

*Excavations at The Old Vicarage, Mellor,
Stockport. 2006 Season. Volume II.*

Draft Copy



MELLOR GEOPHYSICS

**GEOPHYSICAL INVESTIGATIONS AT THE MELLOR
HILLTOP ARCHAEOLOGICAL SITE, 2006**



*A Report to the Mellor Archaeological Trust
May, 2007 (with minor additions, July 2007)*

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SUMMARY

This Report sets out the results of magnetometry surveys carried out during the summer and autumn of 2006, in some of the fields comprising the Mellor Hilltop Archaeological Site. Overall, over 20,000 square metres of ground were surveyed, in 11 composite grids described in the Report.

A primary purpose of the surveys was to attempt to trace the line of the so-called "outer ditch", previously identified by excavation both to the north and to the east of the Old Vicarage site. The southern arm of this ditch, about 1m deep and cut into the sandstone bedrock could be readily identified as a clear, linear magnetic anomaly crossing the field immediately to the east of the Mellor Church car park. Two excavations in this field confirmed the presence of the outer ditch, thus validating the identification of the magnetic anomaly.

Further surveys in the field immediately to the east of this identified a continuation of this magnetic anomaly for a further 120 m, at which point the anomaly converged with a similar magnetic feature which could clearly be identified as a surface track. At the point of convergence, the track diverges at a T-junction, one arm turning sharply to the north and running to a large farm (Boden's Farm). This track forms the main entry for HGVs to the farm, and in consequence has been heavily reinforced with hard-core material. The magnetic signature of the latter obscures that for the outer ditch at this point, and attempts to relocate the outer ditch beyond this T-junction have not been successful. However, many of the possible options have been eliminated, so that, if the outer ditch continues, it is fairly clear along what line it is likely to run. This prediction needs to be further investigated by magnetometry.

Other magnetometry surveys in these fields have not indicated anything of definite archaeological interest. However, a survey of the field lying to the east, at the top end of the Mellor Hilltop Ridge, shows a possibility of interesting archaeology, and this area needs further investigation and excavation.

Magnetometry surveys to locate the northern arm of the outer ditch were interrupted by a dispute with the landowner, and continuation of these surveys depends on resolution of this dispute.

A Ground Penetrating Radar survey of the interior of Mellor Church (February, 2007), a Magnetometry survey at Shaw Cairn, and a Resistivity survey at Cow Hey Farm (March, 2007), have each been reported separately.

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Picture, Front Cover: Magnetometry at the Shaw Cairn site, 25 March 2007, Sue Miall receiving instruction from Philip Day. Photograph by Anthony Boardman. The results of the Shaw Cairn survey have been reported separately.

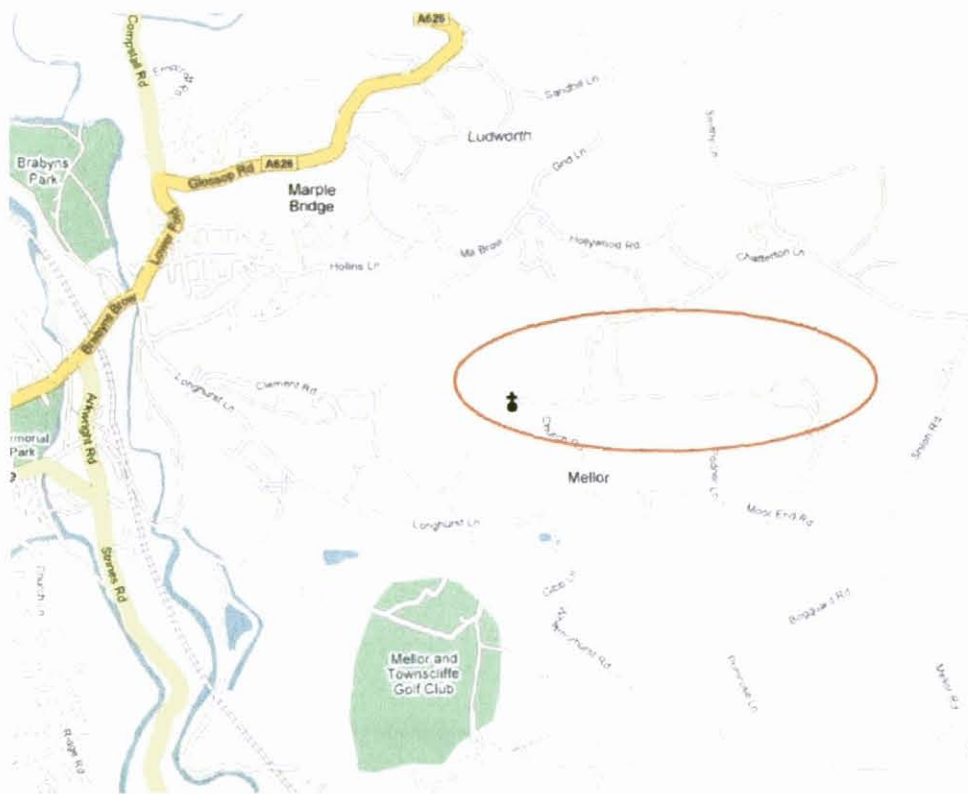
PART I: SURVEY AREAS and METHODOLOGY

BACKGROUND

The Mellor Hilltop Site was identified in the late 1990s, and archaeological investigations have continued there each year since that time. The site is centred on the Old Vicarage, adjacent to Mellor Church (Figures 1 & 2), and indeed the possibility of interesting archaeology in this area was first noticed by the owners and residents of the Old Vicarage, Ann and John Hearle, in the summer of 1996. Early investigations confirmed these suspicions, and the Mellor Archaeological Trust was formed to oversee the investigations and development of the site. This work is funded by voluntary subscription and Open Days, and by grants from Stockport Metropolitan Borough and from the National Heritage Lottery Fund. Late in 2006, the Heritage Lottery Fund allocated a large grant to the Mellor Archaeological Trust to support continued development of the Hilltop site, investigation of other sites in the Mellor area, and educational projects related to this work.

Figure 1. Map of Mellor and Marple Bridge showing the location of the Archaeological Site (red oval).

Acknowledgement: Google Maps (see p. 44)

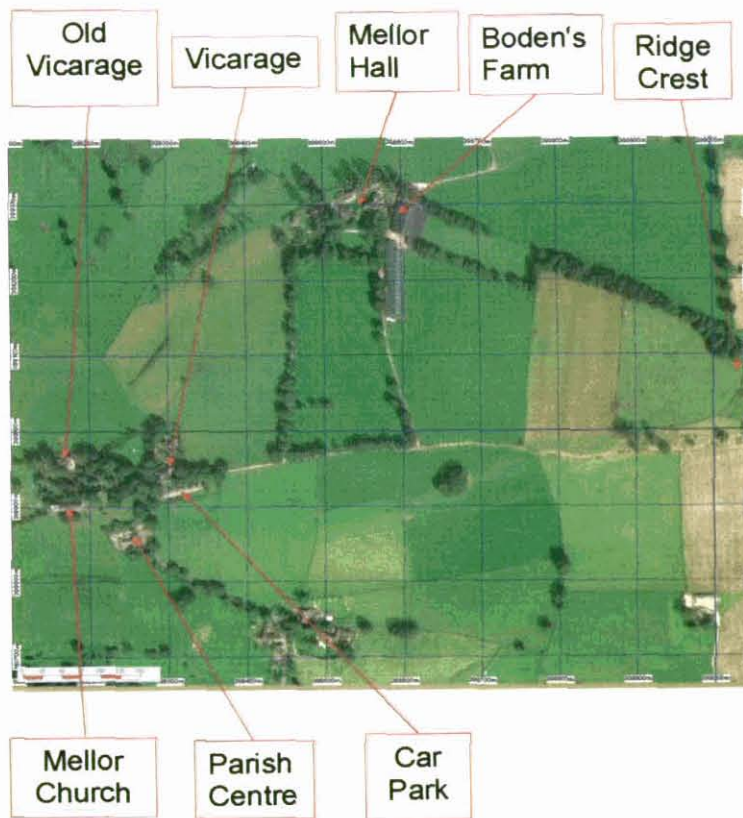


Over the past 8 years, investigations at the Mellor Site have proceeded along two main fronts: geophysical surveys, using resistivity and magnetometry, and direct excavation. The majority of the excavation has been carried out in August/September each year, by volunteers, under the direction of professional archaeologists from the University of Manchester Archaeological Unit (UMAU). These excavations have resulted in the identification of an Iron Age

settlement, with many characteristic artifacts, and indications (flint tools, etc.) of earlier settlement. Although no Roman construction has been identified, there has been a plethora of Roman artifacts – pottery, ornaments, etc. – discovered. More recently (2006), the possible site of a Medieval Hall has been uncovered in the garden of the Old Vicarage.

Figure 2. Mellor Hilltop Site

Acknowledgement: Google Maps (see p. 44)



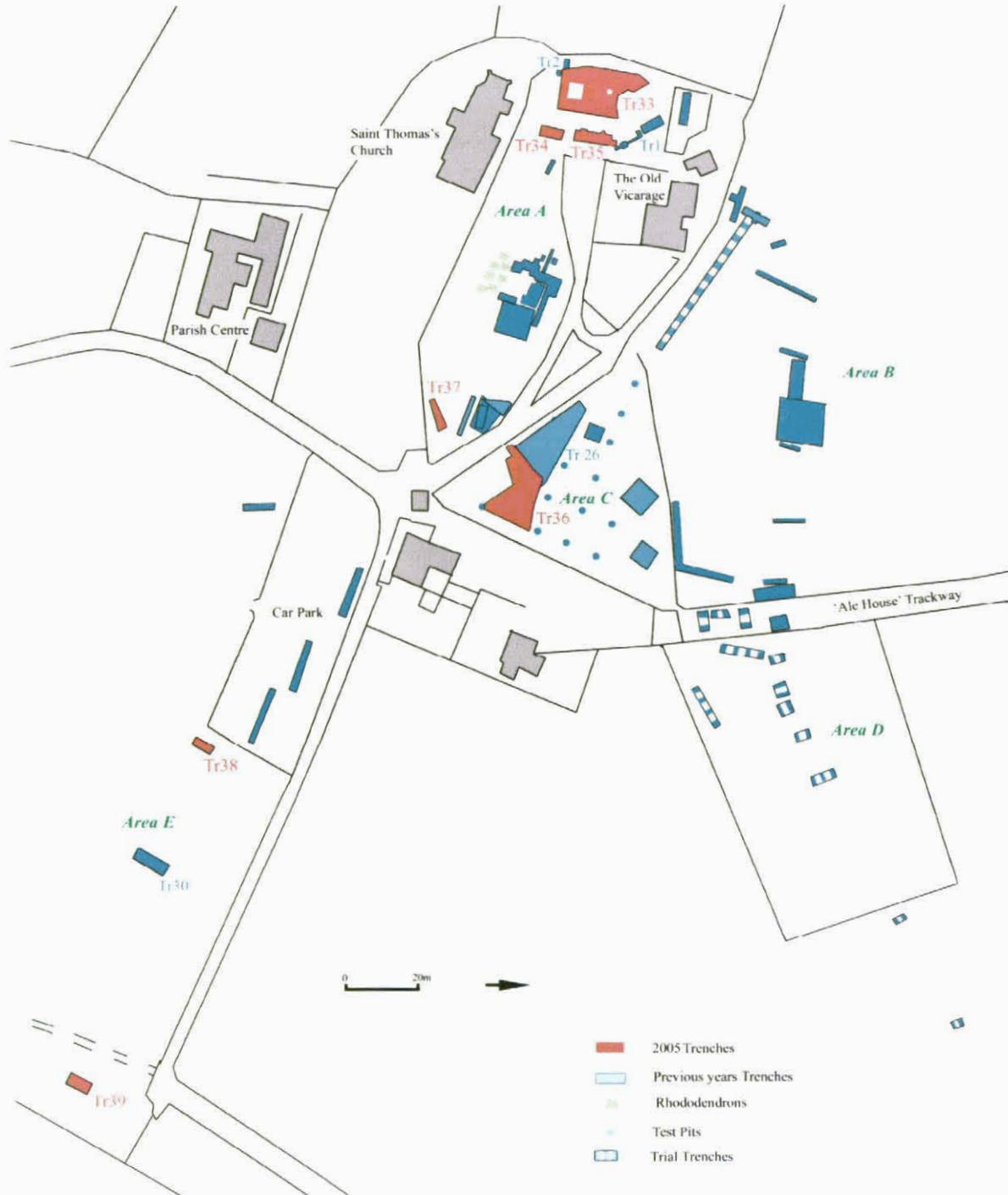
Up until 2004, geophysical surveys were carried out by outside contractors and professional archaeologists from UMAU, and the Reports (see References) have been used to inform subsequent excavation. In 2005, Mellor Geophysics formed as a geophysical research unit, attached to the Department of Chemistry, University of Manchester. Initial purchase was of equipment for Ground Penetrating Radar, which was deployed during the summer of 2005 and more recently. However, the soil is generally not favourable for the application of radar, and the results of these investigations were of limited utility. In 2006, magnetometry (gradiometer) equipment was purchased, and this has proved valuable for large-area survey work in the fields surrounding the site. In early 2007, GPR was again used to investigate the ground underneath the nave of Mellor Church, and in these conditions (where the ground was dry), the technique has proved valuable.

This Report summarises magnetometry surveys carried out during 2006 (July-November), 2006) and early 2007. Earlier Reports are listed in the References (p.43).

SITE MAP

The UMAU site map updated to 2005 is shown below. North is to the RIGHT. Note that distances and directions are approximate only. The position of trench 50, opened in 2006, is shown in Figure 38 on page 42.

Figure 3. Mellor Hilltop Archaeological Site Map 2005 (UMAU)



OBJECTIVES

The principle objective of the geophysical surveys in 2006 has been to attempt to establish the path of the so-called "outer ditch" to the north and east of the main excavation sites in the Old Vicarage garden (Figure 3; RED oval), and to establish whether the two "arms" of the outer ditch (Figure 3; shown in BLUE) meet up to enclose the hilltop area.

Figure 4. Possible track of the "Outer Ditch" on the Mellor Hilltop

Acknowledgement: Google Maps (see p. 44)



Explanation

Excavation over the past eight years, as well as revealing much interesting detailed archaeology, has established some broad features of the hilltop site, namely:

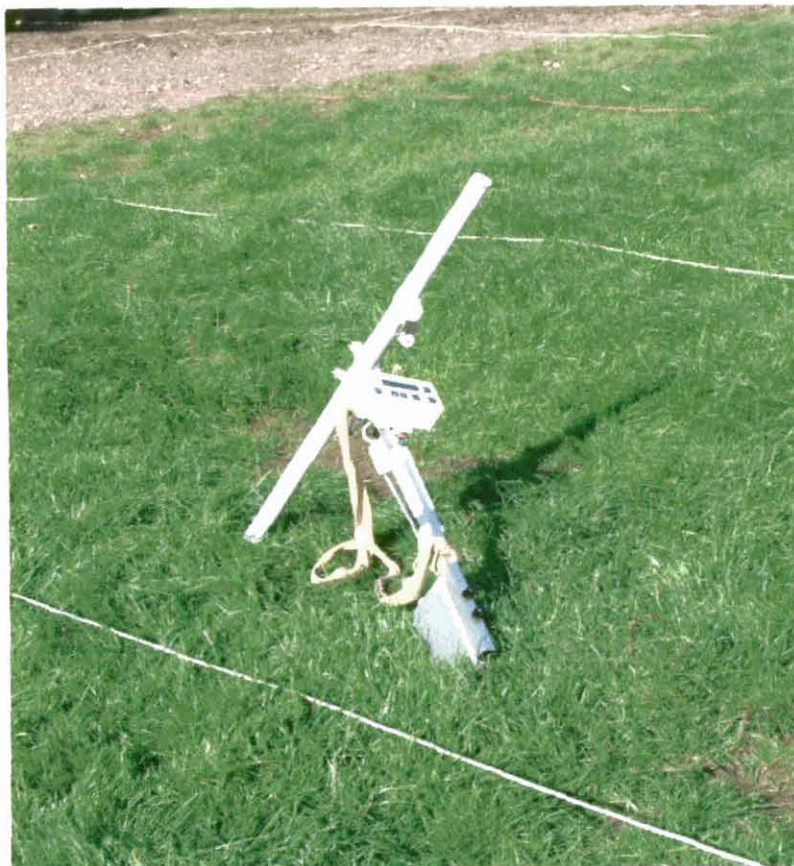
- A major settlement within the garden area of the Old Vicarage (Figure 4: RED oval). This dates back at least to the Iron Age, and appears to have been enclosed within a deep ditch (so-called "inner ditch"). The inner ditch has been excavated and characterised at both the west and east ends of the Old Vicarage garden, although the locus (if any) of the sections of the ditch within the remainder of the garden is not established.
- Pottery and other artifacts, including the foundations of a possible Hall, found within this area show signs of occupation during Roman and Medieval periods.
- Starting just to the north of the Old Vicarage buildings, a lesser ditch (cut into the underlying sandstone) travels approximately north-east, and has been identified by excavation at various points over about 250 m (Figure 4: light blue). This has been termed the "outer ditch" (northern arm).
- A similar "outer ditch" (southern arm) has been established by excavation running from the east end of the Old Vicarage area (adjacent to the Car Park) for about 200 m in an easterly direction (Figure 4: light blue).
- Speculatively, the purpose of the outer ditch may have been to enclose an area of the hilltop, perhaps to retain livestock or establish ownership. In any event, an intriguing question is whether the two arms of the "outer ditch" meet up, and resolving this question is the primary purpose of these investigations.

FIELDWORK: METHODS

Instrumentation

Magnetometry has been carried out using a 1 m Fluxgate Magnetic Gradiometer (Bartington 601.1), with digital data recorder (Figure 5 and Front Cover). The instrument measures the vertical component of the earth's magnetic field at the top and bottom of the 1 m long "pole", held vertically, and converts these measurements into a notional field gradient. In operation, the user walks at a steady pace along a straight line (tape), and readings are taken at specified intervals (e.g. 0.125 m) and recorded digitally. Common practice was to survey 30 x 30 m grids, with transects set at 1 m, or 0.5 m if more detailed resolution was required. The survey data was later downloaded into a desktop computer and analysed using the software package ArcheoSurveyor (DW Consulting, Netherlands: see References).

Figure 5. Bartington 601.1, Single Unit Magnetic Gradiometer



Principle of Operation

The earth's magnetic field is inclined at an angle to the vertical, and points towards the magnetic north pole. The magnetometer is designed to measure the vertical component of the gradient of this field which, at long distances above the ground, will be largely independent of the material in the ground's surface layers. However, because the lower sensor is close to the

ground, it is much more sensitive to changes in the local magnetic field than is the upper sensor, which in effect acts as a reference. Changes in ground composition within 1 – 2 m of the surface may generate measurable fluctuations in the vertical field gradient, which will later show up as “anomalies” when the data are analysed. Quite minor disturbances, e.g. land drains, previous excavation trenches, or even underlying rock outcrops may show up in this way, and not all “anomalies” are interesting archaeology. Furthermore, the magnetometer is sensitive to metal objects, and particularly sensitive to ferromagnetic materials (chiefly iron), so that even a 10 cm long steel nail buried at a depth of 50 cm will produce a measurable signal. The proximity (within about 4 m) of a wire fence will almost certainly obliterate any ground signal to the magnetometer. However, many of these interferences can be identified by close examination of the gradiometer signals when these are transferred for computer analysis, so the problems are not as over-riding as might be expected.

In practice, variations in the magnetic properties of the ground down to a depth of about 2 m will show up, and the width of the magnetometer track is, in practice, around 0.5 m. Thus, for preliminary survey work, transects at 1 m spacing are adequate, but better resolution can be obtained at 0.5 m spacing. Along each transect, readings can be taken down to 0.125 m spacing, and there is considerable advantage in taking as many readings as possible in the field, and averaging the data during processing.

Because the horizontal component of the magnetic field is considerably greater than the vertical, it is of paramount importance that the magnetometer is held vertically, and that the magnetometer always points along the transect line, during the survey. Variations in orientation will show up as random “noise” in the data set, and lead to loss of detail in the magnetic signal.

Calibration

Before use, the magnetometer must be adjusted and calibrated. This is normally done once a day, prior to the first survey, as the Bartington Magnetometer remains stable over this time period. It is necessary to identify a relatively inert (i.e. magnetically inert) piece of ground, and the procedure must be done carefully and according to the manufacturer's instructions. This procedure is designed to adjust and compensate for the specific N-S and E-W variations in magnetic field at the survey site, and to set the instrument baseline to zero. Any imperfections in this adjustment process will carry forward into the magnetometer readings and show up as increased background “noise”. The quality of the survey data will reflect the care taken in calibration.

Survey Grids

Although in principle grids of any dimension can be accommodated, the software provided with the Bartington Magnetometer is designed to process square grids of side 10, 20 or 30 m. In all the surveys reported here, 30 x 30 m grids have been used. Within each grid, survey lines were placed at 3 m intervals, and measurements were carried out on transects parallel to these lines at either 1 m or 0.5 m spacing, the subdivisions under 3 m being estimated by the operator. Along each 30 m transect, readings were taken at regular intervals, at a density of 8 readings/m. Transects were scanned in zig-zag fashion (i.e. in alternate directions), and the resulting data converted to parallel transects by the software.

The method of achieving regularly-spaced readings was based on the manufacturer's recommendations, as follows. The instrument is designed to be carried at a constant speed along a transect, and generates 31 audible signals ("beeps") at set intervals for a 30 m transect. The operator is intended to use these regular beeps to maintain a constant walking pace, and hence a constant spatial interval between readings. For example, by setting a walk rate to 1 m/s, the beeps will be generated at 1 s intervals, and if the operator then ensures that each double step covers 1 m and occurs in time with a beep, a speed of 1 m/s is achieved. However, this setting was found to be too fast to maintain uphill or over rough ground. After various trials on different types of ground and at different slopes, it was found that a speed setting of 0.8 m/s (i.e. beeps at 1.25 s intervals) was generally preferable.

The survey time (and distance walked) is greatly reduced if adjacent transects are surveyed in opposite directions (anti-parallel), and provided the ground is reasonably horizontal this does not lead to problems in data interpretation. The instrument parameters allow for parallel or anti-parallel surveys, and the latter were invariably adopted. If the ground is sloping, or the magnetometer is not held vertically, or does not point exactly along the survey line, anti-parallel surveys can lead to apparent "striping" of the resulting magnetic maps, and although this problem can be partially corrected by the software it is better avoided in the first place.

In practice, survey grids at any given site were generated after first establishing a 30 m baseline (or, in rare cases, 10 or 20 m). Both ends of the baseline were established by physical measurement (tape-line) to identifiable points on the ground (e.g. gatepost, tree, etc.). A square was then constructed from the established baseline, by setting the sides to 30 m and the diagonals to 42.43 m ($30 \times \sqrt{2}$). Subsequently, further squares were generated by visual alignment with the original square. For help with later mapping, the co-ordinates of all corner posts were recorded to 1 m resolution by GPS (although the *absolute* accuracy of these GPS co-ordinates is probably no better than around 10 m).

Instrument Parameters

In summary, the following instrument parameters were normally set.

Pace	0.8 m/s
Grid size	30 x 30 m
Pattern	zig-zag
Lines per metre	1 (sometimes 2)
Samples per meter	8
Measurement range	100 nT
Audio	On
Volume	Low
Threshold	20 nT
Sensors	1
Reject	50 Hz

Data Processing

The magnetometer is capable of storing the data from far more grids than can be surveyed in one day, so data download could be done after return to base. The ArcheoSurveyor software has the facility to download directly from Bartington instruments, and the raw data is stored unaltered, in the original survey grids, whatever data processing is later carried out.

File Structure

The file structure used by ArcheoSurveyor is intended to resemble the archaeological structure of the site. Thus, for each archaeological site (e.g. Mellor Hilltop, Shaw Cairn, etc.), a *root directory* with an appropriate name is specified, and navigating to the correct root directory is the first step for all data processing operations at a particular archaeological site. When each root directory is initially established, four sub-directories are generated: *grids*, *composites*, *graphics*, *export* (other sub-directories may be added at will, but the four basic ones must always exist for the proper operation of the software).

When data grids are downloaded from the magnetometer they are stored (as binary files, .asg) in further sub-directories of the *grids* sub-directory. Thus, in order for the various raw data grids for each part of the site to be distinguished, the option exists to create labeled sub-directories within the *grids* sub-directory itself. In the file system used here, the label attached to each of these sub-sub-directories defines the date and field reference for the data set. By default, each grid within a set will be numbered sequentially, starting at *grid1*, but to distinguish the various grids, a prefix can be added to each grid name as the grid is downloaded. Thus, for example, each grid name may be prefixed by a date, field code, reference number, or some other identifier.

The first step in data processing is the assembly of each set of raw data grids for each area into a "*composite grid*". The composite grid is the collection of survey grids for a given area, generally obtained on the same survey session and with the same instrument calibration, which can be processed together. The software can only assemble raw data grids into a composite if each grid has the same dimensions, transect interval and step size within each transect. Furthermore, the data grids must be adjacent to each other. The assembly process is under software control, and establishes the geographical direction and the relative positions of each data grid within the composite. The composite grids are stored in the *composites* sub-directory, under the root directory for each archaeological site. Again, whatever data processing may later be carried out, the original data for each composite is retained.

Because all the composite grids are stored together, in the same directory, it is important to establish from the start an unambiguous naming system for these composites.

Data Processing

Data are processed as *composite grids*. There are many processing options available in ArcheoSurveyor, but the principal one used in each case is likely to be "*clipping*". This enables the dynamic range of the data to be limited to the range containing useful information, and a useful starting limit is generally found to be ± 3 standard deviations from the dataset mean (which, if instrument calibration was carried out carefully, will be close to zero). Other frequently-used options are *Destagger*, *Destripe*, *Despike*, but many other options exist.

FIELDWORK: AREAS SURVEYED

The Hilltop Site covers an area roughly 1 km (E-W) by 0.5 km (N-S). The area includes Mellor Church, Parish Centre, Vicarage and Old Vicarage, as well as Mellor Hall and the large farm (Boden Farm) adjacent to the Hall. The area covers 14 or more fields belonging to at least 3 separate farms, as well as a number of private dwellings. The overall layout and the field designation scheme used in this Report is shown in Figure 6.

FIGURE 6. Field Designations used in this Report

Acknowledgement: Google Maps (see p. 44)

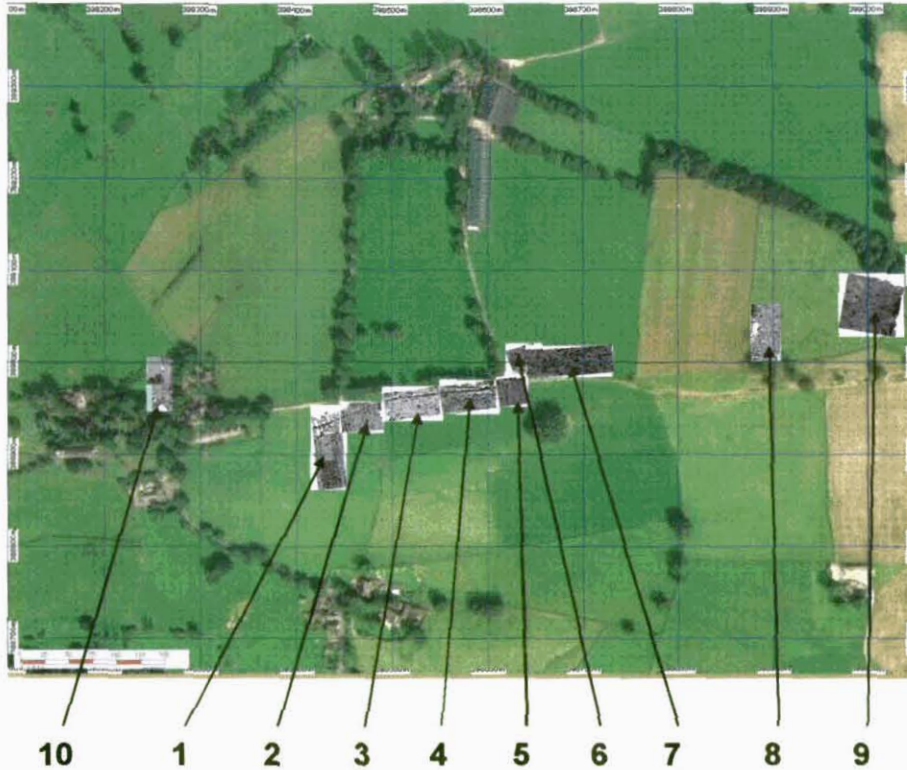


FIELD DESIGNATION	DESCRIPTION
A	Old Vicarage Frontage
B	Boden NW Field
C	Boden Hall Road Field
D	Boden Home Field
E	Boden Mid-ridge Field
F	Boden Top-ridge Field
G	Vicarage Triangular Field
H	Parish Centre Field
J	Car Park Field
K	Arrandale N Field
L	Boden S Field (W end)
M	Boden S Field (E end)
N	Boden Far Field

Magnetometer surveys have been carried out in fields B, D, F, G, K, and L, the primary purpose of these surveys being to track the route of both arms of the supposed "outer ditch" (and hence to locate areas of interest which could later be excavated). Various sets of 30 x 30 m survey grids have been amalgamated into so-called "composite grids", and the positions of the ten composite grids are shown in Figure 7, below.

FIGURE 7. Composite Grids generated in the 2006 Magnetometry Surveys

Acknowledgement: Google Maps (see p. 44)



COMPOSITE GRID NUMBER	FIELD LOCATION
1	Arrandale NorthEast Field (centre)
2	Arrandale NorthEast Field (E end)
3	Boden South Field (west end 1)
4	Boden South Field (west end 2)
5	Boden South Field (centre)
6	Boden Home Field (SW corner)
7	Boden Home Field (south edge)
8	Boden Top Field (SW corner)
9	Boden Top Field (top of ridge)
10	Vicarage Triangular Field

FIELDWORK: MAPPING

Survey grids were located where possible by direct measurements to visible landmarks on the grounds (e.g. gateposts), and in all cases these measurements were supplemented by GPS measurements. In each case, a 30 m baseline OA was established on the ground, and the end points located by GPS. Additional points B, C, D, etc. were similarly located. The GPS measurements have an absolute accuracy of not better than around 10 m, but have a relative accuracy very much better than this. However, the GPS co-ordinates rarely coincided with the map coordinates, as established by direct measurement to landmarks on the ground, and the latter were always used in preference.

Grids were entered on a base map of the area, using the software Map Maker (see references). The Ordnance Survey digital map (1:25,000) was inserted into Map Maker, and located to within 1 m. These coordinates (which do not exactly correspond with the map coordinates established by UMAU, although any discrepancy is within ~2 m) have been regarded as definitive for the purpose of the geophysical surveys.

In general, survey grids have been superimposed on aerial photographs derived from Google Earth. Conversion from the Latitude-longitude coordinates of the Google Earth maps (spherical surface maps) to the planar mapping of the UK National Grid has been achieved through the use of the conversion algorithm available on the Ordnance Survey website (see References).

PART II

FIELDWORK: RESULTS

Notes, applying to all composite grids.

In all composite grids shown in this section, NORTH is (approximately) to the TOP. In grids shown in shades of grey, the more positive magnetic gradients are shown darker. Several of the grids are shown more than once, in varying degrees of contrast. This is only to help to distinguish particular features, the underlying data has not been altered. If other colours are sometimes used, this is solely to improve visibility.

Field K: Location of Composite Grids No. 1 & 2

The possible extension of the south arm of the outer ditch in field K was investigated. Since excavation (in 2005) had already established the presence of the outer ditch at both the western and eastern ends of this field, the magnetometer survey was primarily to identify the type of magnetic anomaly which could be associated with this ditch. The magnetometer survey was also extended to the more southerly parts of this field, in order to investigate the possible presence of other structures. Composite Grid No. 1 comprises three 30 x 30 m scans, and Composite Grid No. 2, one 30 x 30 m and one 30 x 15 m (approx.) scans, the limiting factor being the presence of the field wall (see Figure 8, below)

Figure 8. Map of Field K, showing the location of Composite Grids No.1 & 2.
Acknowledgement: Google Earth (see p. 44)



Composite Grid No.1

Table 9. Field Data: Composite Grid No. 1

INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-1	ArcheoSurveyor
Date/Time	14-08-06	6 hours
Time start/end	10.30	16.30
Location	Arrandale North field	Field K
Coordinates - Nat Grid	Easting	Northing
GPS – baseline O	398446	388953
GPS – baseline A	398449	388923
Map coordinate: O	398448.7	388950.3
Map coordinate: A	398451.4	388920.3
Number/size of grids	3	30x90 m
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	0.5 m	8 readings/m
Total area/distance	2700 m ²	5.4 km
Weather	Sunny, warm, dry	
Operator/Associates	JPD	Brian, Liz

Figure 10a. Composite grid No.1, 30 m x 90 m with North upwards. . *Left*: low contrast, no contours. *Right*: high contrast, with contours. Scans were recorded for individual 30 x 30m grids, starting at the NE corner with initial traverse N-S, i.e. along baseline O – A as shown. Markers are at 3m intervals.

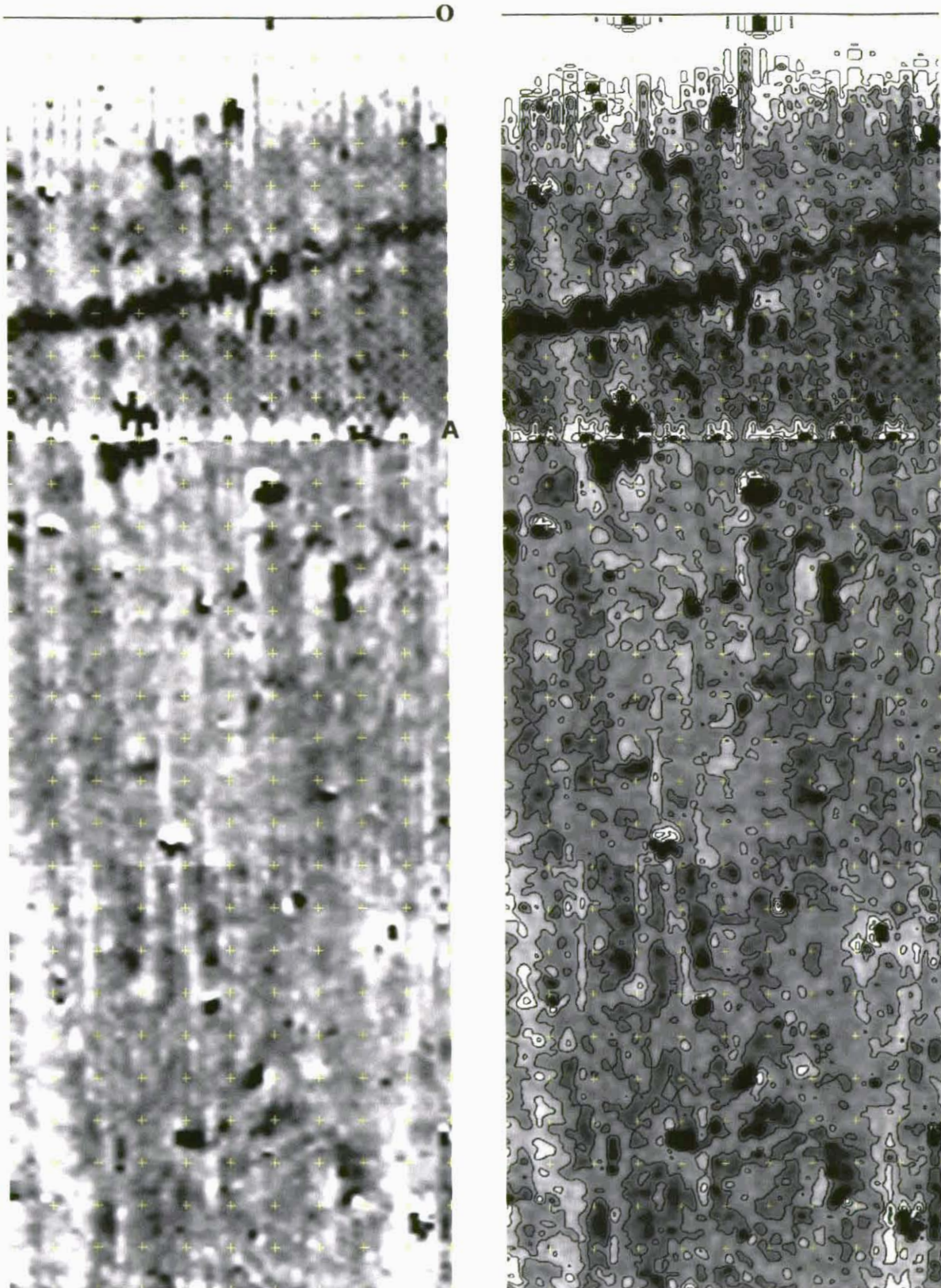
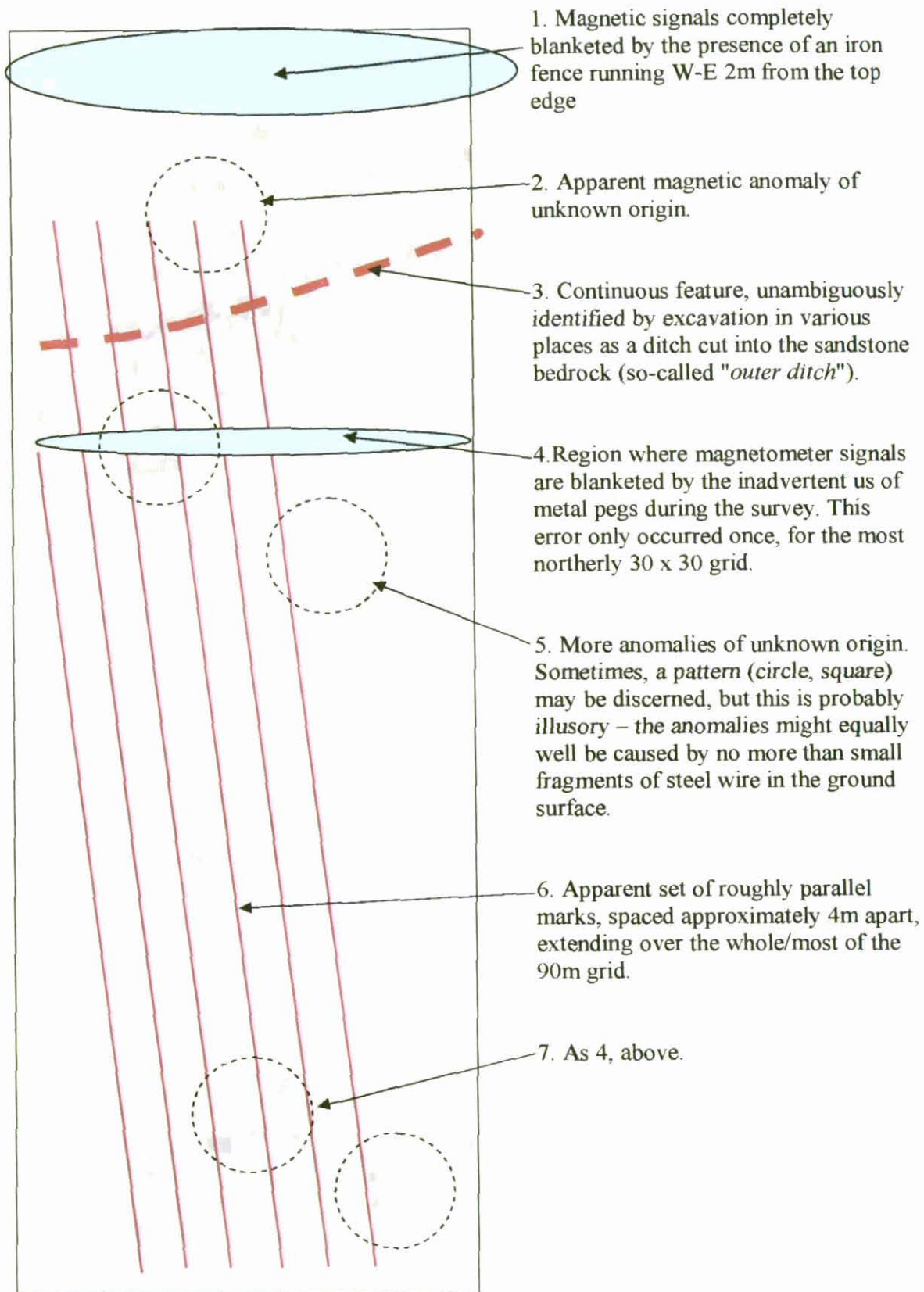


Figure 10b. Composite grid No.1, with features highlighted



Conclusions (Grid No. 1)

- The track of the Outer Ditch (identified in other places by excavation) has been found and clearly identified.
- There is no indication of another, similar, outer ditch further to the south.
- There is possible evidence of past agriculture (plough marks).
- There are several major anomalies which may be of interest for further investigation (e.g. GPR), but for which at present cannot be interpreted.

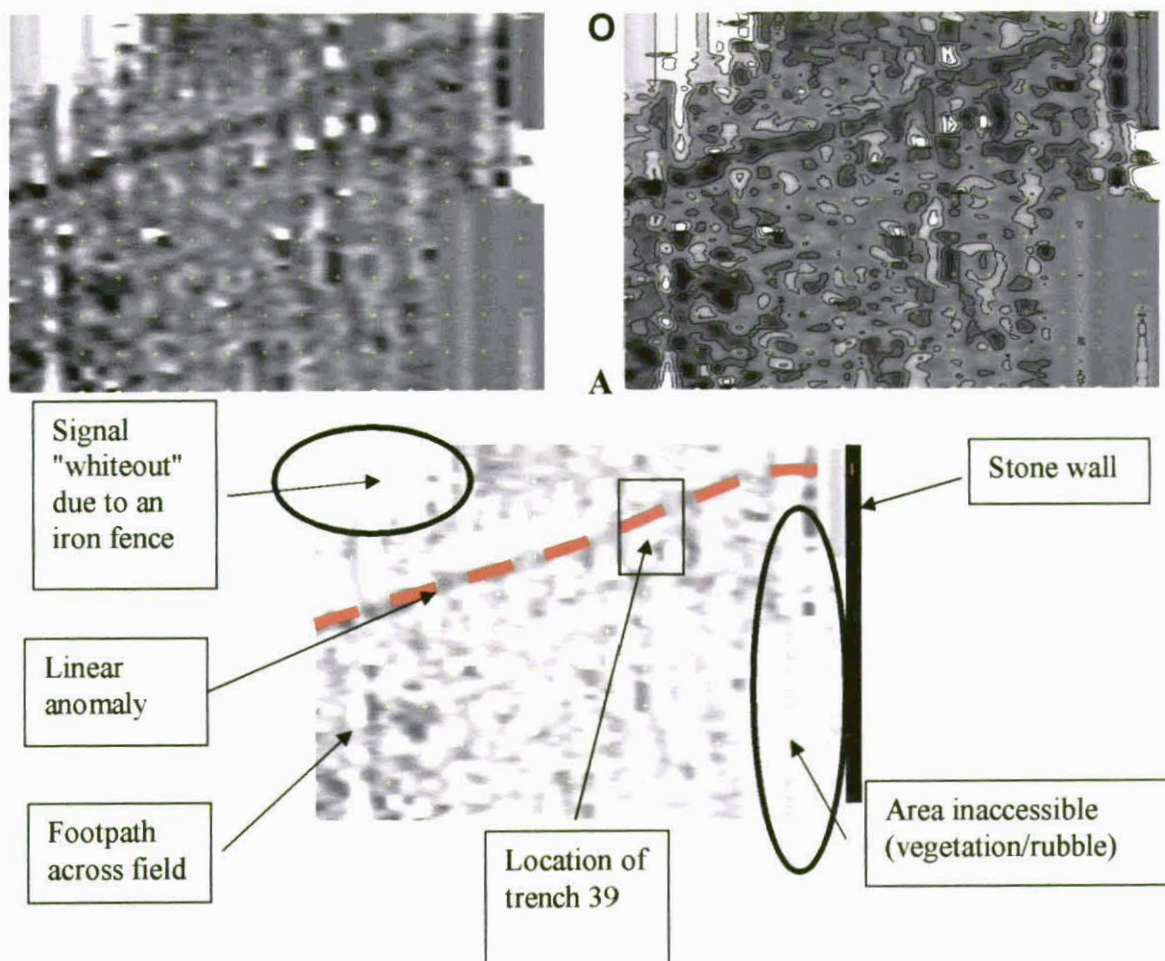
Composite Grid No.2

The probable continued extension of the south arm of the outer ditch, in field K to the east of Grid No.1, was investigated (Table 11). The results of this survey are shown in Figure 12. The principal features are indicated below.

Table 11. Field Data: Composite Grid No. 2

INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-1	ArcheoSurveyor
Date/Time	22-08-06	6 hours
Time start/end	10.30	16.30
Location	Arrandale NE field	Field K
Coordinates - Nat Grid	Easting	Northing
GPS - baseline O	398446	388953
GPS - baseline A	398449	388923
Map coordinate: O	398448.7	388950.3
Map coordinate: A	398451.4	388920.3
Number/size of grids	2	30 x 45 m
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	0.5 m	8 readings/m
Total area/distance	1400 m ²	2.7 km
Weather	Sunny, warm, dry	
Operator/Associates	JPD	Brian, Liz, Helen, Nora

Figure 12. Composite grid No.2, 30 m x 45 m with North upwards. . Left: low contrast, no contours. Right: high contrast, with contours. The indicated baseline O – A is the same as that in Grid 1.



The linear magnetic anomaly, shown above, appears to be a continuation of that shown in Grid 1. Excavation (trench 39) in the summer of 2005 at approximately the point indicated showed the presence of the outer ditch, running roughly west-east and around 1 m deep (the sand stone bedrock at this point is about 0.4 m below the ground surface). Thus, the "linear anomaly" as seen above (both grids 1 and 2) may be confidently identified as the south arm of the outer ditch running across field K, and leaving the field at the east end approximately 7 m from the gatepost at the north end of the boundary wall.

Other features in Grid 2 are identified above. The linear N-S "track" to the left of the figure is probably the line of a public footpath, easily visible in the grass and in line with the gate.

The positions of Grids 1 & 2 in relation to the field boundaries and the excavated trench (trench 39) are shown on the overlaid aerial photograph (Figure 13, next page). *[Note that the trenches visible on the aerial photograph had been filled in before the magnetometry survey was carried out.]*

Figure 13. Grids 1 and 2 overlaid on an aerial photograph (courtesy: Google Earth) of Field K (Arrandale N. field). The Google Earth photograph, which must have been taken during August, 2005, shows clearly the two trenches in this field (trench 38 & 39).

Acknowledgement: Google Earth (see p. 44)



Composite Grids No. 3, 4 & 5

The possible continuation of the south arm of the outer ditch from field K to field L (Boden S field) was investigated. Excavation (in 2005) had already established the presence of the outer ditch at both the western and eastern ends of field K, and in 2006 the magnetometer survey of field K identified a characteristic magnetic anomaly which could be associated with this ditch (Grids 1 & 2, reported above). Thus, the magnetometer survey was extended to the field L (i.e. on the other side of the wall), to see whether the magnetic anomaly continued in an easterly direction. A total of five, 30 x 30 m grids were surveyed in this field, and the results are presented in this and the following sections as composite grids No. 3, 4 and 5 (Figures 14 and 16).

Figure 14. Location of Composite Grids 3, 4 & 5

Acknowledgement: Google Earth (see p. 44)



Composite Grid No. 3

For composite grid number 3, considered in this section, initial findings suggested that the outer ditch did, indeed, continue as expected, and it was decided to excavate a short section to confirm this prediction. Prior to excavation, a 20 x 20 m grid, at high resolution (traverses at 0.5 m intervals) was recorded, so that precise co-ordinates could be determined for the excavation. The details are given in composite grid 3a (Figure 17).

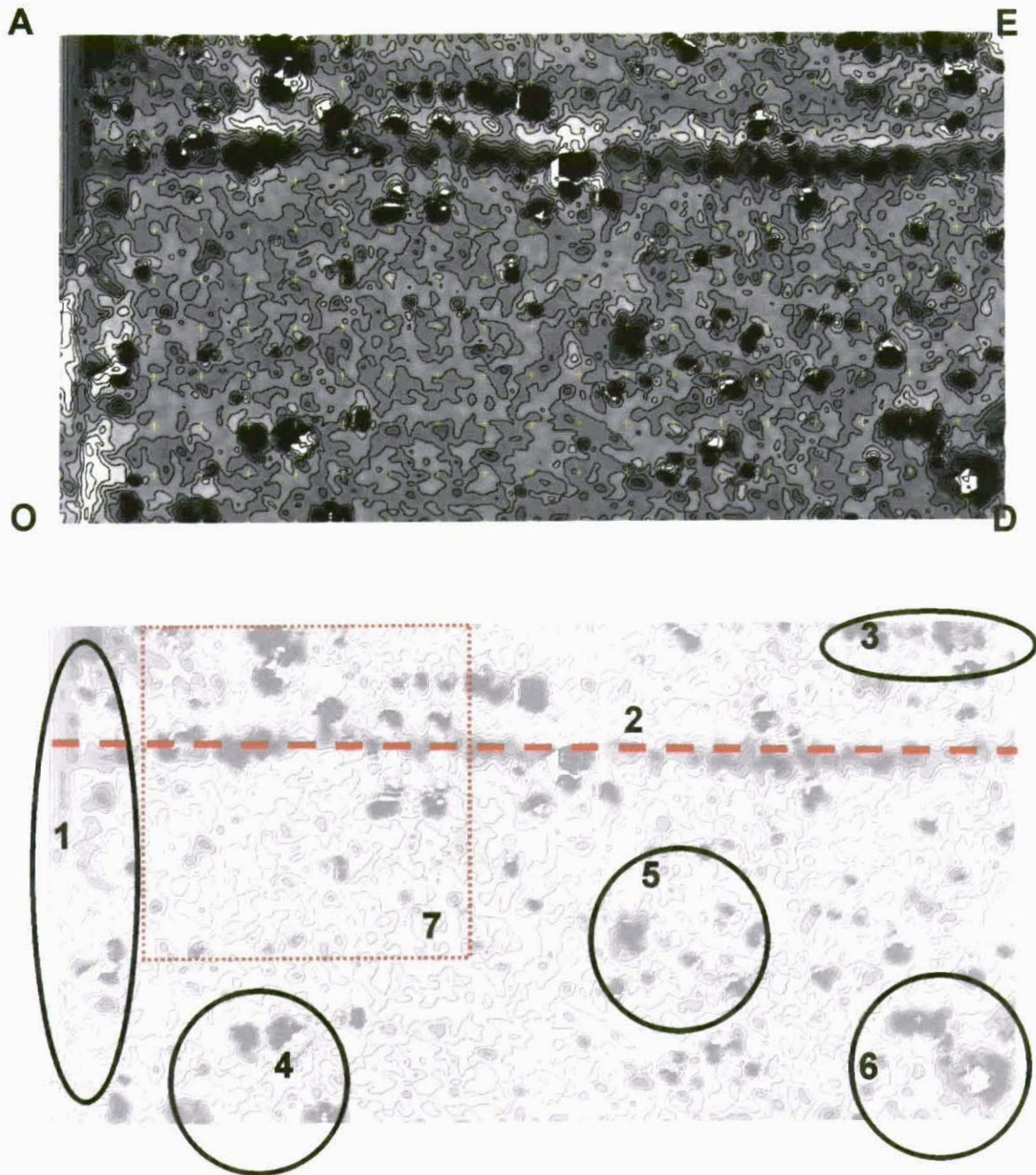
Table 15. Field Data: Composite Grid No. 3

INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-1	ArcheoSurveyor
Date/Time	14-08-06	6 hours
Time start/end	10.30	16.30
Location	Boden South field	Field L
Coordinates - Nat Grid	Easting	Northing
GPS - baseline O	398498	388940
GPS - baseline A	398497	388971
Map coordinate: O	398497.8	388933.3
Map coordinate: A	398492.9	388963.1
Number/size of grids	2	30 m square
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	0.5 m	8 readings/m
Total area/distance	1800 m ²	3.6 km
Weather	Sunny, warm, dry	
Operator/Associates	JPD	Brian, Liz

Table 15a. Sub-grid 3A

INFORMATION	DETAIL	NOTES
Coordinates - Nat Grid	Easting	Northing
Map coordinate: O	398497.8	388933.3
Map coordinate: A	398492.9	388963.1
Number/size of grids	1	20 m square
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	0.25 m	8 readings/m
Operator/Associates	JPD	Brian, Liz

Figure 16. Composite grid No. 3 (30 x 60 m, N upwards).
TOP: magnetometry scan; BOTTOM: principal items of interest



1. Area influenced by iron wire etc. lining the field wall. No useful magnetometry possible.
2. Linear anomaly, interpreted as a continuation of the outer ditch.
3. Possible magnetic anomaly generated by material used to construct a track (e.g. clinker).
- 4, 5, 6. Possible "real" magnetic features, of unknown origin.
7. Location of 20 x 20 m high-resolution scan, Grid 3A (6 m from line OA).

Figure 17a. Composite grid No. 3A (20 x 20 m, markers 2 m spacing, N upwards). The location of this grid is shown in the previous Figure, with the probable line of the outer ditch shown in GREEN. This scan used 0.5m transects (running N-S), to enable precise placement of the planned excavation of trench 50 (2 x 4 m, shown in RED). The excavated trench (trench 50) is shown below.

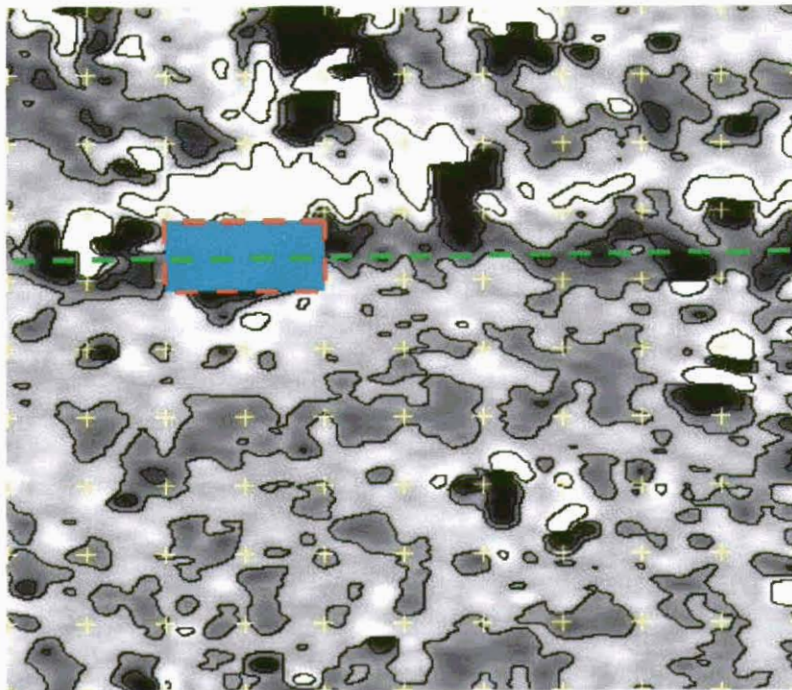


Figure 17b. Trench 50, excavated at the position shown in Fig. 17a.



Composite Grid No. 4

Composite grid number 4 continues immediately to the east of grid No. 3 (details below, Table 18 and Figure 19).

Table 18. Field Data: Composite Grid No. 4

INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-1	ArcheoSurveyor
Date/Time	15-08-06	6 hours
Time start/end	10.30	16.30
Location	Boden South field	Field L
Coordinates - Nat Grid	Easting	Northing
GPS - baseline O	398557	
GPS - baseline A		
Map coordinate: O	398557.6	3889942.8
Map coordinate: A	398552.7	388972.8
Number/size of grids	2	30 x 60 m
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	1.0 m	8 readings/m
Total area/distance	1800 m ²	1.8 km
Weather	Sunny, warm, dry	
Operator/Associates	JPD	Brian, Liz

1. Anomaly which runs along the line of the partly made-up track allowing access to Boden's Farm by HGVs. The magnetic anomaly may be related to the material (clinker, etc.) used to stabilize the track.
2. Area approaching the right hand track junction leading to the Farm, and close to a wall lined with a metal fence. No useful magnetic data from this area.
3. Continuation of the probable line of the outer ditch. Directly matches a similar feature in Composite Grid 3.
4. Magnetic anomaly of unknown origin (several similar anomalies appear in the lower half of this Figure).

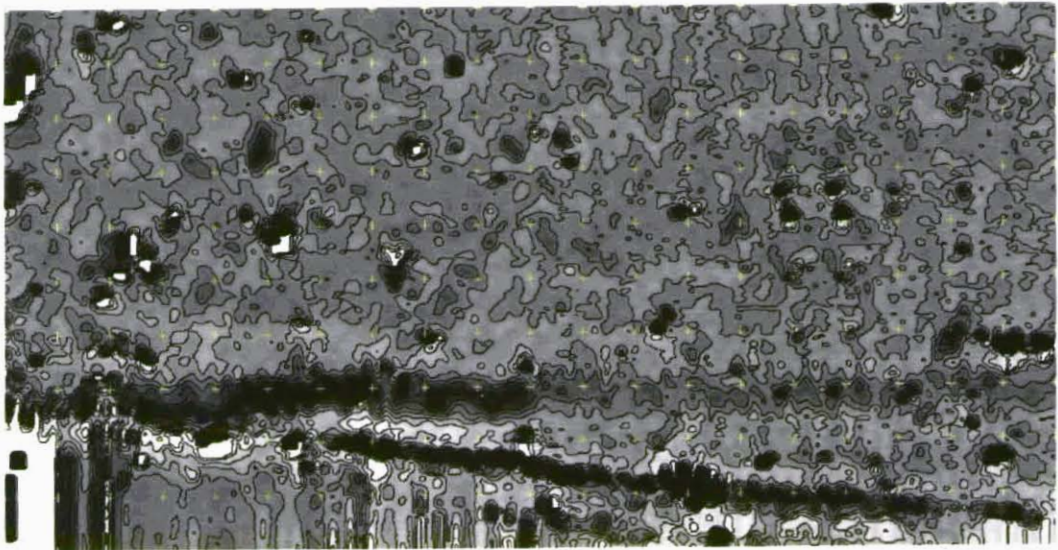
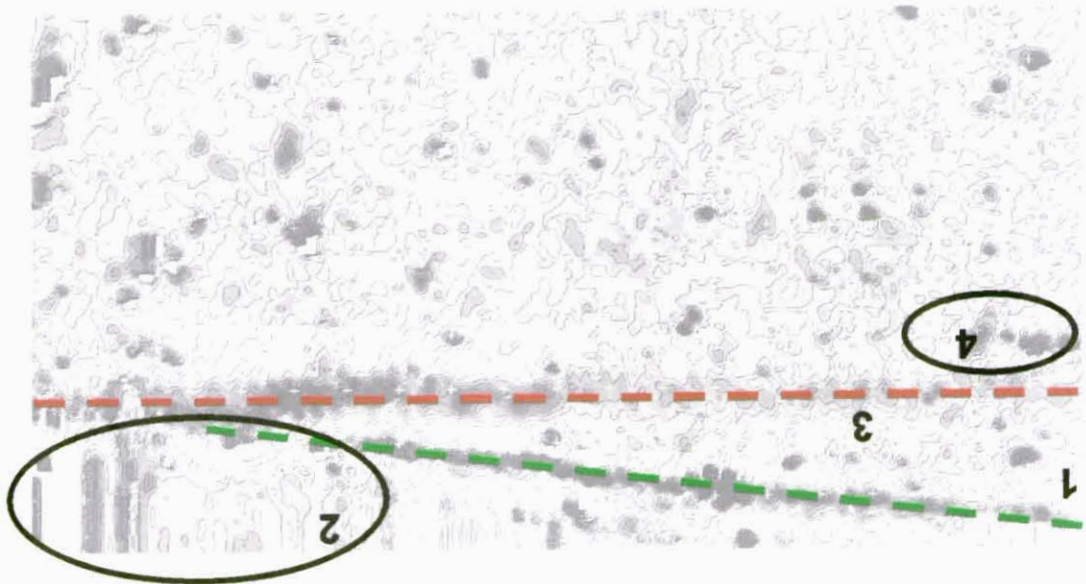


Figure 19. Composite grid No. 4 (30 x 60 m, N upwards).
 TOP: magnetometry scan; BOTTOM: principal items of interest

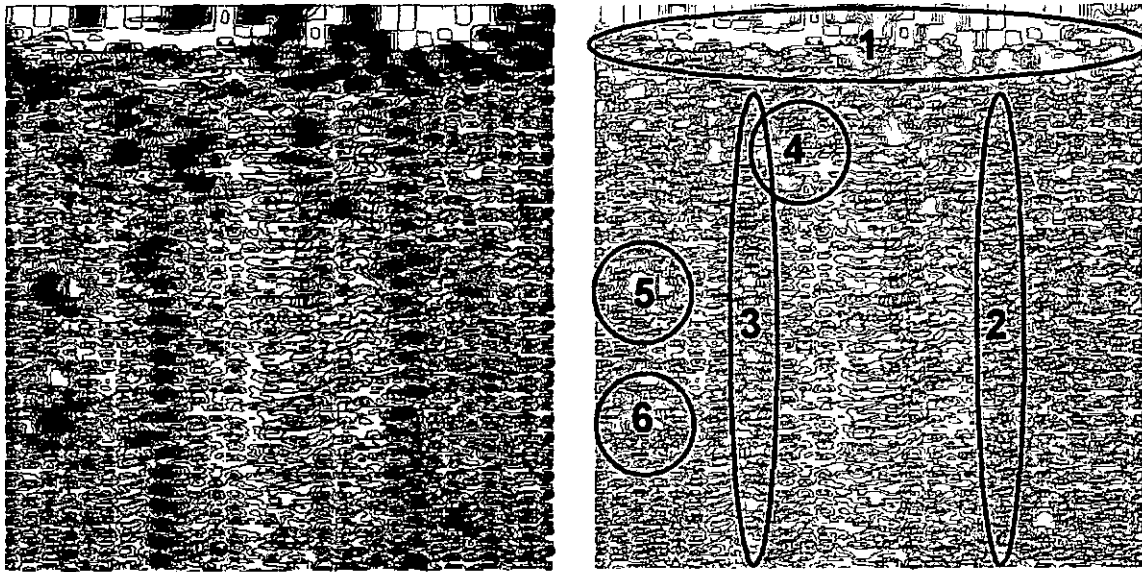
Composite Grid No. 5

Composite grid number 5 comprises one 30 x 30 m grid to the east of grid No. 4, and overlapping it by about 10%. (see Figure 14). The object of scanning the area of Grid 5 was to characterise the area at and surrounding the T-junction in the track providing the main HGV access to Boden's Farm (see Map, Figure 4). Examination of Grid 4 suggests that the outer ditch converges with the track at around this point. Thus, one specific question needed answering: where does the magnetic anomaly, interpreted as the outer ditch and visible as a continuous feature in Grids 3 and 4, go to beyond Grid 4? Does it: (a) continue within Field L, (b) move to the north and disappear under the field wall, (c) or disappear completely? Grid 5 was intended to elucidate this point.

Table 20. Field Data: Composite Grid No. 5

INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-1	ArcheoSurveyor
Date/Time	16-08-06	4 hours
Time start/end	12.30	16.30
Location	Boden South field	Field L
Coordinates - Nat Grid	Easting	Northing
GPS - baseline O	398615	388952
GPS - baseline A	398610	388982
Map coordinate: O	398613.3	388950.8
Map coordinate: A	398609.7	388980.5
Number/size of grids	1	30 m square
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	1.0 m	8 readings/m
Total area/distance	900 m ²	0.9 km
Weather	Sunny, warm, dry	
Operator/Associates	JPD	Brian

**Figure 21. Composite grid No. 5 (30 x 30 m, N to the TOP).
LEFT: magnetometry scan; RIGHT: principal items of interest**



1. Magnetic "washout" due to proximity of metal fence.
2. Linear anomaly, origin unknown
3. Linear anomaly, origin unknown
4. Anomaly, origin unknown
5. Anomaly, origin unknown
6. Anomaly, origin unknown

Overall – this grid shows a number of anomalies of unknown origin, However, there is NO indication of a continuation of the outer ditch seen clearly in Grids 3 and 4.

Composite Grids No. 6 and 7

The survey was extended to the field D (Boden Home Field) to see whether the magnetic anomaly associated with the outer ditch continued in an easterly direction in this field. A total of four, 30 x 30 m grids were surveyed in this field, and the results are presented in this and the following sections as composite grids No. 6 (30 x 30 m) and 7 (30 x 90 m).

Figure 22. Location of Composite Grids 6 & 7

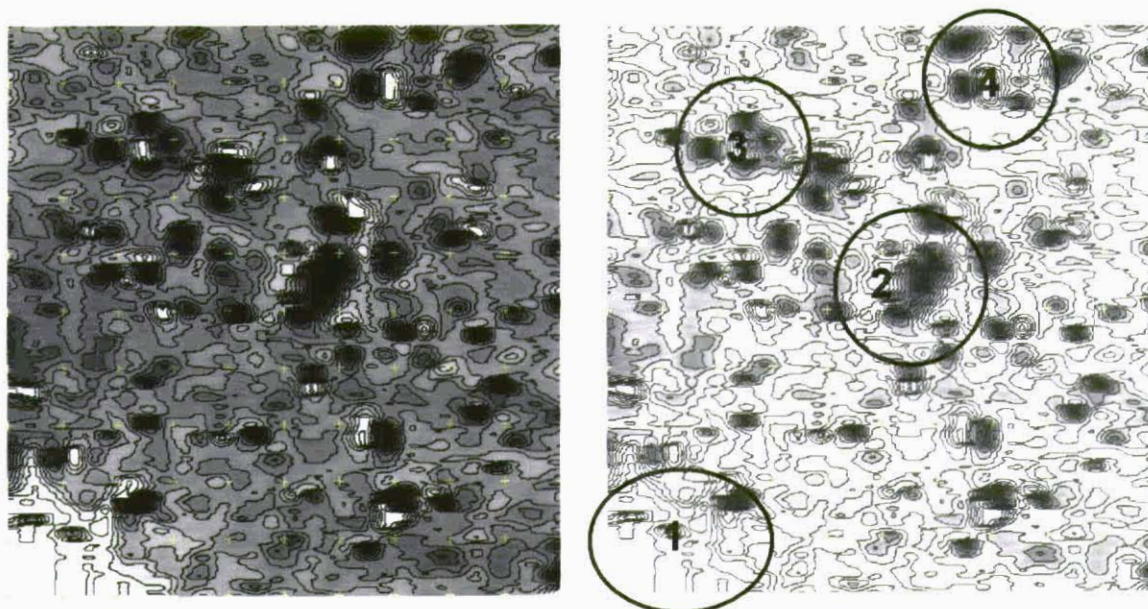
Acknowledgement: Google Earth (see p. 44)



Table 23. Field Data: Composite Grid No. 6

INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-1	ArcheoSurveyor
Date/Time	22-10-06	4 hours
Time start/end	10.30	14.30
Location	Boden Home Field	Field D
Coordinates - Nat Grid	Easting	Northing
GPS – baseline O	398636	388989
GPS – baseline A	398667	388994
Map coordinate: O	398628.0	388983.3
Map coordinate: A	398656.5	388992.1
Number/size of grids	1	30 m square
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	1.0 m	8 readings/m
Weather	Sunny, warm, dry	
Operator/Associates	JPD	none

**Figure 24. Composite grid No. 6 (30 x 30 m, N to the TOP).
LEFT: magnetometry scan; RIGHT: principal items of interest**



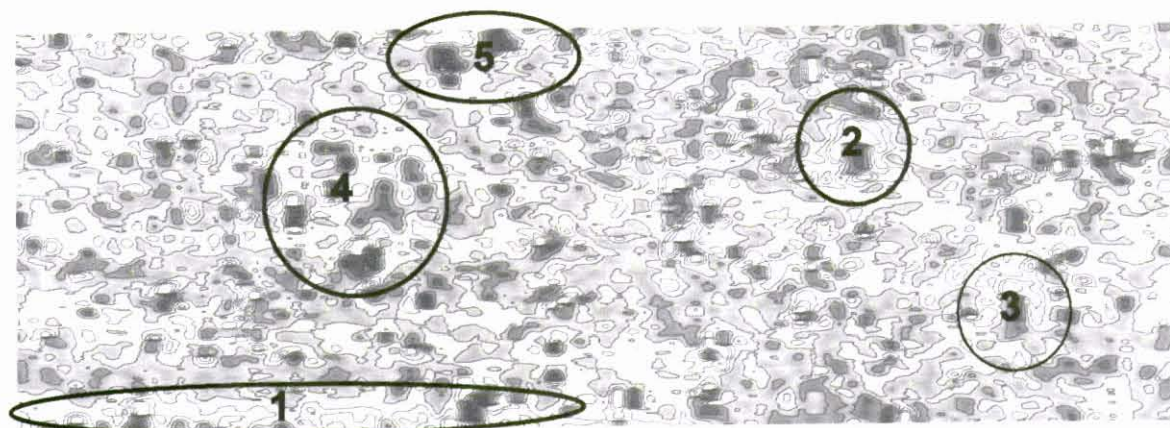
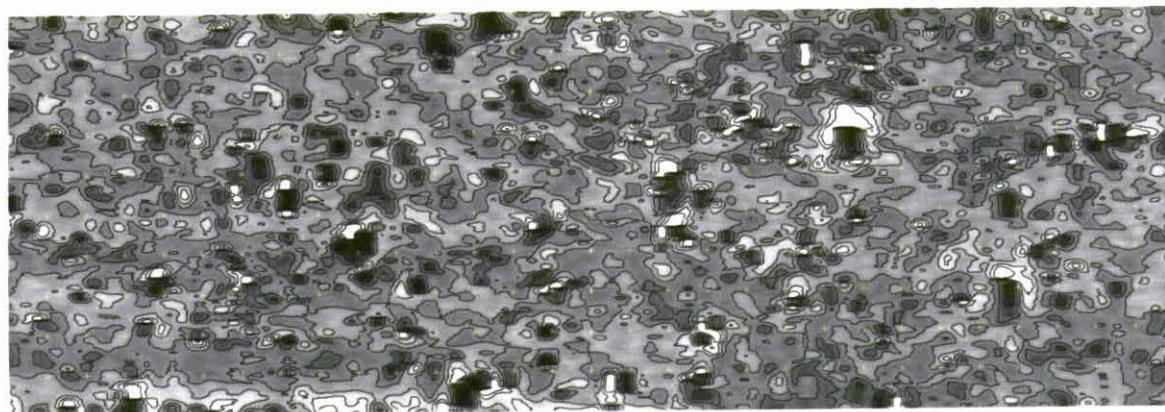
1. Magnetic "washout" due to proximity of metal fence.
2. Anomaly, origin unknown (possibly metal in ground)
3. Anomaly, origin unknown (possibly metal in ground)
4. Anomaly, origin unknown (possibly metal in ground)

Overall – this grid shows a number of anomalies of unknown origin, However, there is NO indication of a continuation of the outer ditch seen clearly in Grids 3 and 4.

Table 25. Field Data: Composite Grid No. 7

INFORMATION	DETAIL	NOTES
Date/Time	3-11-06	6 hours
Time start/end	10.30	16.30
Location	Boden Home Field	Field D
Coordinates - Nat Grid	Easting	Northing
GPS – baseline O	398655	388989
GPS – baseline A	398652	389018
Map coordinate: O	398656.5	388983.9
Map coordinate: A	398640.3	389013.1
Number/size of grids	3	30 x 90 m
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	1.0 m	8 readings/m
Weather/Operator	Sunny, warm, dry	JPD

**Figure 26. Composite grid No. 7 (30 x 90 m, N to the TOP, Markers 3m).
TOP: magnetometry scan; BOTTOM: principal items of interest**



1. Area influenced by proximity to metal fence
2. Possible metallic (iron) object in the ground
3. Possible metallic (iron) object in the ground
4. Circular anomaly of unknown origin
5. Magnetic anomaly of unknown origin

Overall. There is NO indication of a linear magnetic anomaly of the type generated by the outer ditch in e.g. composite grids 3 and 4. It appears that the outer ditch does NOT pass through this area.

Composite Grids No. 8 and 9

The ridge on which Mellor Church marks the westward end runs east for approximately 900 m, reaching its summit in field F (Boden Top-ridge Field: Figure 27). Beyond the wall at the east end of this field, the ground is relatively flat for about 10 m and then drops away rapidly. Grid 9 covers an area 60m square close to the east end of this field. Grid 8 covers a strip at the west end of this field, the intention being to intercept any ditch running up into the field from further to the west, and in particular to see whether the magnetic anomaly associated with the outer ditch could be detected entering this field. A total of six, 30 x 30 m grids were surveyed, and the results are presented in this and the following sections as composite grids No. 8 (30 x 60 m) and 9 (60 x 60 m).

Figure 27. Location of Composite Grids 8 & 9

Acknowledgement: Google Earth (see p. 44)



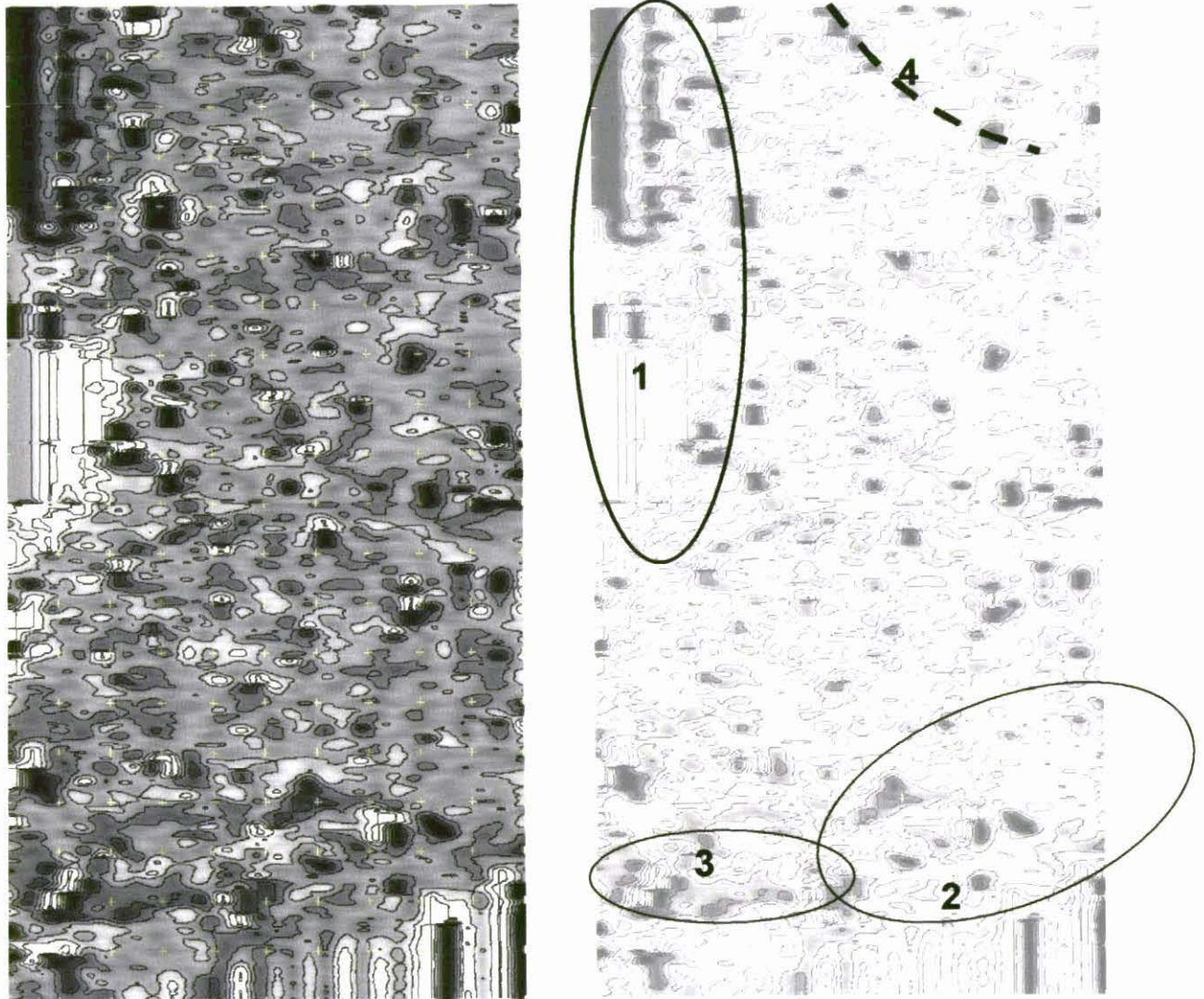
Table 28. Field Data: Composite Grid No. 8

Table 29. Field Data: Composite Grid No. 9

INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-1	ArcheoSurveyor
Date/Time	7-9-06	4 hours
Time start/end	10.30	14.30
Location	Boden Top Ridge Field	Field F
Coordinates - Nat Grid	Easting	Northing
GPS - baseline O	398882	389025
GPS - baseline A	398882	388995
Map coordinate: O	398880.5	388991.7
Map coordinate: A	398882.5	389021.7
Number/size of grids	2	30 x 60 m
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	1.0 m	8 readings/m
Weather	Sunny, warm, dry	
Operator/Associates	JPD	none

INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-1	ArcheoSurveyor
Date/Time	18-8-06	6 hours
Time start/end	10.30	16.30
Location	Boden Top Ridge Field	Field F
Coordinates - Nat Grid	Easting	Northing
GPS - baseline O	399043	389082
GPS - baseline A	398985	389099
Map coordinate: O	399043.0	389077.9
Map coordinate: A	398983.5	389087.3
Number/size of grids	4	60 x 60 m
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	1.0 m	8 readings/m
Weather	Sunny, warm, dry	
Operator/Associates	JPD	Brian Hargreaves

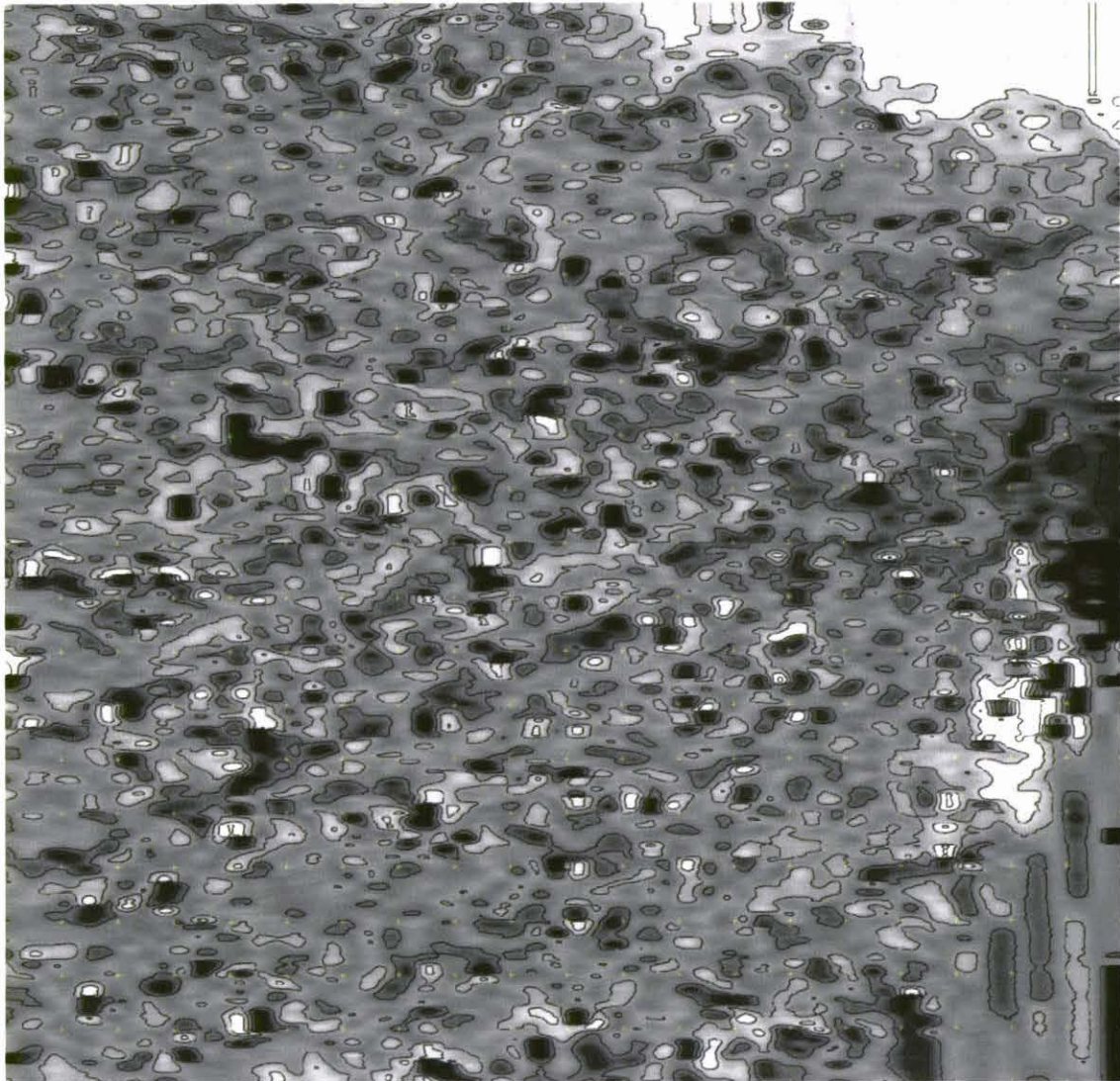
**Figure 30. Composite grid No. 8 (30 x 60 m, N to the TOP, Markers 3m).
LEFT: magnetometry scan; RIGHT: principal items of interest**



1. Magnetic "whiteout" due to proximity of a metal gate
2. Magnetic "whiteout" due to proximity of a metal fence
3. Magnetic anomaly of possible archaeological interest
4. Possible linear feature

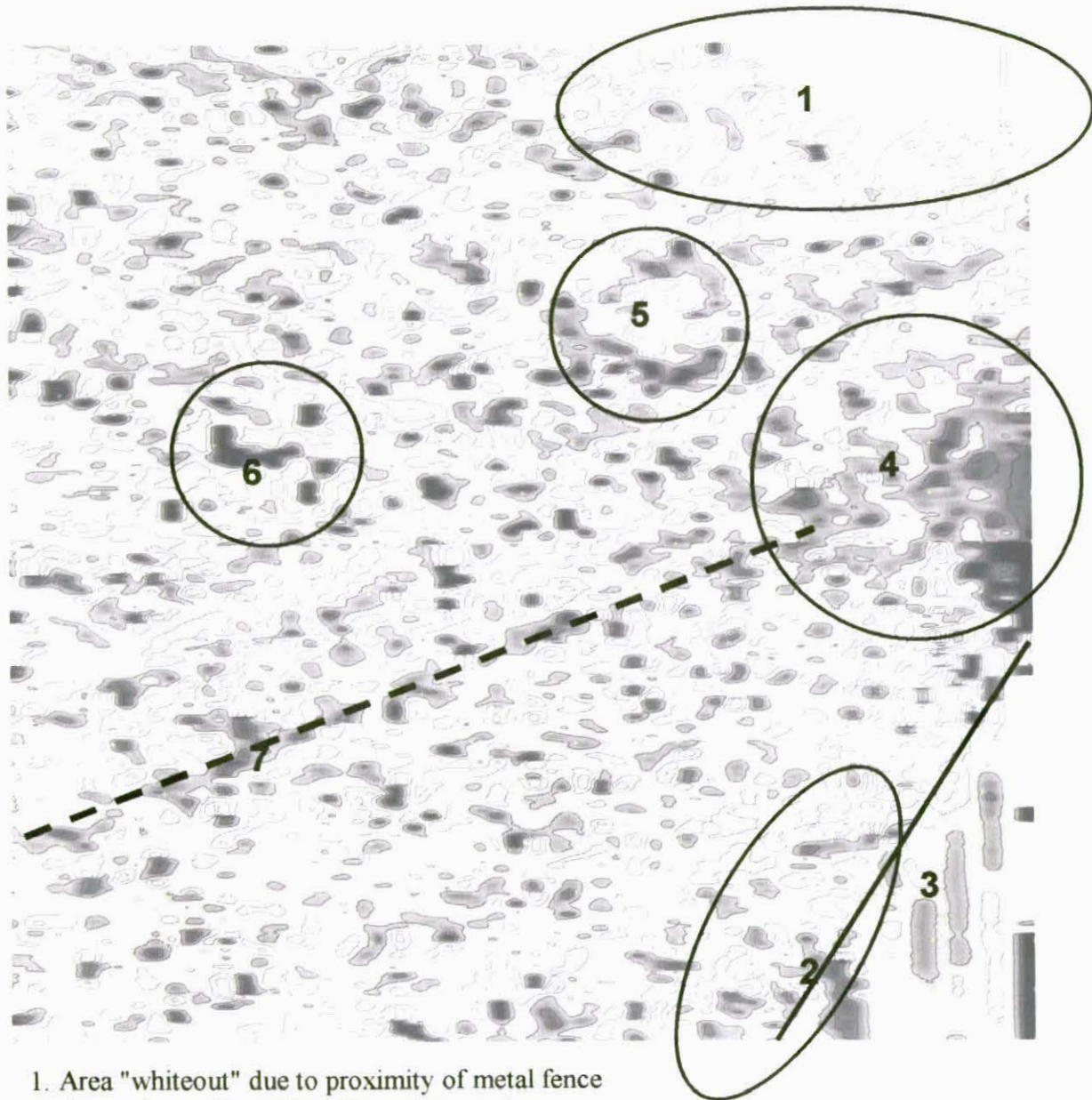
Overall. Not a particularly promising grid. There is no indication of the "outer ditch", although there are one or two features of unknown origin which could be of archaeological interest.

**Figure 31a. Composite grid No. 9 (60 x 60 m, N to the TOP, Markers 3m).
THIS PAGE: magnetometry scan; NEXT PAGE: principal items of interest**



Detailed analysis on the next page.

**Figure 31b. Composite grid No. 9 (60 x 60 m, N to the TOP).
THIS PAGE: principal items of interest; PREVIOUS PAGE: magnetometry scan**



1. Area "whiteout" due to proximity of metal fence
2. Approximate line of field boundary wall
3. Area outside field – not surveyed
4. Principal area of archaeological interest. Magnetic anomaly consistent with buried features of interest, previous diggings, etc.
5. Possible area of archaeological interest
6. Possible area of archaeological interest
7. Possible line of linear magnetic anomaly; possible ditch, drain or linear earthwork.

Overall. This is an area of considerable ambiguity and has possible archaeological interest. The area (4) to the east and at the crest of the hill is particularly interesting.

Composite Grid No. 10

This grid is sited in the "triangular field", Field G. This field was extremely difficult to survey, due to the presence of overhead power cables, a metal fence, a number of trees with metal fence surrounds, an ongoing excavation, etc. The results are of little value.

Figure 32. Location of Composite Grid 10

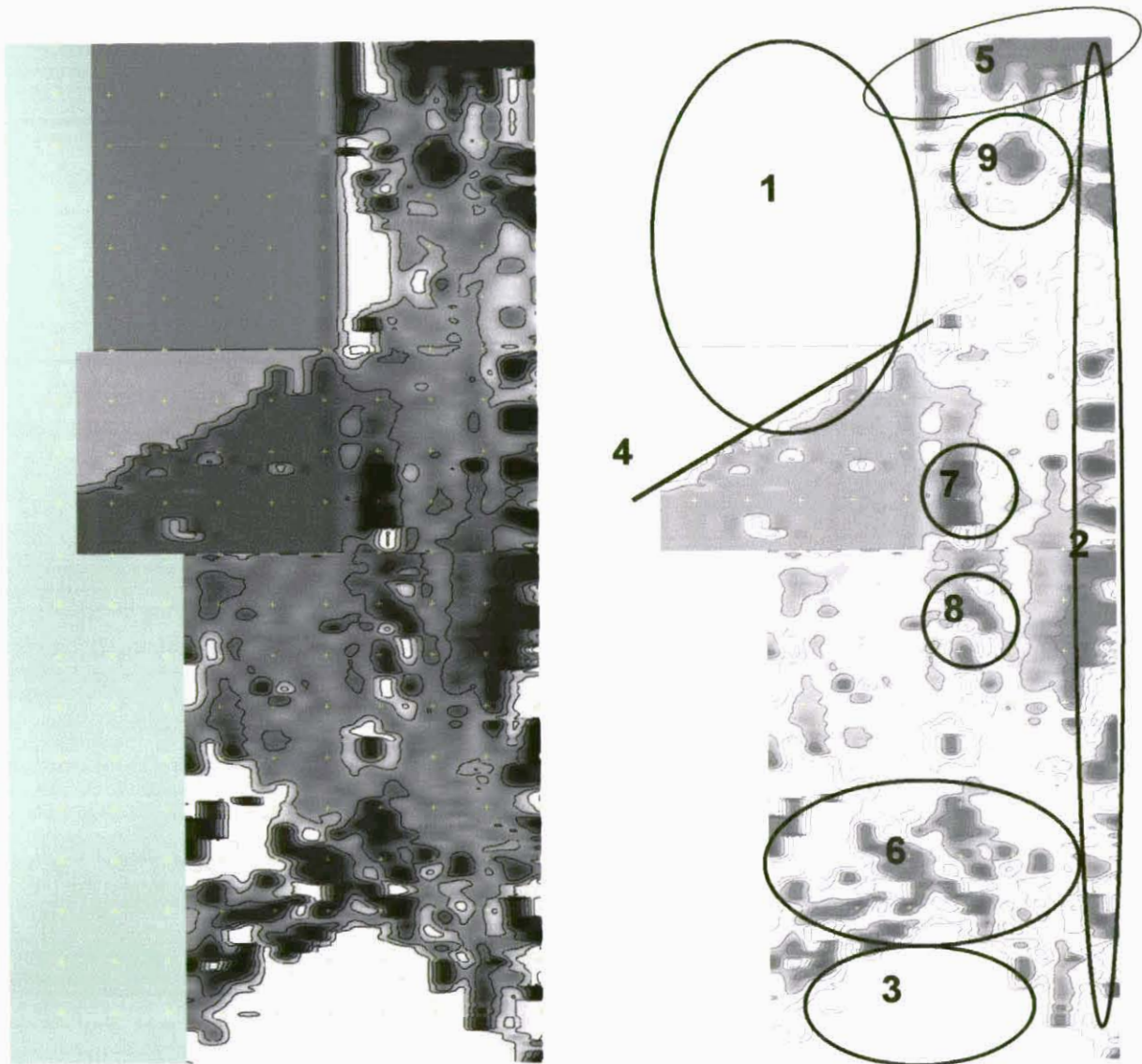
Acknowledgement: Google Maps (see p. 44)



Table 33. Field Data: Composite Grid No. 10

INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-1	ArcheoSurveyor
Date/Time	22-8-06	4 hours
Time start/end	10.30	16.30
Location	Triangular Field	Field G
Coordinates - Nat Grid	Easting	Northing
GPS – baseline O		
GPS – baseline A		
Map coordinate: O	398279.7	389009.0
Map coordinate: A	398279.5	388979.1
Number/size of grids	4	60 x 60 m
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	1.0 m	8 readings/m
Weather	Sunny, warm, dry	
Operator/Associates	JPD	Brian Hargreaves

**Figure 34. Composite grid No. 10: Triangular Field (30 x 60 m, N to the TOP).
LEFT: magnetometry scan; RIGHT: principal items of interest**



1. Area outside fence – not scanned
2. Strip underneath power cables and probably influenced by AC field
3. Wooded area behind fence – not scanned
4. Line of metal fence – area to south influenced by the fence
5. Region close to metal fence and gate – magnetic "whiteout"
6. Area of previous archaeological excavation – trench 26 & 36
7. Tree with metal surrounding fence
8. Tree with metal surrounding fence
9. Magnetic anomaly of possible archaeological significance

Overall. Too many interferences for these scans to be informative. The only unexplained anomaly, which could be archaeologically interesting, is region 9.

Composite Grid No. 11

This grid is sited in field B, Boden's NW Field. This grid was scanned on Sunday, 11 March 2007. Unfortunately, it transpired that permission to carry out geophysical surveys on the Boden's land had been withdrawn prior to carrying out this survey. Therefore, the data and results will not be disclosed until permission is given. The Map below records only the area surveyed.

Figure 35. Location of Composite Grid No.11

Acknowledgement: Google Earth (see p. 44)



Table 36. Field Data: Composite Grid No. 11

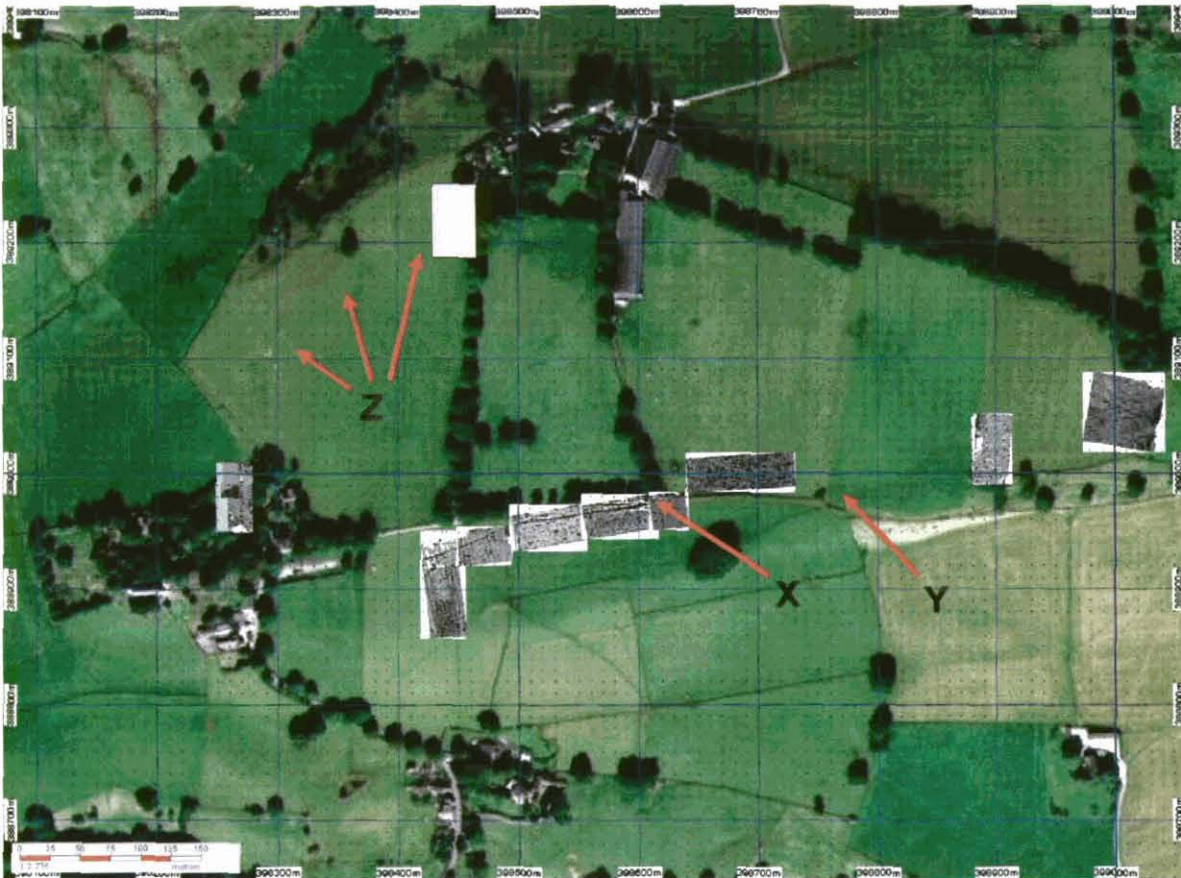
INFORMATION	DETAIL	NOTES
Instrument/Software	Bartington G-601-I	ArcheoSurveyor
Date/Time	11-3-07	4 hours
Time start/end	10.30	14.30
Location	Boden NW Field	Field B
Coordinates - Nat Grid	Easting	Northing
GPS - baseline O	398465	389248
GPS - baseline A	398434	389251
Map coordinate: O	398464.9	389247.9
Map coordinate: A	398434.1	389251.7
Number/size of grids	2	30 x 60 m
Scan mode/rate	Zig-zag	1 m/s
Spacing: transect/readings	1.0 m	8 readings/m
Weather	Sunny, warm, dry	
Operator/Associates	JPD	

SUMMARY

The primary purpose of these magnetometry surveys was to attempt to trace the path of the so-called "outer ditch", and in this respect the magnetometer results are very positive. In field K (Arrandale North Field), a linear magnetic anomaly corresponding to the path of the southern arm of the outer ditch (demonstrated by excavation, trenches 38 and 39) shows up very clearly. This anomaly continues into field L (Boden S Field – west end), and excavation of trench 50, in 2006, confirmed the position of the outer ditch as predicted by the magnetometry (see Figure 38).

Figure 37. Magnetometry Scans 2006 – Summary

Acknowledgement: Google Earth (see p. 44)



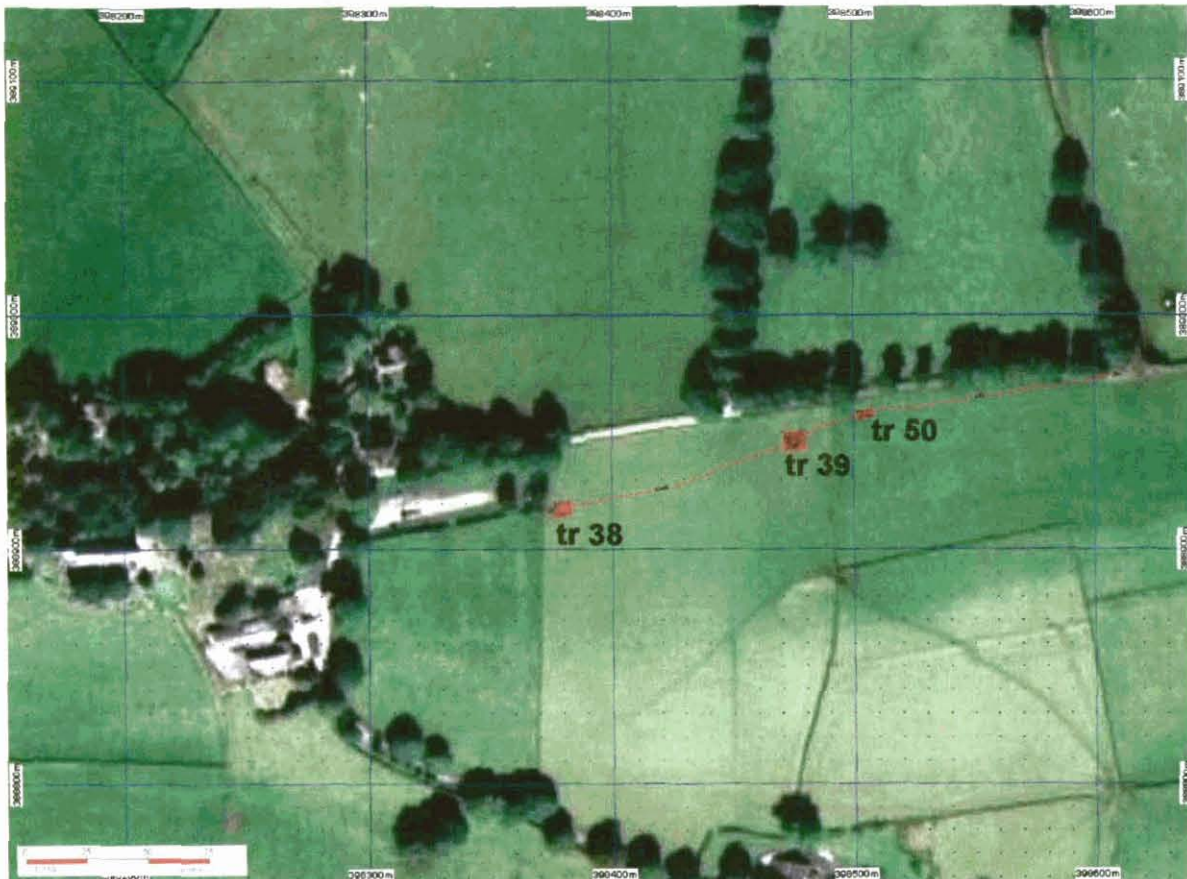
The trace of the outer ditch continues unambiguously for around 120 m eastwards in field L, converging with the track and meeting it at the T-junction at the SW corner of field D (point X in Figure 37). The track to this point, and the extension to the north, along the west side of field D, forms the main entry for Heavy Goods Vehicles to Boden's Farm. The track has been reinforced with considerable quantities of hard-core material (including clinker), and the track itself shows up as a magnetic anomaly. Thus, at the T-junction, where the traces for the outer ditch and the farm track meet, there is considerable ambiguity as to the direction in which the outer ditch continues. Indeed, all surveys carried out to the east of this point, in field D, fail to locate any continuation of the ditch. There appear to be two possibilities: either the outer ditch stops at this point, or the ditch may continue, but under the stone wall separating field D from field M (Boden South Field – east end). Because the stone wall is topped by an iron fence, it

is not possible to carry out magnetometry close to this wall. However, the wall stops around 150 m to the east, at the boundary of field E, and it is proposed to carry out further surveys in this area (i.e around point Y, Figure 37) in an attempt to re-locate the outer ditch.

Figure 38. Outer Ditch and Trench 50

Figure shows the location of the southern branch of the Outer Ditch, determined by magnetometry, and the locating trench (50) opened in August 2006.

Acknowledgement: Google Earth (see p. 44)



Surveys further to the east, in field F, do not locate a linear feature similar to that previously identified as the outer ditch, and it seems unlikely that the ditch enters this field. However, magnetometry at the top of the ridge (in field F) shows a number of features which could be of archaeological interest, and it is suggested that consideration be given to excavation in this area.

The other magnetometry surveys are largely disappointing, as no definite and unambiguous features have been detected. However, there are numerous small anomalies, which may be anything from pieces of buried metal (e.g. lengths of barbed wire), to items of archaeological interest. It would be interesting, but probably unproductive, to excavate some of these sites.

The path of the northern arm of the outer ditch has not been much examined by magnetometry. Excavation (October, 2005), identified the outer ditch at the west end of field B (Boden NW Field), close to the "Ale House Track", and also at a point within field B some 80 m to the north-east. Surveys in 2005, using Ground Penetrating Radar, suggested that the

outer ditch might run across field B to emerge somewhere near the gate at the NE corner, but an excavation in this area (March 2006) failed to locate the ditch. A trial survey, using magnetometry, was carried out (March 2007) at the north-east corner of field B, but for reasons explained in the text, the results of this survey cannot be revealed at present. However, it is clear that more comprehensive magnetometry surveys in field B (around points Z), and subsequently field C (Boden Hall Road Field) are needed to identify the path (if any) of the northern arm of the outer ditch.

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Previous survey reports:

1. **Gregory, 2000.** *Geophysical Investigation at the Old Vicarage, Mellor: a Report to the Mellor Archaeological Trust.* R.A. Gregory, Paleoecological Research Unit (PERU), School of Geography, University of Manchester; September, 2000.
2. **Gregory, 2001.** *Geophysical Investigation at the Old Vicarage, Mellor: a Report to the Mellor Archaeological Trust.* R.A. Gregory, October, 2001.
3. **Testconsult, 2001.** *Mellor Hill Fort, Test Report prepared for the Mellor Archaeological Trust.* Report Number S2207, Testconsult Ltd., 11 Trinity Court Rd., Risley, Warrington, Cheshire WA3 6QT, Job number A3546, December 2001.
4. **GeoQuest Associates, 2002.** *Geophysocal Survey of Three Areas at Mellor, Stockport, 2002.* A programme of research carried out on behalf of the Mellor Archaeological Trust by Geoquest Associates, 2002.
5. **Beale and Grimsditch, 2003.** *Mellor Iron Age Hill Fort: a Geophysical Survey Report.* Deborah Beale and Brian Grimsditch, University of Manchester Archaeology Unit (UMAU), July, 2003.
6. **Day, 2006.** *Ground Penetrating Radar at the Mellor Hilltop Site: Interim Summary Report on Surveys during 2005.* Philip Day, University of Manchester, February, 2006.
7. **Day, 2007a.** *A Survey of the Floor of Mellor Church using Ground Penetrating Radar. A Report to the Mellor Archaeological Trust.* Philip Day, Mellor Geophysics, February, 2007.
8. **Day, 2007b.** *Magnetometry Survey at Shaw Cairn and Resistivity Survey at Cow Hey Farm. Report to the Mellor Archaeological Trust.* Philip Day, Mellor Geophysics, March, 2007.

Instrumentation.

1. **Ground Penetrating Radar.** Equipment from Mala Geosciences AB (main office), Skolgatan 11, S-930 70 Malå, Sweden (<http://ramac.malags.com/>).
2. **Magnetometry,** equipment from Bartington Instruments, 5 & 10 Thorney Leys Business Park, Witney, Oxford OX28 4GE, England (<http://www.bartington.com/>).
3. **GPR Software, ReflexW v4.2,** from: Sandmeir Software, Zipser Strasse 1, D-76227 Karlsruhe, Germany (www.sandmeier-geo.de).

4. **Magnetometry software**, ArcheoSurveyor v2.1.3.3, from: DW Consulting, Boekweitakker 28, 3773 BX Barneveld, The Netherlands (<http://www.dwconsulting.nl/>).
 5. **Mapping Software**, Map Maker v3.5, from: Map Maker Ltd, The Pier, Carradale, Kintyre, Argyll, Scotland PA28 6SQ (<http://www.mapmaker.com/>).
 6. **Conversion software**, Latitude-longitude to National Grid, provided by the Ordnance Survey: <http://gps.ordnancesurvey.co.uk/convert.asp>
-

ACKNOWLEDGEMENTS

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