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Ancient Monuments Laboratory
Report 170/88

GEOPHYSICAL SURVEYS FOR THE STONEHENGE ENVIRONS PROJECT

A D H Bartlett

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Summary

This report describes the geophysical investigations of sites in the vicinity of Stonehenge which were carried out for the Trust For Wessex Archaeology as part of the Stonehenge Environs Project. The sites were surveyed by the AM Laboratory in 1982 and 1983 prior to excavation, and additional extensive magnetic susceptibility surveying was undertaken by the excavators. This approach was adopted following the successful susceptibility survey of the Coneybury Henge in 1980, which is the subject of a separate report (AML report 169/88). The results of the various Stonehenge Environs surveys are brought together here for the first time so that the contribution which geophysical techniques can make to a comprehensive archaeological fieldwork programme can be assessed. The results of a magnetometer survey of the Stonehenge Cursus carried out for TWA by J A Gater in 1987 are also noted.

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Ancient Monuments Laboratory

Geophysical Surveys for the Stonehenge Environs Project

Introduction

This report brings together the results from a series of geophysical surveys carried out for the Trust for Wessex Archaeology at sites which were being investigated by the Stonehenge Environs Project under the direction of Julian Richards. The survey of the Coneybury Henge site (excavator's designation W2), which was done at the start of the Project in 1980, has not been included here, and is the subject of a separate A M Laboratory report.

The magnetometer surveys (of all sites except the Stonehenge Cursus, W56) were carried out by the A M Laboratory in 1982-3 using the then standard analogue recording technique in which traverses at 1m intervals were plotted on a chart recorder. Plans based on the charts are included in the report. The results of a survey of the terminals of the Stonehenge Cursus done for the Trust for Wessex Archaeology by J A Gater in 1987 are also noted for completeness.

The Coneybury survey had shown that magnetic susceptibility measurements, which had until then usually been used only to provide a general indication of the presence of a site, might also (if sampled closely) provide a direct indication of archaeologically significant features confined entirely to the topsoil (Clark, 1983, 1986). Further work of this kind was desirable to discover whether comparable results could be obtained from other sites, especially those (such as W31, W32, W59; see below) which had been identified from fieldwalking and where close examination of the topsoil might contribute significantly to the overall archaeological picture. The laborious work of collecting susceptibility readings at close intervals over substantial areas was undertaken by the Project staff. The data were then supplied to the A M Laboratory, and processed version of the results are included in this report.

All the sites except W56 and the ring ditch E of W59 have been excavated to a greater or lesser extent since they were surveyed. Correspondences and discrepancies between the survey results and some of the main excavation findings (as described in notes provided by the excavator) are commented upon below. The results from each of the sites surveyed (W31, W32, W34, W59, ring ditch near W59, W55, W56) will be described in turn .

W31: Wilsford Down

NG SU 107 408
Date of AML fieldwork: 9-10 August 1982

The intention at this site was to investigate an extensive flint scatter (about 100m in diameter) which had been identified during fieldwalking. The survey grid (of standard 30m magnetic survey squares) was positioned to form a transect across the area of the flint scatter. (See plan 1.1 for location of grid.)

Magnetometer survey

The full gridded area (210 x 60m) was surveyed to give the plot as shown on plan 1.2. There are several conspicuous magnetic disturbances of a kind which are likely to be caused by buried iron, but otherwise there are only some small localized magnetic anomalies, which could represent pits or short sections of ditch. Features of this kind which were identified at the time of the original survey are shaded on plan 1.2. On the evidence of the survey such features

could be of archaeological origin, but the activity is rather sparse and the magnetometer evidence alone does not suggest this was a significant settlement site.

Subsequent excavation of the anomalies labelled A, K, L, R, T, M confirmed that the anomalies did represent subsurface features, but all except the linear feature M were found to be pits of natural origin. The site is on a broken and uneven chalk bedrock, and the pits were reported by the excavator to be irregularly shaped natural hollows in the chalk between 0.15 and 0.4m deep, with silty loam fill. The fills contained a high proportion of flint (30-40%), including knapping debris, and features K, L, R and T also contained sherds, some of them of late Neolithic / early Bronze Age date. The magnetic anomaly M was a ditch 1m deep.

Susceptibility survey

Readings were collected at 1m intervals (using a Bartington MS1 meter with field sensor coil) from an area 175 x 30m set within the magnetometer survey as shown on plans 1.1 and 1.2. The results are shown using two different forms of presentation on plan 1.3. Plot (i) shows the data (between two standard deviations above and below the mean) mapped as shaded squares with no other treatment. The plot shows that the readings increase at a fairly constant rate from the SE end to the NW end of the survey. There are also many localized variations superimposed on this trend, but these cannot be interpreted easily given the rather coarse increments of the display. The results have therefore been presented in plot (ii) using a treatment similar to that commonly employed for resistivity surveys, where the aim is to suppress broad variations and emphasise smaller features. The readings have been subjected to slight numerical smoothing, and then filtered by subtracting the mean of neighbours at a given radius (in this case 4) from each reading. Localized variations in the data can then be plotted against a uniform background level. Plot (ii) shows only the positive anomalies in the data following this treatment.

Some potentially significant features emerge: There is a tendency for anomalies to align along the length of the survey, but there is also a diagonal feature (arrowed) at the SE end. There are also distinct localized positive anomalies (eg as labelled at a, b, c; and elsewhere) which appear similar to the anomalies seen at Coneybury. (This site is considerably more active overall than Coneybury: the mean of the suceptibility readings here is 55 [x 10^{-8} SI/kg], and the standard deviation is 17: at Coneybury the values were 37 and 4 respectively.)

There have been few surveys where susceptibility readings have been collected at close enough spacing to be processed and displayed as they are here. Susceptibility surveys have more often been used to establish broad trends on the basis of coarse data, and so there are few precedents to guide the interpretation of these more detailed results. There may be a contribution from non-archaeological sources. The linear features running along the survey align with the field boundary, which suggests that cultivation might be a factor, but since an earthwork follows the boundary, the effect could be modern or ancient. The ground also slopes, and this could contribute to the variation seen between the two ends of plot (i). This is, however, unlikely to be the full explanation: Some of the possible relationships between susceptibility values and other variables which were examined during the excavation have been discussed by Entwistle and Richards (1987). By comparing phosphate concentrations and distributions of burnt and worked flint, as well as the susceptibility data, they identify a focus of domestic activity near the centre of the site, with waste disposal and flint working elsewhere. The evidence suggests a shifting palimpsest of activities, which can to some extent be discriminated when chemical and physical evidence is considered together with the excavation and fieldwalking results. The picture they construct is of a site which is much more substantial than the few subsurface features found by the magnetometer and confirmed by the excavation would suggest.

It would be tempting to suggest that the susceptibility anomalies at a,b etc might relate to specific events or activities within this general picture, as appears to have been the case at Coneybury, but without further corroboration such an interpretation remains rather speculative. There can be little doubt, though, that there is at least an archaeological

contribution to the observed susceptibility response, and that much of the evidence for archaeological activity at the site is confined to the topsoil. The suceptibility meter therefore appears to have provided a more adequate indication of archaeological activity than the magnetometer.

W32: Fargo Wood 1 and W34: Fargo Wood 2

NG SU 112 432
Date of AML fieldwork: 1 September 1982

These sites lie close together at the east side of Fargo Wood as shown on plan 2.1. Site W32 was identified during fieldwalking as a nucleated flint scatter, which from its disposition might represent a ploughed-out long barrow. Three 30m grid squares were marked out to cover the scatter, and surveyed with the magnetometer to give the chart as shown (together with the results from site W34) on plan 2.2. W34 was also found by fieldwalking, and was identified as a prehistoric pottery scatter. Two separate areas of the site were surveyed with the magnetometer, and part of the larger one was also surveyed with the susceptibility meter.

Magnetometer survey

The magnetometer surveys of the two sites showed only a few weak magnetic anomalies, which have been shaded on the chart. At W32 the survey failed to produce any evidence of side ditches or quarry pits that would suggest this was a long barrow. Most of the anomalies, as at W31, appear to represent small pits, but at W34 there is also an irregular ditch-like feature. Excavation trenches at W32 were positioned at A and B as shown on plan 2.2. The site is on a mixture of chalk with coombe rock and clay, and three features were found on excavation. They were all of natural origin, irregular in plan and section, and from 0.2 to 0.6m deep. One of them contained five prehistoric sherds and 430g of burnt flint. The features detected at W34 were unproductive when excavated, although much disturbed by rabbits, and again were presumably of largely natural origin.

Susceptibility survey

A 50m square taking in a number of the magnetic anomalies at W34 was surveyed also with the susceptibility meter, with readings collected at 1m intervals as at W31. the readings on this occasion were affected by instability in the zero setting of the meter, as can be seen in the initial density plot (i, on plan 2.3), where some of the discontinuities are arrowed. The readings were therefore corrected by subtracting a least-squares fitted baseline from the lines of readings within each initial 25m square, to give the results as shown (by means of shaded squares) in plot (ii). A filtered density plot showing the positive anomalies is also included (iii).

The shaded plot (ii) shows a concentration of high readings to the bottom left, with both high and low readings fairly uniformly scattered elsewhere. In the filtered version (iii) some clearly defined positive anomalies emerge, eg at a and b. These again suggest the possibility, as at W31, that the topsoil has been subjected to a greater degree of archaeological disturbance than the limited number of features cut into the subsoil would suggest. Plot (iii) also again shows a faint linear pattern (arrowed), which tends to align with the field boundary. This might, as at W31, suggest that cultivation has contributed to the overall pattern of susceptibility variations.

The susceptibility readings at W34 fall within a range which, on the evidence of other sites nearby, is compatible with the presence of significant archaeological activity. The mean susceptibility reading here is 46 [x 10^{-8} SI/kg], and the standard deviation is 11, compared with 55 and 17 respectively at W31 (and 37 and 4 at Coneybury).

W59: King Barrow Ridge

NG SU 135 425
Date of AML fieldwork: 22 August 1983

This site (unlike the previous ones) is on a hard chalk subsoil. The area investigated lies immediately to the north of the King Barrows as shown on plan 3.1. Large numbers of flint tools were collected from the surface here, and subsequent investigations also included a phosphate survey (not done by AML) as well as the sample excavations.

Magnetometer survey

The magnetic anomalies shaded on plan 3.2 are those which were identified from the initial field chart at the time of the survey, and notified to the excavators. Most of them again appear to be pits. The northern ditch of the Stonehenge Avenue was also clearly detected, and follows a line slightly different to that shown on the OS map. The linear feature at the west of the survey (marked by broken line; arrowed) was not identified in the initial interpretation. It aligns with the field boundary and might have been caused by a plough furrow.

A number of sample squares were excavated within the area covered by the survey, and these took in the anomalies labelled E and J/K. Anomaly E was a natural hollow 0.4m deep with no finds. At J/K there were three substantial pits and a shallow linear feature of periglacial origin. The pits contained flint tools, animal bones and late Neolithic pottery.

Susceptibility survey

Readings were collected from the greater part of the site (using the field sensor coil as previously) at 5m intervals, as shown by shading on plot 3.3 (i). Additional readings were taken at 1m intervals from the areas to be excavated, and these are plotted in the gaps of the 5m survey.

Plot (i) shows low readings at the north end of the site, and then (slightly to the south) a band of higher readings which affect both the 5m data and the 1m data from excavated squares F, B and M. The boundary between high and low readings corresponds to the northern limit of the main flint scatter, as noted by Entwistle and Richards (1987). There is another area of high susceptibility readings around the square excavated at L. An attempt has been made in plot (ii) to apply a filtering process similar to that used to emphasise the localized anomalies in the surveys mentioned previously, but the plot lacks detail because of the sparse data. Individual high readings in the 5m survey produce conspicuous anomalies, which are not in themselves very reliable, but which do allow the possibility that distinct localized anomalies might well be present, as at the other sites. This site produced the highest mean susceptibility value of all those surveyed: The mean value is 120 [$x10^{-8}$ SI/kg], and the standard deviation is 28.

The phosphate results (not reproduced here, but mentioned by Entwistle and Richards) also show an area of maximum concentration roughly centred within the survey, but with additional peripheral maxima as would be expected if phosphate enhancement represents the distribution of midden deposits, and susceptibility more directly relates to the presence of a settlement. The distributions of these quantities are discussed extensively by Entwistle and Richards.

Ring Ditch E of King Barrow Ridge

NG SU 1457 4260
Date of fieldwork: 22 August 1983

This small test survey was done at the same time as the survey at King Barrow Ridge. The feature investigated is a parch mark or soil mark which possibly represents a small henge. A single 30m square located as shown on plan 4.1 was surveyed with the magnetometer, giving the plot as reproduced on plan 4.2.

The plot shows a certain amount of extraneous iron and no immediately identifiable archaeological features. There is, however, an area in the centre of the survey where the readings are raised relative to the level elsewhere, and when this area is outlined it forms an elliptical shape as shown on the plot. The readings immediately outside this area are depressed in places, which could indicate vestiges of a bank, but there is no indication of a ditch inside or outside this supposed bank. The raised readings as outlined could perhaps be the result of a slight increase in the depth of topsoil preserved within an enclosing bank, but further investigation would be needed to confirm this very tentative interpretation.

W55: Lesser Cursus

NG SU 1055 4350 (mid point)
Date of AML fieldwork: 5 August 1983

This survey was carried out with the practical aim of finding the precise location of the ditches of the Lesser Cursus in advance of excavation. Survey squares were located as shown on plan 5.1, and the two ends of the cursus and the cross ditch in the centre were examined with the magnetometer. There is some modern interference in the squares surveyed at the western end of the cursus (see plan 5.2), but the ditches responded very clearly and can be traced in spite of this. The location of the ditches in fact departs in some places by a few metres from the position as marked on the OS map.

It was hoped that the survey would help clarify the rather indeterminate eastern end of the cursus, but the ditches as visible on the chart appear simply to stop in much the same way as the cropmarks. The ditches were subsequently sectioned at locations A, B and C as shown on plan 5.1. An additional magnetic anomaly inside the cursus ditch as shown at D on plan 5.2 was also excavated, and was found to be a natural periglacial hollow of irregular plan.

W56: The Stonehenge Cursus

The results are noted here of a magnetometer survey which was carried out for the Trust for Wessex Archaeology by J A Gater in 1987. The two terminals of the cursus were investigated. Magnetic scanning at the western end showed that there is considerable magnetic interference caused by now-demolished military buildings. No archaeological features could therefore be identified, although some might be visible if a detailed recorded survey were to be attempted.

A recorded survey was done at the eastern terminal, and showed that the site there is less affected by interference. The cursus ditch responded well, and could be traced as it turned from the south side of the cursus northward to form the terminal. The northern ditch lies close to a fence and was obscured by the associated magnetic disturbance. (See Gater 1987 for plot of survey.) An additional ditch (oriented SW-NE) was detected within the cursus, as well as other anomalies. Some of these could have been pits as seen in the various AML surveys, but the picture is rather confused by the presence also of pieces of iron.

The Amesbury 42 Long Barrow which lies immediately to the east of the cursus was not investigated.

Conclusions

The Stonehenge Environs Project provided an opportunity to test geophysical techniques across a series of sites of varied archaeological character, but in reasonably uniform and favourable geological conditions. The excavations showed that natural as well as man-made pits and hollows could be detected by the magnetometer, and this was the case both on solid chalk bedrock, and at sites where the chalk had been glacially disturbed. A more significant finding was that the magnetometer by itself could give a very incomplete picture of the archaeological character of a site. The magnetometer is most effective where there are substantial earth-filled features cut into the subsoil (as for the Cursus and Lesser Cursus), but where such features are lacking, conclusions based on a magnetometer survey alone could be very misleading.

The Project has demonstrated that, by deploying a full range of fieldwork techniques, significant information can be recovered even from sites where much of the archaeological evidence is confined within the topsoil. It has also shown the potential value of magnetic susceptibility measurements in studies of this kind. The susceptibility results showed that, although non-archaeological influences such as cultivation or topography could not necessarily be excluded from the total response, a pattern of activity which related well to the other archaeological evidence could still be observed. Comparison of the findings from W31 and 34 with those from the less intensive survey at W59 shows that not only can information about the broad disposition of a settlement site be obtained, but there is the possibility also of identifying distinct small scale anomalies if the site is surveyed in sufficient detail. A direct association between a localized susceptibilty anomaly and a specific archaeological feature (a concentration of burnt filnts in the topsoil) has so far only been demonstrated at Coneybury, but the results from W31 and W34 suggest that it might be interesting to seek other such correspondences elsewhere.

Surveyed by:

A D H Bartlett, A E U David, D Bolton

Date of report:

July 1988

Acknowledgements

I should like to thank the Project director, Julian Richards, and his staff for supplying the magnetic susceptibility data on which much of this report is based, and also for providing much other information including site plans and details of excavation findings. Thanks are also due to John Gater for permission to refer to his report on the survey of the Stonehenge Cursus, and to Mr B Turton for the provision of computing facilities used in preparing this report.

References

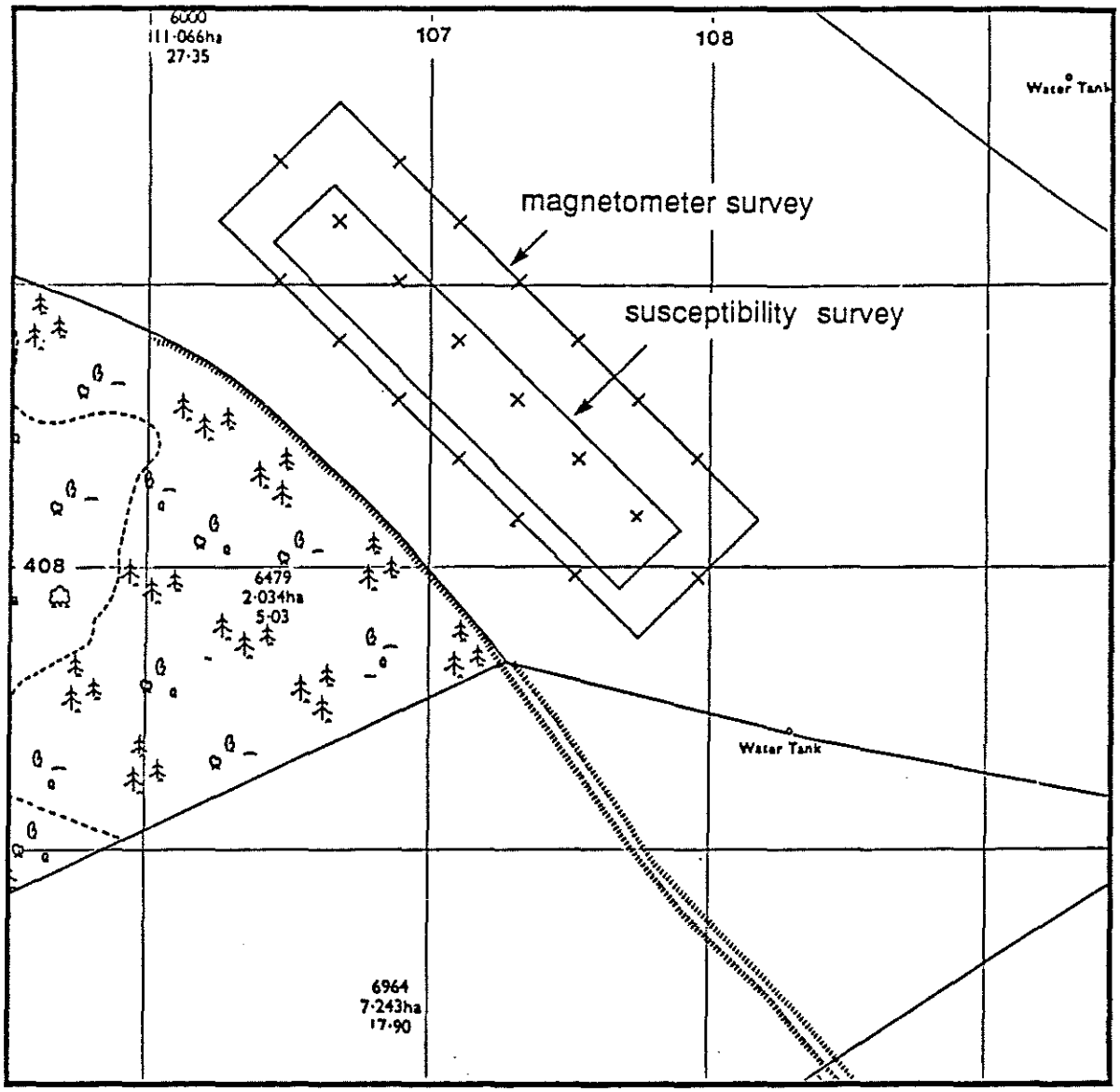
Clark, A J (1983) The Testimony of the Topsoil: *in* Maxwell, G S , Ed, The impact of aerial reconnaissance on archaeology: CBA Research Report 49, 1983, 128-135

Clark, A J (1986) Archaeological Geophysics in Britain: Geophysics, **51**, No. 7, July 1986, 1404-1413

Gater, J A (1987) Report on Geophysical Survey ; Stonehenge Cursus, Wiltshire (unpublished report for Trust for Wessex Archaeology), June 1987

Entwistle, R and Richards, J (1987) The Geochemical and Geophysical Properties of Lithic Scatters: *in* Brown, A G and Edmonds, M R (eds), Lithic analysis and later British prehistory: BAR British Series 162, 1987, 19-38

(Thirteen plans are enclosed with this report)



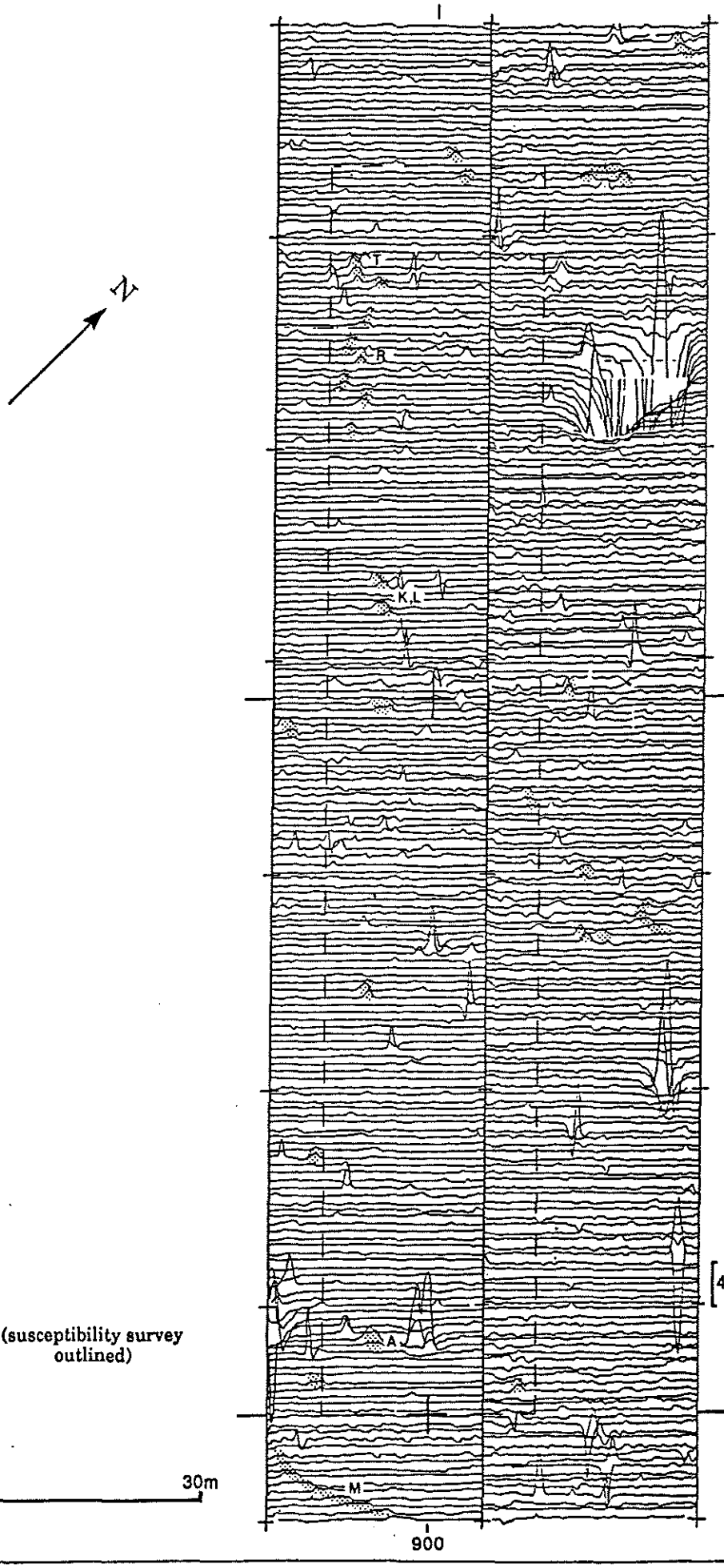
W31 Wilsford Down

Location of magnetometer and susceptibility surveys

1:2500

A M Laboratory

AB



W31: Wilsford Down
Magnetometer Survey

A M Laboratory

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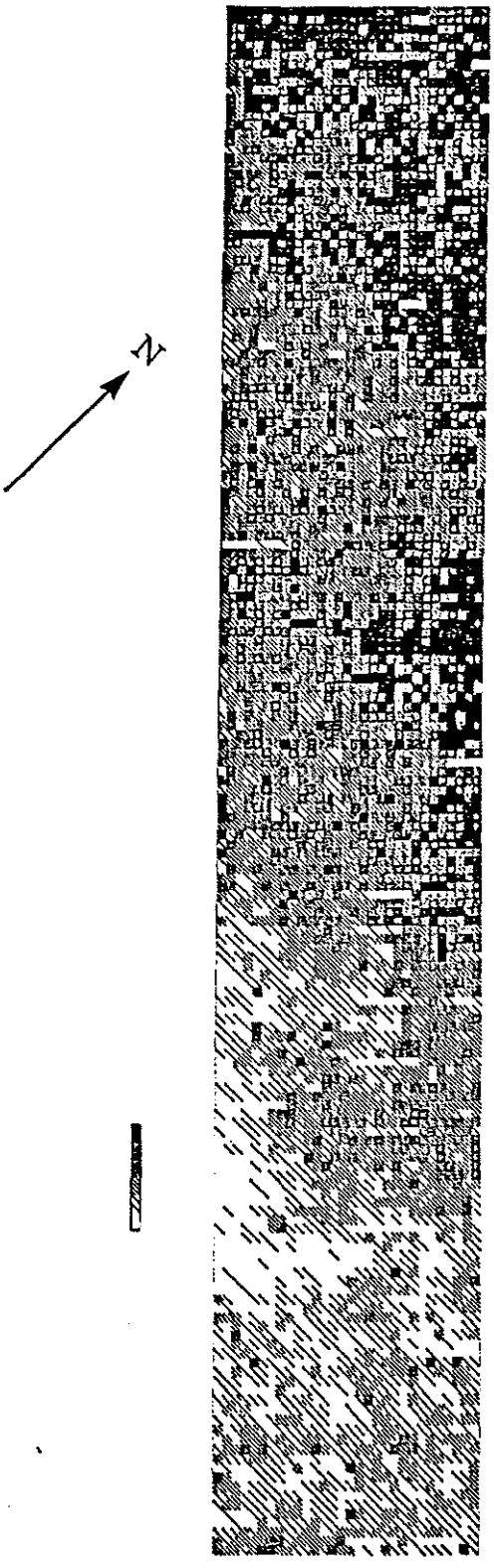

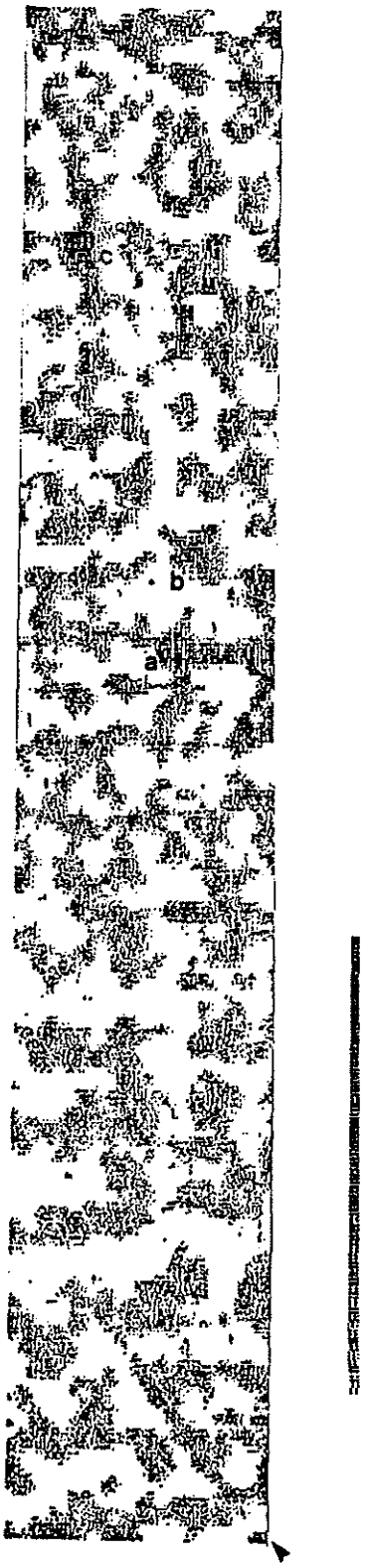

(i) Initial data

(display range: mean - 2 sd to mean + 2 sd;
ie 25 - 85 in 6 levels)

(ii) Filtered data; positive anomalies

(display range: mean to mean + 2 sd)

Initial data: mean = 55;
standard deviation = 17 (x 10^{-8}SI/kg)

0 30m

W31: Wilsford Down
Magnetic susceptibility survey

A M Laboratory

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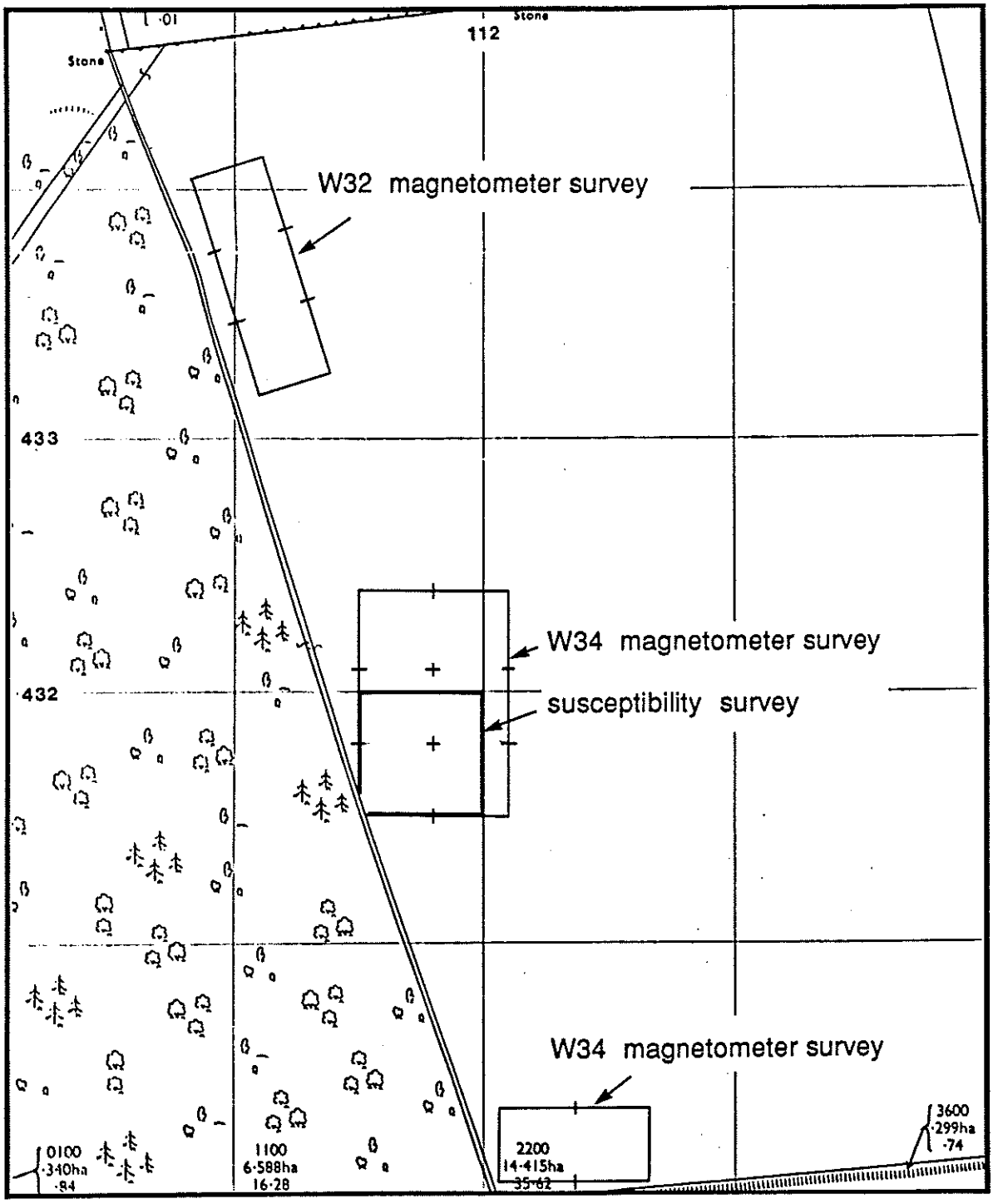
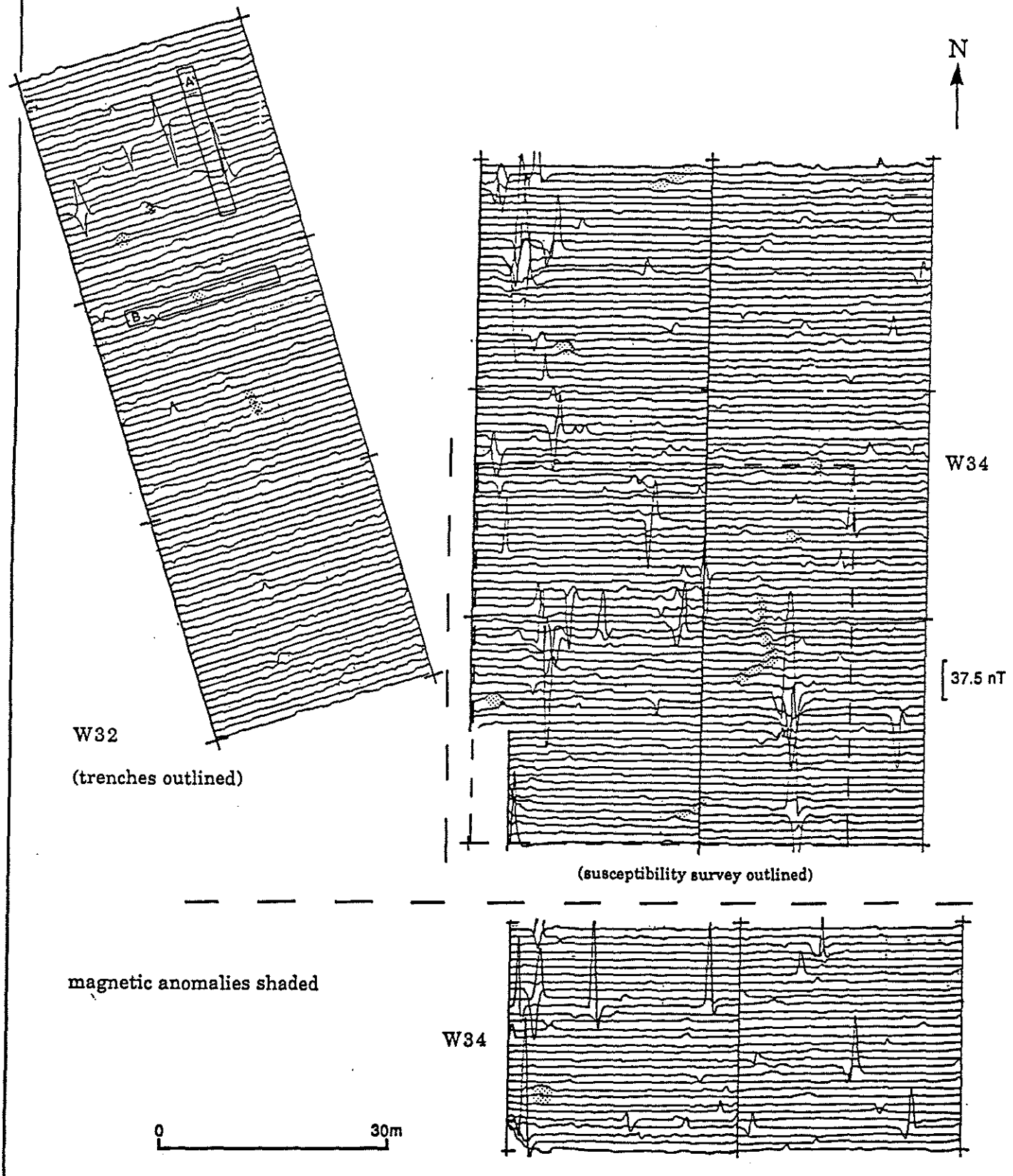


W32 Fargo Wood 1 and W34 Fargo Wood 2

Location of magnetometer and susceptibility surveys

1:2500

A M Laboratory



W32 Fargo Wood 1 and W34 Fargo Wood 2

Magnetometer Surveys

A M Laboratory

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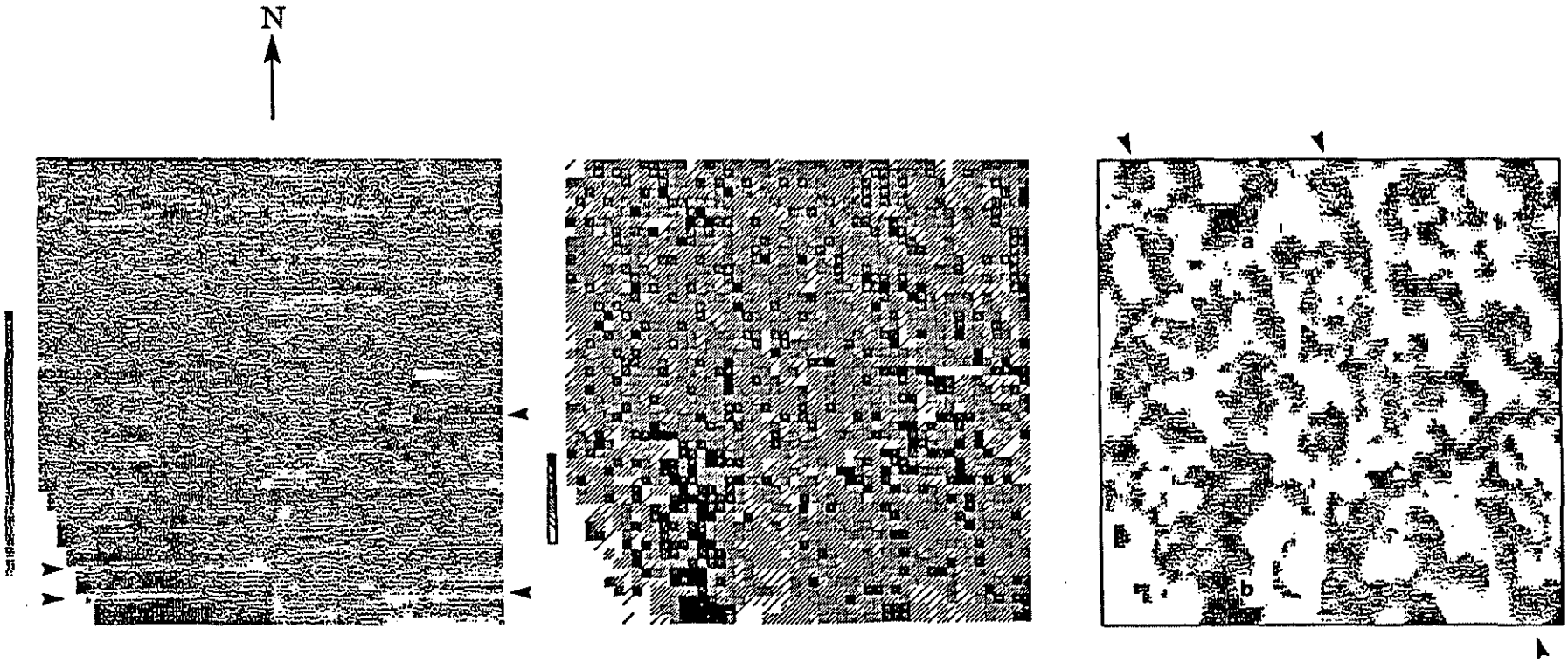


(i) Initial (uncorrected) data

(display range: mean - 2 sd to mean + 2 sd)

(ii) Data corrected for zero drift

(display range: mean - 2 sd to mean + 2 sd in 6 levels)

(iii) Corrected and filtered plot; positive anomalies

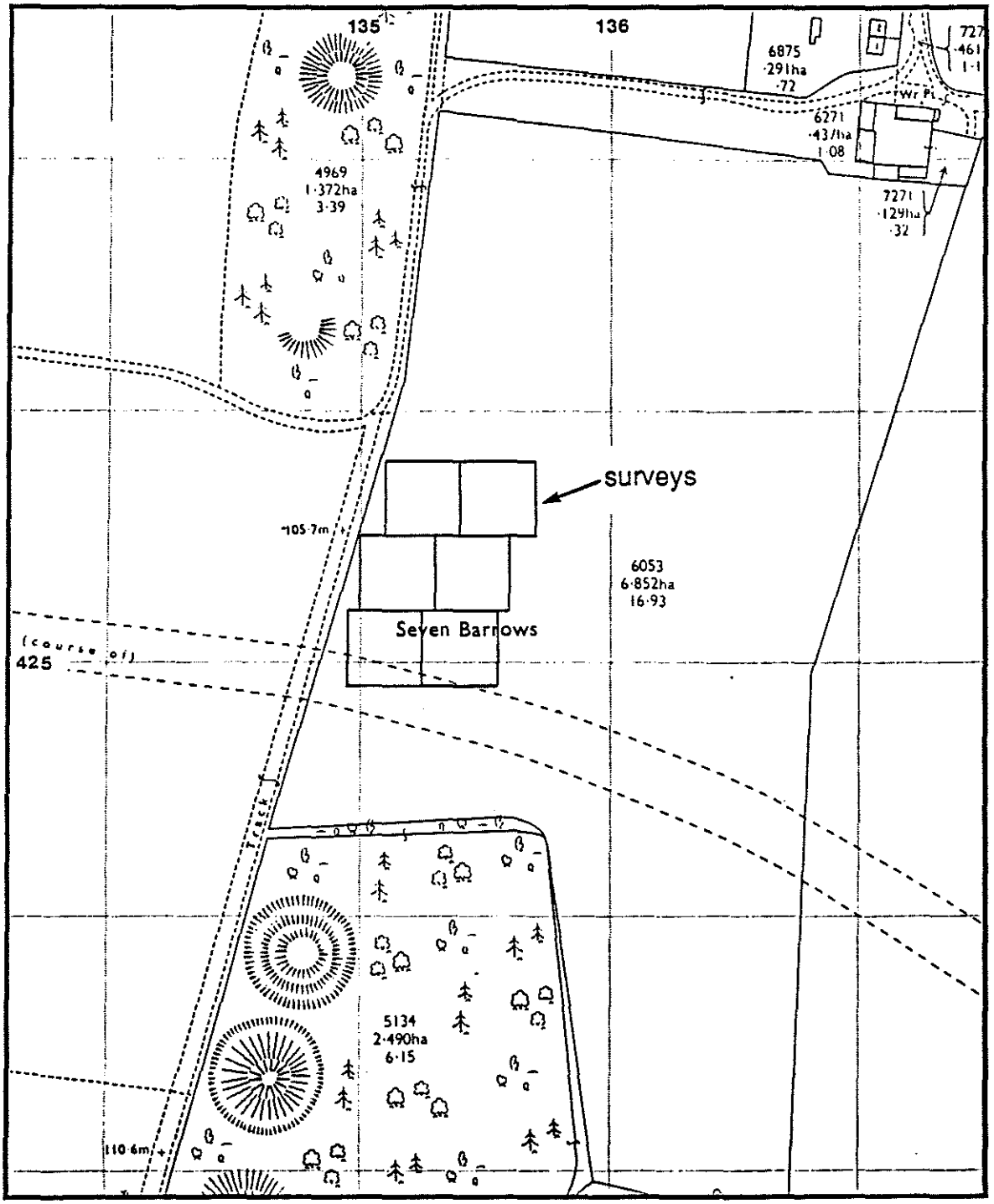
(display range: mean to mean + 2 sd)

Initial data: mean = 46; standard deviation = 11 (x 10^{-8} SI/kg)

0 30m

W34 Fargo Wood 2

Magnetic susceptibility survey



W59 King Barrow Ridge

Location of magnetometer and susceptibility surveys

1:2500

A M Laboratory

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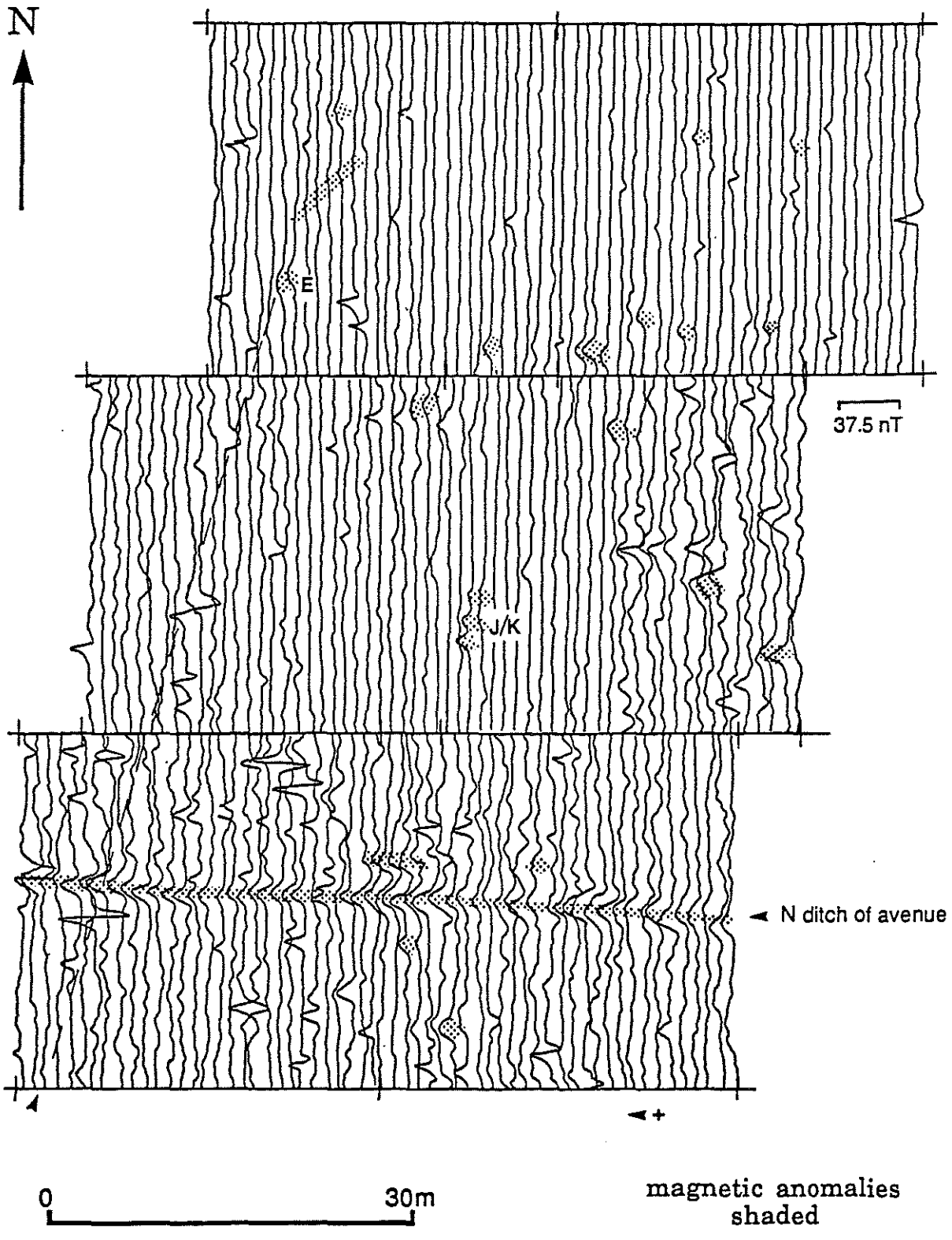
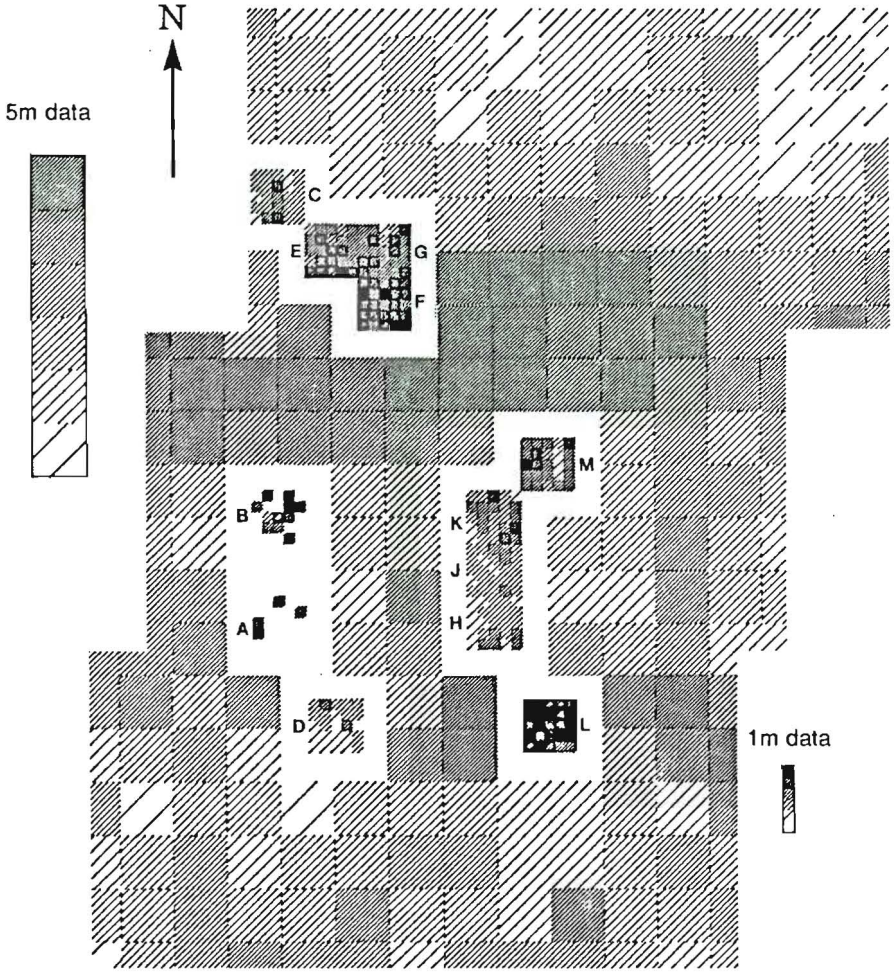


W59 King Barrow Ridge

Magnetometer survey

A M Laboratory AB



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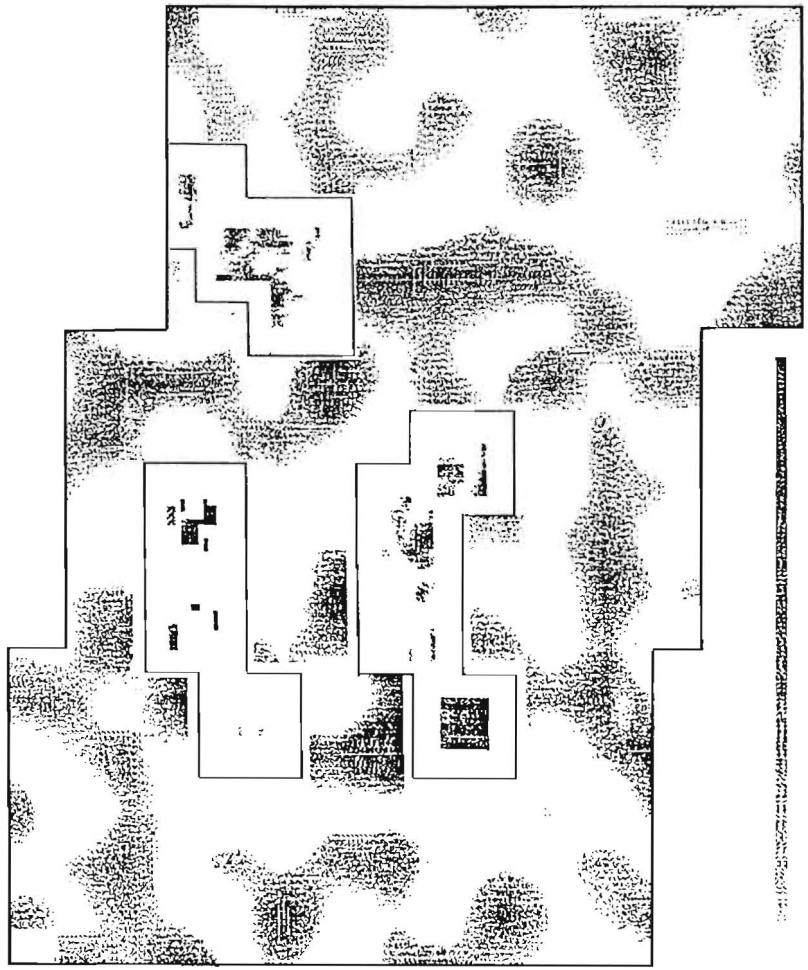
ie 60 - 180 in 6 levels)



(ii) Filtered data; positive anomalies

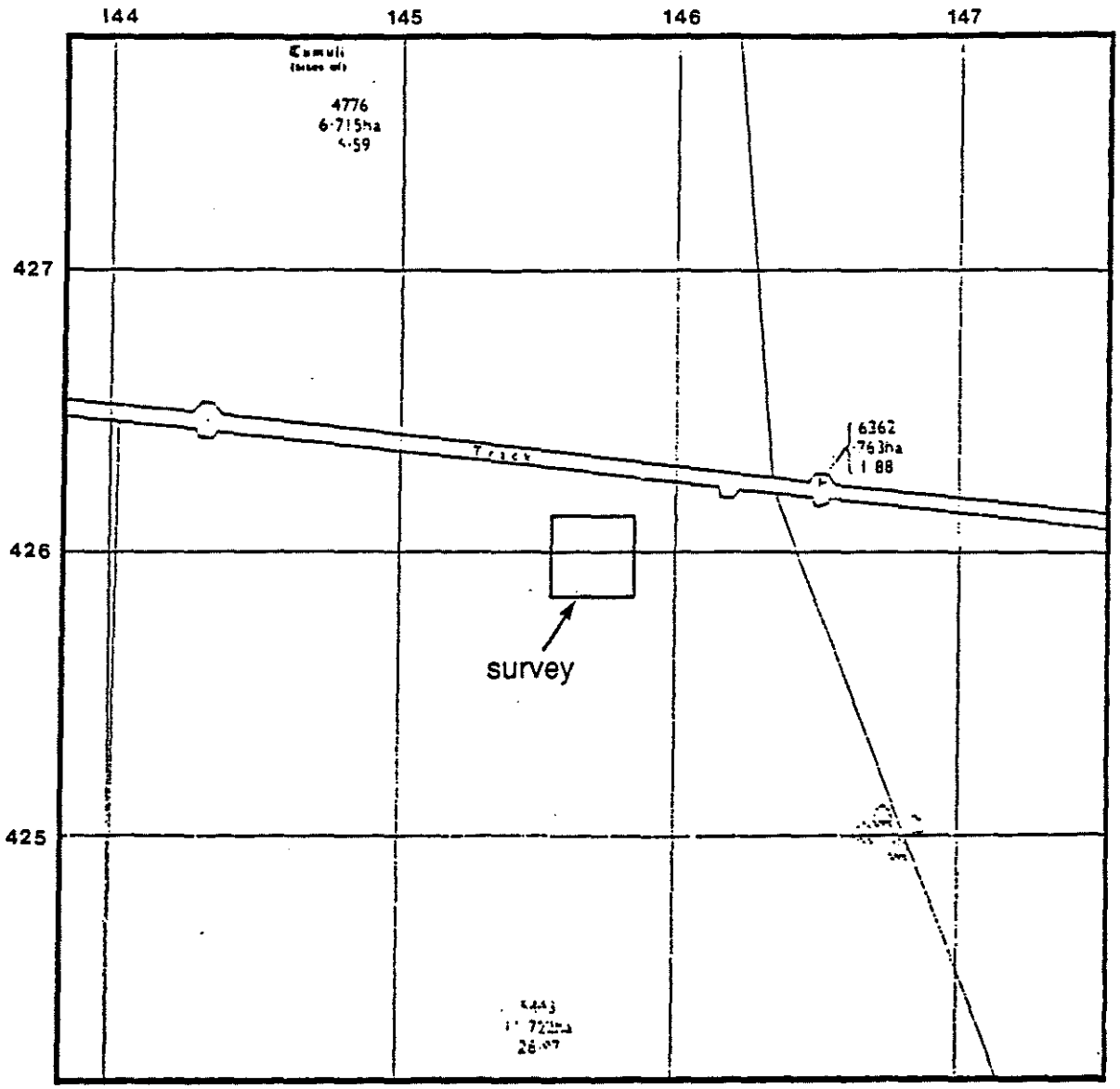
(display range: mean to mean + 2 sd)

0 30m

Initial data: mean = 120; standard deviation = 28 (x 10^{-8} SI/kg)

W59 King Barrow Ridge
Magnetic susceptibility survey

A M Laboratory



Ring ditch E of King Barrow Ridge

Location of magnetometer survey

1:2500

A M Laboratory

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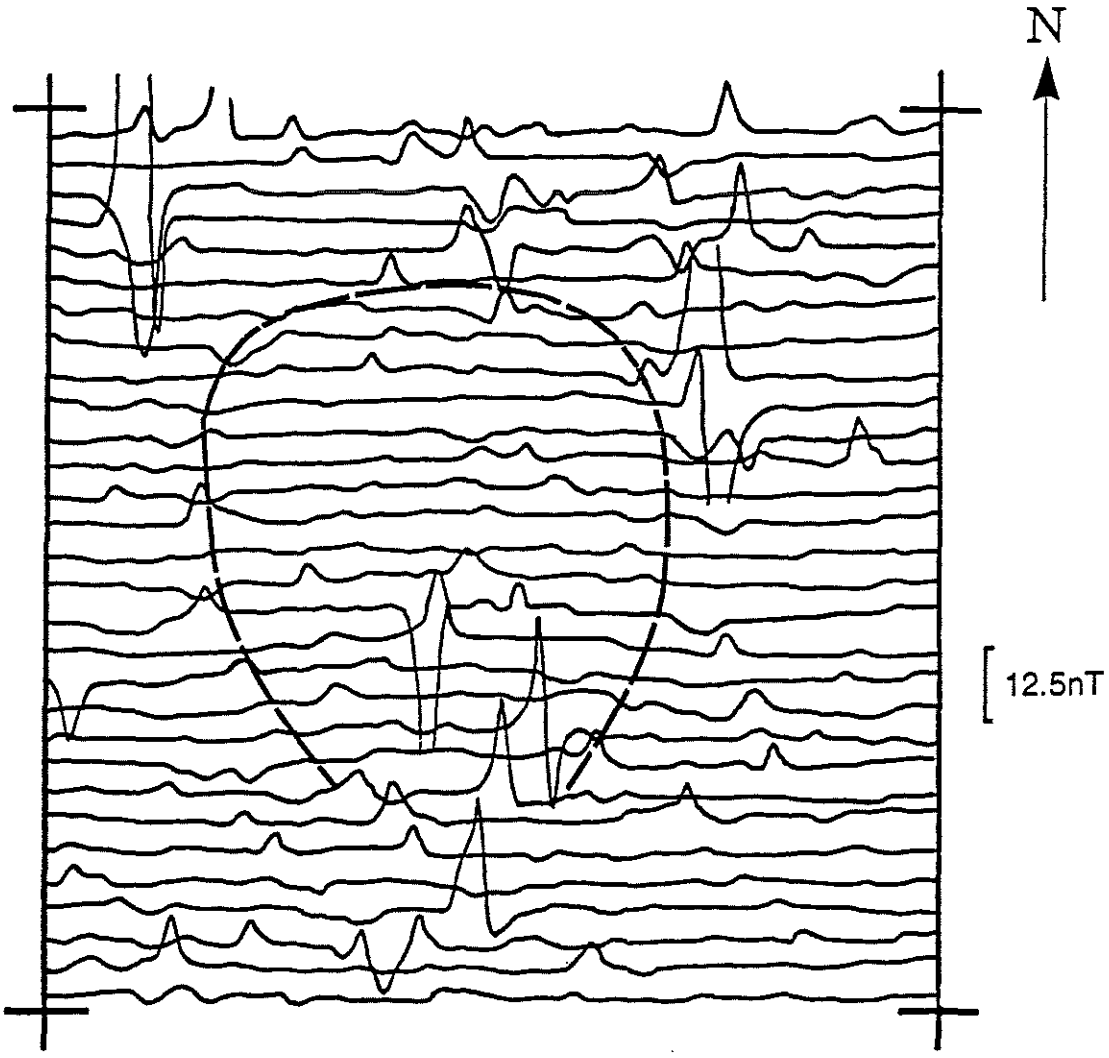


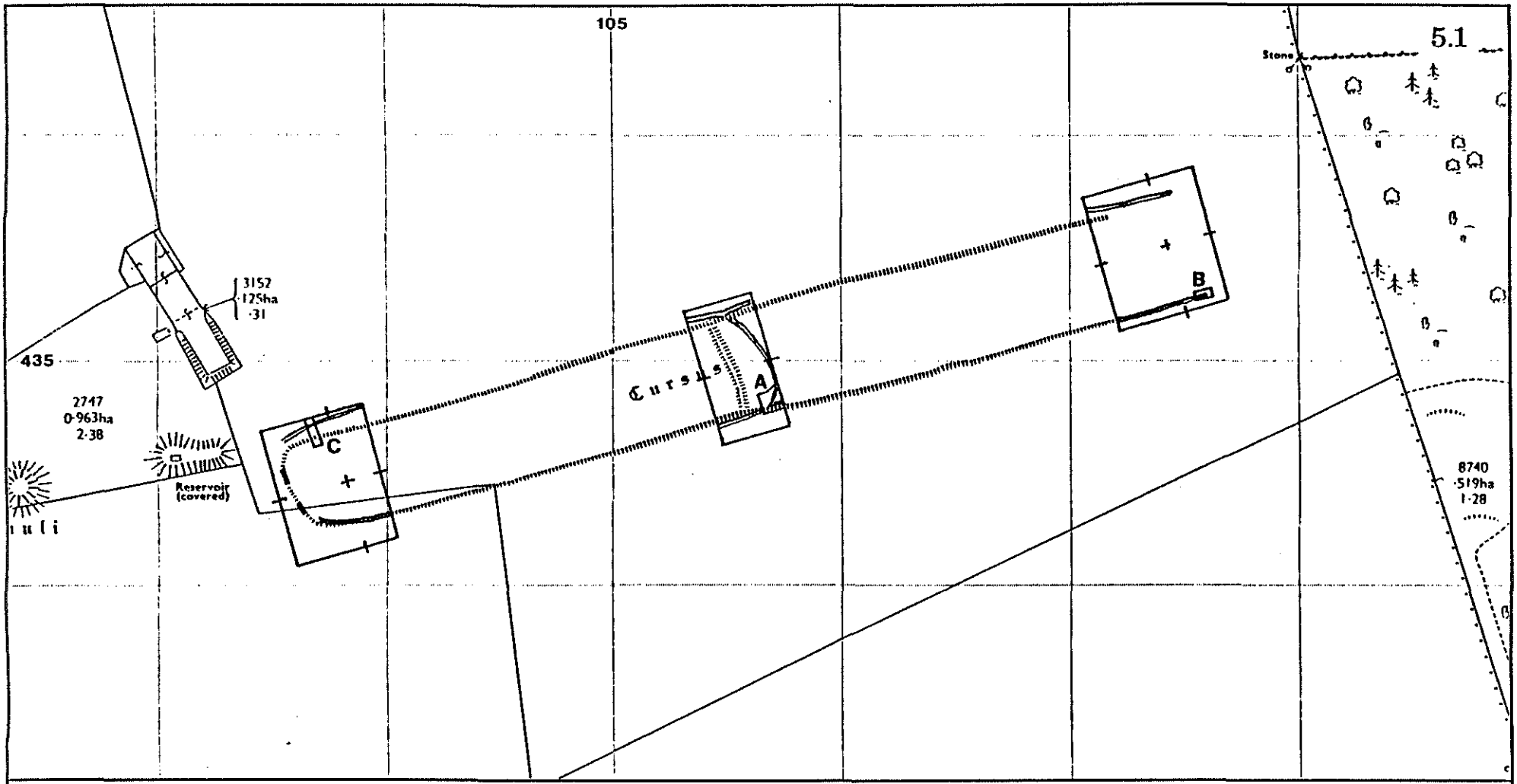
Ring ditch E of King Barrow Ridge

Magnetometer Survey

(Positive anomaly outlined)

0 10m

A M Laboratory AB



W55 Lesser Cursus

Location of magnetometer survey

1:2500

A M Laboratory

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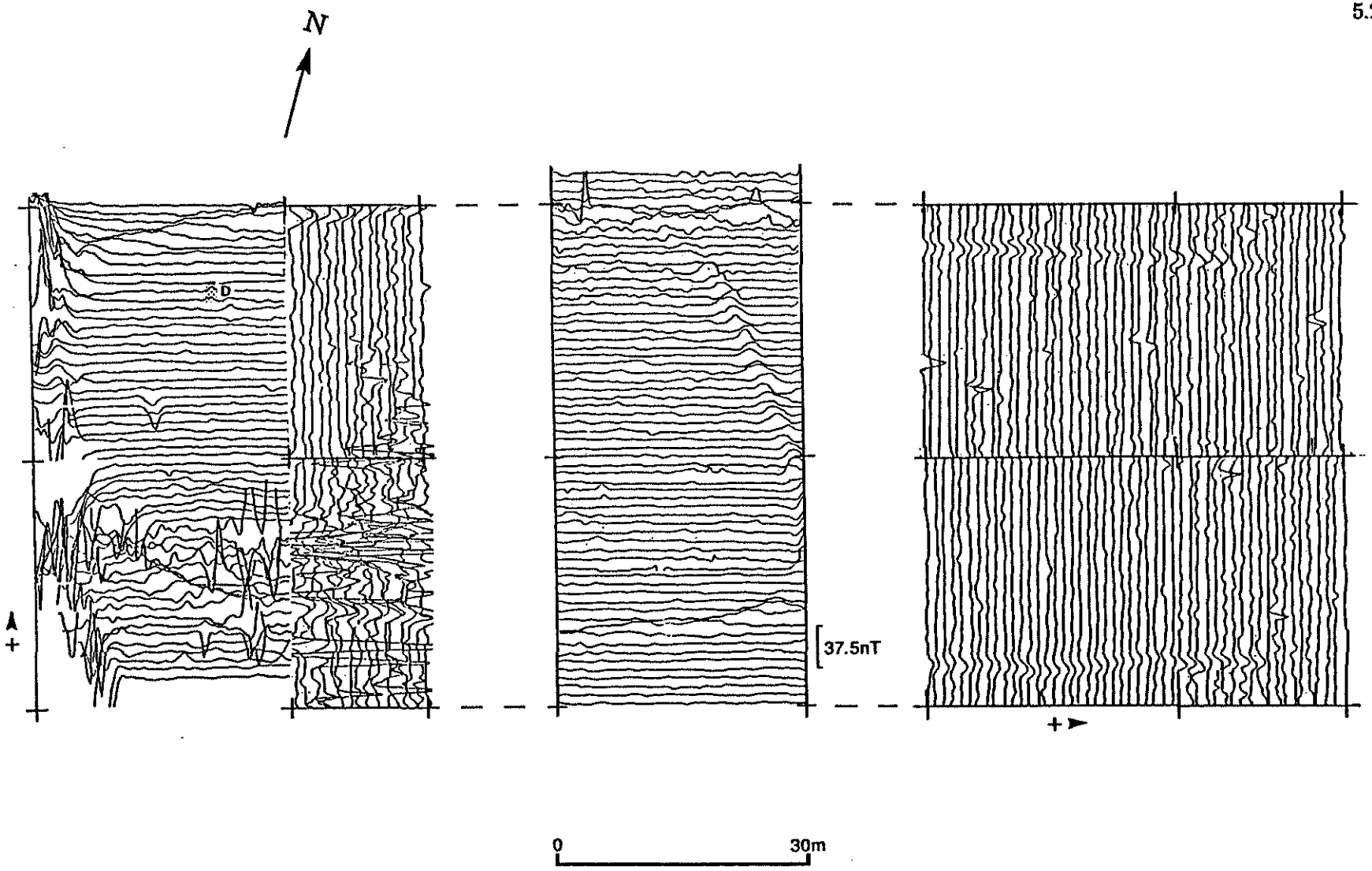

W55 Lesser Cursus

Magnetometer Survey

A M Laboratory

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