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Tenantry Farm, Rockbourne, Hampshire. Report on the Geophysical and Topographical Surveys, November 2001

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Summary

Geophysical and topographical surveys were carried out over the long barrow at Tenantry Farm, Rockbourne, Hampshire (Monument No. 12096). Both magnetometer and earth resistance surveys successfully defined both the barrow ditches and the barrow mound. A possible internal structure was also revealed. The topographical survey showed that the barrow was still eroding ten years after the previous survey, and that the rate of erosion appeared to be steady. The topographical survey also provided firm geo-referencing for all the survey data.

Keywords

Geophysics
Survey

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TENANTRY FARM, ROCKBOURNE, Hampshire.

Report on geophysical and topographical surveys, November 2001.

Introduction

A geophysical and topographical survey of approximately 0.5 ha was conducted over a long barrow at Tenantry Farm, Rockbourne, Hampshire (National Monument Number: 12096) as part of an investigation into the impact of agriculture on archaeological sites. This site was scheduled in 1977 and subsequently subjected to a light agricultural regime in an attempt to aid its preservation.

Previous archaeological work on the site included an annual topographic survey of the barrow, conducted by the then Central Excavation Unit each spring between 1982-1991. The aim was to assess and quantify the effects of the agricultural regime by establishing a baseline model of the ground surface and then monitoring changes to the shape of the barrow over time.

Recent interest in long-term erosion studies led to a new topographical and geophysical survey of the barrow. The aim of this work was to capture digitally the topography of the mound, for comparison with the earlier surveys; to provide repeatable Ordnance Survey co-ordinates for the grid for greater analytical potential of future surveys; and to investigate the geophysical response over the barrow to provide more information on the archaeology of the site.

The site (SU 101 222) lies on shallow well drained calcareous silty soils of the Andover 1 association (Soil Survey of England and Wales 1983) developed over Upper Chalk (Institute of Geological Sciences 1976). At the time of the survey the weather was dry and ground conditions were firm. The field was under a young cereal crop and the soil was clearly visible.

Methods

Magnetometer survey

Magnetometer survey was chosen for the rapidity of coverage and its ability to detect the ditches that might be expected to either side of a long barrow (e.g. West Kennet long barrow: Martin 2001). The survey was conducted over all the numbered grid squares (Figure 1) using the standard method outlined in note 2 of Annex 1, but with the survey traverses aligned perpendicular to the main axis of the barrow.

Plots of the data-set are presented as both an X-Y traceplot and a linear greyscale, at a scale of 1:750 on Plan A and superimposed on the base OS map (1:1500) on Figure 2. The main corrections made to the measured values displayed in the plots were to zero-mean each instrument traverse to remove heading errors; to 'despike' the data through the application of a 2m by 2m thresholding median filter (Scollar *et al* 1990), to reduce the detrimental effects produced by surface iron objects; and to 'destagger' the data to remove horizontal offsets caused by walking error. A Butterworth filter in the frequency domain was applied to the data from one instrument to remove periodic artefacts caused by operator gait. In addition the lower and upper values have been trimmed for presentation as a traceplot.

Earth resistance survey

An earth resistance survey was conducted to provide complementary information to the magnetometer survey, particularly with respect to the barrow mound. The survey was conducted over all the numbered grid-squares (Figure 1). Measurements were collected with a Geoscan RM15 resistance meter, PA1 mobile probe array in the Twin-Electrode configuration. Readings were collected using the standard method outlined in note 1 of Annex 1, with a sample interval of 1.0m x 1.0m. Plots of the data-set are presented as both an X-Y traceplot and a linear greyscale, at a scale of 1:750 in Plan B and superimposed on the base OS map (1:1500) on Figure 3.

Topographical survey

Previous surveys

From 1982 to 1991, the surveys were all conducted with a grid of tapes and either a level or a theodolite to produce A1-sized sheets of drafting film with all the levels marked out at a scale of 1:100 on the page. These were all quoted with reference to a concrete temporary benchmark (TBM) that was set under the end of a hedgerow at the west of the entrance to the field, which was given an arbitrary elevation of zero. Contour plots were derived from the levels and were also inked up at 1:100 scale on drafting film. Horizontal alignment of the different surveys was achieved visually due to factors set out in Annex 2 below.

2001 survey

The topographic survey was conducted using Trimble GPS equipment, recording points at two-metre intervals in order to match the recording intervals of all but one of the previous surveys, on the same 60m x 90m grid used for the geophysical survey to ensure compatibility across the data sets. The grid was established along an arbitrary baseline representing the long axis of the mound, and was in-filled with tapes to create the 2m grid for topographic purposes. Points were taken with the receiver mounted on a detail pole with a flat tip so it could rest firmly on the ground for each point, and readings were triggered manually. Vertical referencing to previous surveys was more secure, since the original temporary benchmark from the 1982-1991 surveys was relocated and recorded as part of the exercise. All of the data was captured digitally, and was output to AutoCAD for processing.

Survey comparisons

A digital terrain model (DTM) was produced from the 2001 data in Key Terra Firma V (KTF) as a Triangular Irregular Network (TIN) using the surveyed data points as the vertices of surface triangles, and KTF then generated the contours from this model. The data from 1982 and 1988 were also input into AutoCAD for similar treatment, and KTF was used to generate the profiles from these surface models.

Figure 4 shows the 2001 survey results plotted as contours with OS-derived elevations. Figure 7 shows a comparison of the 1982, 1988, 1991, and 2001 contour plots, plotted against the TBM set at zero elevation. Figures 8-10 show a comparison of profiles across the mound from 1982, 1988, 1991, and 2001, with vertical scales exaggerated by a factor of 10, all aligned vertically based on a ‘best fit’ alignment of the surveys (see Annex 2). The location of the profiles is shown on the 1991 plot, Figure 7.

Figure 11 shows the geophysical data draped over an isometric view of a DTM of the 2001 topographic data, generated with Geosoft software. Again the vertical scale is exaggerated for clarity.

Results

Magnetometer survey

A graphical summary of the significant anomalies discussed in the following text is provided on Figure 5.

The overall magnetic response is quiet (~ $\pm$1nT) with the most intense magnetic responses at [1-2] most probably deriving from modern ferrous detritus.

Two bands of positive magnetic readings [3] and [4] represent the barrow ditches. The northern ends of both of these appear interrupted. This may be due to segmented construction, episodic infilling or more recent disturbance by the plough. East of [3] lies an area of negative readings [5]. This may be an artefact of the positive readings surrounding it, but more probably represents the presence of less magnetic material. More or less centrally placed between the ditches is a linear zone of stronger magnetic readings [6], indicative of more magnetised material in this area, perhaps suggestive of a burnt deposit and/or the filling of a former chamber.

Around the barrow, but mainly to the south, are discrete positive magnetic anomalies, the strongest of which are at [7]. These could possibly represent pits, though their relationship to the barrow is not discernible.

Earth resistance survey

A graphical summary of the significant anomalies discussed in the following text is provided on Figure 6.

The survey clearly shows the location of the barrow ditches as defined by the low resistance anomalies [R1-2]. As with the magnetic data the nature of the resistance response at their northern extremities is unclear. It is possible that they curve around the mound here, but they seem unlikely to connect.

The central mound has been defined by mainly high resistance readings. However, though these are strongest at the southern end, there is also a marked low resistance anomaly [R3] here, coinciding with the raised magnetic readings referred to above. Such low readings would not be inconsistent with the preservation of a burnt or mortuary chamber deposit.

There are areas of higher resistance of uncertain significance around the mound. Some of these to the south [R4-5] seem linear, but due to the small area surveyed their exact nature is unclear.

Topographic survey

The 2001 survey (Figures 4 & 11a) clearly shows a linear earthwork roughly 60 metres long by 28 metres wide standing approximately one metre tall at its southern end, with shallow depressions running up the west and east sides. The northern end is also distinct, although it does not stand out as clearly as the southern end due to the upward slope of the field to the north and east. There appear to be two separate peaks along the ridge of the mound, with a saddle in between. The northern peak is at a higher elevation by approximately 0.10m, and the southern slope of the southern peak has an area of exposed chalk fragments covering an area approximately 60 m^2 in size. The mound profile is fairly shallow and rounded. A shallow depression in the south-east corner of the survey may represent the low scarp identified as running off across the field in a south-easterly direction by the Royal Commission in 1979 (RCHME 1979), and is more visible on the earlier surveys. It may relate to the county boundary as seen on the Ordnance Survey First Edition map, which appears to run through the barrow (RCHME 1979).

The 1982-1991 surveys show a gradual erosion of the top of the mound, with a corresponding filling of the ditches at either side (Wilson, 1991). In this period the maximum height (at the north end of the mound) dropped from 2.16m above TBM to 2.10m above TBM, with a corresponding loss of the 2.15m contour, and the reduction of the 2.00m contour from a single oval to two smaller ovals separated by a 2 metre gap. By 2001 this maximum height had dropped to 2.05m, and the 2.00m contour had been reduced to a single oval at the north end of the mound.

The previous surveys indicate that there was more infilling to the south of the mound, representing general downhill movement of soil from the top of the mound in the direction of cultivation (Wilson 1991). However, a similar if somewhat subtler effect is also noticeable along the north side of the mound where it meets the upward slope of the field. The amounts of deposition quoted from 1982-1991 (0.05-0.10m) are consistent with a comparison of the 1982 and 2001 data, suggesting that the rate of deposition around the base of the mound slowed down between 1991 and 2001. The rate of erosion at the top, however, appears to have been consistent over the two decades, suggesting that it can be projected forward to determine the likely height of the mound at any point in the future if the present management regime continues.

Over all, the data suggest that the top of the mound is still eroding steadily, while there is less soil accumulating visibly around the base. This might represent the effects of soil compaction over the relatively soft ditches masking any perceived accumulation of soil.

Conclusion

The geophysical survey of the long barrow produced excellent results. Although the background magnetic response was quiet, the main elements of the barrow have been clearly identified. Both the magnetic and the earth resistance survey have defined the ditches, which taper in towards the mound at the northern end, and are possibly truncated here. Within the mound along its long axis, there are both magnetic and resistance anomalies suggestive of a central feature. The readings are more pronounced towards the southern end of the mound and it is possible that some sort of mortuary deposit is represented.

In contrast to the clear magnetic evidence, the earth resistance survey suggests that the ditches at the northern end of the barrow may curve round the mound. This phenomenon could be attributed to the silting up with mound material of a former depression between the barrow and higher ground to the north. From the comparison of the geophysical and topographical surveys (Figure 11b & c), the location of the ditches appear to be part way up the flanks of the mound; this indicates that the mound has spread considerably over time.

From the geophysical results it would appear that much of the barrow structure is still intact. However, the results of the topographic survey suggest that this could be in jeopardy. The latter survey suggests that the top of the mound is still eroding steadily, but that the perimeter of the mound is no longer accumulating much in the way of deposited soil. At an erosion rate of ~0.005m/year in height, the mound could disappear completely in approximately 200 years if the agricultural regime remains the same. Damage to internal structures, as the soil covering is eroded would happen much sooner.

Aside from the lowering in height, the biggest change since 1982 has been the gradual infilling of the ditches. In particular, the ditches started out being clearly visible along both sides of the southern half of the mound, as well as along the north end. By 1991 these had lost some of their definition. The shape of the top of the mound has, however, remained the same since 1982, even though its height has been reduced. The saddle may represent slumping of an internal chamber or a later intervention. While the successive topographic surveys indicate that the mound has not spread appreciably since 1982, the silting-up of the ditch especially on the north and south sides suggests that some mound material has definitely been moved within the lifetime of the surveys. The agreement to cultivate along the axis of the mound in a ‘light cultivation’ regime may thus have limited further sideways spread by introducing longitudinal spread instead (see Wilson, 1987).

Geophysical survey by:	L Martin A Payne	Date of survey: 12-14/11/2001
Topographical survey by:	T Cromwell	Date of survey: 12-14/11/2001
Reported by:	T Cromwell L Martin	Date of report: 22/7/2002

English Heritage,
Centre for Archaeology.

Acknowledgements

The authors would like to extend the thanks of English Heritage to Mr McLeod of Tenantry Farm, Rockbourne, for allowing the surveys to take place, and for helping relocate the concrete TBM after a ten-year gap. Thanks also to Neil Linford for his help with the DTM and digital drapes of the geophysical data.

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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.

Annex 2: Factors affecting the topographic surveys and interpretations

The resolution of the 2001 survey data, being gathered by GPS, is approximately 0.01m in horizontal and 0.02m in vertical planes. This tolerance is randomly distributed across the data, so the net effect on a dense survey grid is neutral. However, this tolerance affects single-point readings such as the TBM, which are crucial to comparisons with other data, making sub-centimetre height comparisons unreliable. Also, while the grid was laid out at two-metre intervals using tapes as guidelines for walking, the recorded eastings and northings of each data point are true co-ordinates that might not be exactly 2 metres apart.

The 1982-1991 surveys, conducted with levels and/or theodolites, have single-point tolerances of +/-0.005m in height, whereas the horizontal positions are arbitrarily recorded as the two-metre grid vertices. For each year's survey the grid itself is not recorded in reference to any other fixed map features, so the exact position and orientation cannot now be reconstructed. Each grid appears to be based on a line through the centre of the mound as seen on the day, and it is clear from the data that the grids do not align perfectly from year to year. Also, some of the grids cover a greater area than others. The net result is that profile comparisons are compromised by the need to manually rotate and align the surveys from each year to achieve a 'best fit' of the contour models before choosing section lines. Interpretations regarding soil movement are therefore confined to those effects that appear beyond any doubt, while subtle apparent changes must be discarded as suspect. Finally, the lack of horizontal control means that the data cannot be interrogated for large-scale unidirectional horizontal movement trends that are expected on sloping sites.

By comparison the 2001 data are fully geo-referenced, and it should be possible in future to reconstruct the 2001 survey grid as part of any further topographic survey work.

It should also be borne in mind that the TBM is located at a field entrance, and there is anecdotal evidence that tractors and other farm equipment may have run over it on occasion, so there is potential for height discrepancies from year to year. By the time of the 2001 survey, however, the hedge had engulfed the TBM, so it is unlikely to have been subjected to any further compression in recent years.

Figure 1

ROCKBOURNE LONG BARROW, HAMPSHIRE.
Location of surveys, November 2001.

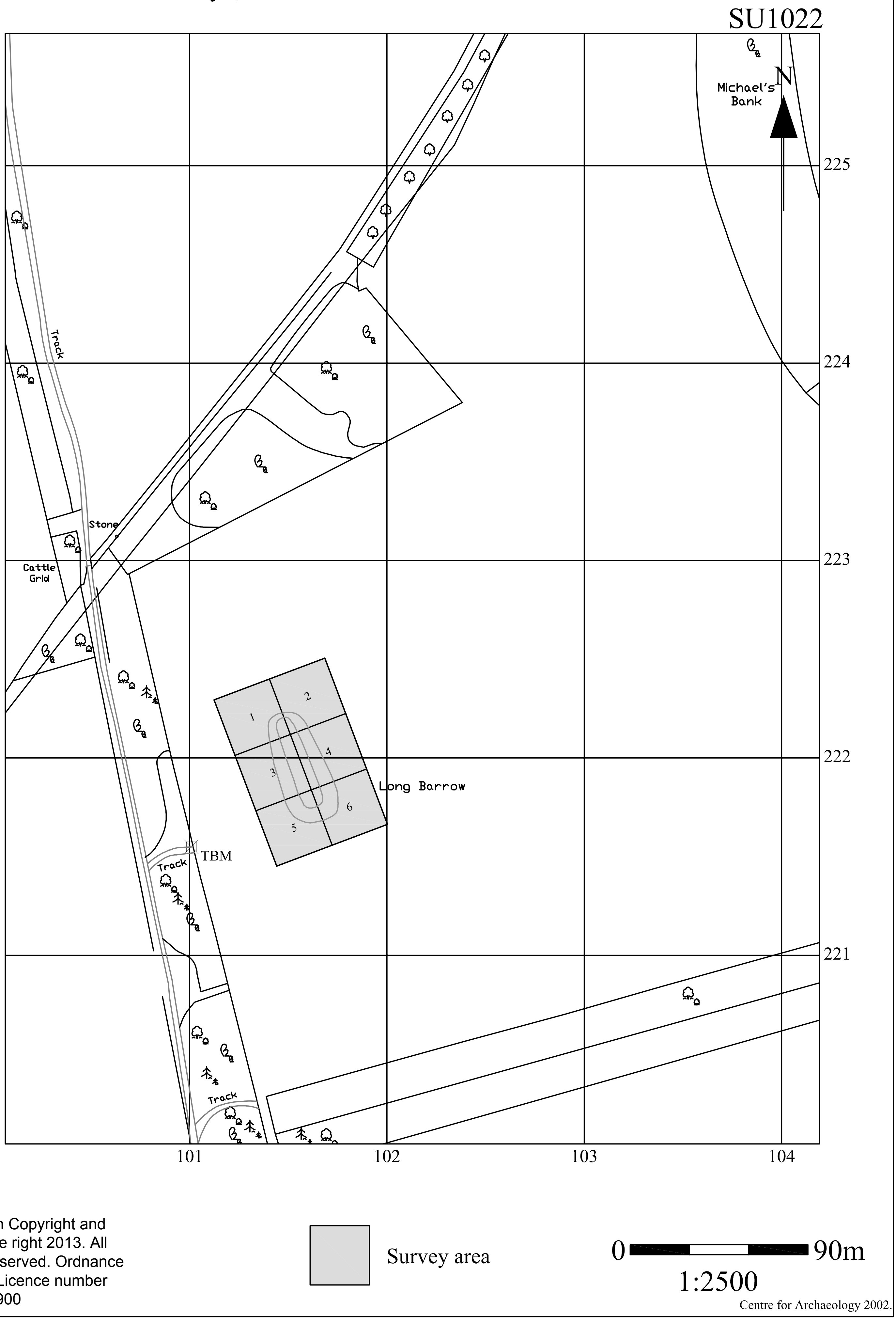
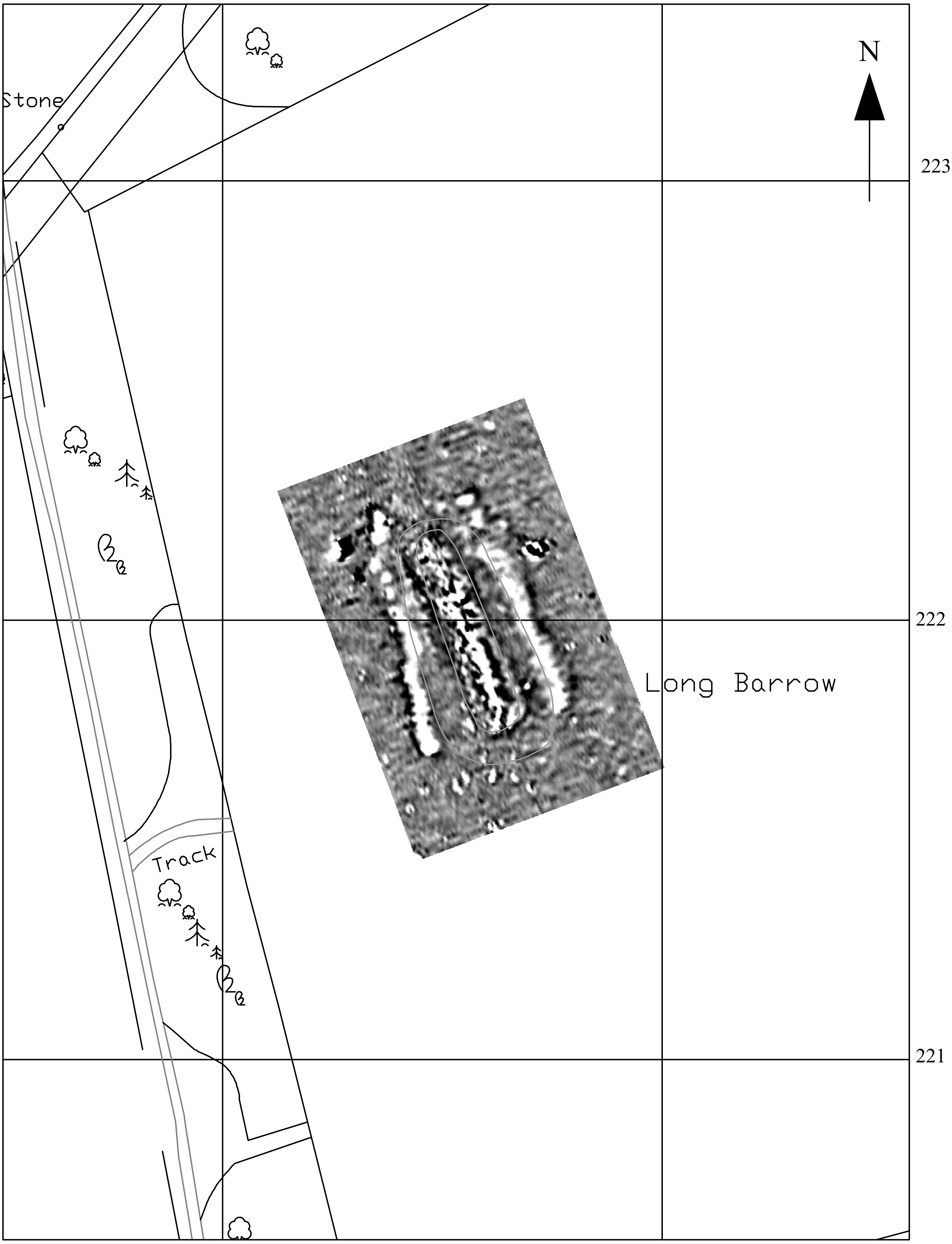
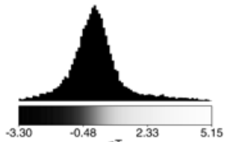


Figure 2

ROCKBOURNE LONG BARROW, HAMPSHIRE.
Magnetometer survey, November 2001.

SU1022





0 60m
1:1250

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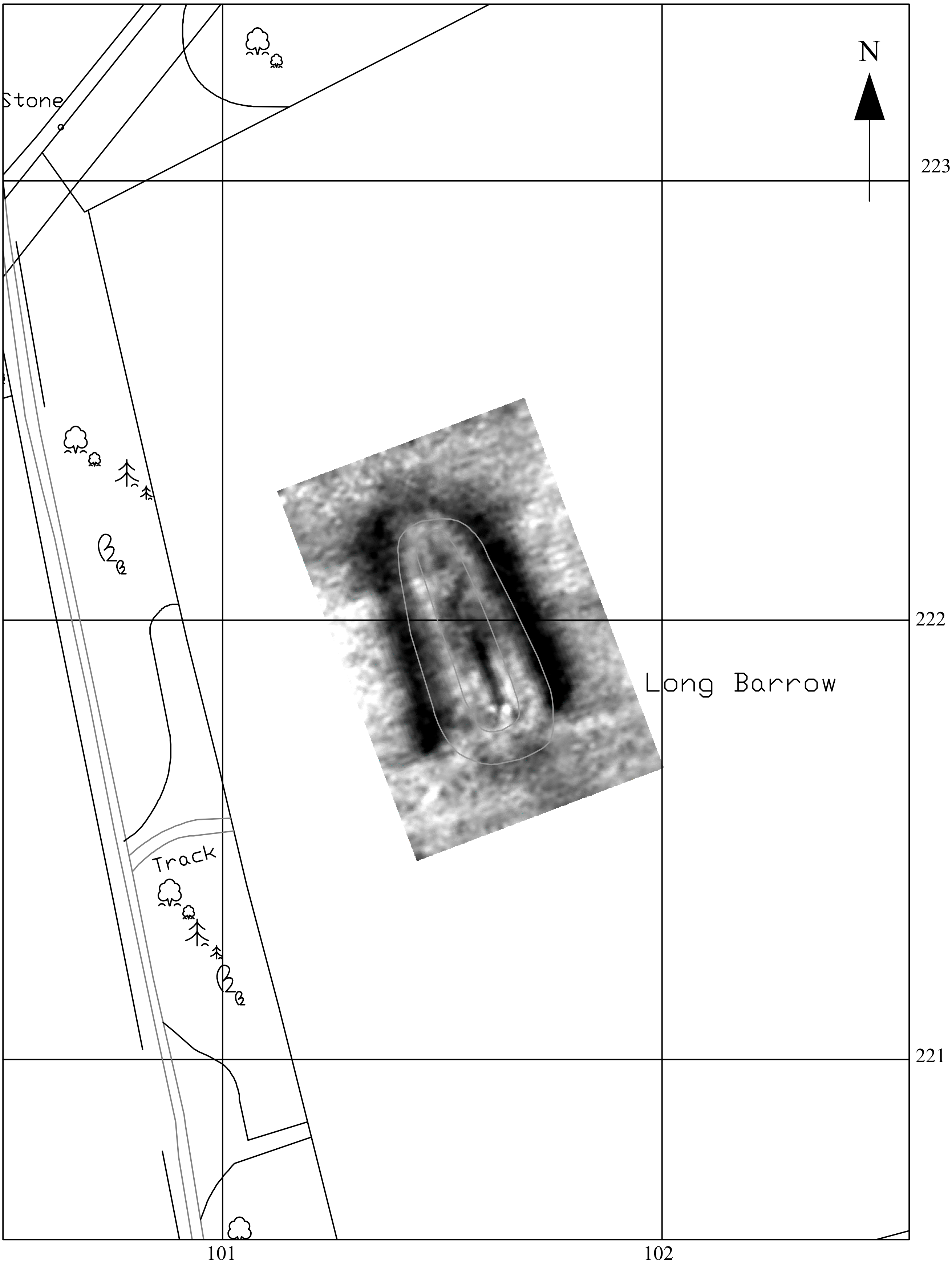
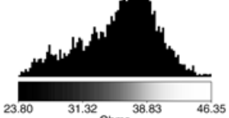
Figure 3

ROCKBOURNE LONG BARROW, HAMPSHIRE.
Resistivity survey, November 2001.

SU1022





0 60m
1:1250

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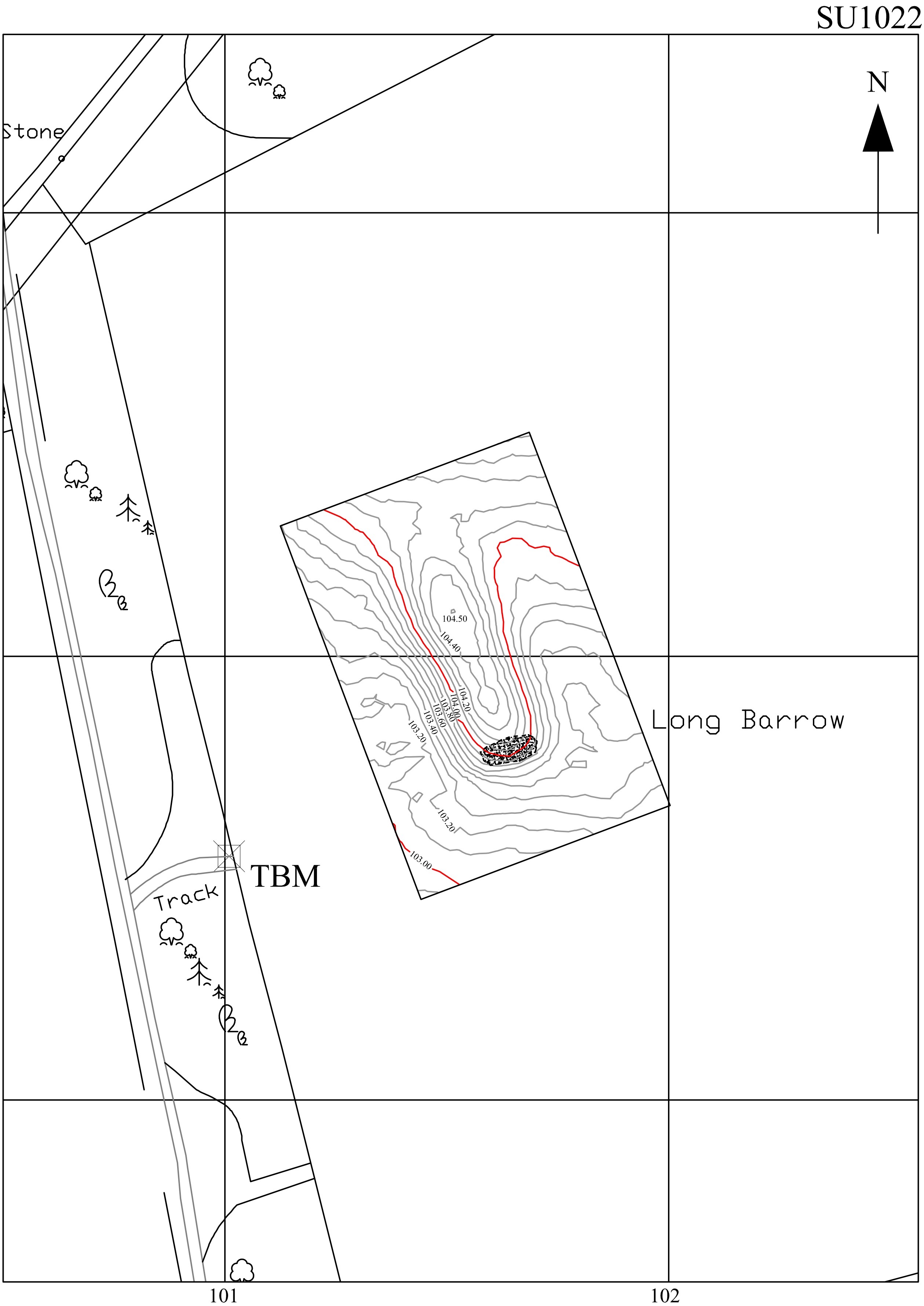
Figure 4

ROCKBOURNE LONG BARROW, HAMPSHIRE.
Topographic survey, November 2001.



Exposed chalk fragments

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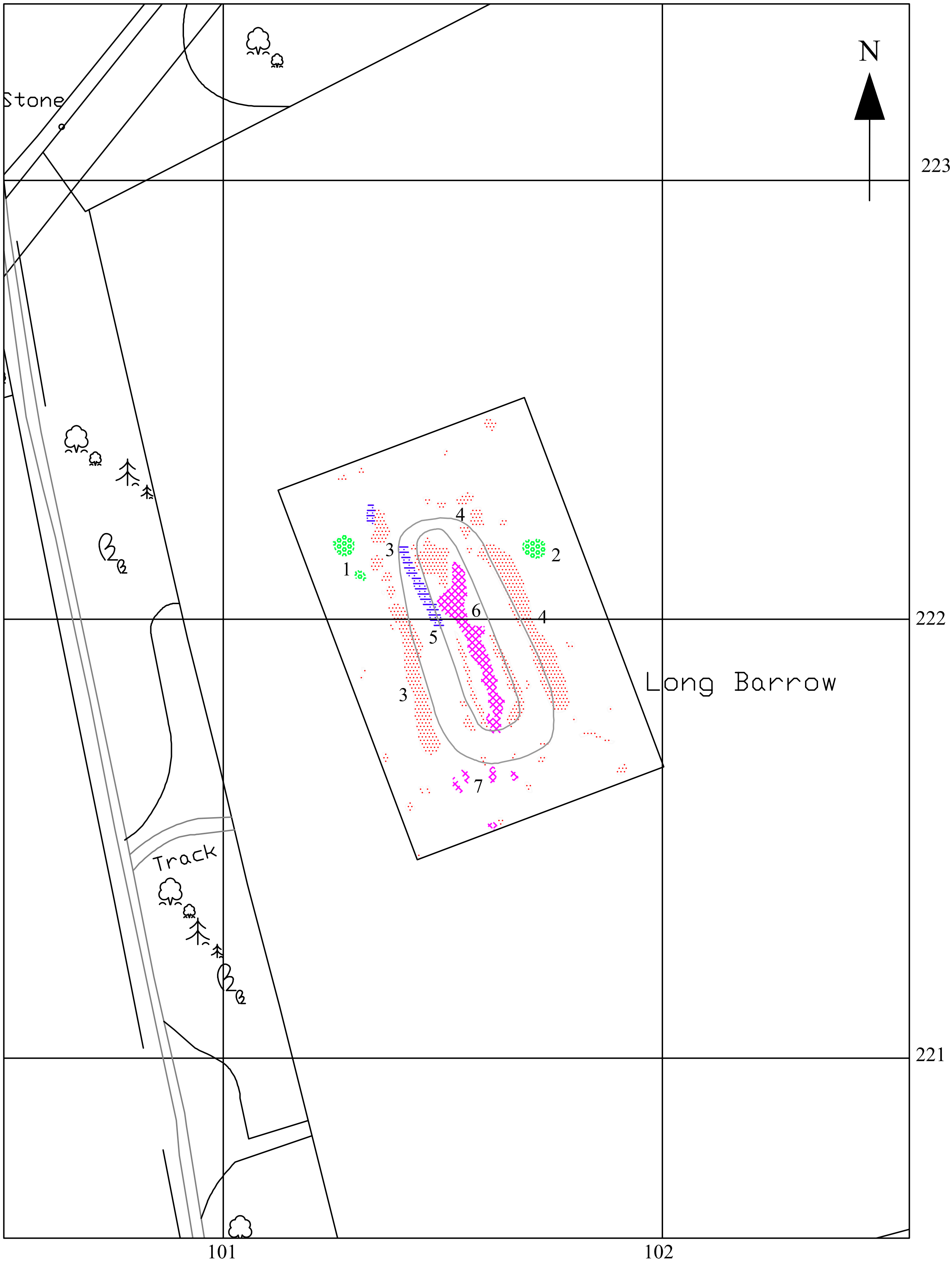
Figure 5

ROCKBOURNE LONG BARROW, HAMPSHIRE.

Graphical representation of magnetometer survey, November 2001.

SU1022



Positive magnetic anomaly.

Area of magnetic noise.

Strong positive magnetic anomaly.

Negative magnetic anomaly.

0 60m

1:1250

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Figure 6

ROCKBOURNE LONG BARROW, HAMPSHIRE.

Graphical representation of resistivity survey, November 2001.

SU1022

This map is reproduced from the OS map by English Heritage with the permission of

High resistivity anomaly.

Low resistivity anomaly.

Strong resistivity anomaly.

0 60m

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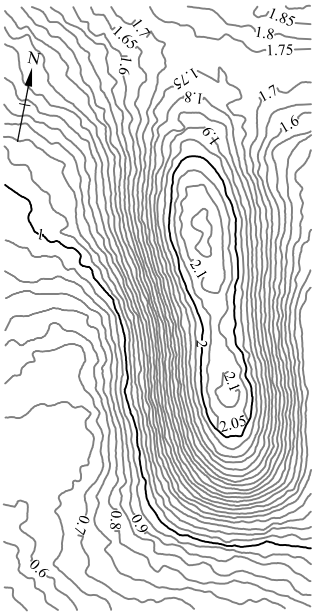
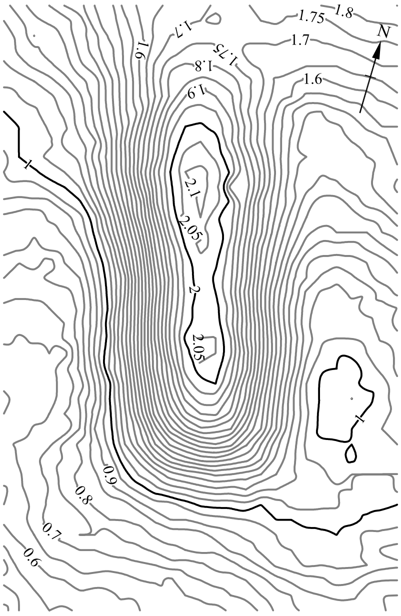
Figure 7

ROCKBOURNE LONG BARROW, HAMPSHIRE.
Comparative plots of topographic surveys

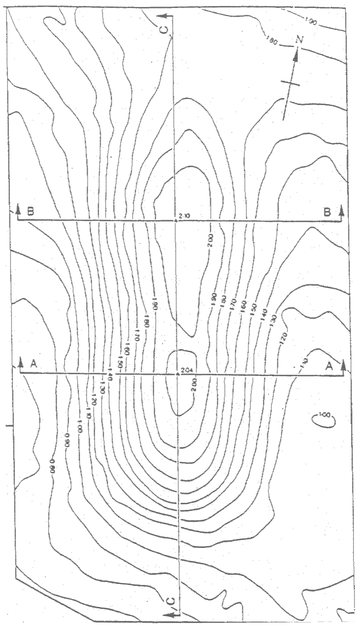
SU1022



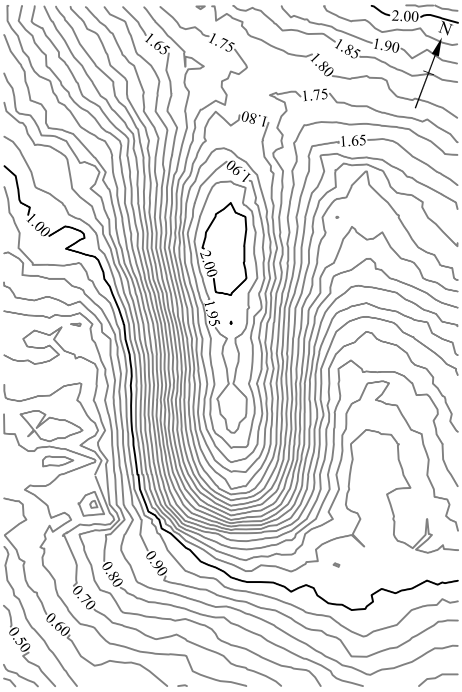
1982



1988



1991 (from Wilson 1991)



2001

All surveys plotted relative to TBM as zero elevation. Contours at 5 cm intervals.

0 60m

1:1000

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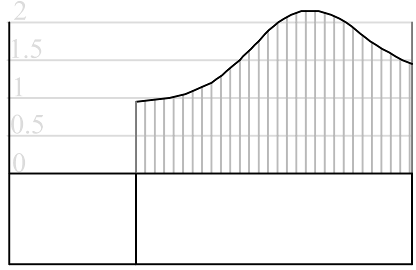
Figure 8

ROCKBOURNE LONG BARROW, HAMPSHIRE.

Profiles across the mound at line A-A (marked on 1991 plot, Figure 7)

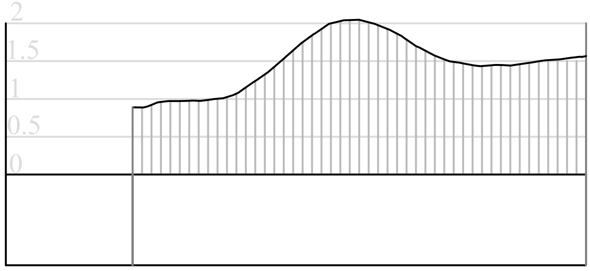
SU1022



1982 section A-A

1988 section A-A

1991 section A-A



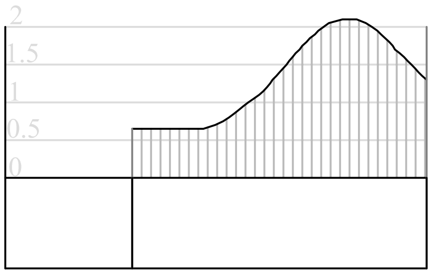
2001 section A-A

Vertical scale exaggerated x10, with profiles vertically aligned for comparison.

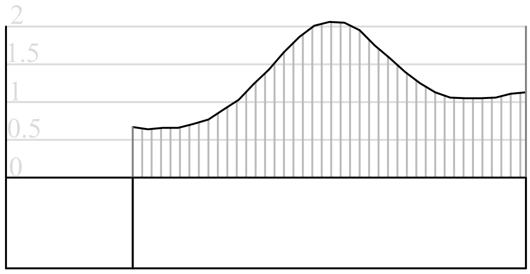
0 60m

1:1000

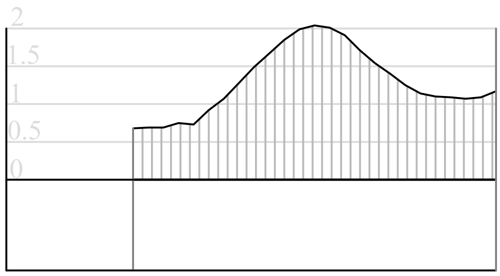
ROCKBOURNE LONG BARROW, HAMPSHIRE.
Profiles across the mound at line B-B (marked on 1991 plot, Figure 7)
SU1022



1982 section B-B



1988 section B-B



1991 section B-B

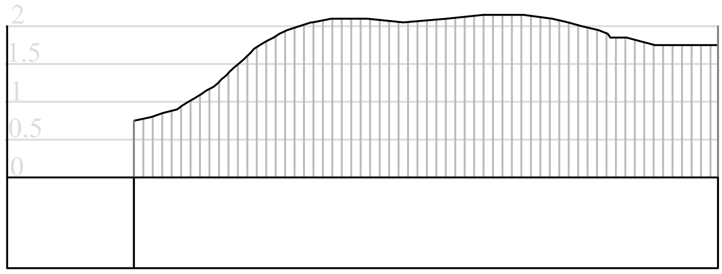
2001 section B-B

Vertical scale exaggerated x10, with profiles vertically aligned for comparison.

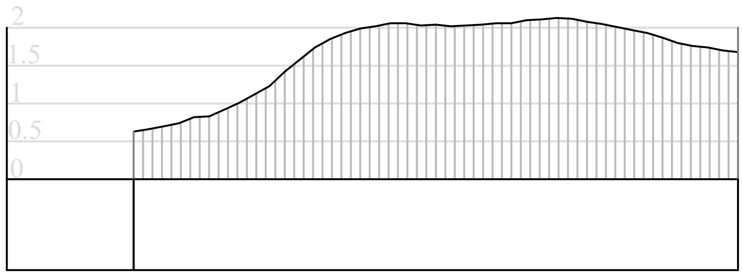
0 60m
1:1000

Figure 10

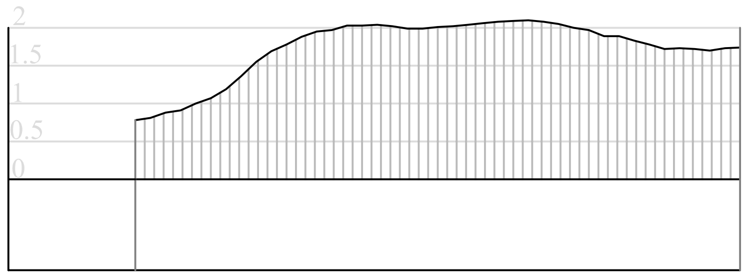
ROCKBOURNE LONG BARROW, HAMPSHIRE.
Profiles across the mound at line C-C (marked on 1991 plot, Figure 7)
SU1022



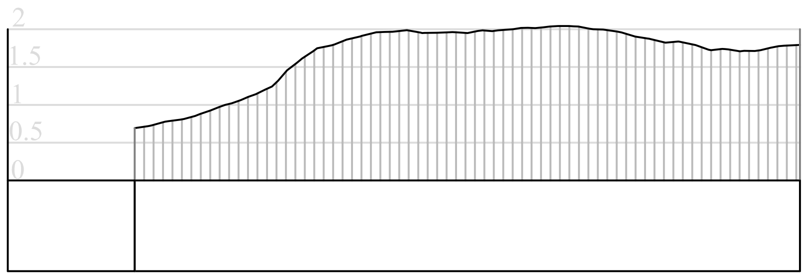
1982 section C-C



1988 section C-C



1991 section C-C



2001 section C-C

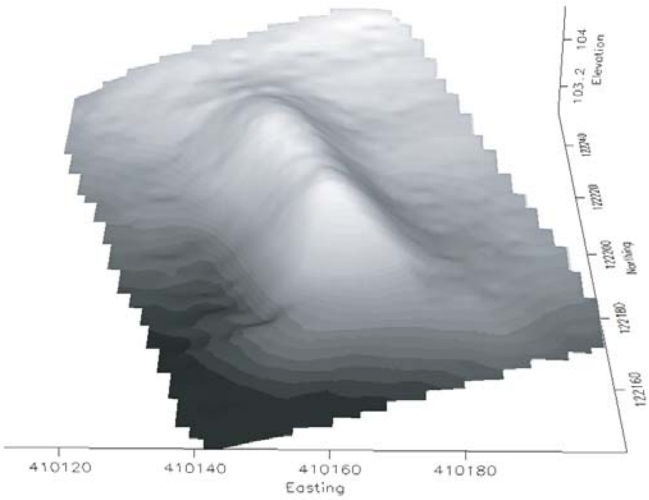
Vertical scale exaggerated x10, with profiles vertically aligned for comparison.

0 60m
1:1000

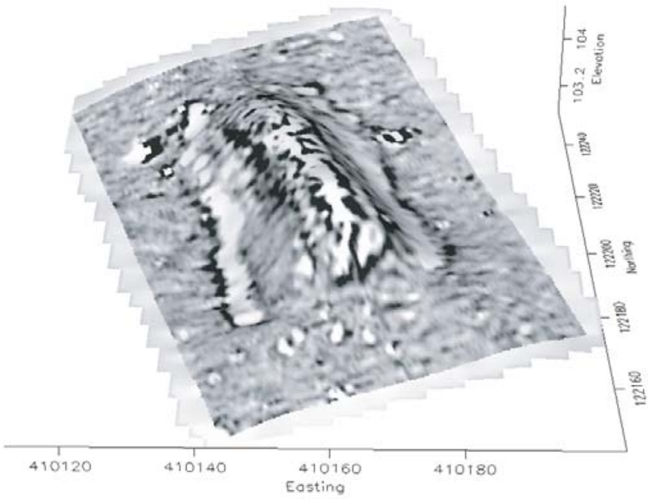
ROCKBOURNE LONG BARROW, HAMPSHIRE.
3D visualisation of survey data.

Figure 11

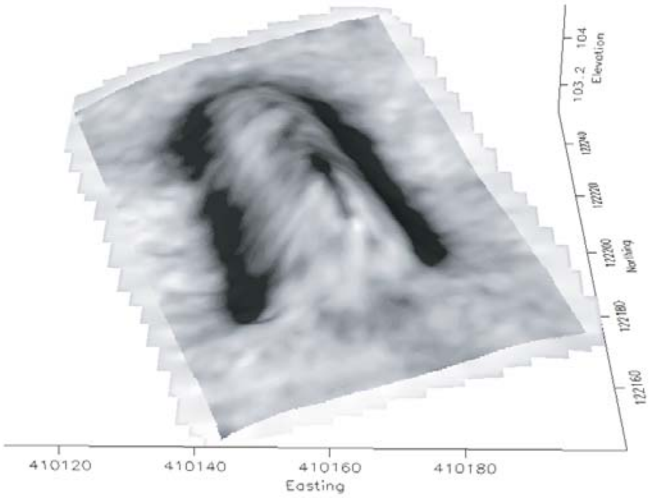
a) Greyscale image of Digital Terrain Model (DTM).



b) Greyscale image of magnetometer data draped over DTM.



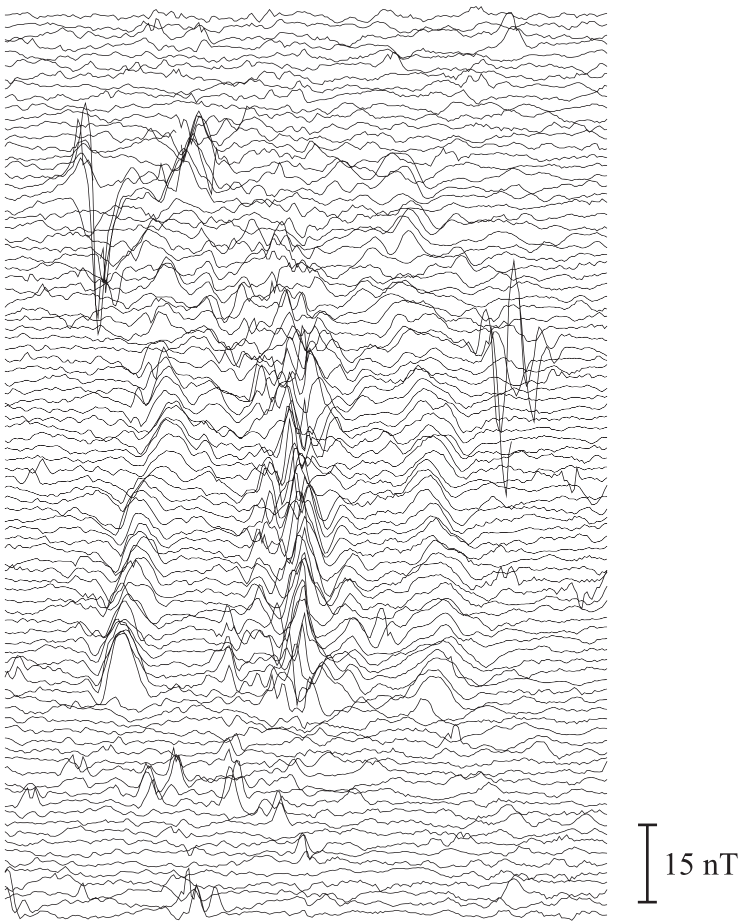
c) Greyscale image of earth resistance data draped over DTM.

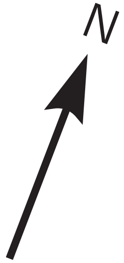


TENANTRY FARM, ROCKBOURNE, HAMPSHIRE.
Magnetometer survey, November 2001.

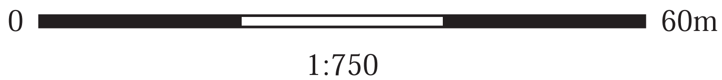
PLAN A

1) Traceplot of magnetometer data.





2) Linear greyscale of magnetometer data.



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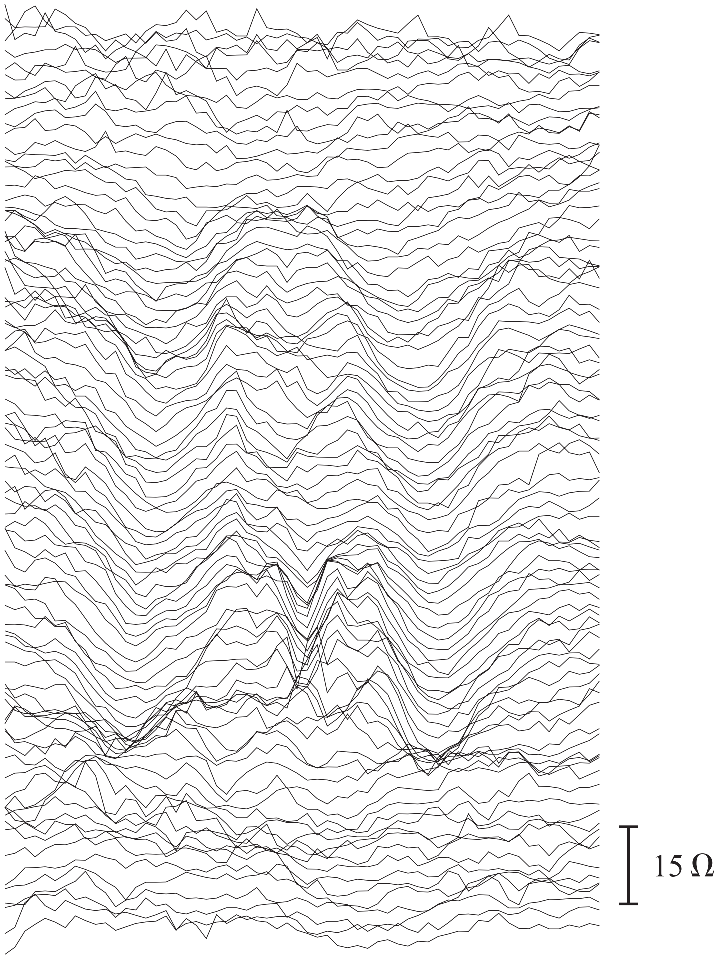
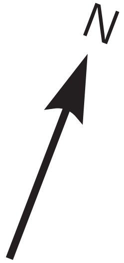
TENANTRY FARM, ROCKBOURNE, HAMPSHIRE.
Resistivity survey, November 2001.

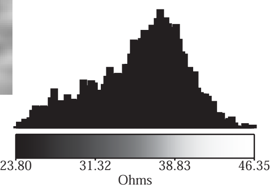
PLAN B

1) Traceplot of resistivity data.





2) Linear greyscale of resistivity data.



0 60m

1:750

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