

The Landscape Research Centre

A geophysical and topographic survey report



carried out at

Weaverthorpe, North Yorkshire

on behalf of the Friends of St Andrews Church, Weaverthorpe

between June and October, 2011

Table of contents

Report information.....	2
Summary.....	3
Methodology.....	4
Working with the public.....	6
Resistivity results.....	6
Interpretation.....	7
Gradiometer results.....	9
Dipoles.....	9
Interpretation.....	10
The topographic survey.....	13
Conclusions.....	15
References.....	16

Table of figures

Figure 1 Extant earthworks in relation to Brewster's excavation plan (plan after Brewster, 1972).....	3
Figure 2 The location and extent of the area covered by the surveys, with the extent of the scheduled area outlined in black.....	5
Figure 3 A greyscale image of the resistivity data.....	7
Figure 4 Interpretation of resistivity anomalies.....	8
Figure 5 A greyscale plot of the geophysical data.....	9
Figure 6 Showing the magnetic response of iron objects within the ploughsoil.....	10
Figure 7 Archaeological features detected by magnetic survey (colour coded).....	10
Figure 8 Anomaly 16.....	11
Figure 9 Potential structure 21.....	12
Figure 10 3D points collected for topographic survey.....	13
Figure 11 One metre contour lines across the surveyed area.....	14
Figure 12 Topographic image showing height values as greyscale.....	15
Figure 13 Showing the interpreted returns from both surveys.....	16

Report information

Client	Friends of St Andrews Church, Weaverthorpe
Report type	Fluxgate gradiometer, resistivity and topographic surveys
Parish	Weaverthorpe
County	North Yorkshire
Central grid reference	SE 9671058 7102151
Report number	LRC 122
Site code	548
Section 42 number	SL00000784
Date of fieldwork	16/06/2011 to 3/10/2011
Date of report	02/11/2011
Fieldwork personnel	James Lyall MA (Hons), MSc with volunteers and students
Report by	James Lyall MA (Hons), MSc
Produced by	The Landscape Research Centre Ltd

Summary

The Landscape Research Centre Ltd (LRC) carried out a fluxgate gradiometer, resistivity and topographic survey on behalf of the Friends of St Andrews Church, Weaverthorpe as a component of a LEADER project (part of the Coast, Wolds, Wetlands & Waterways programme). The survey area consisted of the churchyard, churchyard extension and the field to the south and east, part of the latter and the churchyard extension being a scheduled monument, number 1004879 (legacy County number NY321), (see Figure 2 for the location of the surveys and the scheduled area). A number of earthwork banks and ditches are still upstanding (see Figure 1). The surveys were carried out to test for the presence of archaeological features both within and outside the bounds of a Medieval manor (partially excavated by Brewster in 1960, see Figure 1 for location). The magnetic response of the area was good, and detected the remains of all of the upstanding banks, as well as a number of buried features. Despite inclement weather conditions, the resistivity survey also produced good results, with the banks and ditches clearly defined.

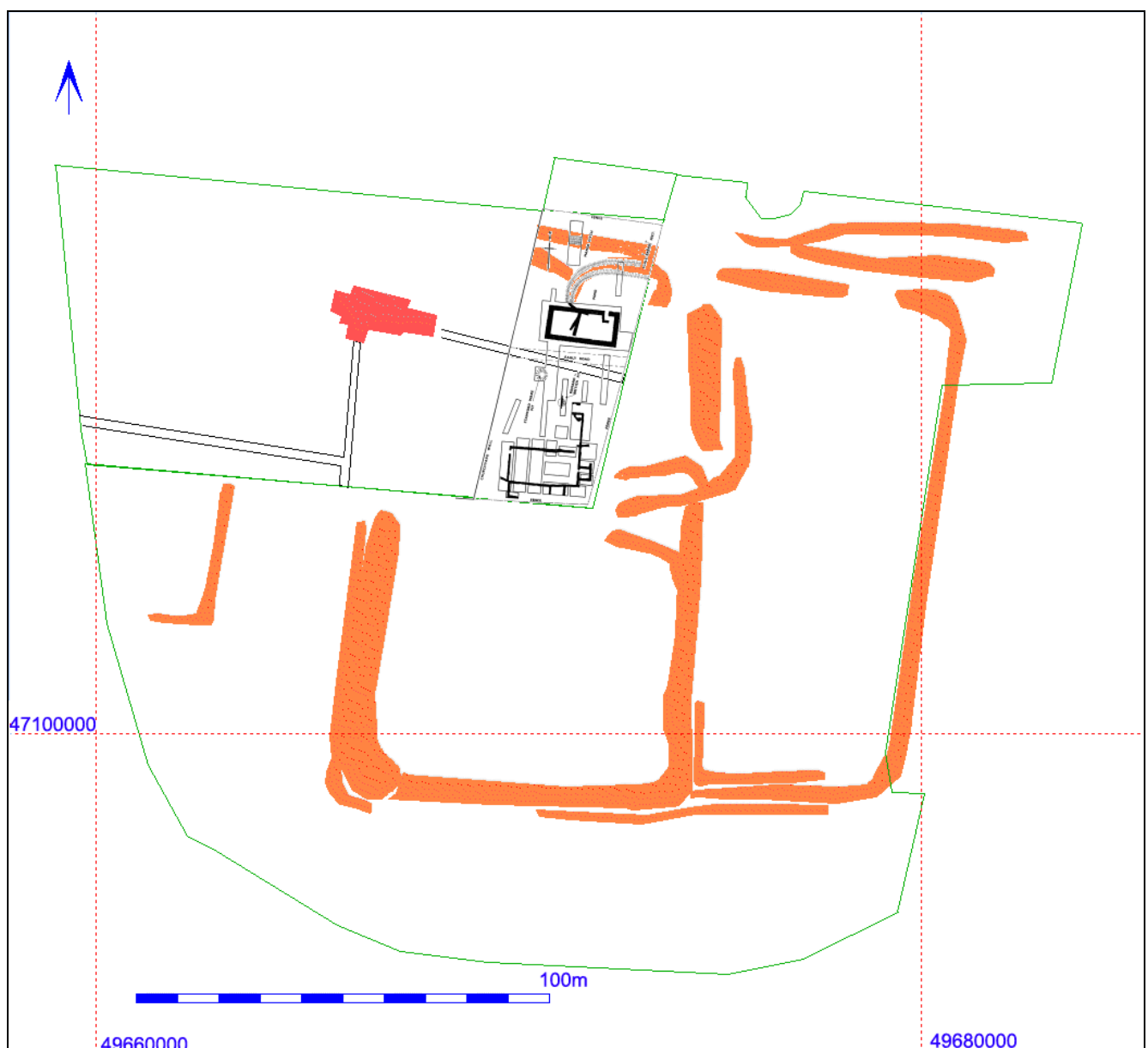


Figure 1 Extant earthworks in relation to Brewster's excavation plan (plan after Brewster, 1972)

Methodology

The magnetic survey of the field outside the church was conducted using a *Foerster Ferex 4.032 DLG* fluxgate gradiometer 4-probe array. This machine is capable of high resolution data collection, and takes readings every 10cm along the traverse axis and every 50cm along the grid axis (thus achieving 18000 readings per 30m square). The machine collects samples at a 0.2 nT sensitivity range. Because the cart uses a real time kinematic GPS to position itself, each data point of the survey has an inbuilt sub 2cm accuracy.

It was not possible to employ the Foerster for the area around the church because of the presence of numerous gravestones and trees, so here a Bartington Grad 601-2 fluxgate gradiometer was utilised. The zigzag traverse method of survey was used. The survey was carried out by taking readings every 25cm along the traverse (walking) axis and every metre along the grid axis (thus 3600 readings for each 30m by 30m grid). The sensitivity of the machine was set to detect magnetic variation in the order of 0.1 nanoTesla (nT).

The resistivity survey was conducted using a *Geoscan Research* resistivity meter (model RM15) in the twin probe array, with readings being taken every metre in both the east/west and the north/south axes (thus 900 readings for every 30m square grid).

The areas covered by each machine are listed below in Table 1 (see Figure 2 for location of these surveys).

Machine	Type	Area (Ha)
Foerster Ferex 4.032	Magnetic	2.453
Bartington Grad 601-2	Magnetic	0.583
Geoscan Research RM15	Resistivity	1.454

Table 1 Showing areas covered by machine

Apart from the churchyard, Site 548 is currently under permanent pasture, and at the time of the survey the field was cut low, which presented no obstacles to data collection. The underlying geology is chalk, which generally gives a reasonable magnetic contrast with cut archaeological features such as ditches and pits.

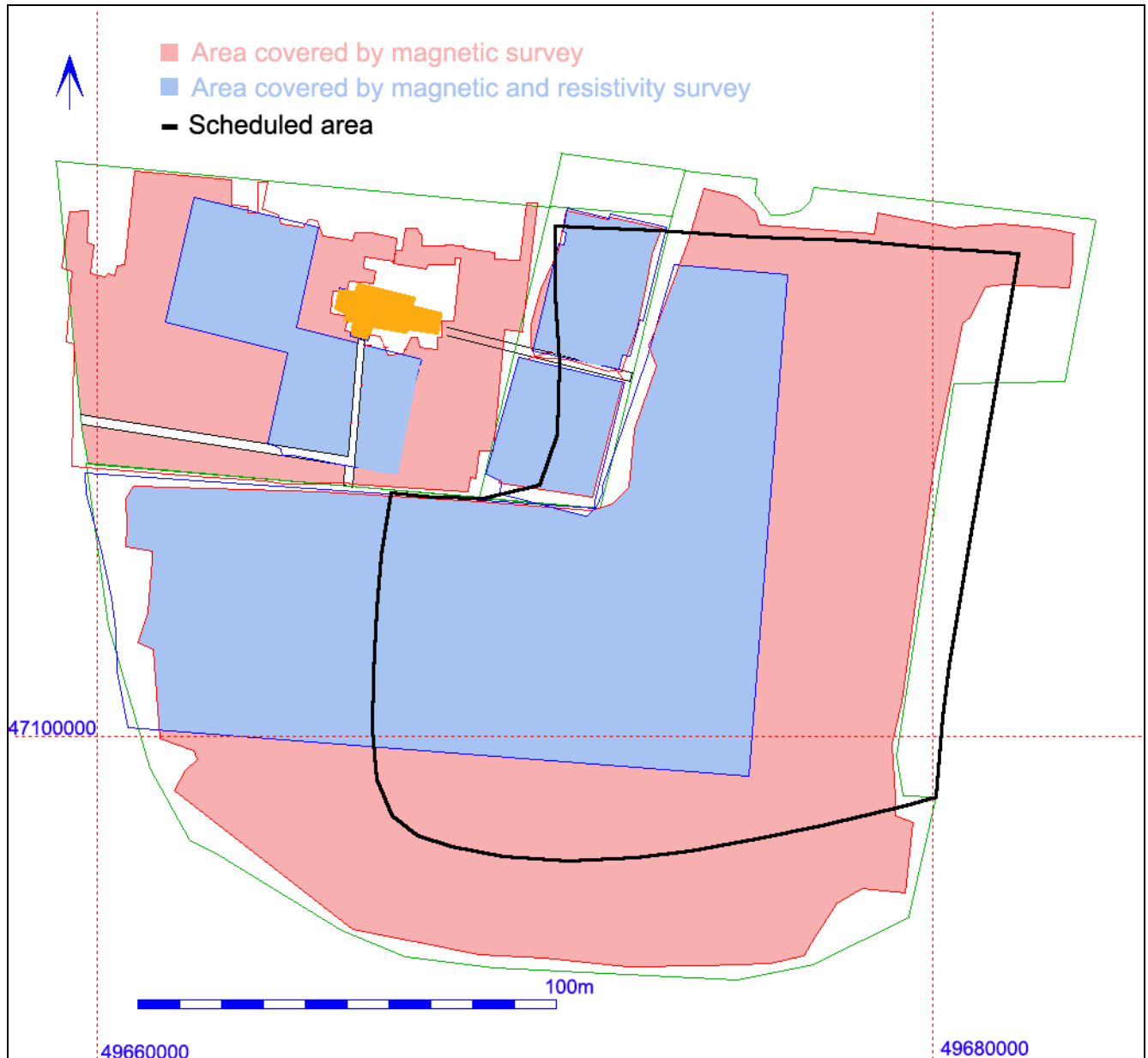


Figure 2 The location and extent of the area covered by the surveys, with the extent of the scheduled area outlined in black.

The data from the magnetometer has been processed and presented using G-Sys (an in-house developed Geographic Database Management program which can also display, process and present digitised plans and images). The resistivity data was processed using Snuffler, a freeware program. This report was produced using Microsoft Word 2000 and Adobe Photoshop 7 for further image manipulation. All maps have north pointing to the top of the page.

Working with the public

As part of the LEADER programme, engagement with the local community was at the heart of the survey element of the project. Firstly, on the 15th and 16th June 2011, James Lyall and a work placement student from Lady Lumley's School, Pickering (Ethan Richardson), conducted the Foerster magnetic survey of the field to the south and east of the church. A topographic survey of the area was also begun at this time.

Then, on the 6th of July, 2011, James gave an introductory talk on archaeology to the children of Weaverthorpe Primary School. Following this, the older children from the school acquired their first taste of geophysical survey by helping to carry out a resistivity survey to the south of the churchyard, which they greatly enjoyed, despite a sudden downpour!

Two days were set aside for training interested local people in how to conduct a geophysical survey. The first of these was held on Saturday 16th July 2011, and even though the morning was characterised by incessant rain, seven members of the public learned how to carry out a resistivity survey.

From the 18th to the 21st of July a second work placement student (Ben Esse) from Lady Lumleys continued the resistivity survey with James Lyall, where nearly a hectare was added to the total. In addition, further topographic survey around the church was undertaken.

The second training day for geophysical survey was held on Sunday 4th September, and seven people conducted a resistivity survey in the churchyard, before learning how to use the Bartington magnetometer in the afternoon.

Sunday the 11th of September was Heritage Open Day, and lectures were given in the church by Professor Dominic Powlesland and Dr Pete Wilson, with James Lyall answering questions on the geophysical surveys.

James Lyall completed the magnetic, topographic and resistivity survey in the churchyard extension on the 3/10/2011.

Resistivity results

A total of 1.454 Ha of resistivity survey was carried out to the south and east of the St Andrews Church. The results are displayed both as a greyscale image (see Figure 3) and an interpretative plan (numbered on Figure 4) of potential archaeological features. Eighteen high or low resistance features were detected, with 8 of these relating to extant banks or ditches, and 10 more to potential buried features. Features discovered by geophysical survey techniques are referred to as "anomalies", defined as such because they are different from the background norm.

As stated above, the resistivity surveys were conducted on different days, over quite a long period, and on many of these days it was raining. This has affected the results of the resistivity survey, because increased moisture in the soil reduces the overall resistance. This can be seen clearly in the south-eastern part of the survey, which was carried out on one of the drier days. The survey data from this area show a much higher contrast in resistance values, giving a greater level of definition of anomalies for this area.

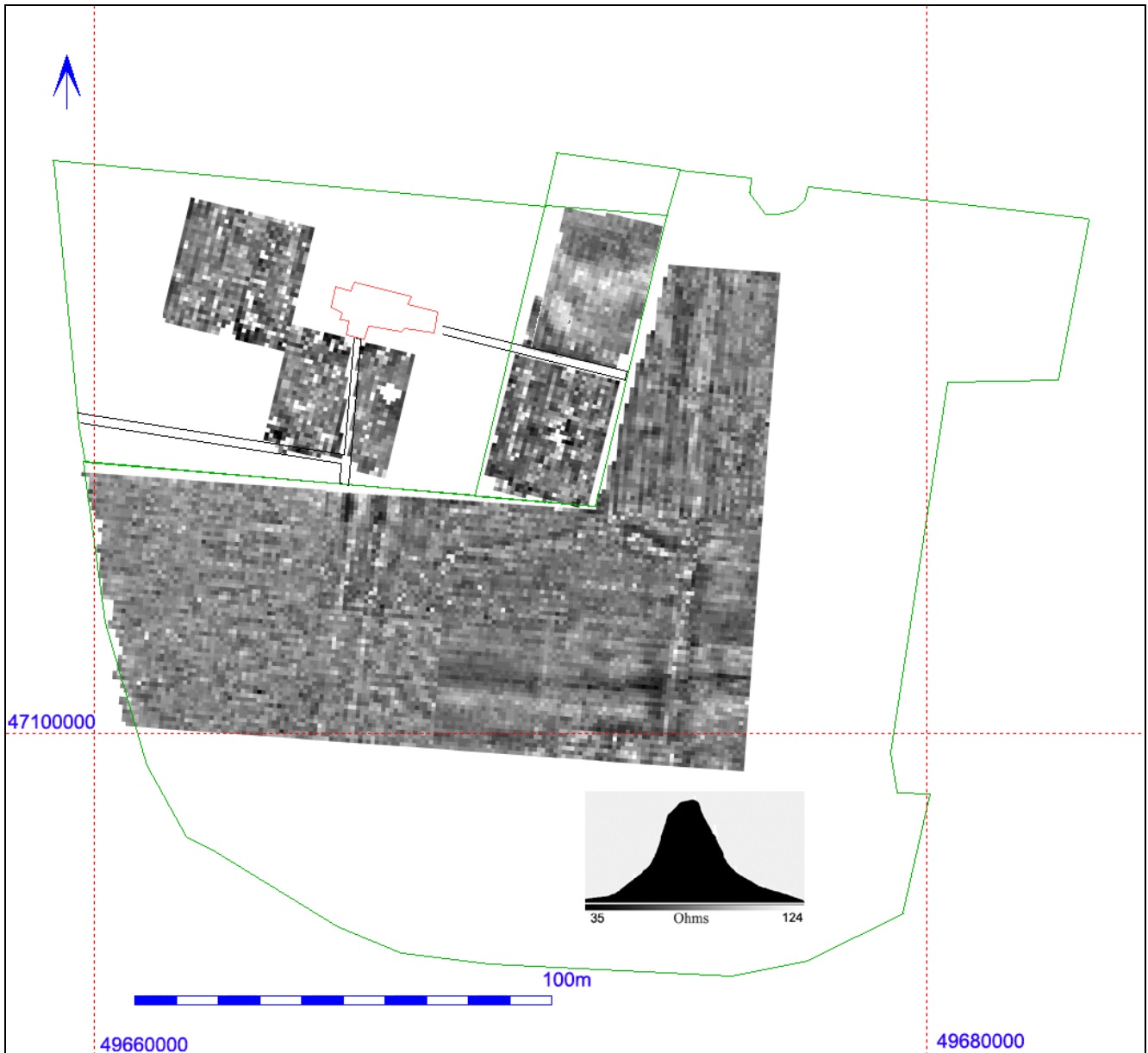


Figure 3 A greyscale image of the resistivity data

Interpretation

Only two potential features were detected within the original churchyard, both very slight high resistance anomalies. The first (number 1 in Figure 4) was located to the west of the church, and appears to form a right angle. However, it is possible that they could relate to where people have been walking through the churchyard, causing compacted soil, and thus high resistance readings.

The second (number 2 in Figure 4) was to the south of the church, and was much wider than the first. It is possible that this anomaly could relate to the presence of a buried chalk earthwork, although its alignment is different from all of the upstanding earthworks in the area. It is possible that this could represent the outer boundary of the manorial enclosure turning to the east to respect the southern limit of the Medieval churchyard. A magnetic anomaly (13) with the same orientation was also detected, adding confidence to this interpretation.



Figure 4 Interpretation of resistivity anomalies

Anomaly 3 is unusual in that it is a low resistance feature, indicating a possible ditch. There is no direct magnetic correlation, but it is on the same alignment as a number of magnetic anomalies. Like these, anomaly 3 seems to underlie the upstanding earthworks, suggesting that these features may be earlier than the creation of the manorial garth boundary.

Anomaly 5 has an unusual curvilinear shape, with a high resistance outer band. The upper part of this feature coincides with the lower part of a potential structure detected magnetically, and this could be some external feature related to the structure.

Anomalies 4 and 6 are slight linear anomalies, perhaps forming a smaller enclosure within the main boundary. Once again, there is no magnetic correlation.

Anomalies 7 and 8 are linear anomalies within the churchyard extension. If Anomaly 2 does relate to the manorial boundary, then Anomaly 7 could represent an inner element, potentially being suppressed prior to the construction of Brewster's "Great Hall", or at least the westward extension of that structure. However, although potentially medieval, they are on a different alignment to the halls excavated by Brewster, and it is possible that they could relate to the post 1960 use of the area for burial.

Gradiometer results

The results of the survey are displayed both as a greyscale image (see Figure 5) and an interpretative plan (see Figure 7) of potential archaeological features. All magnetic images use a range of $\pm 7\text{nT}$.

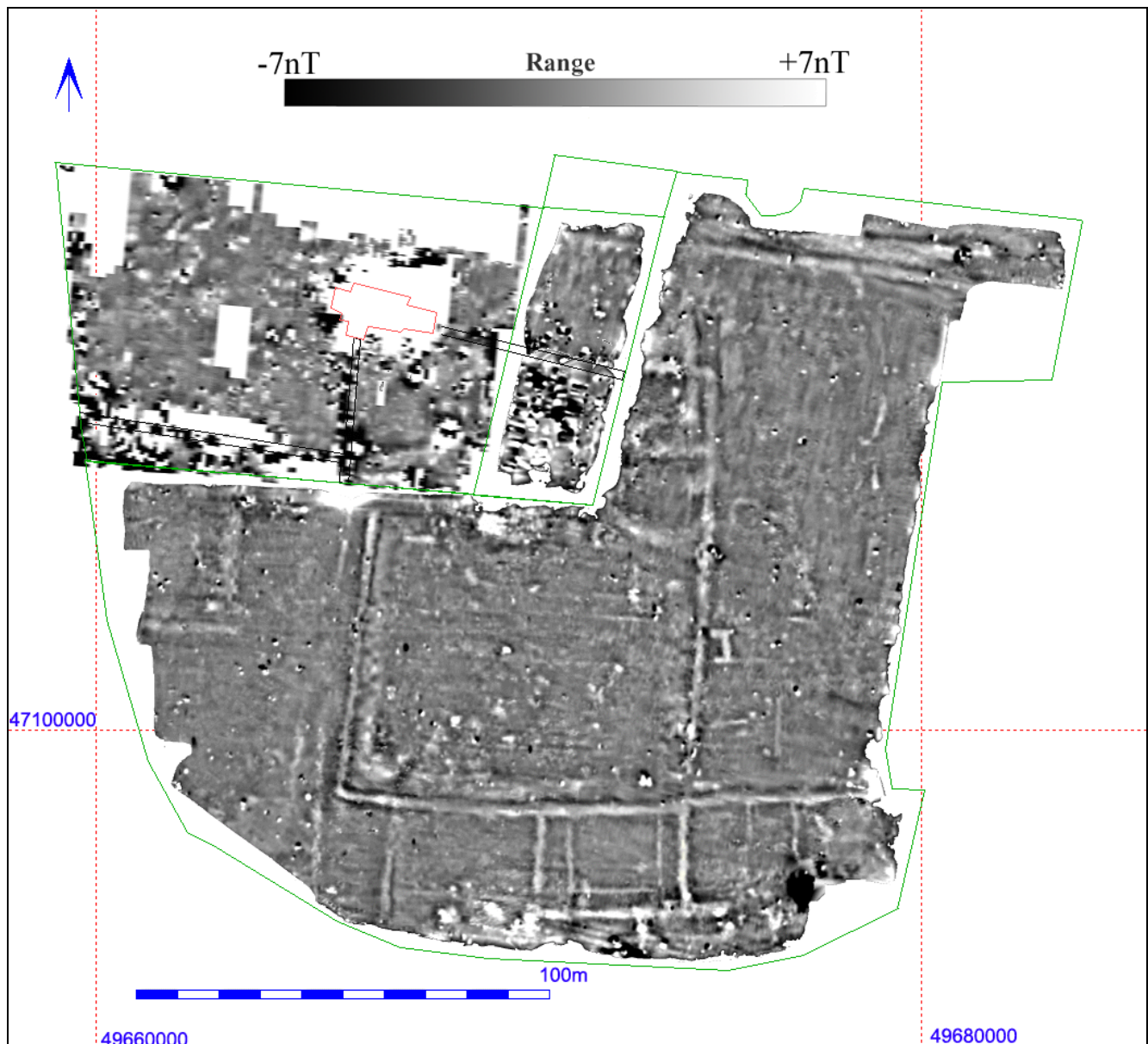


Figure 5 A greyscale plot of the geophysical data

A total of 108 magnetic anomalies have been identified, including 60 linear anomalies, of which 22 relate to extant banks or ditches. There were also 1 square, 1 curvilinear, 3 circular, 3 rectilinear and 39 discrete anomalies detected. The anomalies will be discussed in groups, which are either colour-coded or identified by number in Figure 7.

Dipoles

The small black and white areas in the greyscale images (see Figure 6) are dipoles (iron spikes), which indicate the presence of magnetic (iron or steel) objects. These are generally found in the topsoil, and although they could signify the presence of archaeological objects, it is much more likely that they relate to more modern detritus, such as broken ploughshares, iron horseshoes, shotgun cartridges etc.

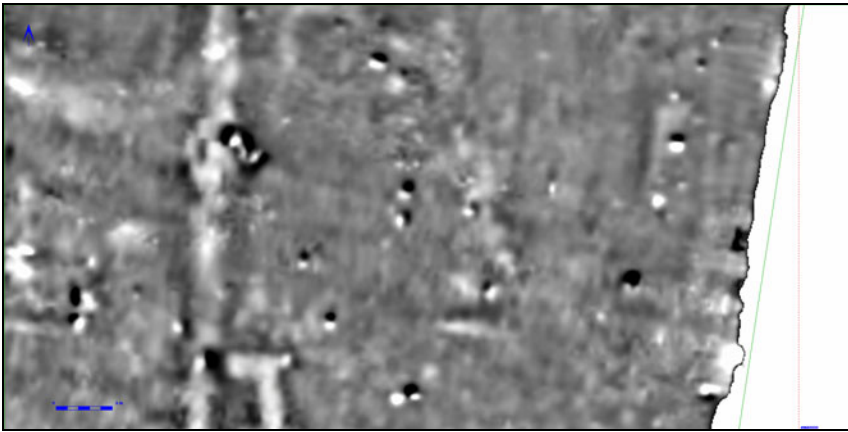


Figure 6 Showing the magnetic response of iron objects within the ploughsoil

Interpretation

A number of linear anomalies were detected magnetically, including all of the upstanding banks as well as features no longer visible on the surface.

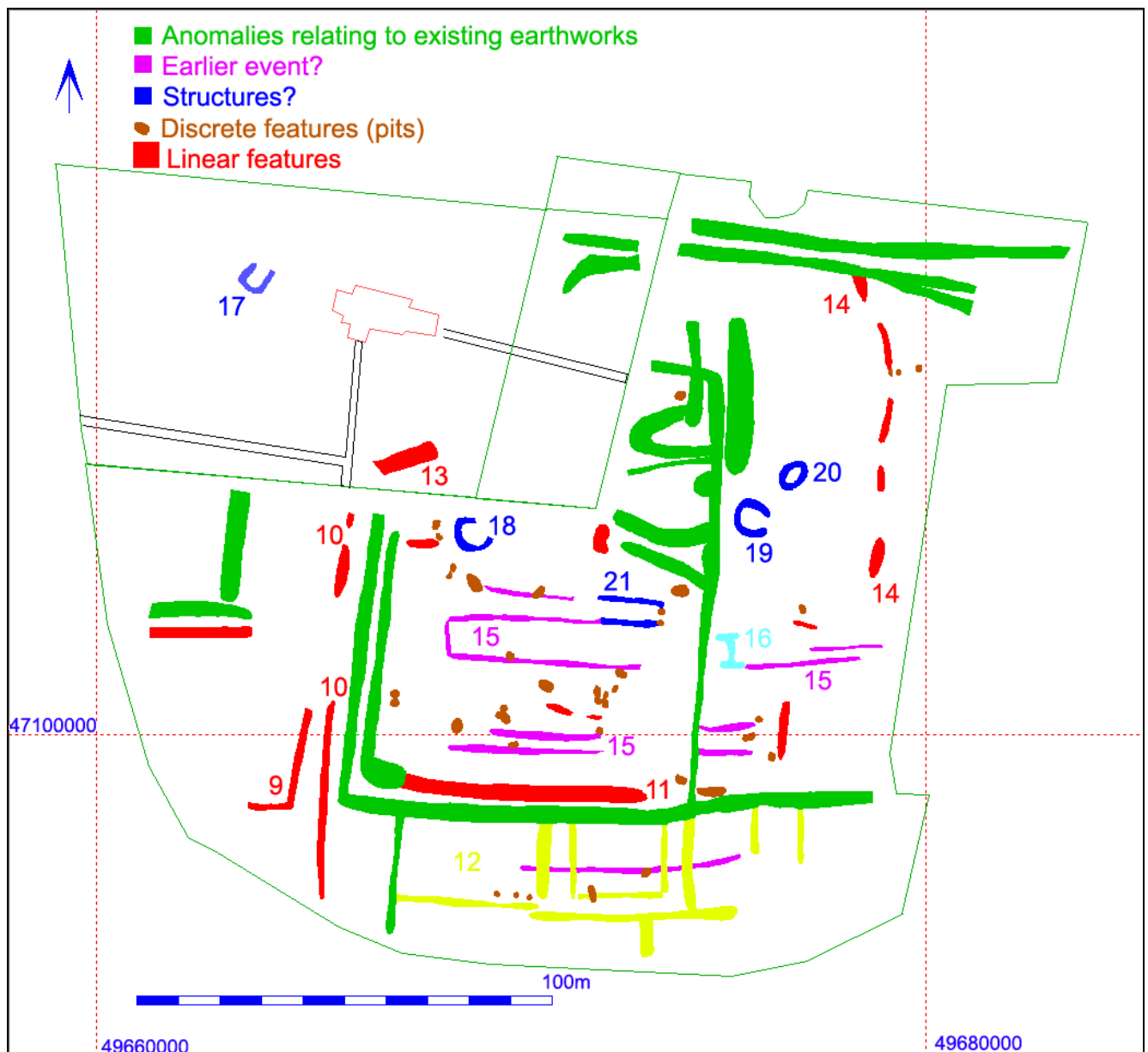


Figure 7 Archaeological features detected by magnetic survey (colour coded)

Anomaly 9 is a feature which runs roughly parallel with the main bank to the east, before turning a right angle to the west. It may continue to the west, but if so is a very faint magnetic anomaly.

Feature 10 is made up of three separate linear anomalies, all of which are on the same alignment as the upstanding bank to the east. It is likely that these relate to the presence of a footpath leading from the village in the south to the church.

Anomaly 11 is a wide feature which runs parallel to the upstanding bank to the south. It has a strange mixed magnetic response, and is probably the remains of another chalk bank, since removed.

A set of linear anomalies has been grouped together as number 12 (in yellow on Figure 7). These all either are attached to the southern bank of the manorial complex, or are at a right angle to the bank. It is clear that they are related, and appear to form a series of rectangular enclosures to the south of the main area. A small number of discrete anomalies are to be found here, including three in a row which is parallel to the enclosure boundaries. They could relate to a set of stock enclosures, which would be closer to the only source of water in the area, the Gypsy Race.

Anomaly 13 is one of only two potential features detected within the boundary of the churchyard. This paucity of anomalies is because the presence of graves, both Medieval and particularly modern, which will probably have a number of iron or steel objects within them, which would serve to mask any underlying features which might exist. This is a wide linear anomaly, only detected for a short length. It is on a similar alignment to resistance anomaly 2, although its location is just to the south. This is because the two techniques are finding different parts of the same structure, with resistance potentially detecting the remains of a buried chalk bank, and magnetic survey detecting its associated ditch.

A group of linear features have been assigned the number 14, despite having a rather segmented look. They extend southwards from an east-west aligned bank in the north, and possibly relate to an earlier bank (or subdivision) within the main enclosed area. It is also possible that they are natural cracks in the chalk, filled with a more magnetically susceptible material.

Eleven linear features have been grouped together as number 15, with all but one of them on the same east-west alignment. They are all relatively very faint magnetic anomalies. They also appear not to respect the upstanding bank or enclosures to the south, thus implying that they may be an earlier set of features.

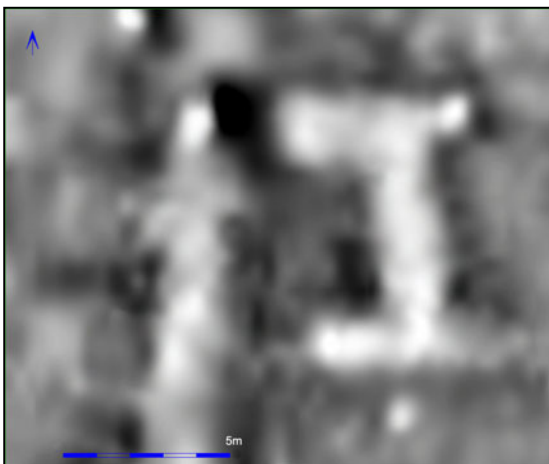


Figure 8 shows the magnetic data for anomaly 16, an unusually shaped feature found just outside the main north-south bank. It has an I-shape, with the top and bottom struts roughly 6.5m wide, while it has a total length of 8m. It is filled with a strongly magnetically susceptible material, but not the strength that would indicate a kiln or furnace. It is thus possible that the feature may be a corn dryer, although its shape is still curious. There is a slight earthwork associated with this feature, but it is not this shape above ground.

Figure 8 Anomaly 16

Anomaly 17 is the second possible feature detected within the bounds of the churchyard, and is a very weakly positive anomaly. It appears to form part of a square, but without further evidence its interpretation as a potential structure must remain conjectural at best.

Anomalies 18 and 19 are both sub-circular features, 18 within the main enclosure and 19 just outside to the east. Anomaly 20 is an ovate feature just to the north-east of 19, but has a very faint magnetic strength. These three anomalies are currently interpreted as potential structures, although function and date remain uncertain.

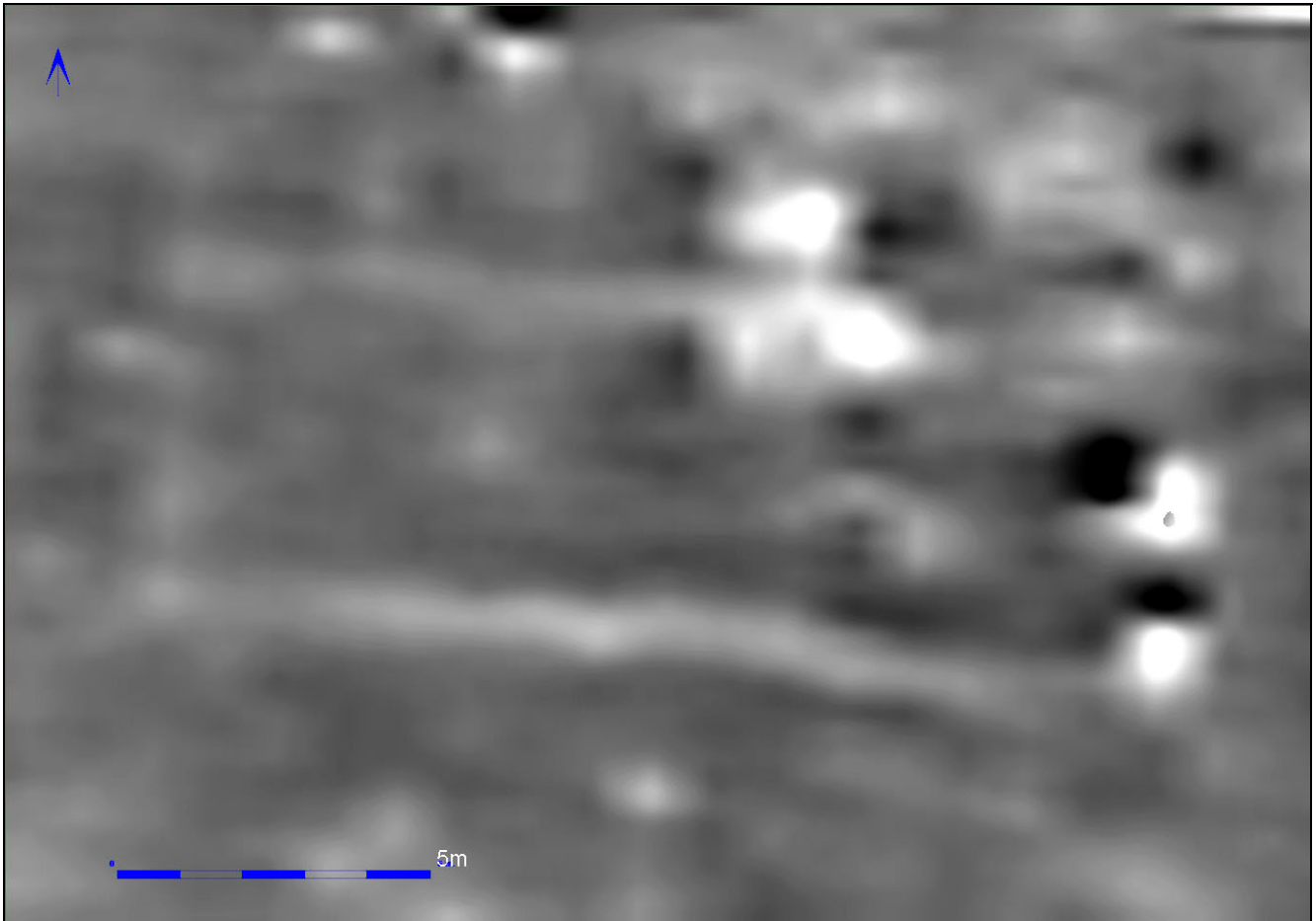


Figure 9 Potential structure 21

Anomaly 21 is a potential rectangular structure, located within the main enclosure. It is 16.7m long and 5.2 metres wide. Two dipoles are to be found along the eastern side, but it is not clear whether these could relate to an entrance. If the structure was presumed to be Anglian or Middle Saxon in date, the entrances would normally be in the long walls. If it is later, it may have a much more prosaic function, for instance the stables or some other outbuilding related to the Manor house located some 35m to the north.

Of the remaining 33 discrete anomalies, 22 are to be found within the main Manor enclosure. It is likely that they have numerous functions, but most of them are probably refuse pits. Seven discrete anomalies were found to the east of the main enclosure, but the area to the west was comparatively blank.

The topographic survey

As indicated earlier (see Figure 1), a number of banks and ditches remain visible on the ground, marking out the boundaries of the manorial complex. The topographic survey of the main area was carried out at the same time as the magnetic survey, mounted on the Foerster instrument. The survey of the churchyard was carried out on foot, avoiding the trees and bushes where possible. A total of 20293 points were collected (see Figure 10).

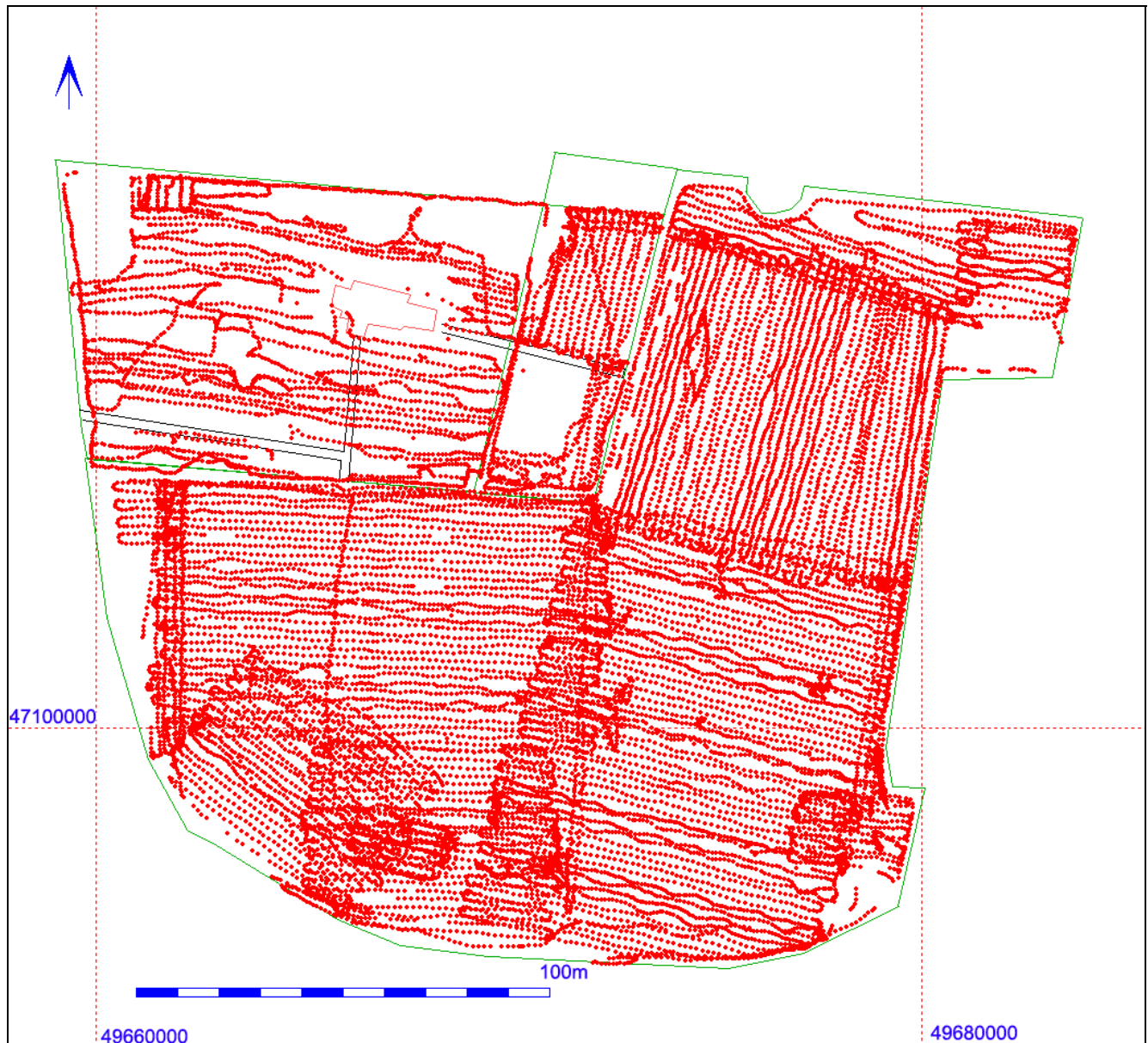


Figure 10 3D points collected for topographic survey

The elevation of the site is highest in the north, sloping down from 101.34m AOD to the south towards the Great Wold valley and the modern village (the lowest point in the surveyed area is at 77.91m AOD see Figure 11). At one point, the climb from the bottom of the hill to the top is 1 in 8, rising 24m over a distance of 184m.

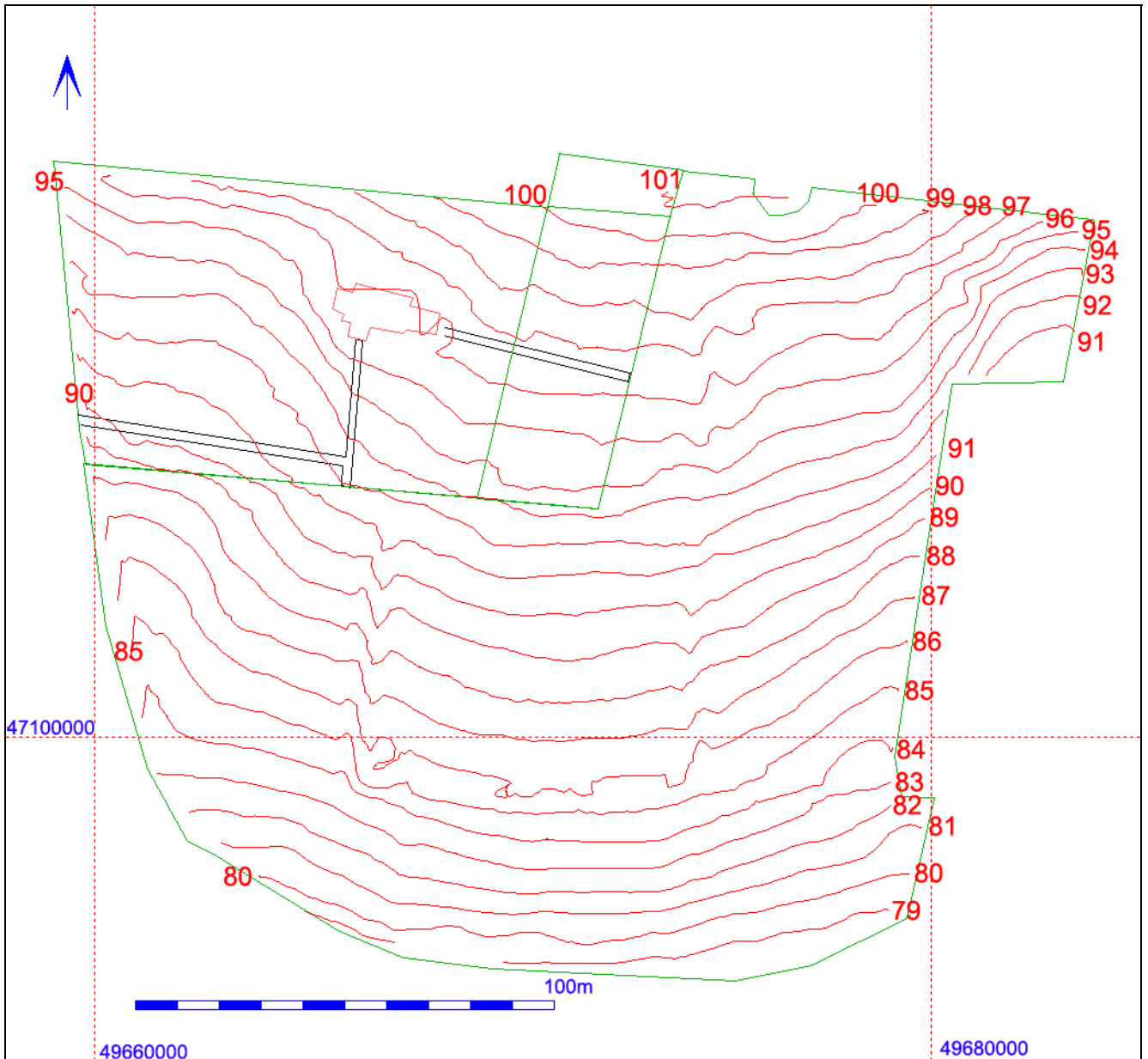


Figure 11 One metre contour lines across the surveyed area

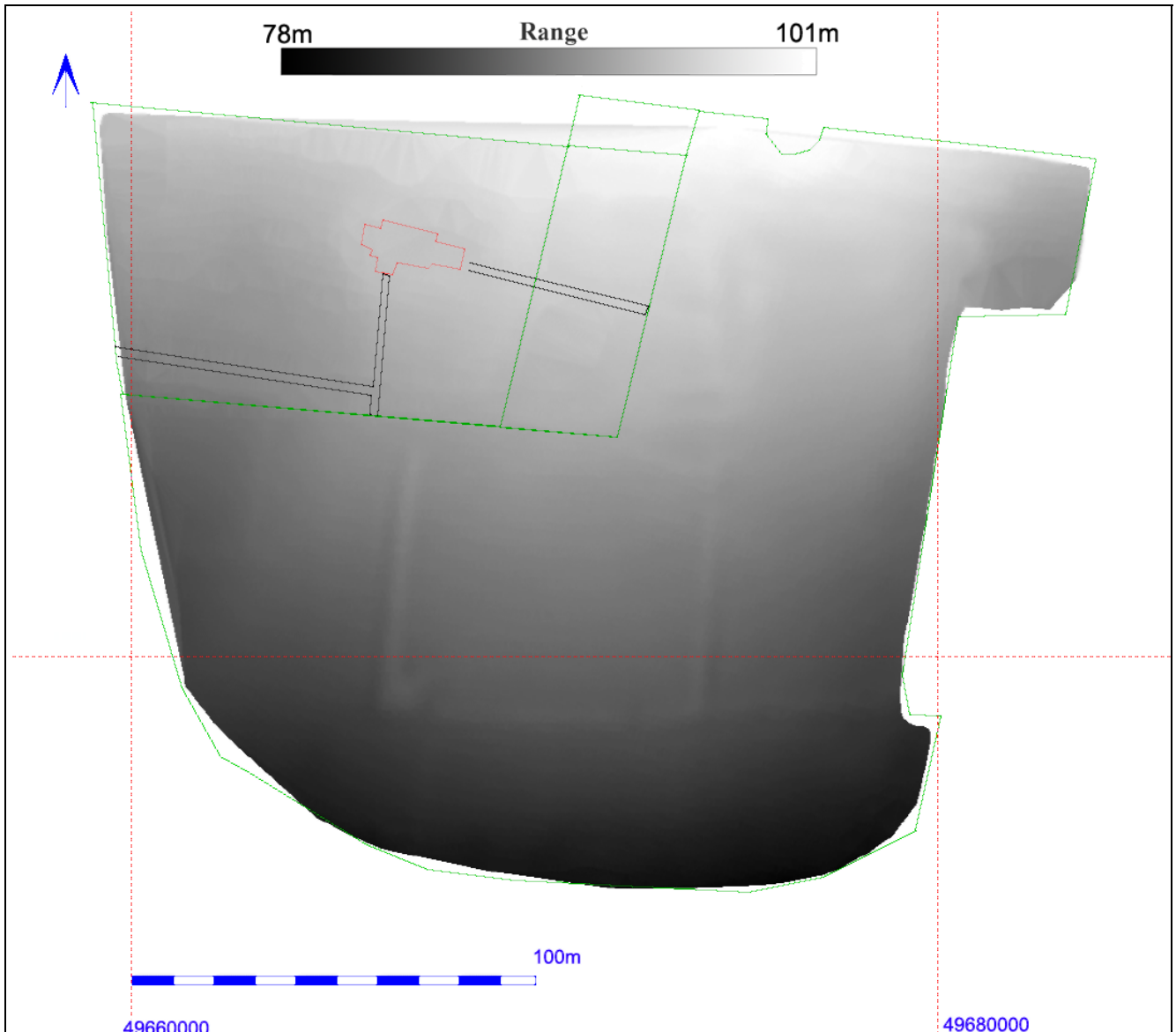


Figure 12 Topographic image showing height values as greyscale

Conclusions

In conclusion, it can be stated that the underlying chalk provided a good magnetic contrast to the in-filled features. A total of 108 magnetic anomalies were detected, of which 22 could be related to extant banks and ditches. The potential of earlier features was noted, and a number of potential structures were identified. The resistivity survey detected 18 anomalies, of which 8 related to extant features. The topographic survey successfully mapped the upstanding earthworks in the area.

It is worth emphasising that the resistivity survey was very successful in detecting the upstanding earthwork banks, whereas the magnetic survey was better at detecting the corresponding ditches (see Figure 13). This demonstrates the complementary nature of the two different geophysical techniques, where the combined returns generate a better understanding of the underlying features than either technique could achieve on its own.

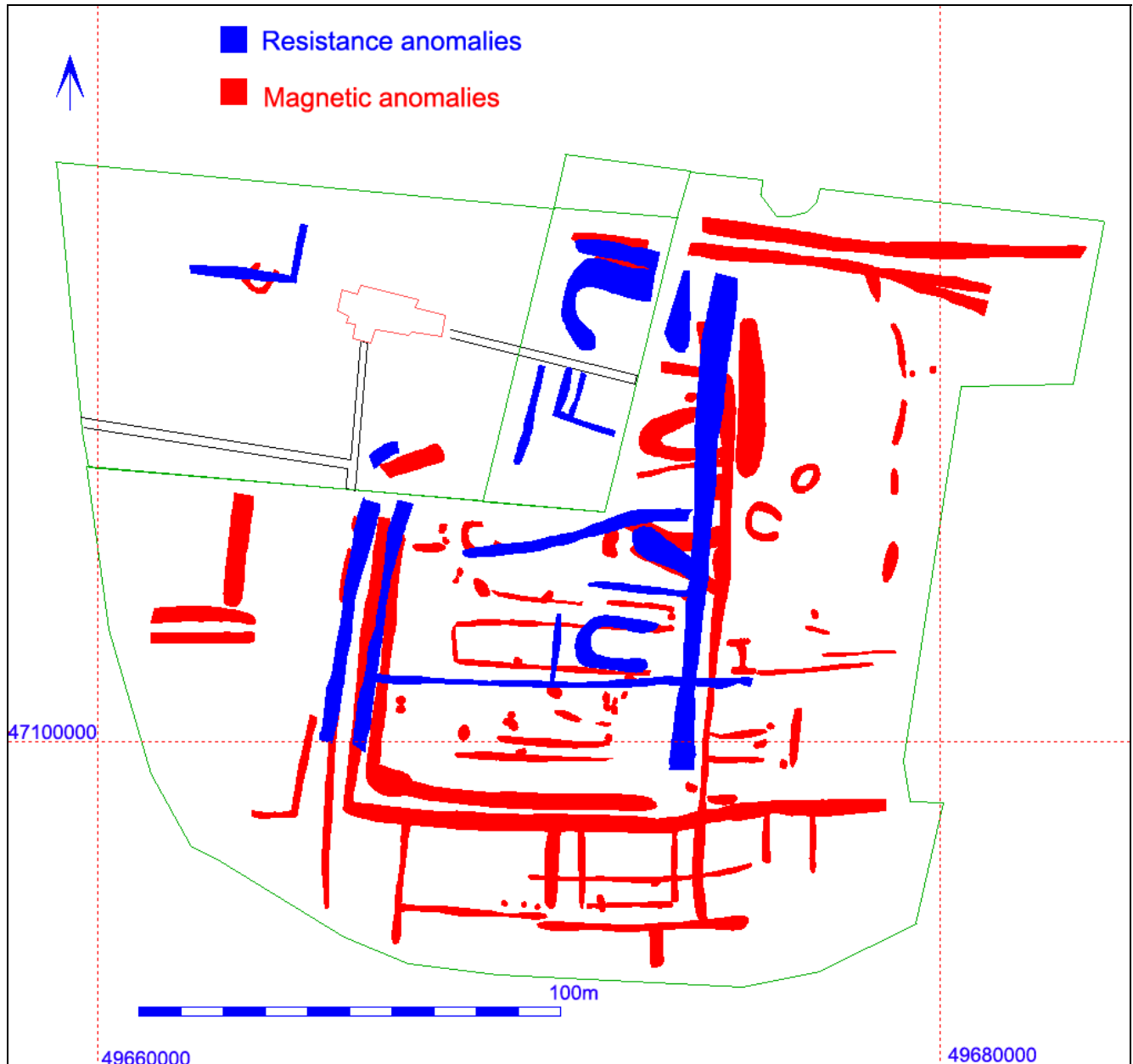


Figure 13 Showing the interpreted returns from both surveys.

References

Brewster, T. C. M. (1972) An Excavation At Weaverthorpe Manor, East Riding, 1960. *Yorkshire Archaeological Journal*, 44, pp.114-133.

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