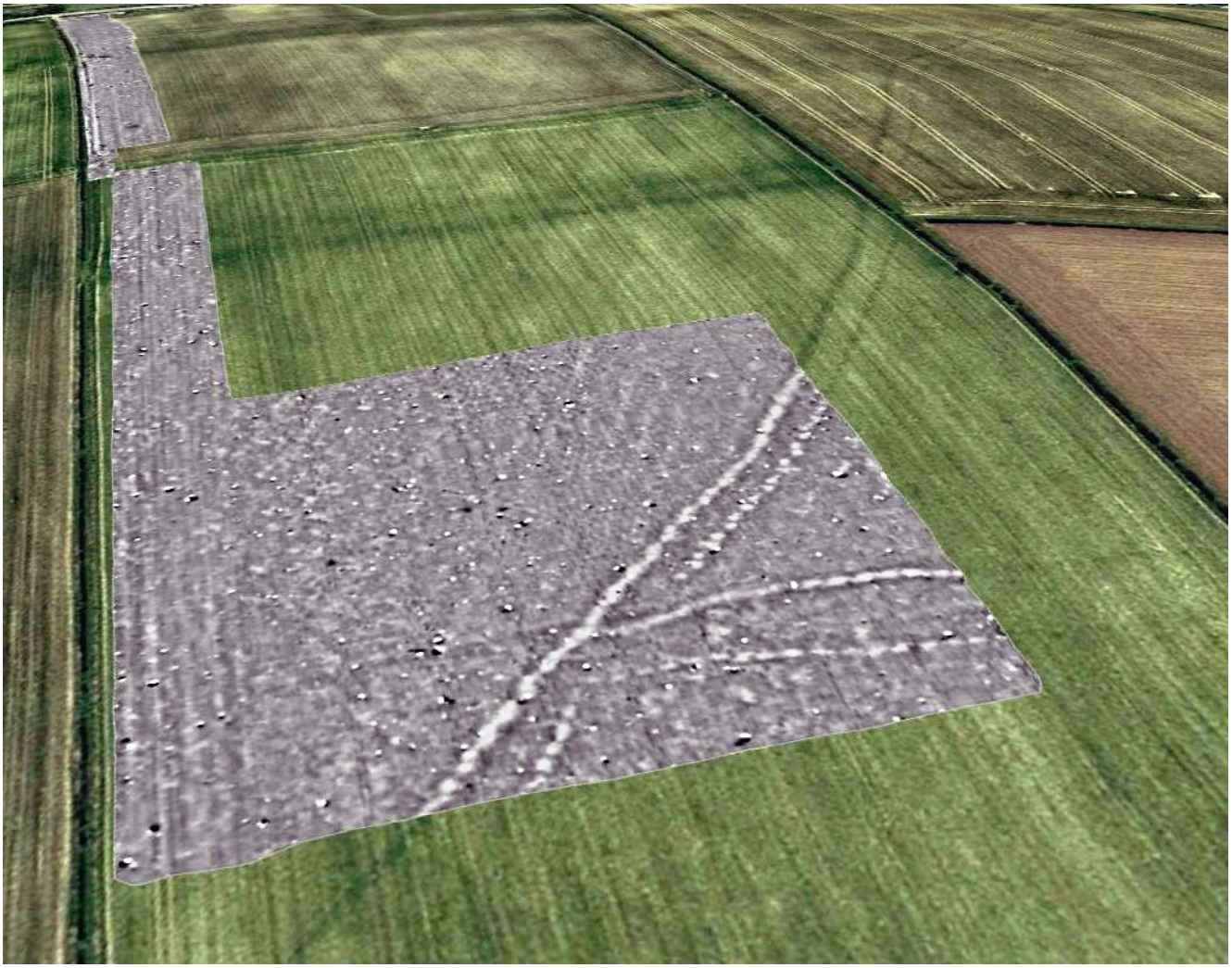
The Landscape Research Centre

Report on two fluxgate gradiometer surveys carried out at Weaverthorpe, North Yorkshire during August 2013



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Report information

Client	Wold Valley Wind Collective Ltd. & Weaverthorpe Wind Ltd.
Report type	Fluxgate gradiometer survey
Parish	Weaverthorpe
County	North Yorkshire
Central grid reference	SE 9784 7135
Report number	LRC 130
Site code	Sites 574 and 575
Date of Fieldwork	29-30/08/2013
Date of report	04/09/2013
Fieldwork personnel	James Lyall MA (Hons), MSc
Report by	James Lyall and Prof. D. Powlesland
Produced by	The Landscape Research Centre Ltd

Summary

The Landscape Research Centre Ltd (LRC) was engaged to undertake a fluxgate gradiometer survey to investigate two fields in Weaverthorpe parish, North Yorkshire (see

Figure 1 for location). The primary aim of the survey was to confirm the presence of the cropmark evidence and to identify any unknown underlying archaeological features along the corridor of two potential wind turbine sites. On both sites, the location and morphology of the cropmarks were confirmed, and in addition, a number of smaller features were also identified in both areas.

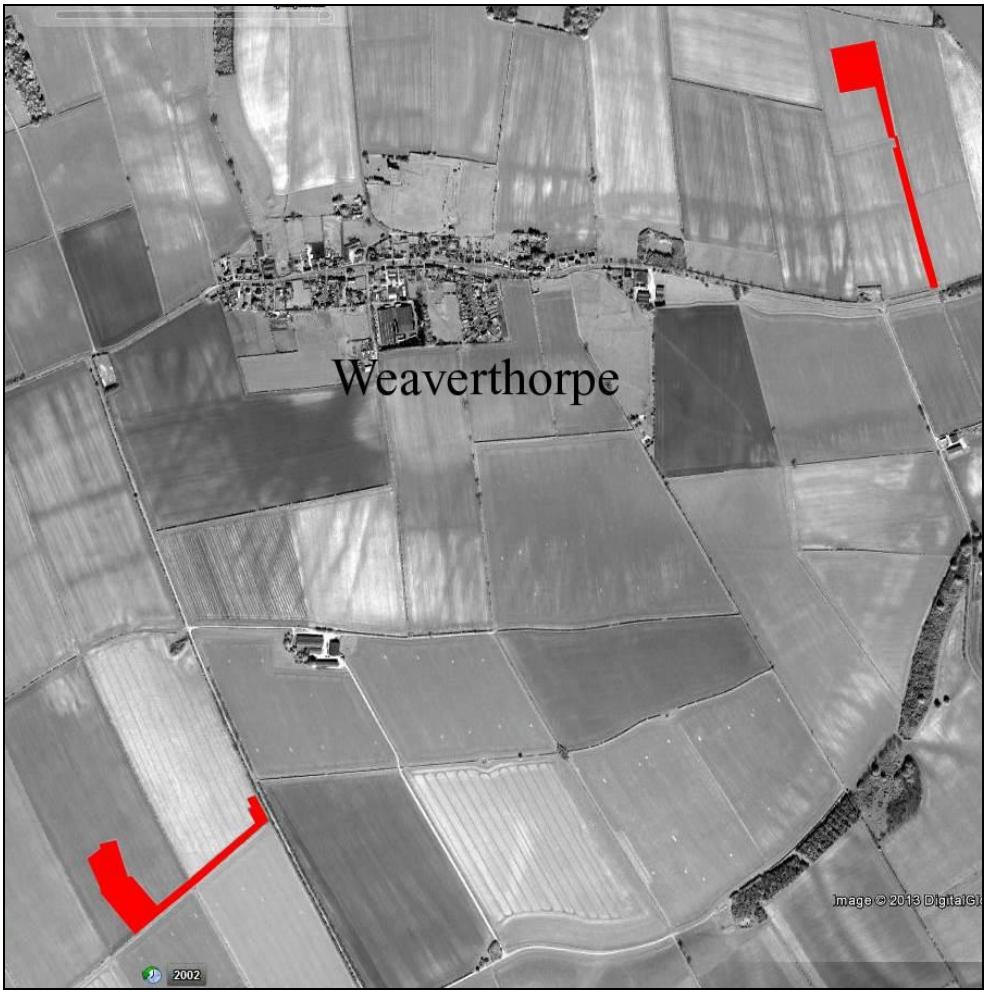

Figure 1 Showing the location of the geophysical survey areas on a Google Earth background

Methodology

The survey 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 data within 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.

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). This report was produced using Microsoft Word 2010 and Adobe Photoshop 7 for further image manipulation. All maps have north pointing to the top of the page, and Google Earth images are used for background map location.

The survey consisted of two areas, the eastern field (site 574) being recently harvested and the western field (site 575) recently drilled and rolled, so both provided a good underlying surface for walking, although wheel ruts were present in both fields, and are visible in the magnetic data. The only obstacle to surveying was a pile of silage in the centre of the eastern field along the line of the cable corridor.

Geology

The underlying solid geology is classified as being of the Welton Chalk Formation or Burnham Chalk Formation (undifferentiated). These are a sedimentary bedrock formed approximately 84 to 99 million years ago in the Cretaceous Period, formed in a local environment previously dominated by warm chalk seas.

(derived from http://mapapps.bgs.ac.uk/geologyofbritain/home.html).

Gradiometer results and interpretation

The results of the surveys are displayed as a number of greyscale images and also with the interpretations superimposed. Features discovered by magnetic survey techniques are referred to as "anomalies", defined as such because they are different from the background magnetic norm. All greyscale images are processed at +-7nT, apart from that shown in Figure 12, which has been contrast stretched to enhance visibility.

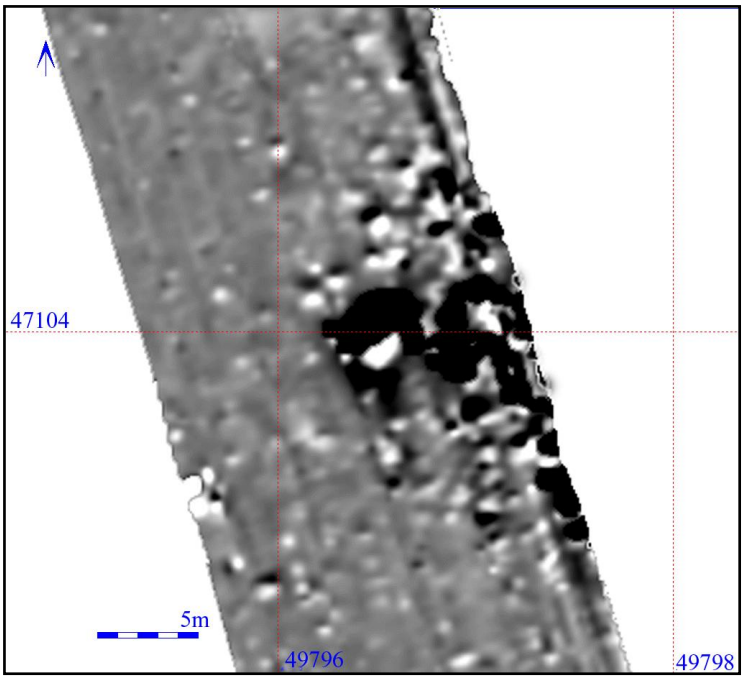

Figure 2 Dipolar anomalies in magnetic data

The large and small black and white areas in the greyscale images (see Figure 2) are dipoles (iron spikes), which indicate the presence of 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.

Site 574

Site 574 consisted of a 20m wide transect which began in the south-eastern corner of the field and ran northwards for 623m. The northernmost 111m was then extended out 94m to the west to accommodate the potential location of the wind turbine (see

Figure 1 and Figure 3 for location maps).

There are 5 main areas of interest detected by the magnetic survey (numbered in red in Figure 3). Each area will be discussed in turn.

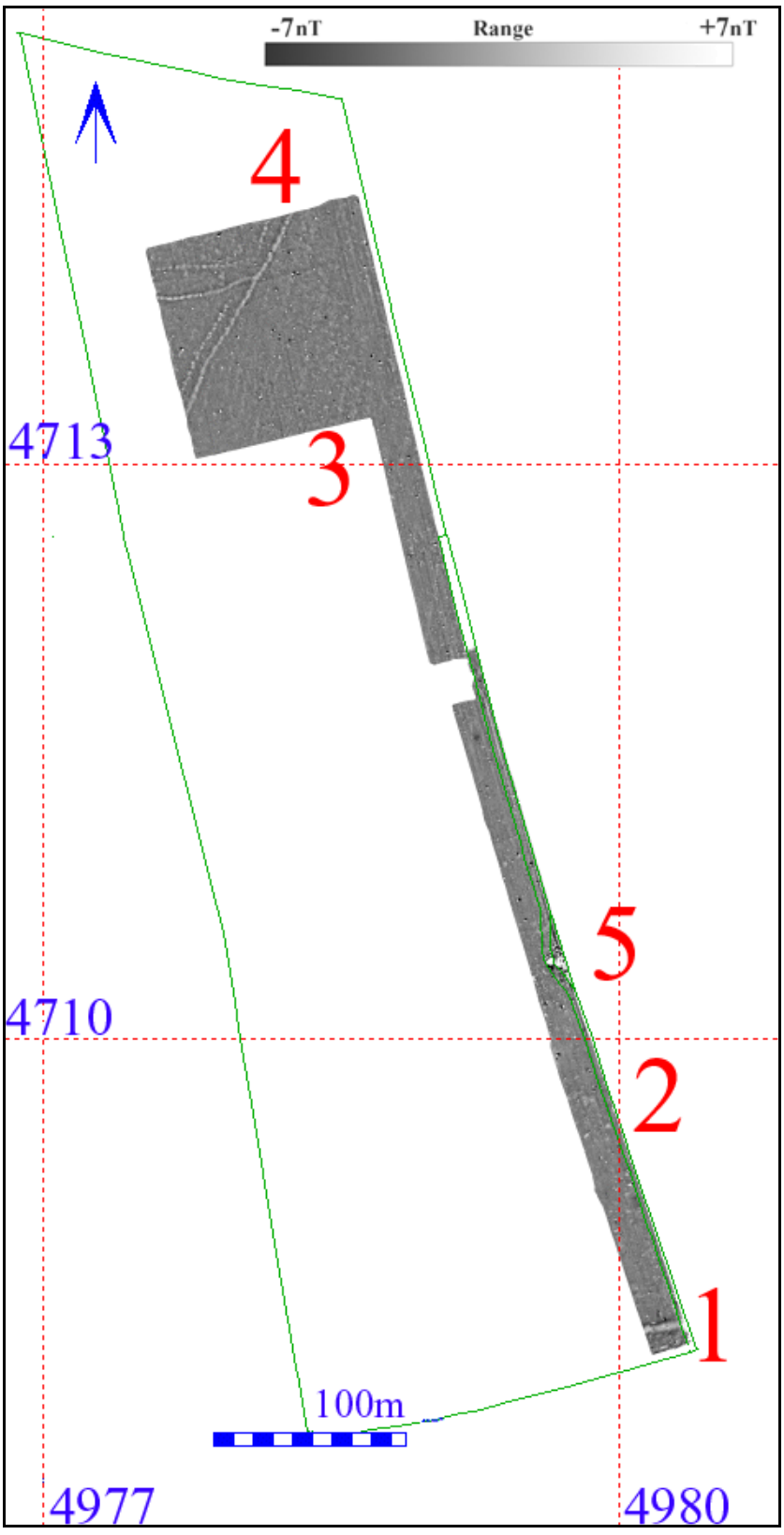

Figure 3 Greyscale image of site 574 in relation to the Ordnance Survey grid

Anomaly 1 is located in the north-south 20m transect, and is part of a linear feature known from cropmark plots (see Figure 4).

Figure 4 Geophysical survey showing linear anomaly 1 in relation to the cropmark (arrowed)

The cropmark has been known for some time, but it is interesting to note that the magnetic anomaly is almost twice the width of the feature indicated by the cropmark. This indicates multiple phases in the life of this monument, with the cropmark likely showing only the final ditched phase of the feature.

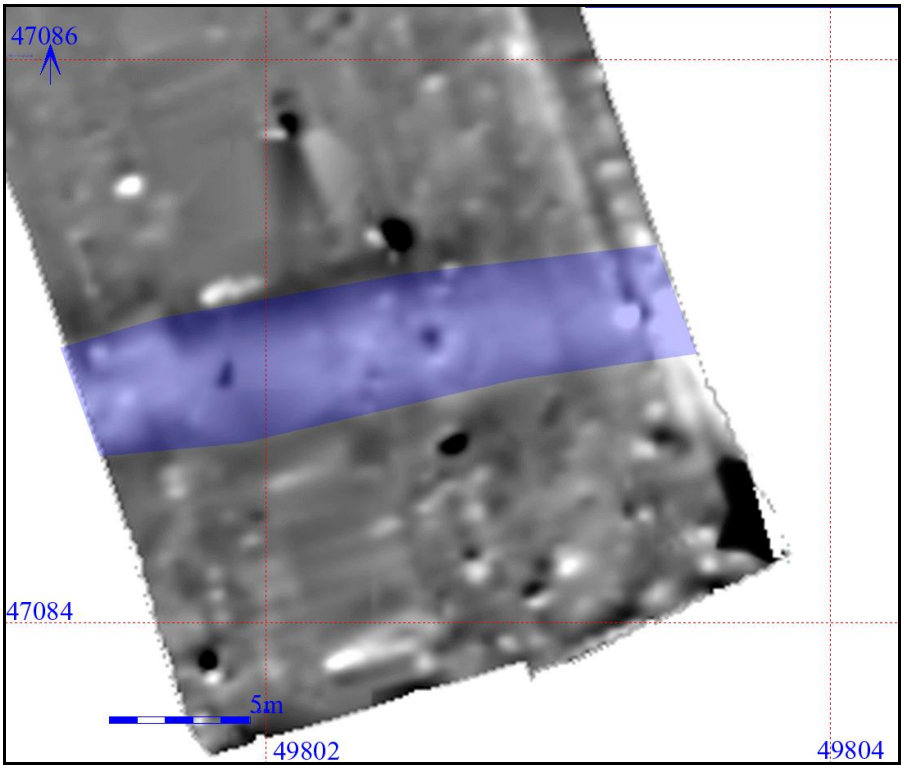

Figure 5 Site 574 anomaly 1 (in transparent blue) location

Anomaly group 2 is a small area where two sets of localised anomalies area present (see Figure 6).

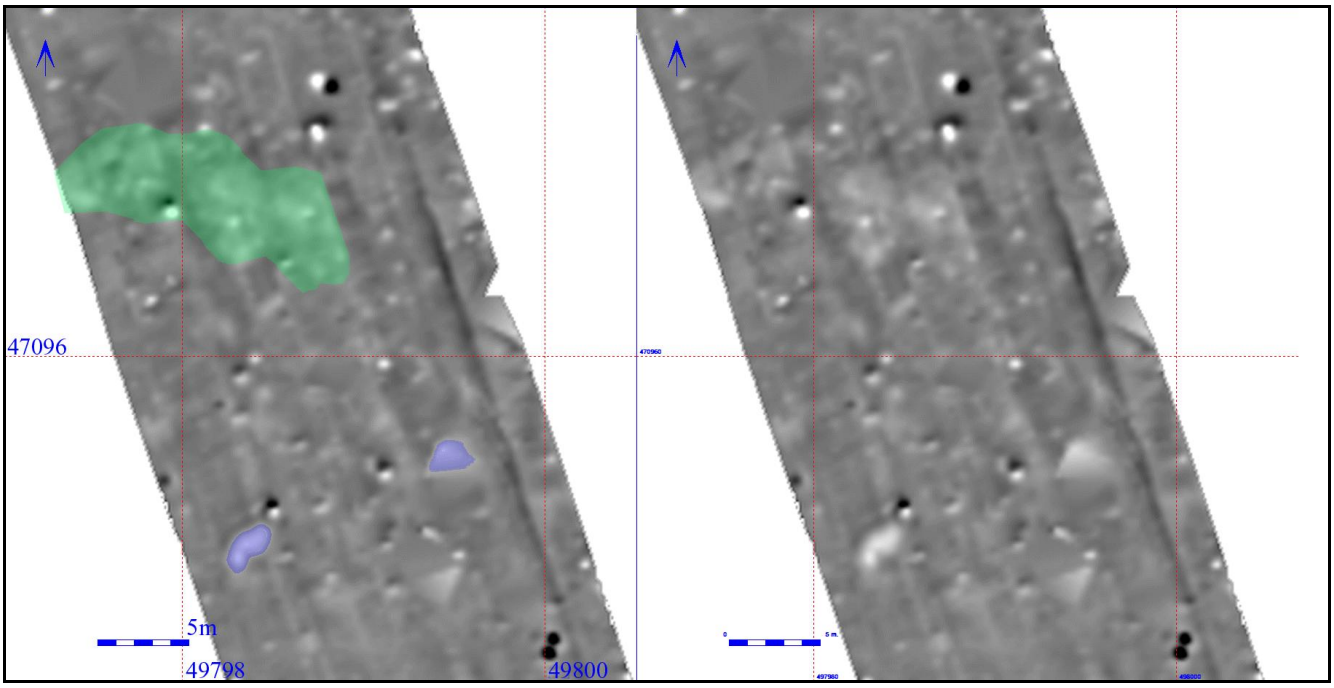

Figure 6 Interpretation of anomaly group 2 (greyscale data on the right)

The anomalies interpreted in blue are potential pits (note the dark line in the east marks the edge of the track which runs up the edge of the field). The anomaly interpreted in green is more difficult to assign, as it is quite amorphous. It could be the truncated remnants of a chalk quarry pit, but it is more likely to be natural in origin.

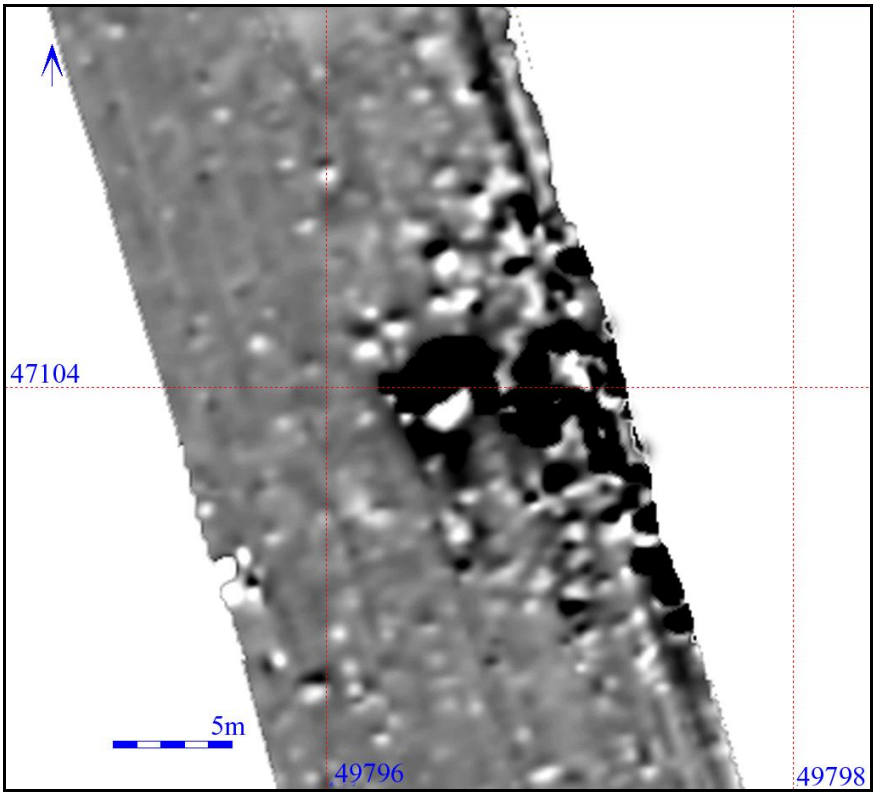

Figure 7 Anomaly group 5

Anomaly group 5 (see Figure 7) consists of a large number of dipolar signals, indicating a relatively recent origin. It is possible that a pit or pits were present here, before being filled in with modern detritus.

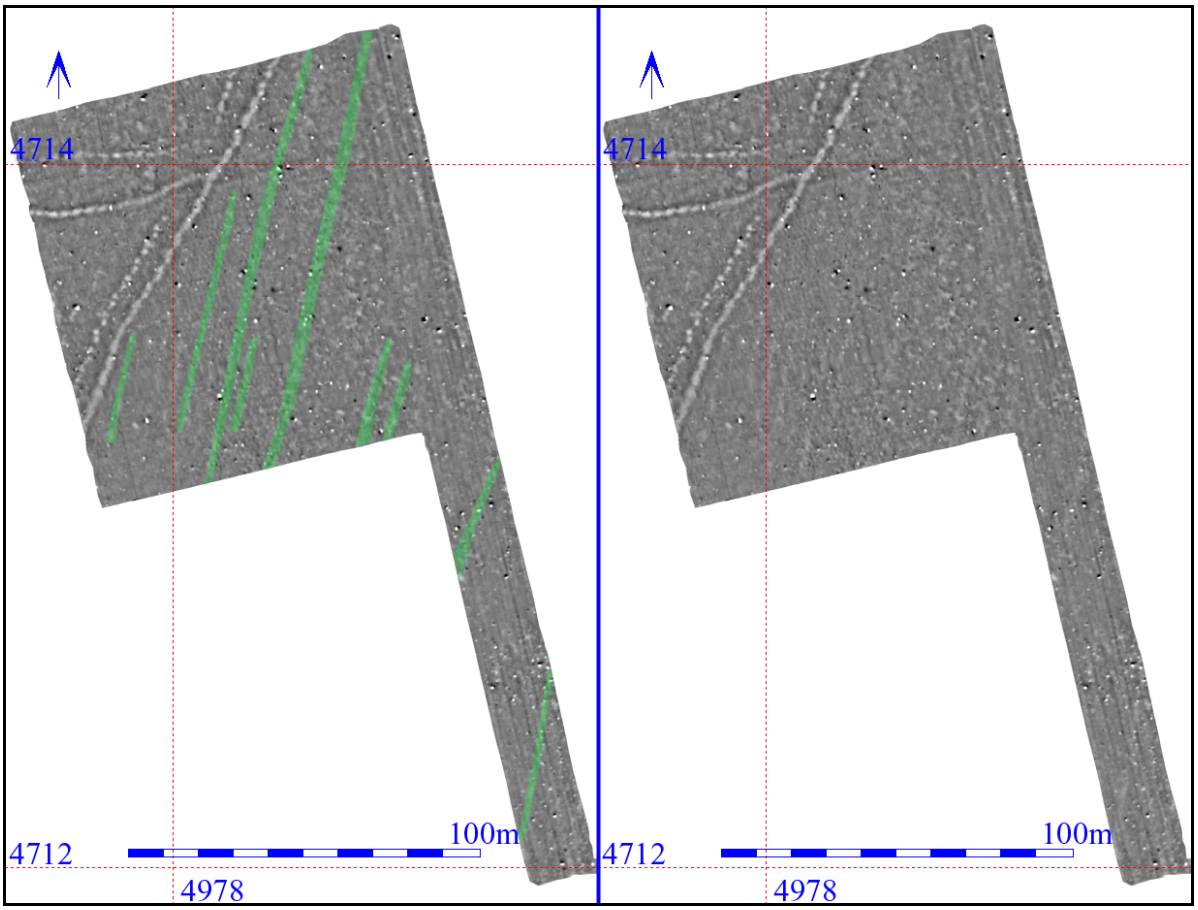

Figure 8 Interpretation of anomaly group 3 (greyscale image on the right)

Anomaly group 3 comprise of a set of linear features, extending across the area from the north to the south-west. They are characterized by being very weakly magnetically positive. Interpreting these from the magnetic survey data alone is difficult, and at first glance they would be classified as natural in origin (possibly glacial scars in the chalk).

Figure 9 Showing full extent of feature group 3 (derived from Google Earth and enhanced)

However, when seen in certain years as cropmarks, they tell a slightly different story (see Figure 9). Here they seem to be far more regularly spaced, and could be interpreted as the remains of Medieval ridge and furrow ploughing.

In fact, when combining different image sets from Google Earth it is possible to track the field system on the northern side of the road all the way back to Weaverthorpe. This is illustrated in Figure 10, where the data from three different Google Earth image sets has been combined and enhanced, and red arrows indicate the location of the most obvious furrows.

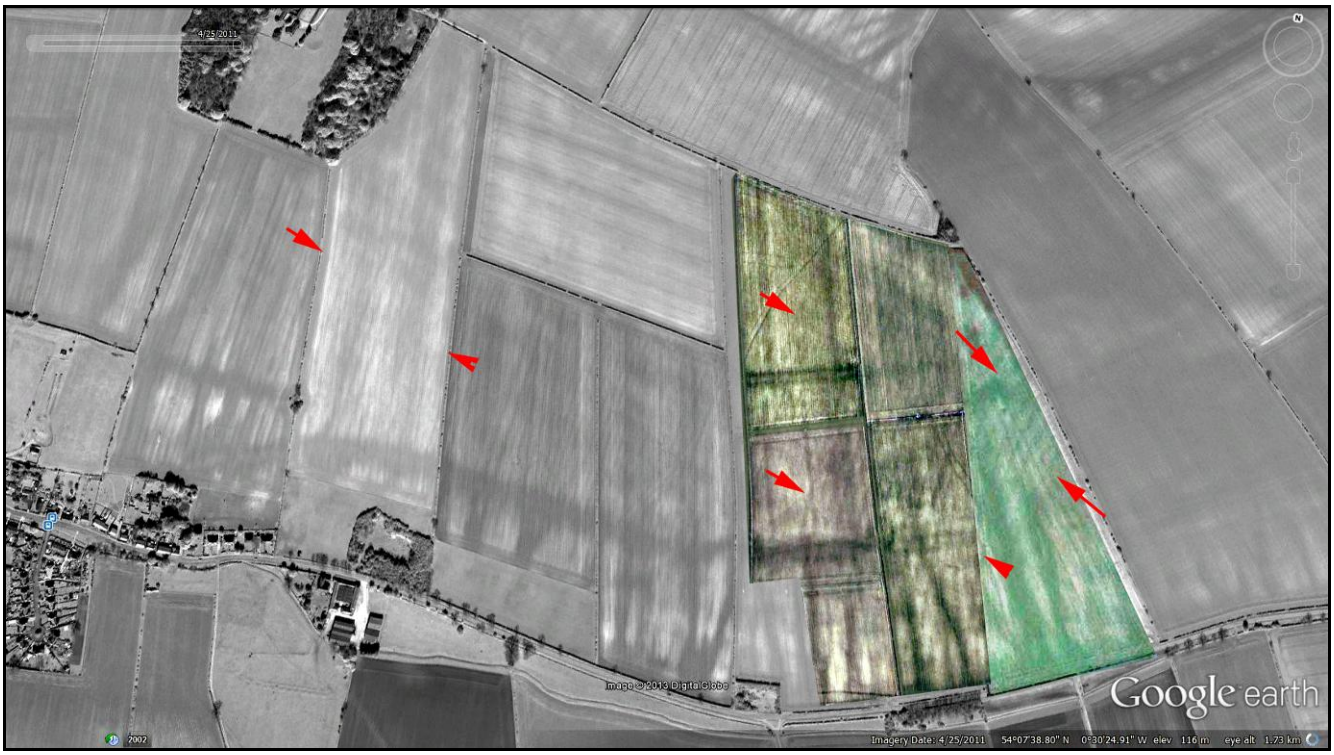

Figure 10 Ridge and furrow field system to the north and east of Weaverthorpe

Anomaly group 4 has long been known from cropmark evidence (see Figure 11, left), so there were no surprises when the magnetic data confirmed the presence of these linear features (lettered A-D on Figure 11).

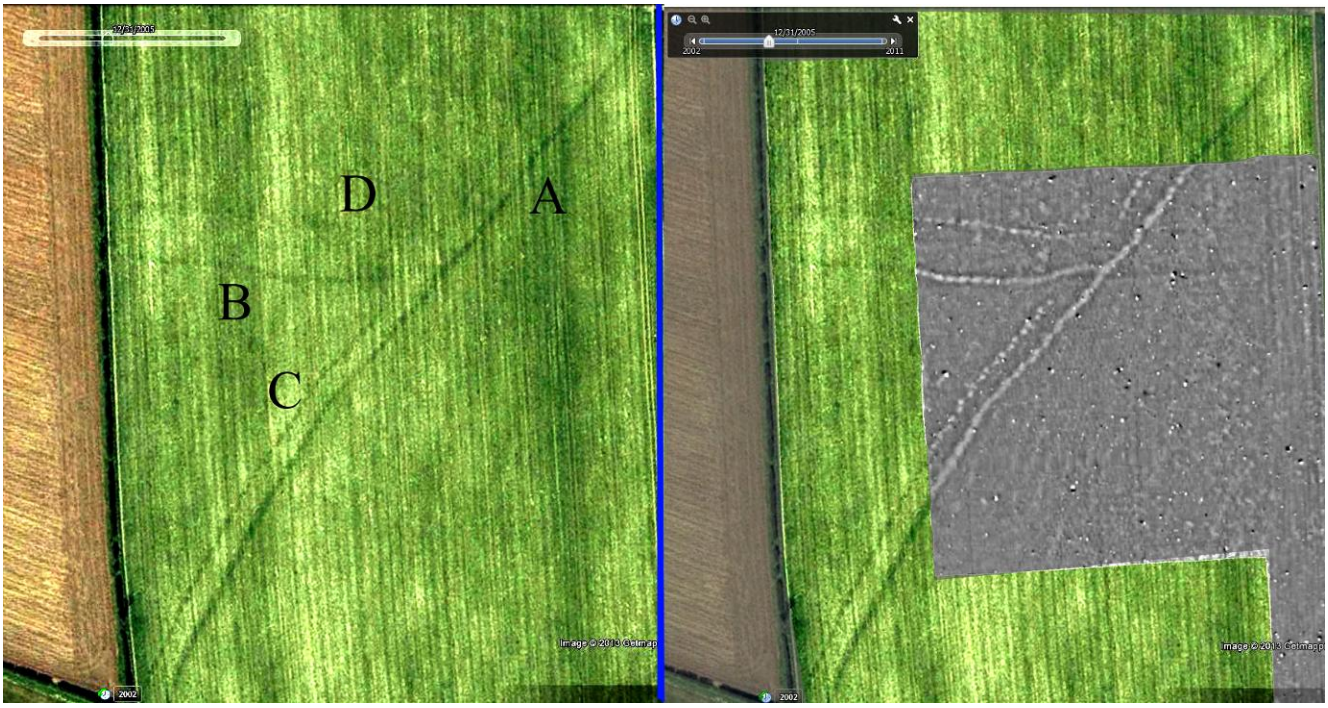

Figure 11 Digitally enhanced cropmark evidence (left) and with superimpose magnetic data (right)

However, the cropmark evidence indicated that, while features C and possibly B were pit alignments, both A and D appeared to be linear ditched features. The magnetic data (see Figure 12) clearly shows that all four of the linear features were pit alignments during the early phase of their development. In fact, it is possible to begin to create a putative chronological sequence for the features, based on their morphology and relative positioning.

It appears as though the north-west/south-east aligned pit alignment (A) was the first to be established, certainly by the middle Bronze Age, if not earlier. It initially comprised of a series of large pits (up to 2m across) with a small gap between each pit.

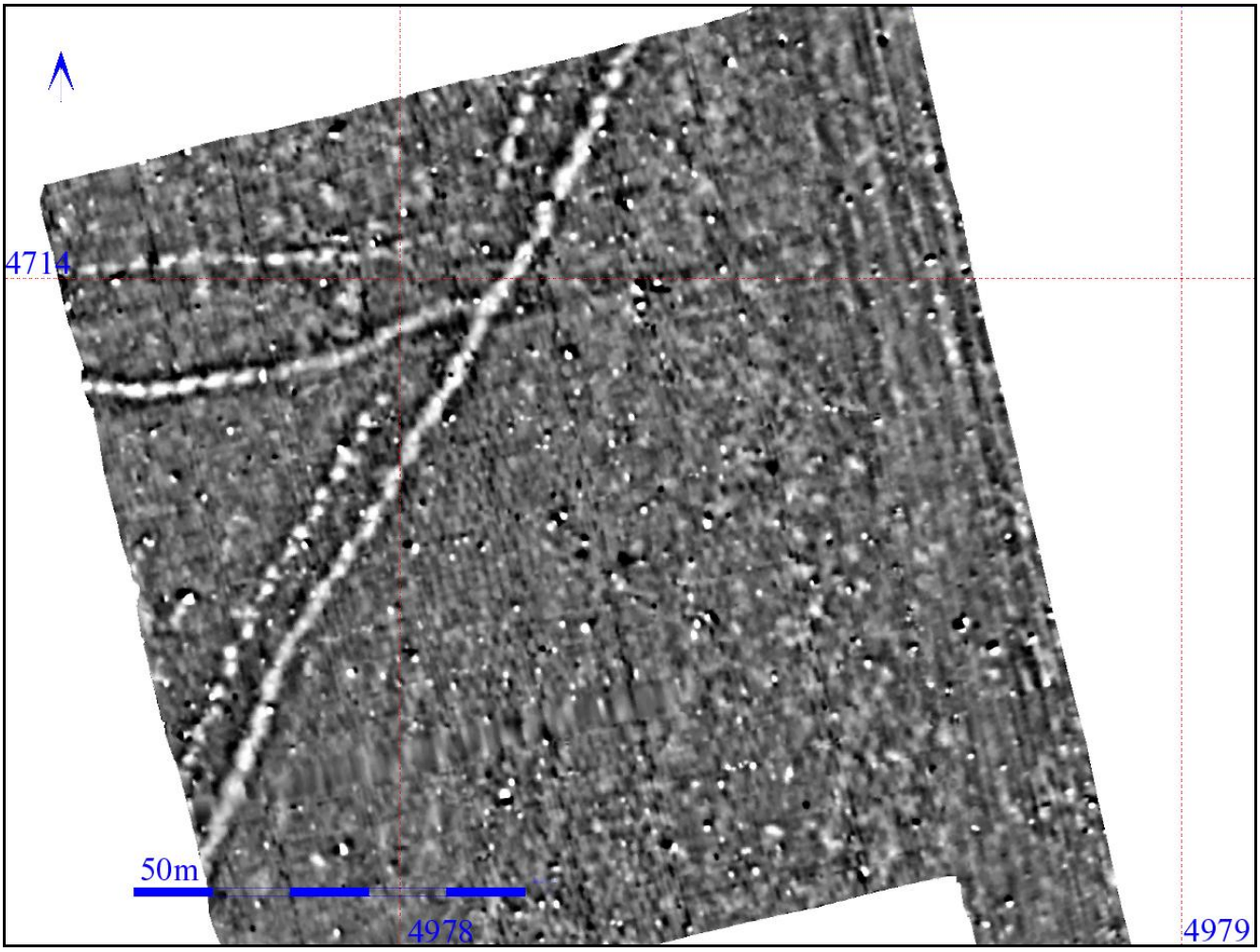

Figure 12 Contrast stretched greyscale image showing pit alignments

At some point after this, the east-west oriented pit alignment B was established, apparently butting up to pit alignment A. Alignments C and D were later, and may or may not have been constructed contemporaneously, as they both follow the line of the earlier alignments. However, they are made up of slightly smaller pits, which often indicates a later date (?late Bronze or early Iron Age). The final phase of both A and B sees them becoming a continuous ditch, a common occurrence for this type of feature across the Wolds. It appears that both C and D were not treated in this way, and were left to fill up naturally over time.

Also of note is the area concerning the junction of the four alignments. Previous interpretations of the cropmarks had both B and D joining into A, where it is now clear that D turns and respects the line of A. It is also clear that C follows closely the alignment of A, and definitely stops before reaching B, confirming it is one of the later events in the sequence.

Site 575

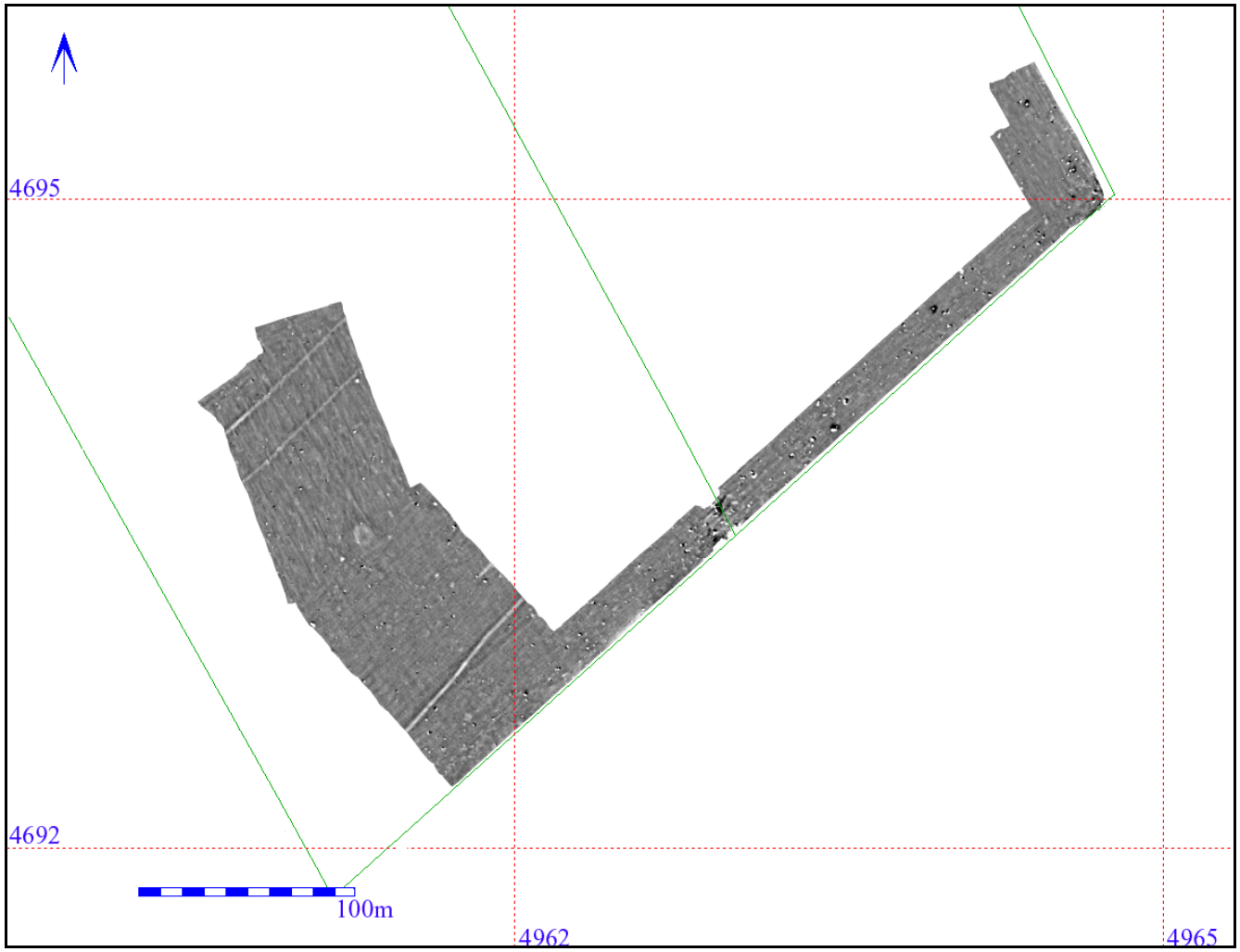

Figure 13 Greyscale image of site 575 in relation to the Ordnance Survey grid

Site 575 consisted of a 20m wide transect which began in the south-eastern corner of the field and ran south-west for 402m. The easternmost 30m was then extended 50m to the north and the westernmost 80m was extended a further 184m to the north to accommodate the potential location of the wind turbine (see Figure 1 and Figure 13 for location maps).

All of the magnetic anomalies detected in site 575 were in the westernmost part of the survey area, in the location of the proposed wind turbine. Virtually all of the main features were already known from cropmarks (see Figure 14). These included three linear features and a ring ditch (numbered 1 to 4 on Figure 15). The three linear features (plus a further similar feature just to the north of the surveyed area, all curve round into the field to the east, where they help to form a funnel-like feature, almost certainly to do with stock control, presumably keeping them from fouling the Gypsey Race to the north.

Figure 14 Site 575 geophysical survey with cropmark background

Anomaly number 1 (see Figure 15) is a small oval ring ditch, measuring 10.5m north-south and 8.8m east-west. It has all the characteristics of a burial feature, possibly later Iron Age in date, although if this were the case, it would normally be expected that there would be more of these features in the immediate area.

The three linear features are all part of a very large system located on the southern side of the valley, extending from Butterwick in the east to Kirkby Grindalyth in the west, with long curving ditches all heading towards funnel-like features, in this case in the field immediately to the east. From this funnel, a single ditched trackway leads north towards a ladder settlement located just to the south of the present village of Weaverthorpe. The whole system appears to be part of a form of stock control, probably linked with transhumance activities from the summer upper grazing slopes down into the valleys during the winter months.

Anomaly number 5 is subtly different from the other three linear features. Firstly, it is not represented as a cropmark, and while this does not preclude it from being of an archaeological origin, it does need to be explained. Secondly, unlike the other three linears, it is simply a positive magnetic signal, with no corresponding negative halo to either side. This implies a very shallow feature, possibly of a modern origin. Unfortunately, only 9m or so of the anomaly was surveyed, so it is not possible to indicate the extent of the feature.

A number of localised anomalies were present in the surveyed area, and it is possible that they represent the location of pits. However, most of them are only very slightly magnetically positive, and it is much more likely that they are of a natural origin. However, a number of these localised anomalies are magnetically stronger (coloured red in Figure 15) and it is more likely that these anomalies may represent archaeological activity in the form of pits.

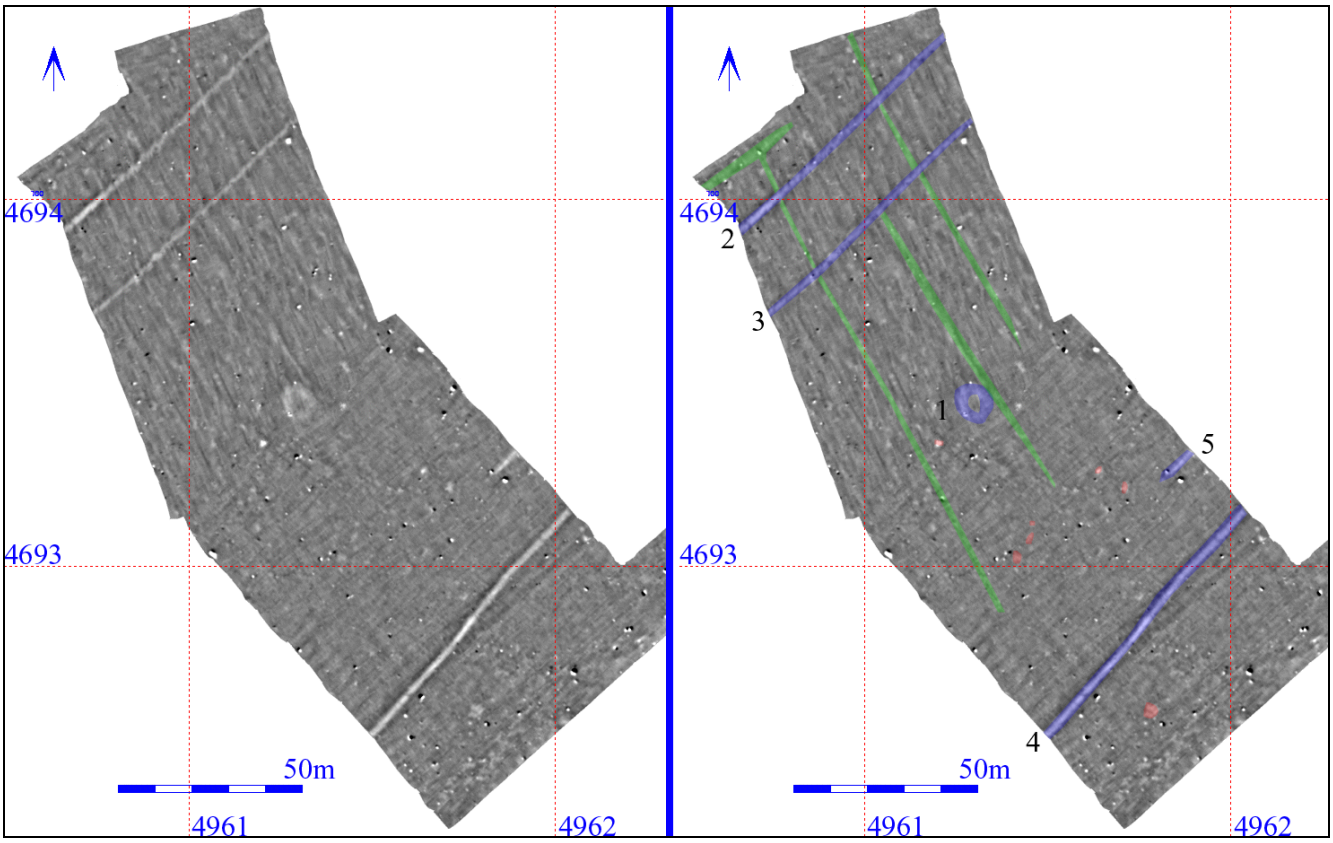

Figure 15 Greyscale image(left) and interpreted anomalies (right)

Finally, a number of long, linear north-south aligned anomalies were also present in the magnetic data (coloured green in Figure 15). At first glance, they are similar to those seen on the survey of site 575 to the east, but close perusal of all of the aerial photographs of the area show no further indication of ridge and furrow ploughing in this area. It must therefore be assumed that these anomalies are natural in origin, presumably glacial scrapes in the underlying chalk.

Conclusions

In conclusion, it can be stated that the underlying chalk geology provided a good magnetic contrast for the detection of infilled features. All of the previously known cropmarks were detected, as well as a number of new features. Ridge and furrow ploughmarks were detected in the eastern surveyed site, but not in the west.

Archaeological Advice

The geophysical surveys undertaken at Weaverthorpe both enhance and add detail to the known picture of features documented through the air-photographic record. No significant new features have been identified as a result of the surveys. The Wolds chalk provides an exceptionally reliable environment for geomagnetic prospection and it is very unlikely that any major features would not been detected, on the top and slopes of the Wolds levels of plough damage are now so great that major features are likely to be truncated and minor features either removed completely or seriously compromised. Nevertheless any ground disturbance associated with the construction of the turbines should be conducted under archaeological supervision. Any ground disturbance should be conducted under archaeological supervision with the plough soil removed using a toothless ditching blade on a back actor arm rather than a toothed bucket. Where cable runs or the construction platform extend across the identified features theses should be excavated by hand and recorded to professional archaeological standards. In the case of Site 574 anomaly 1, a major ditch running along the line of the valley, should be excavated by hand on a minimum width of 1.5m to recover an understanding of it's construction sequence, dating evidence and environmental samples that have the potential for returning information that could be used to characterize the past landscape. Should the turbine base extend over any part of the pit alignment and ditched boundary complex observed in the geophysical survey then these should also be examined with the objective of examining 50% of any exposed features through half sectioning pit alignment pits and

examination of ditch sections with the same objectives. It must be acknowledged that linear features of the kind observed here are notoriously difficult to date and often contain not material culture evidence at all.

In the case of Site 575 the cable run from the turbine will cut through two of the four ditches observed in the geophysical survey results, these link to the elaborate funnel entrance in the field to the east of the turbine site examined in 2004 by Melanie Giles. The cable run should be sited to avoid impacting the possible feature described as anomaly 1, a possible burial monument. As in the case of Site 574 any ground disturbance should be conducted under archaeological supervision with the plough soil removed using a toothless ditching blade on a back actor arm rather than a toothed bucket. It is recommended that the route of the cable run is stripped as a 1.5m wide trench as this will greatly improve the archaeologist's ability to observe any features exposed. This is particularly important in areas where there is any reason to suspect the location of burials as individual unenclosed burials are not highly susceptible to observation through geomagnetic survey. Should the possible pits identified in the geophysical survey be observed during stripping then a minimum of 50% of each feature should be examined. Where the cable runs cut across the identified ditches these should be excavated by hand on a minimum width of 1.5 metres with a view to recovering dating material and environmental samples. Should disturbance associated with the construction of the turbine base extend over either of the ditches crossing the centre of the western of the two fields impacted a minimum of 50% of the exposed ditch segments should be excavated by hand and fully documented.

It should be noted that the disturbance and associated examination of parts of the main features identified in the geophysical survey, as a consequence of the proposed development, should be seen as positive outcome in that these features run for many kilometers and are under perpetual threat from industrialised agriculture.