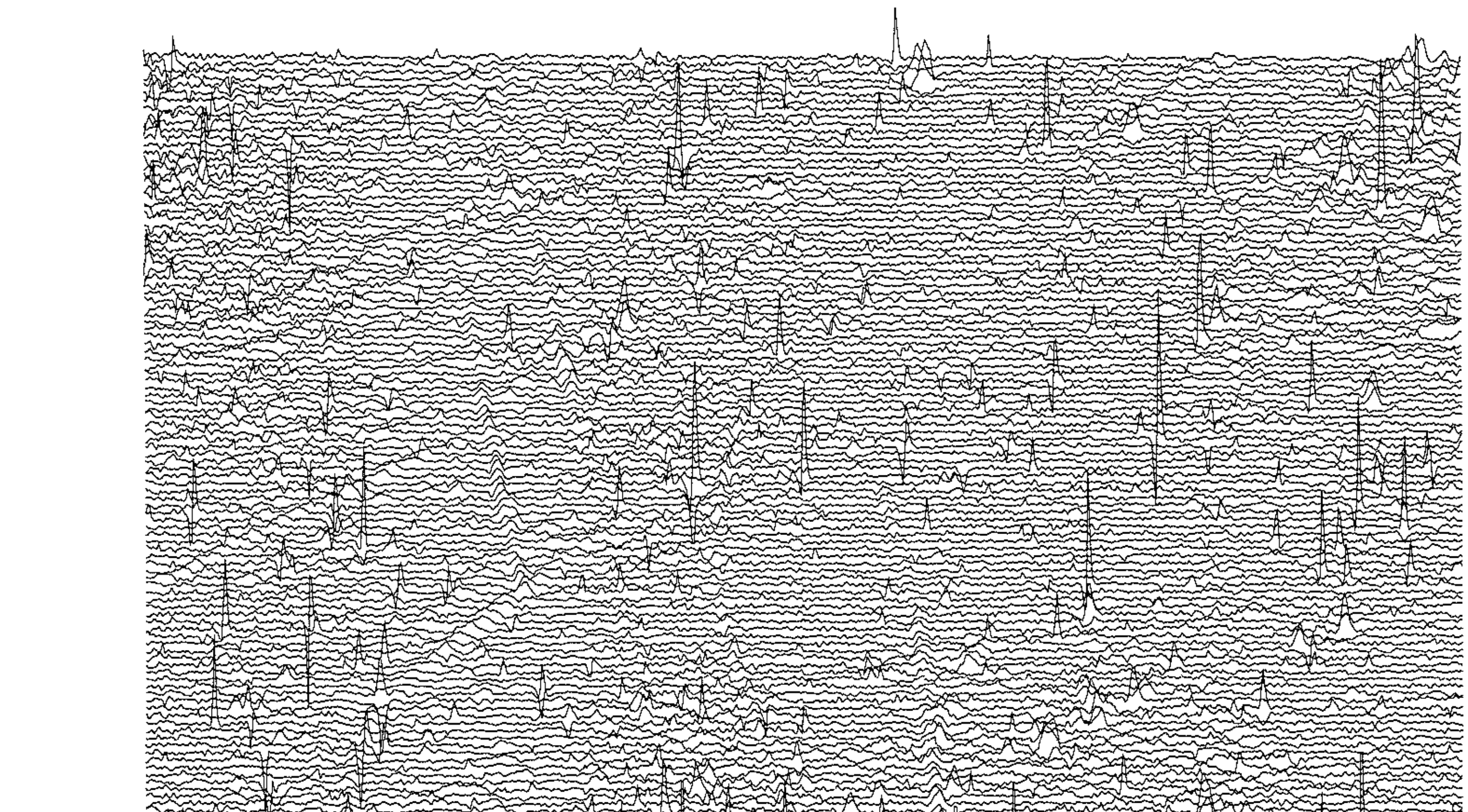
Figure. 3.

ROSSINGTON BRIDGE, ROMAN CAMP Trial Magnetometer Survey, Oct 1995

A) Greyscale plot of enhanced data



B) Traceplot of raw data



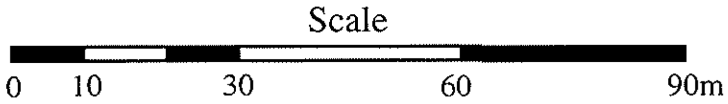
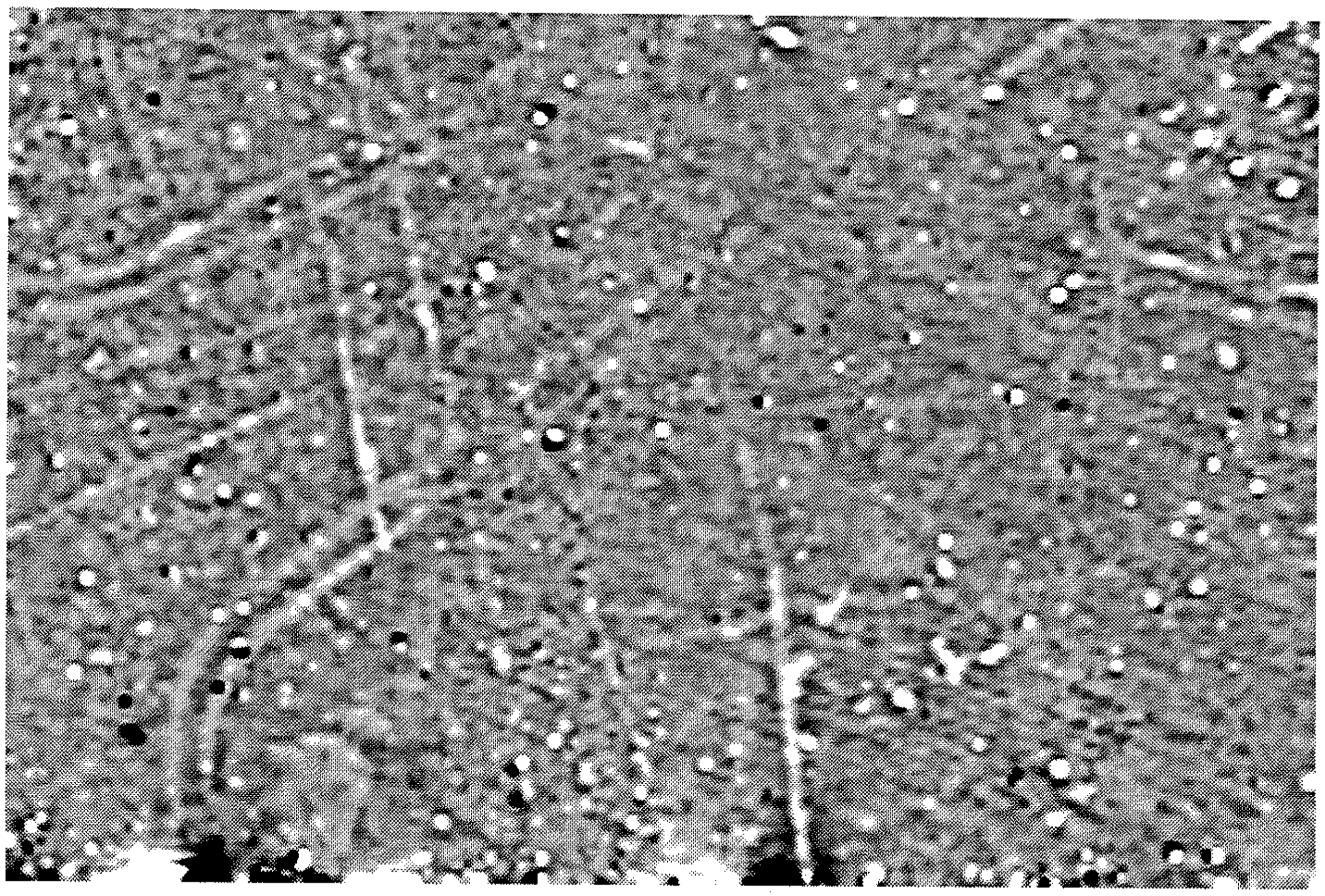
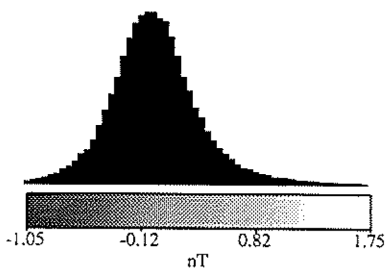


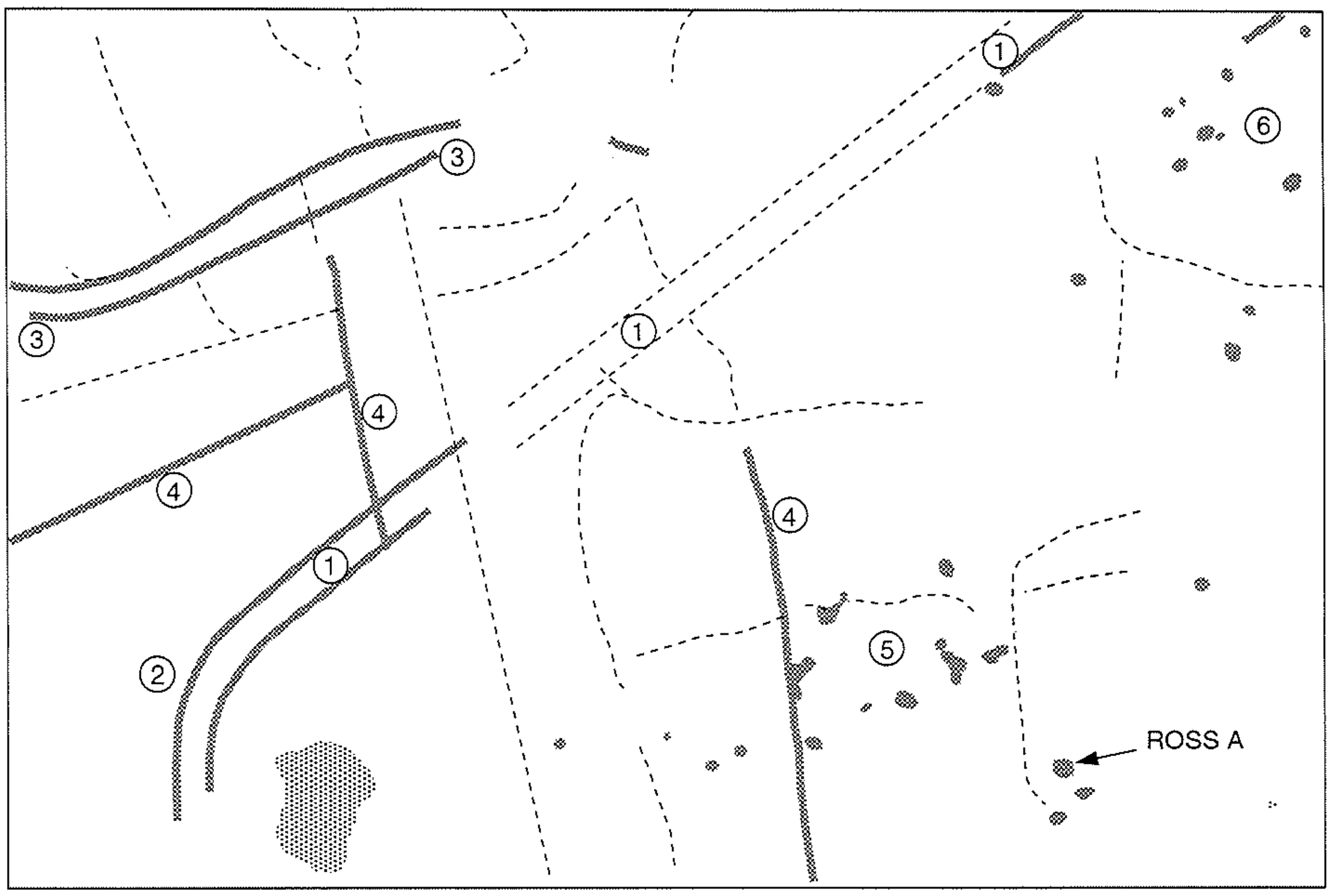
Figure. 4.

ROSSINGTON BRIDGE, ROMAN CAMP Trial Magnetometer Survey, Oct 1995

Interpretation of Magnetometer Survey







KEY

LINEAR ANOMALIES

well defined

uncertain or projected

DISCRETE ANOMALIES

possible filled in quarry

Scale

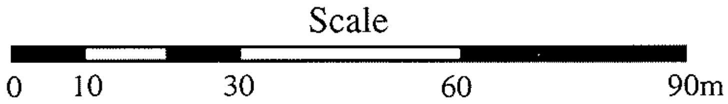
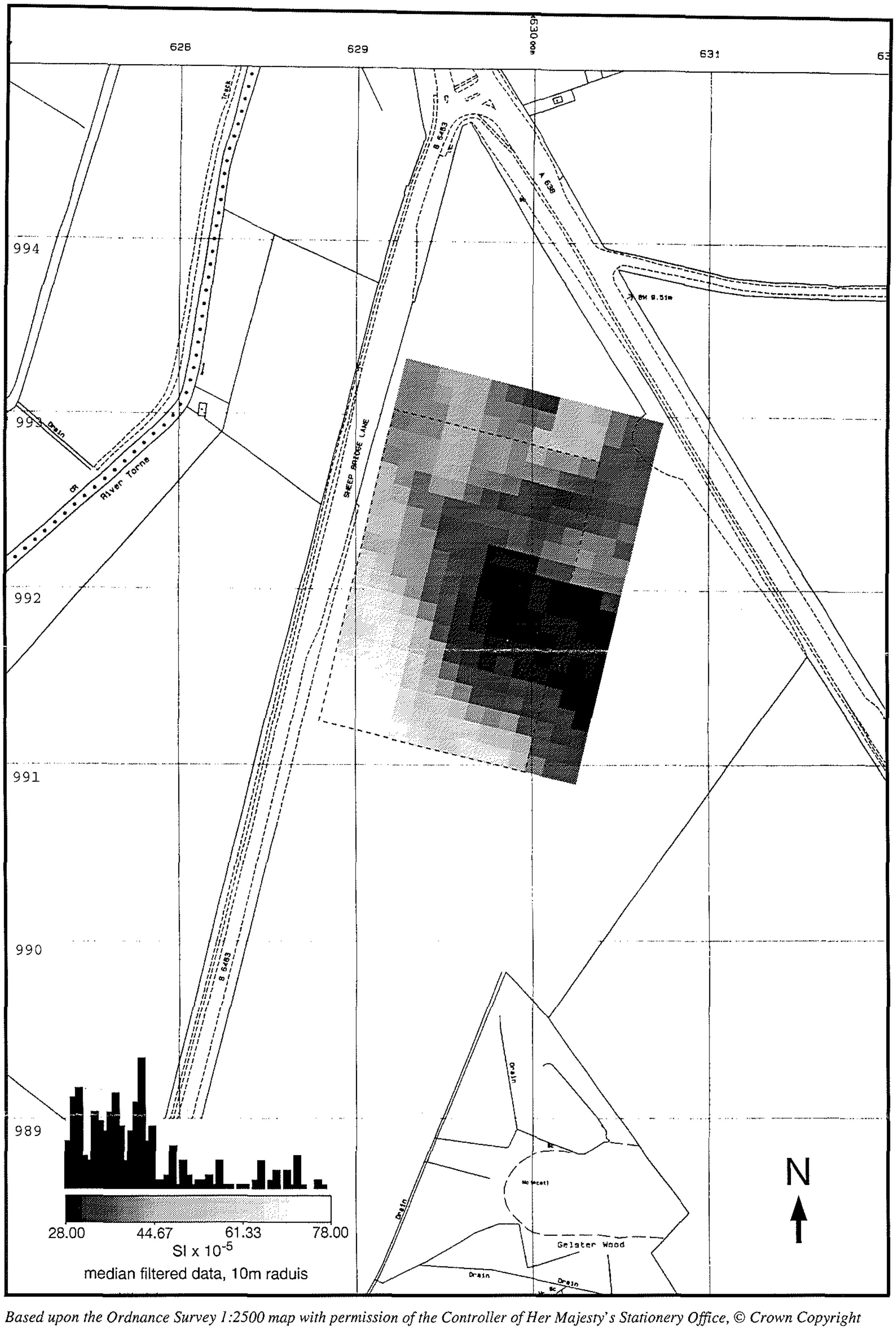


Figure. 5.

ROSSINGTON BRIDGE ROMAN CAMP, S YORKS

Field Loop Magnetic Susceptibility Survey



Based upon the Ordnance Survey 1:2500 map with permission of the Controller of Her Majesty's Stationery Office, © Crown Copyright

Scale

0 50 150m

---------------- boundary of magnetometer survey

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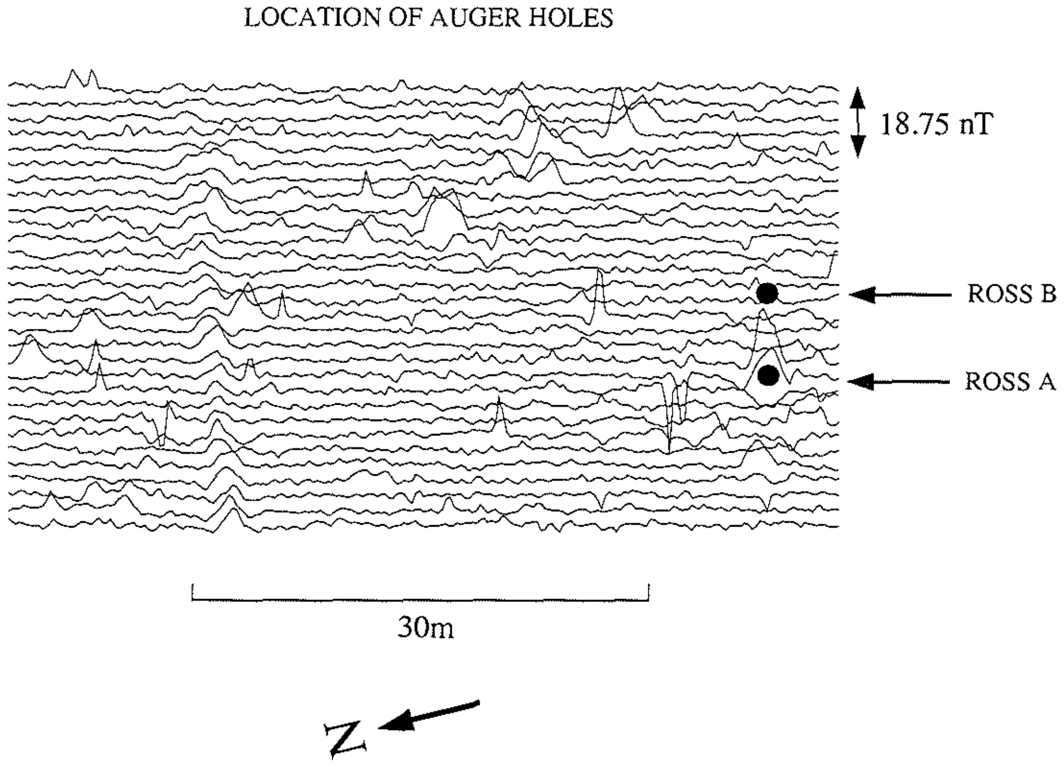
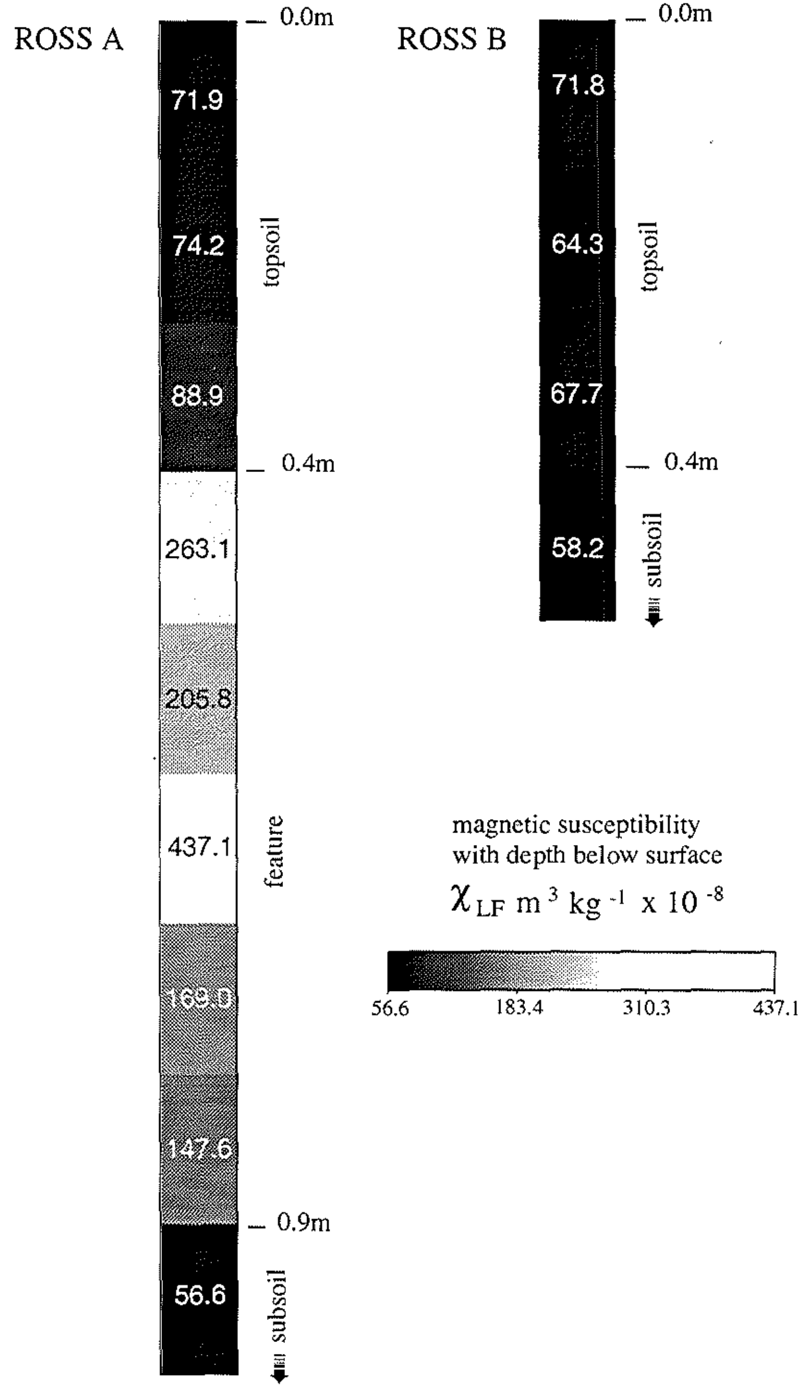
Figure. 6.

ROSSINGTON, S. YORKS

Magnetic susceptibility of augered soil samples from ROSS A and B.





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