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Ancient Monuments Laboratory
Report 53/95

REPORT ON GEOPHYSICAL SURVEY, 1995
PARK FARM, SNETTISHAM, NORFOLK

P Linford

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Summary

A geophysical survey on the site of the Roman villa at Park Farm near Snettisham, Norfolk, was requested by the landowner Mr E. Stanton, to improve the understanding of remains uncovered there during 1971-2. Although ground conditions made it impossible to detect traces of the villa building itself, evidence was found for possible associated activity. This included several putative defensive ditches and a number of anomalies almost certainly associated with iron working. A limited survey was also carried out at a second and unrelated site on the farm, thought to be the location of a medieval chapel. Results at this site were less clear but a possible wall footing was detected.

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Report on geophysical survey, 1995

Introduction

A tree clearance and replanting programme at Park Farm, Snettisham was undertaken in the winter of 1971-2. During the course of this work traces of a Roman building of some importance were uncovered when a bank was cut back. The site of the discovery (TF 689 336) is about 100 metres west of an area which has yielded occasional Roman building material, and lies on or near the crest of a hill that slopes gently down to the River Ingol. The remains are recorded in the Norfolk County Sites and Monuments Record as Snettisham Roman villa, monument number 330. The Ancient Monuments Laboratory survey described herein was in response to a request to English Heritage from the owner of Park Farm, Mr E. Stanton, for geophysical prospecting in the area around the remains to help improve the interpretation of the site.

Further geophysical survey was requested for a second, unrelated, area on the farm where the medieval remains of St. Thomas's chapel and a water mill were thought to be situated. This area is in a field which slopes down to the River Ingol to the south. An earthwork ditch and bank can be seen here, and the remains of a buried wall are also visible on the same alignment, where it is exposed in the bank of a small pond. Owing to unfavourable conditions, described below, only a limited amount of survey work was possible at this second site.

The remains of the Roman villa are marked on the 1:50,000 Series Geological Survey map of King's Lynn and the Wash (sheet 145, date 1978), as lying on a Cretaceous carstone outcrop at the top of the hill mentioned above. The field to the east (field number 1062), where Roman building material has occasionally been found, also lies on the carstone which might be expected to produce a soil with a high magnetic mineral content. However, in the field to the west (field number 8150), which lies on the slope down to the River Ingol, Snettisham Clay outcrops from beneath the carstone. The geological map also notes that landslip has occurred across the entirety of this western field hence the nature of the immediate underlying geology is uncertain.

The site of the chapel (field number 3200) is on the interface between the outcropping of carstone and the Snettisham Clay which underlies it. It is likely that most of this field lies on the latter substrate.

Method

An area of approximately 3 hectares was marked out for geophysical survey around the site of the Roman villa, 2 hectares in the field to the east of the excavated remains (1062) and 1 hectare in the field to the west (8150). This area, shown in plan A.1 overlaid on the relevant portion of the Ordnance Survey 1:2500 map, was divided up into a grid of 30 metre squares, located by measurement to the field boundaries. A magnetometer survey was conducted over the entire grid using the standard method outlined in note 2 of Annex 1. In addition, earth resistance survey was carried out over about 1 hectare around the villa using the technique outlined in Annex 1, note 1, and indicated by the shaded squares on plan A.1.

A limited earth resistance survey was also conducted in the field thought to contain the remains of St. Thomas's chapel (3200). Two 30 metres squares were surveyed, positioned so that they covered the features described in the introduction. These squares are shown in plan A.2 located on the relevant portion of the Ordnance Survey 1:2500 map. The boundaries of this field have been altered since the area was last mapped, hence offsets from the surveyed area are depicted to points on the boundary that have not changed.

Results

1) The magnetometer survey of the Roman villa site

The results of the magnetometer survey around the Roman villa are shown in a stacked trace plot at 1:1000 scale in Plan B; the only correction applied to the raw measured values was to remove 'striping' between adjacent traverses. In this plan the orientation has been changed so that the horizontal traces run along the traverses walked in the field, thus it should be noted that north is to the left rather than at the top. Plan C shows the same data, after some processing, plotted as a linear greyscale. The entire dataset has been filtered with a thresholded median filter to remove surface iron 'spikes'. The data from the eastern field (1062) has been further processed with a fourier domain directional cosine filter, to remove a distracting periodic striping effect caused by ploughing of the field in the recent past. Some striping is still visible in plan C from ploughing in other directions but this does not seriously impair the interpretation of other anomalies in the plot. It is interesting that this problem only occurs in the data from the eastern field, although both fields have been ploughed in the past, and it is tempting to speculate that the difference in underlying geologies is responsible.

Plan E shows a composite interpretation plot of the features of interest identified in the magnetometer survey, incorporating some information from the resistivity survey discussed below. In the text that follows, numbers in bold refer to the anomalies labelled on plan E.

1a) The western field (number 8150)

One of the most noticeable features in the trace plot (plan B) is the large amount of magnetic disturbance in north-east corner of the western field, over the bank where the Roman building remains were uncovered. This is marked as the cross-hatched area of disturbed ground in plan E. It was observed while carrying out the survey that this bank had been considerably relandscaped and that chicken wire had been buried in it, to protect the saplings that used to grow there from attack by rabbits. Being both ferrous and highly conductive this wire has corrupted the results of both the magnetometer and resistance surveys and no geophysical information about remains in the bank could be obtained. Also clear from its response in the trace plot is a modern pipeline. This is shown in plan E as a thick, dashed black line.

Further interpretation of the geophysical survey results from this field should be covered by the *caveat* that the geological map indicates that landslip has occurred over this area. This might explain the somewhat confusing appearance of the magnetometer survey, and may even be responsible for some of the anomalies identified in the discussion below.

At the northern end of the field an area of magnetic disturbance can be discerned in the greyscale plot (plan C) which, given its amorphous form, may be geomorphological in origin. This area is indicated in plan E with a triangular stipple and labelled **1**. The northern field boundary abuts an unmade road known as Water Lane which runs down hill in a westerly direction. The area of disturbance appears to join then run along the line of the northern field boundary and it might thus be conjectured that it marks the location of a former water course, although no topographical evidence of a depression was visible to support this assertion.

The most noticeable linear feature in the field is labelled **2** in plan E. It runs in a very approximate 90 degree arc with two distinct kinks, around the contour of the slope. The centre of the arc is roughly at the point where the villa building remains are located. The anomaly appears to consist of both a positive (white in plan C) magnetic linear anomaly and a parallel negative (black) one on the down-slope side. It is possible that this anomaly represents a ditch feature either a lynchet or possibly a defensive ditch contemporary with the Roman villa. Consideration should also be given to the possibility that this feature might denote the interface between the carstone and the Snettisham Clay, the different magnetic properties of each producing a discontinuity in the local magnetic field at the point where they meet. Unfortunately, it is not possible to determine to the necessary precision where in the field this interface should lie using the geological information available, so this suggestion can not be confirmed.

A number of less distinct linear anomalies may also be discerned in the magnetometer plot of the west field. The strongest of these are at the south end of the survey area where a negative magnetic linear anomaly, flanked on either side by narrower positive linear anomalies, can be seen running east-west. It is possible that this feature bifurcates at its eastern end but the geophysical response is not clear. This feature is represented in plan E, labelled **3**. One interpretation for this anomaly is as a previous road or trackway, the positive anomalies representing infilled ditches on either side.

Finally, a number of more subtle linear anomalies can be seen, the most significant of which are shown in light grey in plan E. They form a confusing pattern and it is difficult to interpret them. It is possible that at least some represent enclosures associated with the villa and the one forming a right angle in the south-west corner of the survey may represent part of a previous field boundary. A potential hearth or furnace is also indicated which is surrounded by an area of slightly stronger magnetic activity.

1b) The eastern field (number 1062)

Focusing attention on the field to the east, the most striking features visible in the greyscale plot are the three linear positive magnetic anomalies running parallel in a north-south direction and separated from each other by about 7 metres. These anomalies are labelled **4a** in the interpretation plan. A second pair of very similar anomalies are also apparent running east-west crossing the first set (**4b**). These anomalies are almost certainly caused by infilled ditches and it is possible that they represent old field boundaries or trackways. However, it is not clear why field boundaries should be cut 7 metres apart or, if they represent successive recuts, why the boundary should have been displaced by this distance. David Gurney of Norfolk Landscape Archaeology has provided a more plausible explanation (*pers. comm.*), noting that they resemble both the early defensive ditches observed outside Caistor Roman town and the double ditches around Fring Roman villa, both observed in cropmarks. Assuming this latter interpretation, it is interesting that the two sets of ditches, **4a** and **4b**, do not respect each other, suggesting two separate phases to the defences.

A number of other linear positive magnetic anomalies are also visible. These have been indicated in light grey on the interpretation plan and are likely to represent previous field boundaries. Indeed, the particularly strong one at the north end of the survey area, **5**, coincides with the position of a field boundary that was in existence until recently, the line of which is still visible as a vegetation change on the surface.

It is clear from the trace plot of the magnetometer survey that magnetic noise is very strong in the area immediately to the south of **5**. The precise area of this increased noise is marked with a stippled shading in the interpretation plan. Three discrete strong positive magnetic anomalies that have magnetic signatures characteristic of hearths or furnaces are visible near the centre of this area and are indicated on the interpretation plan. Pieces of iron slag were visible on the surface in this part of the field and it is thus not unreasonable to conclude that iron working took place here. Slag samples taken back to the laboratory were identified as being smithing slag (D. Starley *pers. comm.*). Ferrous hammer scale from this process would become mixed with the surrounding soil, explaining the increased magnetic noise in the area. Furthermore, the magnitude of the magnetic response from some of the linear ditch features (**4a**, **5**, **6**) increases in the vicinity, suggesting that they are filled with this material. This may indicate that these ditches were open during the same period as the iron working activity. However, it is also possible that, more recently, large pieces of slag were deliberately moved to the side of the field to facilitate ploughing, explaining perhaps why feature **5**, which still existed during this century, exhibits such a strong response.

Also marked on the interpretation plan in this area is a winding linear anomaly that may represent another trackway similar to **3** in the western field. Additionally, in other parts of the field, anomalies similar in character to the hearth/furnace features described above are indicated. However, it is conceivable that a large buried piece of iron slag might exhibit this response, so the interpretation is not certain.

Finally, at the south end of the survey area in the eastern field a number of indistinct linear anomalies can be discerned. These are shown on the interpretation plan in the area labelled **7**. Whilst their explanation is unclear, it is possible that they represent foundation or enclosure trenches perhaps associated in some way with the Roman villa.

2) The resistivity survey of the Roman villa site

Plan D.1 depicts a stacked trace plot of the unprocessed resistivity survey data from around the villa site. This survey was greatly hampered by the extremely dry summer and, as is immediately evident from the trace plot, the data was corrupted by a high degree of measurement error due to high contact resistance. For this reason it was smoothed with a 3 by 3 median filter to produce the greyscale image depicted in D.2. The greyscale used in D.2 has been assigned by applying the equal area scheme to the datasets from each field separately; this was to compress the overall dynamic range as the mean resistance value from the east field was much higher than that from the western field.

It is clear from the trace plot, D.1, that measurement noise is particularly bad in the area of the bank in which the Roman remains were uncovered, due to both high contact resistance and large pieces of buried chicken wire producing spurious anomalies. Thus, little can be said about this area. Furthermore, whilst it was hoped that wall footings might extend underneath the farm track into the east field, the two grids surveyed there contain no traces of any such anomalies. Thus only the western field (8150) features in the discussion below.

2a) The western field (number 8150)

The most striking feature is the boundary between the high resistance (white) area, which covers most of the survey area, and the low resistance (black) area at the western edge of the plot. This boundary exactly follows the line of the arc-shaped linear anomaly identified in the magnetometer survey and labelled **2** on the interpretation plan. This lends weight to the conjecture that the anomaly represents the boundary between the outcroppings of carstone and the Snettisham Clay, the former being better drained and thus less conductive. The lobed shape would also be consistent with its interpretation as representing an area of landslip. However, an archaeological explanation might also be feasible, the high resistance area representing terracing of the slope behind a defensive ditch and bank at **2**.

Two distinct oval shaped areas of low resistance are also visible within the high resistance area of D.2 and these are shown on the interpretation plan. It is possible that these mark the location of undocumented excavations known to have occurred in this area in the past. Finally, two possible high resistance linear anomalies are visible on D.2 and are indicated on the location plan, labelled **8**. Given the high degree measurement error in this dataset it is impossible to come to a firm conclusion about these; however, if feature **2** is a defensive ditch, these might perhaps represent an entrance.

3) The resistivity survey of the chapel site

Owing to the problems with contact resistance discussed above, resistivity surveying was greatly slowed and it was only possible to survey two 30 metre squares at the site of St. Thomas's chapel. The data from this survey is depicted in plan F, where F.1 depicts trace plot of the unprocessed data and F.2 shows a greyscale plot of the same data filtered and plotted in exactly the same way as the villa site resistivity survey described above.

Immediately apparent in the greyscale plot F.2 is the low resistance (black) linear anomaly caused by a stream bed running north-south through the centre of the survey area. The farm track in this field is also visible as a narrower, arcing linear anomaly in square 37 (see A.2), entering at its southern edge. The buried wall, visible in section in the bank of the pond, is represented by a narrow linear high resistance anomaly running east-west along the northern edge of square 37. About 10 metres to the south, a second high resistance linear anomaly can be discerned in F.2 running parallel to the former. It separates an area of relatively high resistance lying between these two anomalies from the area of low resistance to the south. It is thus tempting to suggest that this anomaly represents a second wall footing related to the visible one and defining part of a building about 10 metres wide. However, no evidence is visible for any cross walls linking the two east-west running features, so this interpretation is uncertain.

The eastern part of square 38 has been badly affected by the high contact resistance problems mentioned above. The only anomalies apparent in this square are at the northern end, where a linear high resistance feature marks the position of the earthwork bank and north of this the low resistance area corresponds with the extant ditch.

Conclusion

Geophysical survey at the site of Snettisham Roman villa has revealed a complex system of features of both archaeological and geomorphological origin. Unfortunately, it was not possible to detect remains of the villa itself as the bank where Roman remains have been uncovered has been relandscaped and has chicken wire buried in it, rendering it unsatisfactory for both electrical and magnetic prospecting. It is also likely that the remains continue under the farm track that separates the two surveyed fields. This was flanked by steel fences rendering magnetic prospecting impossible and at the time of the survey the ground was too badly dried and compacted for electrical prospecting.

It is difficult to place some of the features identified in context and to some extent the geophysical survey poses more questions than it answers. There is evidence in the field to the east of the villa remains for two sets of possible defensive ditches (**4a** and **4b**), although their relationship to each other is unclear as one set appears to be cut through the other. A more extensive magnetic survey, covering the rest of this field and parts of surrounding area, would help to clarify this by finding the ends of the ditches and any other related ditches not extending into the present survey area.

Extensive evidence for iron smithing has also been found in the north-western corner of the survey area in this field and at the southern end other anomalies have been detected that may be associated with villa buildings (**7**). Whilst a more extensive resistivity survey under more conducive conditions might elucidate more about the latter, it is likely that only trial excavation could significantly add to the interpretation of these features.

In the field west of the location where the Roman remains were uncovered, geophysical survey is complicated by the change in geological conditions. The most interesting feature here is an arcing linear anomaly (**2**) that might either represent a defensive ditch, the interface between the carstone and the Snettisham Clay, or the edge of the area covered by landslip. A trial trench dug across this, perhaps also covering the putative road feature (**3**), would greatly enhance the interpretation of the geophysical results.

Finally, at the site of St Thomas's chapel a limited resistivity survey has very tentatively detected a possible second wall running parallel to that observed in section in the bank of the pond. This suggestion confirms that a building may have existed here but, without more complete evidence for its plan, it is not possible to estimate its function or date. Possibly, a more extensive resistivity survey, under less dry conditions, could improve the understanding of remains in this area.

Surveyed by: M Cole
P Linford

Date of survey: 25-28/7/95

Reported by: P Linford

Date of report: 12/10/95

Archaeometry Branch,
Ancient Monuments Laboratory,
English Heritage.

List of enclosed plans:

Plan A	*Location plan of survey grid squares and relocation details (1:2500).*
Plan B	*Trace plot of unprocessed magnetometer survey data from the Roman villa site (1:1000).*
Plan C	*Greyscale plot of processed magnetometer survey data from the Roman villa site (1:1000).*
Plan D	*Trace and greyscale plots of resistivity survey data from the Roman villa site (1:1000).*
Plan E	*Interpretation plan showing significant anomalies detected at the Roman villa site (1:1000).*
Plan F	*Trace and greyscale plots of resistivity survey data from the site of St. Thomas's chapel (1:1000).*

Annex 1: Notes on standard procedures

1) **Resistivity Survey:** Each 30 metre square is surveyed by making repeated parallel traverses across it, all aligned parallel to one pair of the square's edges, 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 square edge. Readings are taken along each traverse at 1 metre intervals, the first and last readings being 0.5 metres from the nearest square edge.

   Unless otherwise stated the measurements are made with a Geoscan RM15 earth resistance meter incorporating a built-in data logger, using the twin electrode configuration with a 0.5 metre mobile electrode separation. As it is usually only relative changes in resistivity that are of interest in archaeological prospecting, no attempt is made to correct these measurements for the geometry of the twin electrode array to produce an estimate of the true apparent resistivity. Thus, the readings presented in plots will be the actual values of earth resistance recorded by the meter, measured in Ohms (Ω). Where correction to apparent resistivity has been made, for comparison with other electrical prospecting techniques, the results are quoted in the units of apparent resistivity, Ohm-m (Ωm).

   Measurements are recorded digitally by the RM15 meter and subsequently transferred to a portable laptop computer for permanent storage and preliminary processing. Additional processing is performed on return to the Ancient Monuments Laboratory using desktop workstations.

2) **Magnetometer Survey:** Each 30 metre square is surveyed by making repeated parallel traverses across it, all parallel to that pair of square edges most closely aligned with the direction of magnetic North. Each traverse is separated by a distance of 1 metre from the last; the first and last traverses being 0.5 metre from the nearest parallel square edge. Readings are taken along each traverse at 0.25 metre intervals, the first and last readings being 0.125 metre from the nearest square edge.

   These traverses are walked in so called 'zig-zag' fashion, in which the direction of travel alternates between adjacent traverses to maximise survey speed. However, the magnetometer is always kept facing in the same direction, regardless of the direction of travel, to minimise heading error.

   Unless otherwise stated the measurements are made with a Geoscan FM36 fluxgate gradiometer which incorporates two vertically aligned fluxgates, one situated 0.5 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 Ancient Monuments Laboratory 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.

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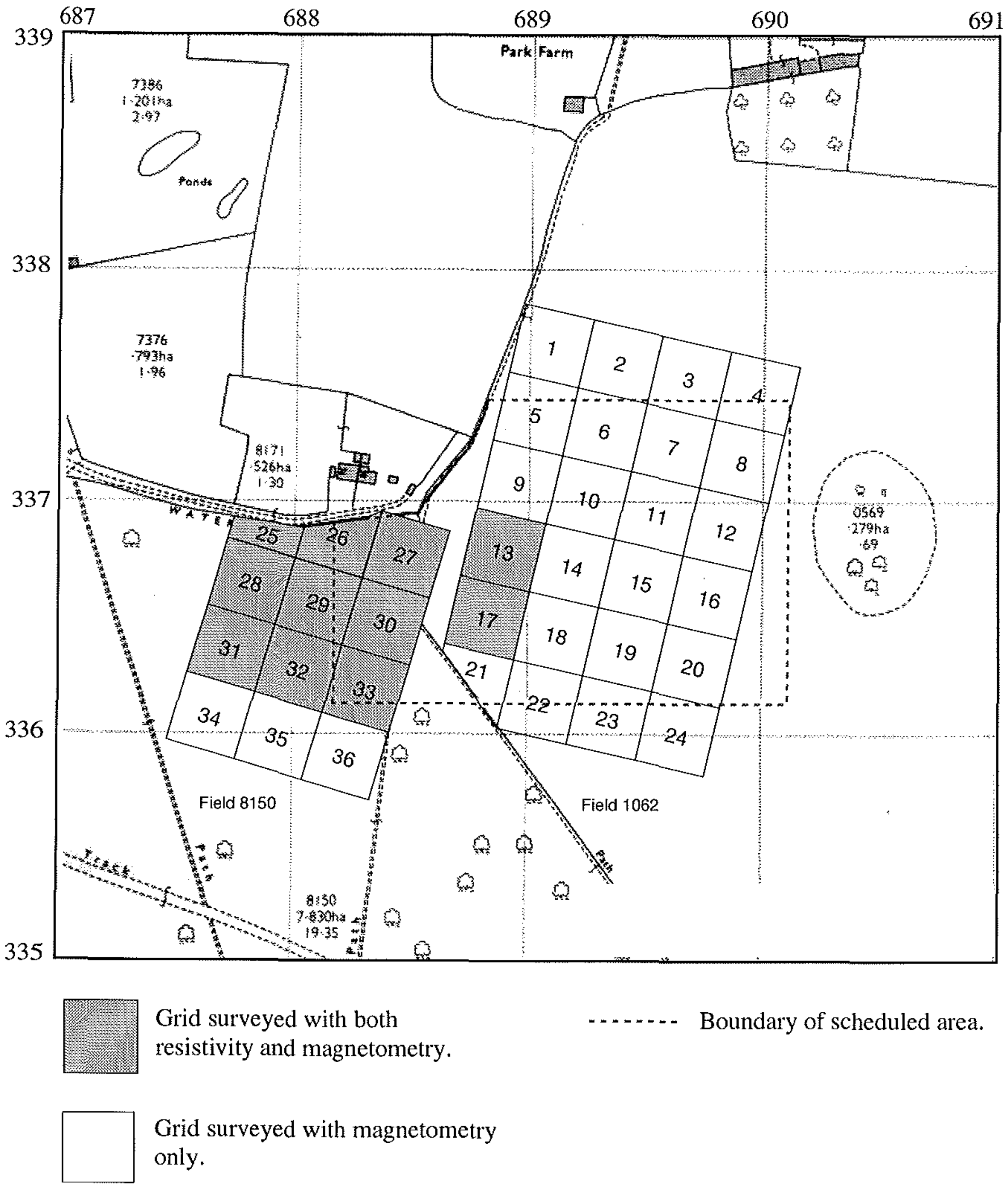
PLAN A

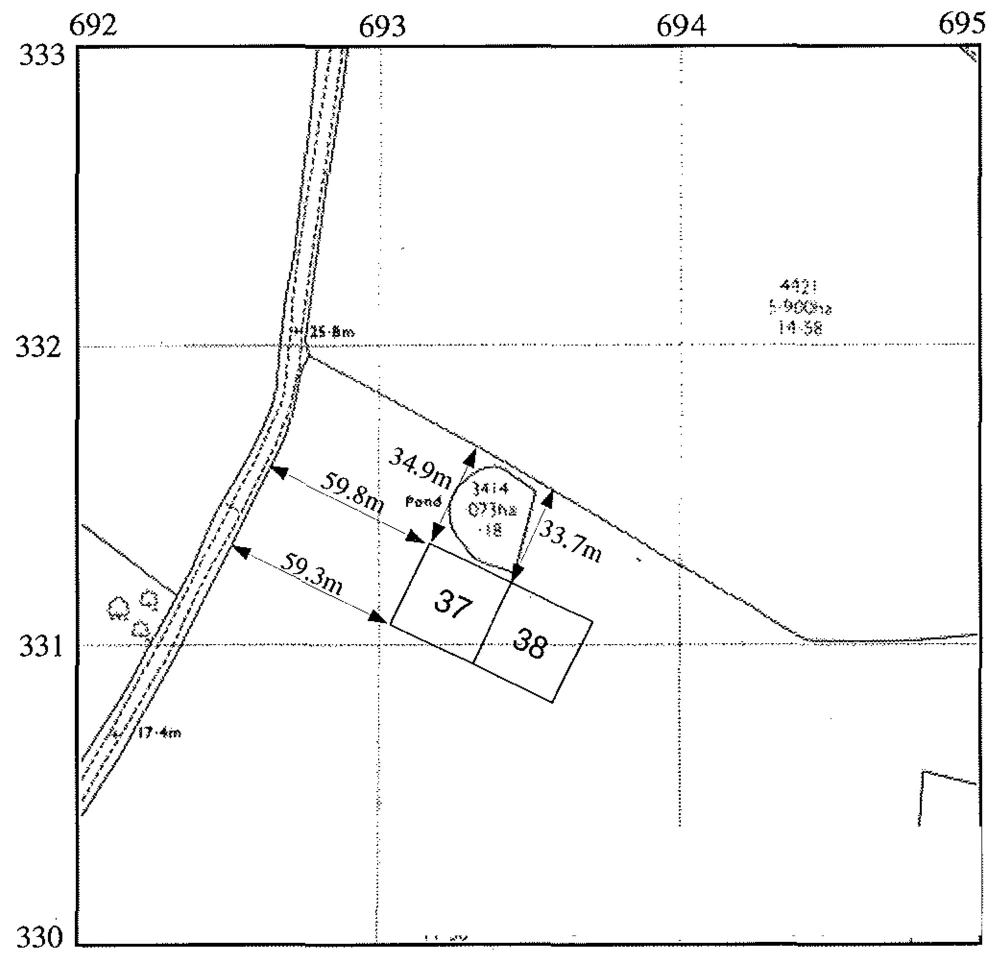
Geophysical Survey, July 1995.

Location of surveys, based upon Ordnance Survey 1:2500 sheet TF 6833.

A.1 Survey grid over the Roman villa site, showing scheduled area.



A.2 Survey grid over the site of St. Thomas's chapel.



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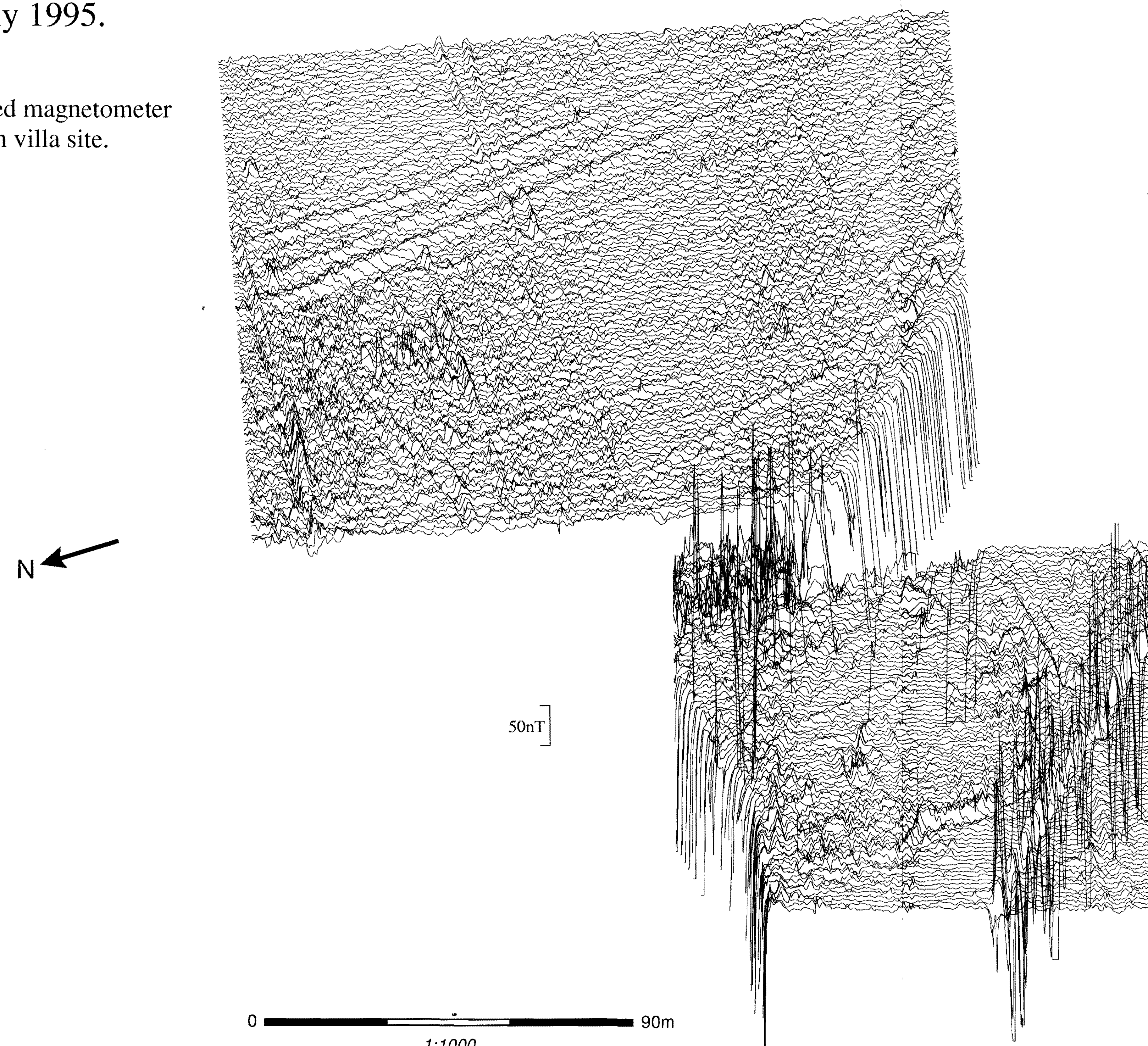
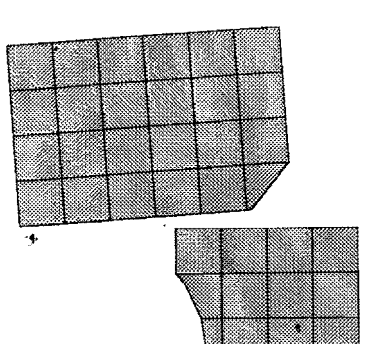
Geophysical Survey, July 1995.

PLAN B

B.1 Trace plot of the unprocessed magnetometer survey data from the Roman villa site.





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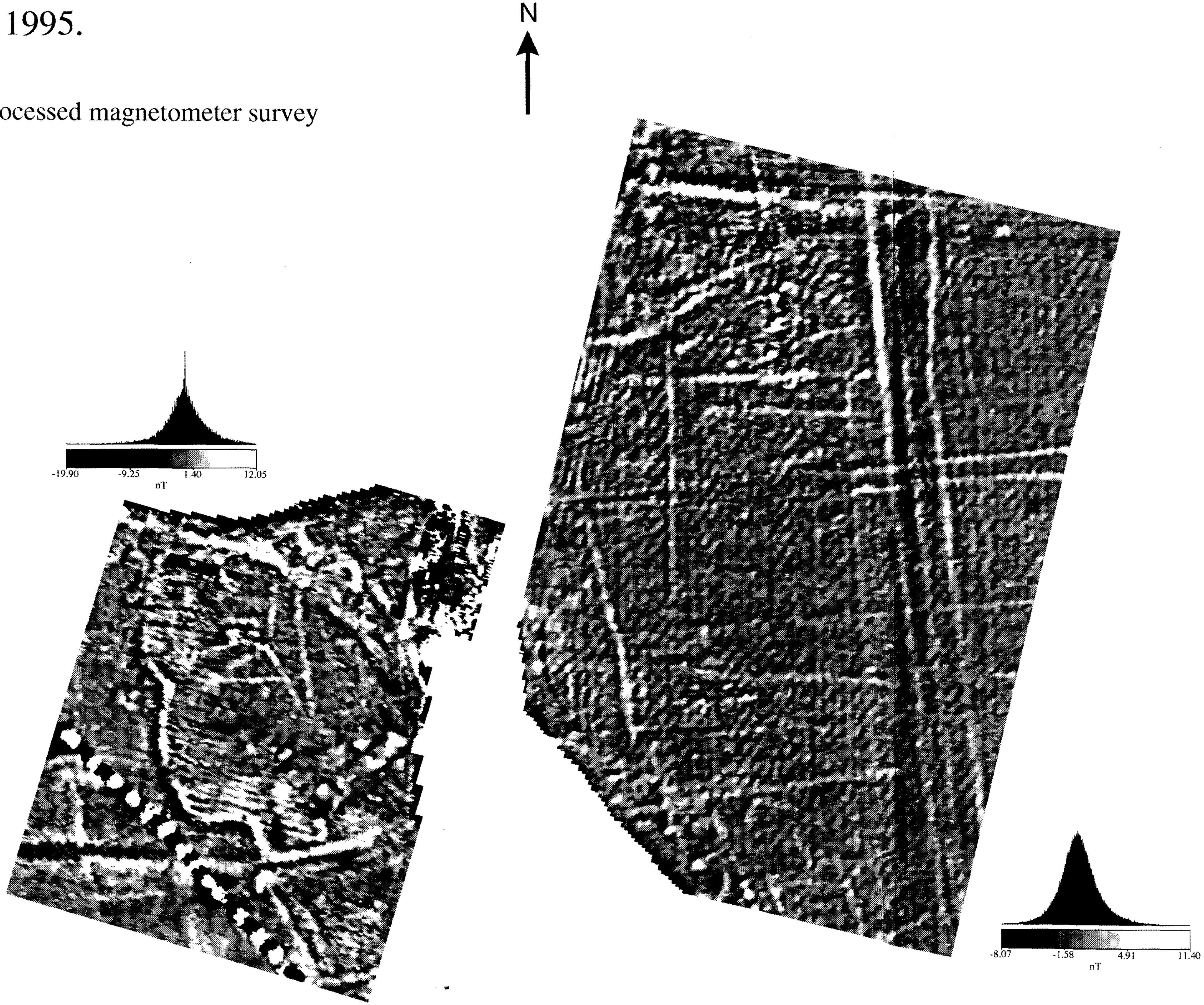
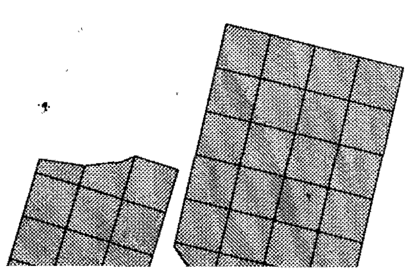
Geophysical Survey, July 1995.

PLAN C

C.1 Linear greyscale plot of the processed magnetometer survey of the Roman villa site.





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Geophysical Survey, July 1995.

PLAN D

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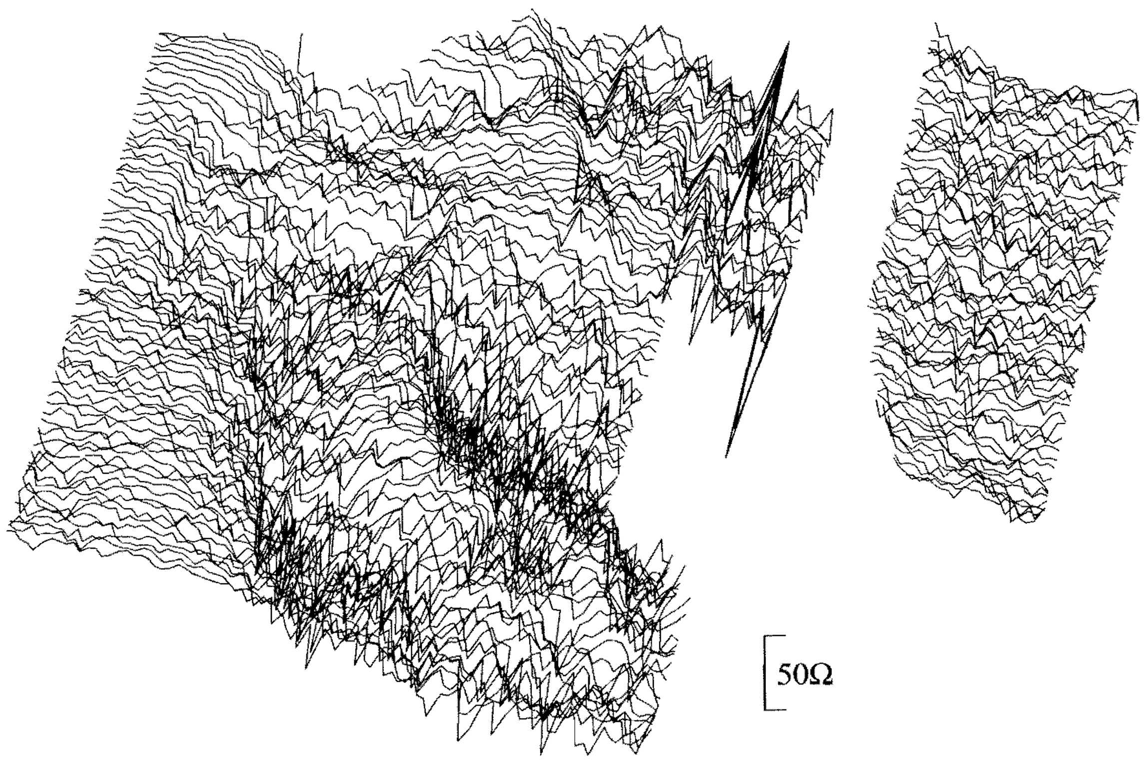
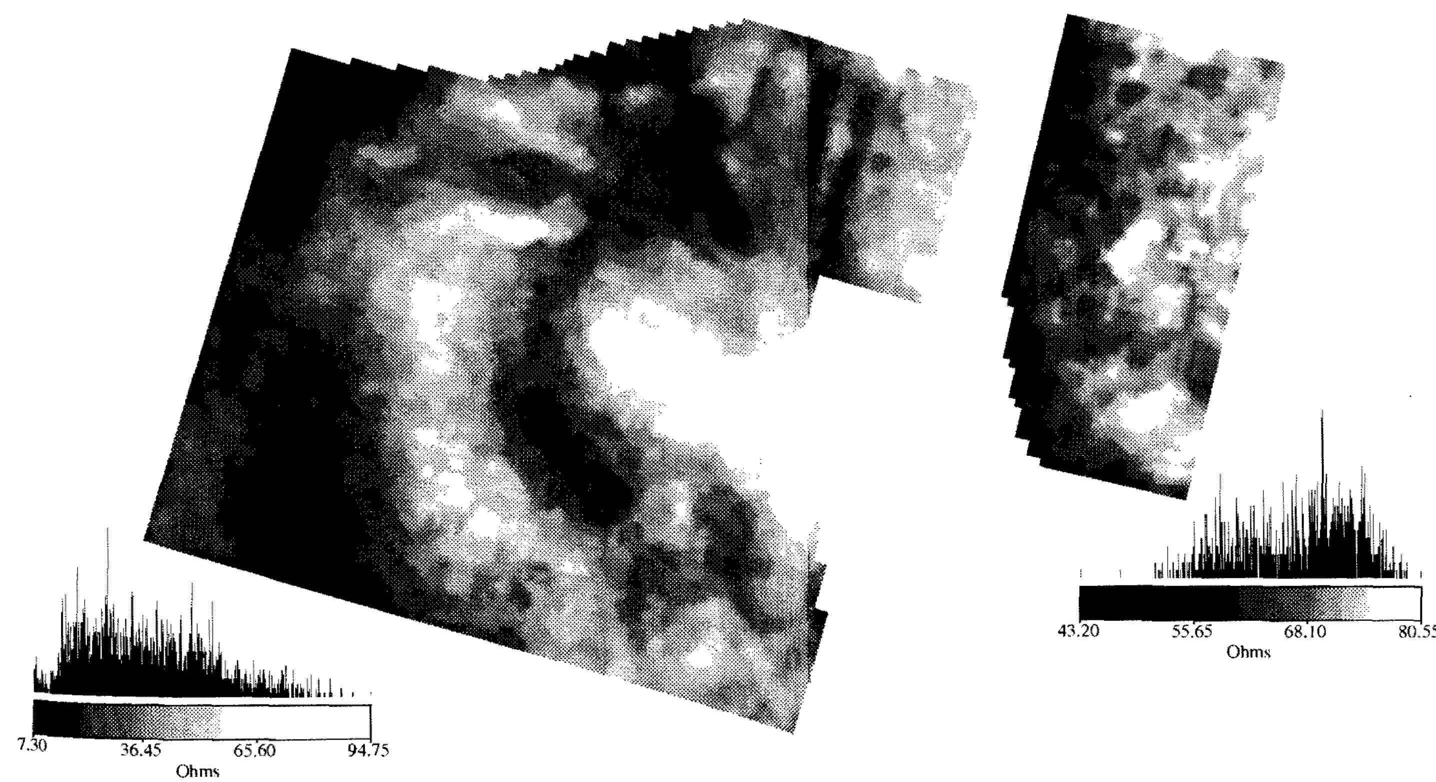
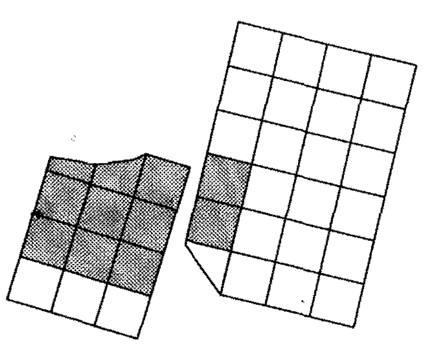
D.1 Trace plot of the unprocessed earth resistance survey of the Roman villa site.



D.2 Equal area greyscale plot of the processed earth resistance survey of the Roman villa site.





0 90m

1:1000

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Geophysical Survey, July 1995.

PLAN E

E.1 Interpretation plan of anomalies at Roman villa site.

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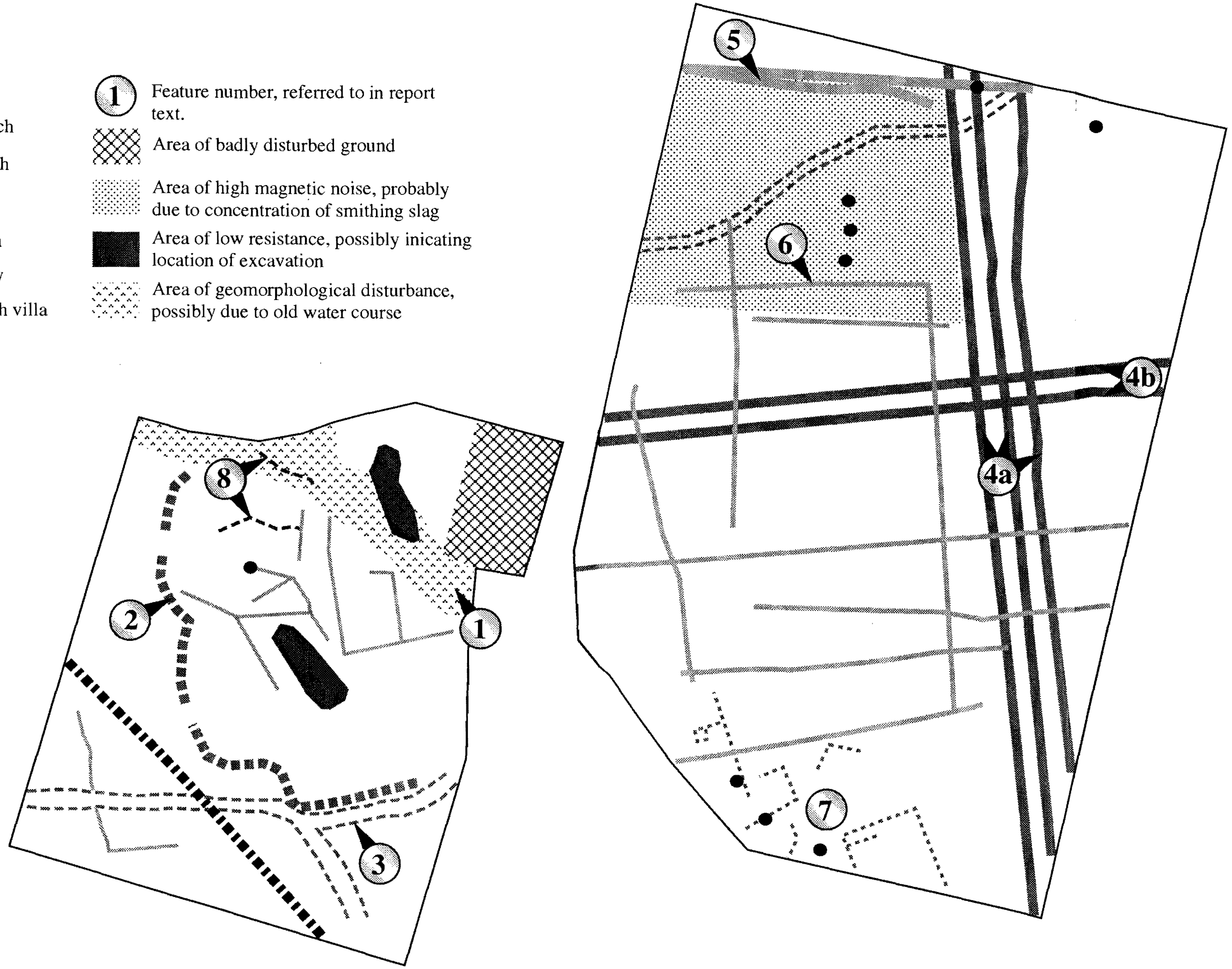
Key to Symbols

- Modern drainage pipe
- Probable Roman defensive ditch
- Possible Roman defensive ditch
- Possible trackway feature
- Field/enclosure boundary ditch
- Linear high resistance anomaly
- Possible ditches associated with villa
- Probable hearth or furnace
- (1) Feature number, referred to in report text.
- Area of badly disturbed ground
- Area of high magnetic noise, probably due to concentration of smithing slag
- Area of low resistance, possibly inicating location of excavation
- Area of geomorphological disturbance, possibly due to old water course



0 90m

1:1000

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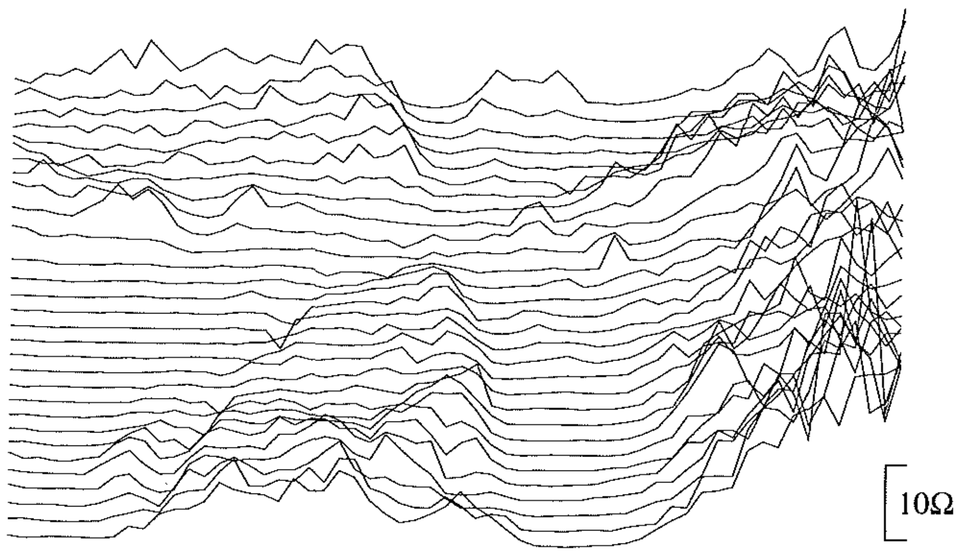
Geophysical Survey, July 1995.

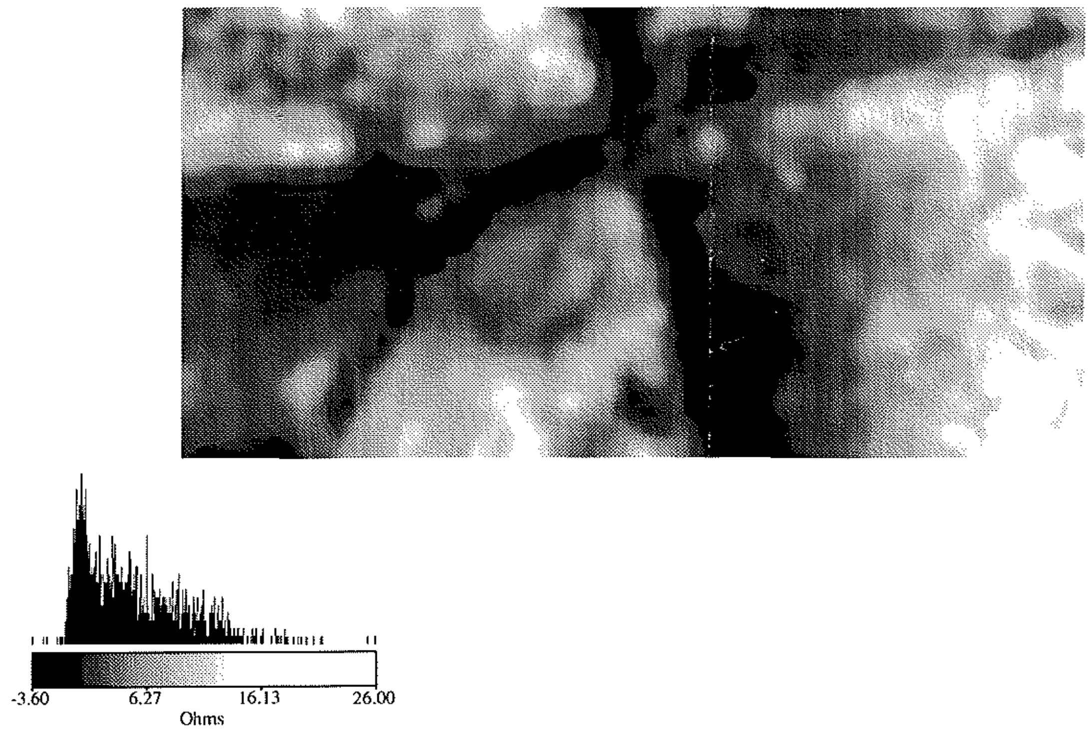
PLAN F

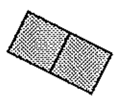
N

F.1 Trace plot of the unprocessed earth resistance survey of the St. Thomas's Chapel site.



F.2 Equal area greyscale plot of the processed earth resistance survey of the St. Thomas's Chapel site.





0 30m
1:500

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