South Kirkby Camp,

South Kirkby,

West Yorkshire

Gradiometer Survey

by

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Contents

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(SE 435 105 site centred)

Gradiometer Survey

1. Summary

Objectives
To determine whether there was any evidence for the presence of a reported southern annexe to the camp and, if possible, to determine the limits of the site. It was also hoped to evaluate the presence and extent of any sub-surface archaeological remains within the scheduled area and, where possible, to characterise the archaeology thus located.

Methodology
A detailed magnetometer survey using a Geoscan FM36 fluxgate gradiometer was carried out over a 4.0ha area. The survey area was tied in to the Ordnance Survey National Grid using a Geotronics Geodimeter 600 total station theodolite.

Results & Conclusions
The gradiometry data revealed no evidence for the presence of an attached southern annexe. Inside the scheduled monument there are anomalies which are of possible archaeological origin and which may indicate the presence of a second, inner ditch and an internal enclosure.

2. Introduction and Methodology

2.1 Archaeological Services (WYAS) were commissioned to undertake a undertake a detailed gradiometer survey over an area of 4.0 hectares at South Kirkby Iron Age Camp, South Kirkby at SE 435 105 (see Figs 1 & 2). This survey was part of a programme of improved site management and interpretation. It was hoped that the full extent of the site could be determined, with the intention of bringing the site under single ownership.

2.2 The survey incorporated both the upstanding earthworks and an area to the south, believed to be an attached annexe, which are both part of a Scheduled Ancient Monument (monument number 384),

2.3 As the site is a protected monument, permission was sought and granted from the regional inspector of English Heritage, Mr. John Ette, before the surveys were undertaken.

Comment [J1]:

2.4 The survey was carried out in three stages, on the 2nd October, from 28th October to 3rd November 1997 and on the 9th December. Over this time the interior of the scheduled monument was under rough pasture, with dense bracken and gorse in the north-east corner of the scheduled area. Throughout the site there were concentrations of dense bracken and bramble, which made surveying in these areas impossible. In places the topography also limited the areas which could be surveyed, particularly across the east of the site and in a gully to the north-west, where a stream runs through. The field believed to contain the attached southern annexe was under stubble at the time of the survey.

2.5 The site overlies sandstones and shales of the Upper Carboniferous Middle Coal Measures, with an unknown depth of soil cover.

2.6 The interior of the monument has been landscaped to an unknown extent (c. 1978) and has had crops on it until the 1970's, and so will probably have been ploughed extensively.

3. Archaeological Background

3.1 In the past the site has been referred to as a hillfort but, as it is situated below the summit of a hill on ground falling away to the north-west, this is no longer believed to be true. It is now believed to be an Iron Age (and possibly Romano-British) defended enclosure.

3.2 The area enclosed by the visible earthworks covers an area of about 1.9 hectares, is defined by a single bank and ditch and is approximately oval in shape, with the long axis trending north-east to south-west. The depth of the ditch and height of the bank vary, with maximums of c. 1m deep, at the west, and c. 1.5m high, at the east, respectively. It is believed that the ditch has been recut and, what is termed a "natural gully occupied by a stream" (see Appendix 4) has probably also been recut as there appears to be evidence of small spoil heaps on the southern bank of the stream.
3.3 The location of the attached southern annexe is described by Atkinson (1949) in an unpublished excavation report. It was described as covering an area of c. 150m x c.40m

and was originally defined by a bank (and possibly a ditch).There is no existing topographical evidence for this bank.

3.4 In 1978 a limited resistivity survey was conducted over the "apparent" gap in the northern rampart (Howard and Howard-Davis 1978). This survey indicated a small high resistance anomaly with a low resistance anomaly outside it, several metres to the north of the stream. These readings were interpreted as representing the remains of the bank, possibly with the ditch outside it.

4. Results and Discussion

4.1 The Presentation of the Results

4.1.1 The gradiometer data is presented in Appendix 4 in dot density and X-Y trace formats at a scale of 1:500. A grey scale plot at 1:2500 is superimposed on an Ordnance Survey base in Figure 2, with an interpretation of the data at 1:1250 shown in Figure 3.

4.2 The Gradiometer Survey (Figs 2 & 3)

4.2.1 There are many different types of anomalies observable across the site, of both possible archaeological and non-archaeological origin. Many of these anomalies appear faint or broken up and so it is difficult to interpret them. This lack of clarity of anomalies is probably exacerbated by two factors. The first is that the site has undergone recent ploughing, which may have disturbed or partially removed any sub-surface features.

The second problem is that much of the site has a very irregular topography. This, combined with a differential vegetation cover, made surveying very difficult and meant that many data grids had to be processed to remove discrepancies caused by the terrain, such as "striping". This can sometimes lead to the removal of true, faint anomalies, or the creation of spurious anomalies. Those anomalies which have a strong response or which do not have the same orientation as a grid edge can be ascribed, with a greater degree of certainty, to definite features. However, it is still possible that other anomalies do represent definite features.

4.2.2 The first of the anomaly types are the isolated positive/negative (dipolar) responses ("iron spikes") which are ubiquitous across all parts of the site. They are indicative of ferrous material on the ground surface and in the topsoil and are not normally archaeologically significant.

4.2.3 Similar to these dipolar responses, but concentrated in areas rather than isolated responses, are the areas of magnetic disturbance. These are probably of modern origin and represent areas where there are concentrations of ferrous material or areas of recent burning. The areas of magnetic disturbance in the eastern-most survey area (**A**), outside the scheduled monument, correspond with large visible areas of burning, as well as much modern ferrous waste. The areas to the north-west of the "natural" gully (**B**) correspond to the top of a ridge and had a range of over 400nT. This indicates large concentrations of either ferrous or burnt material very close to the surface. It is unlikely that these will be of archaeological origin.

4.2.4 The area to the east also contains a strong dipolar linear anomaly (**C**), indicative of a modern ferrous service pipe.

4.2.5 Positive linear/curvi-linear anomalies can be observed, in the north-western and south-eastern survey areas (**E**). The linearity and strength of response of these anomalies indicates that they are relatively recent features and probably represent modern land drains.

4.2.6 Another anomaly, which probably represents a modern feature, can be observed in the north-western survey area (**D**). This response is a negative linear anomaly, indicating that it is caused by a non-ferrous feature. The anomaly seems to cut the land drains and probably represents a modern non-ferrous feature, such as a plastic pipe.

4.2.7 A strong, positive linear anomaly (**F**) can be observed trending east-north-east to west-south-west across the centre of the site. This anomaly does not have the same orientation as any other anomalies or topographical features and is not continuous across the site. If this anomaly represents an archaeological feature then its irregularity may indicate that it has been disturbed by ploughing. This may also explain why the anomaly appears to terminate abruptly.

It is also possible that this anomaly represents a geological feature. It is known that there are several minor geological faults in the South Kirkby area and, although there are no faults marked directly over the site, this anomaly may represent a small unrecorded fault.

4.2.8 There are many areas of magnetic enhancement across the site which have strong, positive magnetic responses. These responses do not have the characteristic sharpness of iron spikes and this, coupled with the breadth of many of the responses, indicate that they are probably not of a ferrous origin.

It is noticeable that many of these areas of magnetic enhancement are concentrated around Anomaly **G** and appear to form "sides" of a sub-rectangular enclosure, 20m by 30m. The positioning of these anomalies may be coincidental but the regularity of the shape which they form suggests they may be cultural in origin

4.2.9 Anomaly **G** consists of a non-continuous, negative linear anomaly trending approximately north to south and which terminates, at either end, at an area of magnetic enhancement. Inside the area described by the linear anomaly and areas of enhancement a faint square-shaped, positive anomaly, 8m by 8m can be observed. It is difficult to evaluate the origin of this anomaly.

4.2.10 Several positive, linear/curvi-linear anomalies can be observed in the north and eastern areas of the scheduled monument, which may represent archaeological ditches. The most noticeable of these is Anomaly **H**. This anomaly closely follows the orientation of the extant ditch and appears to lie within the area encompassed by the ditch. The anomaly is strongest in the north, where the inner bank is no longer visible, and so may be associated with the remains of the bank. However, from their resistance data, Howard and Howard-Davis (1978) suggest that the bank is approximately 10m further north than the location of Anomaly **H** indicating that the anomaly is not associated with the bank. It is possible, therefore, that Anomaly **H** represents part of a smaller, inner ditch, which is no longer visible as a major topographical feature. Anomaly **I** corresponds with the bottom of the extant ditch, and was the only area where the topography allowed the extant earthwork remains to be surveyed.

5. Conclusions

5.1 Although the data is difficult to interpret, there are many anomalies which can be reliably ascribed to cultural features. The majority of these are, however, probably of modern origin.

5.2 No evidence of the supposed southern annexe could be found. If there was a feature here, which was only represented by a bank, then recent ploughing may have dispersed the feature such that no magnetic contrast remained. It is possible, therefore, that the southern annexe may have once existed but its remains are not detectable by magnetic survey techniques.

5.3 Within the interior of the scheduled monument there are anomalies which are of possible archaeological origin. Of these, Anomaly **H**, which indicates the presence of a possible second, inner ditch, is perhaps the most definite, but there is also evidence of a possible enclosure, or at least an area of concentrated cultural activity, as described by Anomaly **G**.

The results and subsequent interpretation of geophysical surveys should not be treated as an absolute representation of the underlying archaeology. It is normally only possible to prove the archaeological nature of anomalies through intrusive means such as by trial excavation.

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Appendices

Appendix 1 Gradiometer Survey: technical information and methods
Appendix 2 Survey location information
Appendix 3 Survey specification
Appendix 4 Gradiometer data plots

Appendix 1

Gradiometer Survey: technical information and methods

1. Technical Information

1.1 Iron makes up about 6% of the Earth's crust and is mostly dispersed through soils, clays and rocks as chemical compounds. These compounds have a weak, measurable magnetic response which is termed its magnetic susceptibility. Human activities can redistribute these compounds and change (enhance) others into more magnetic forms. These anthropogenic processes result in small localised anomalies in the Earth's magnetic field which are detectable by a gradiometer.

1.2 In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for the more magnetic compounds to concentrate in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. Less magnetic material such as masonry or plastic service pipes which intrude into the topsoil will tend to give a negative magnetic response relative to the background level.

1.3 The magnetic susceptibility of the soil can also be enhanced significantly by heating. This can lead to the detection of features such as hearths, kilns or burnt areas.

1.4 High, sharp responses are usually due to iron objects in the topsoil. These produce a rapid change from positive to negative readings ("iron spikes").

1.5 The types of response mentioned above can be divided into five main categories which are described below:

1. **Iron Spikes (Dipolar Anomalies)**
   These responses are referred to as dipolar and are caused by buried or surface iron objects. Little emphasis is usually given to such responses as iron objects of recent origin are common on agricultural sites. Occasionally, however, iron spikes can indicate the presence of archaeological industrial activity.

2. **Rapid, strong variations in magnetic response**
   Also referred to as areas of magnetic disturbance, these can be due to a number of different types of feature. They are often associated with burnt material, such as industrial waste or other strongly magnetised material. It is not always easy to determine their date or origin without supporting information.

3. **Positive, linear anomalies**

The strength of these responses varies depending on the underlying geology. They are commonly caused by ancient ditches or more recent agricultural features.

4. **Isolated positive responses**
These usually exhibit a magnitude of between 2nT and 300nT and, depending on their response, can be due to pits, ovens or kilns. They can also be due to natural features on certain geologies. It can, therefore, be very difficult to establish an anthropogenic origin without an intrusive means of examining the features.

5. **Negative linear anomalies**
These are normally very faint and are commonly caused by features such as plastic water pipes which are less magnetic than the surrounding soils and geology. They too can be caused by natural features on some geologies.

2. Methodology

2.1 There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as *scanning* and requires the operator to visually identify anomalous responses whilst covering the site in widely spaced traverses, typically 10-15m apart. The instrument logger is not used and there is therefore no data collection. This method is used as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be surveyed. Scanning can also be used to map out the full extent of features located during a detailed survey.

2.2 The second method is referred to as *detailed survey* and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.5m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation.

2.3 The detailed technique was the method employed during this survey. A Geoscan FM36 fluxgate gradiometer and ST1 sample trigger were used to take readings at 0.5m intervals on zig-zag traverses 1m apart within 20m x 20m square grids, with the instrument held pointing north-west. 800 readings were taken in each grid and in-house software (Geocon Version 9) was used to interpolate the “missing” line of data so that 1600 readings in total were obtained for each complete grid. The Contors programme was used to present the grey-scale and dot density plots, whilst Geoplot was used to present the X-Y trace plot. Due to the irregular topography across the site discrepancies in the data caused by operator error, such as an artificial striping effect, arose, which did not represent true features. The data was therefore processed (destriped) to remove these. The X-Y trace plot was clipped between values of -15nT and +15nT to reduce the effects of strong “spikes”.

Appendix 2

Survey location information

A separate survey baseline, laid out to best fit in with the nearest field boundaries, was used for each of the three survey stages. Semi-permanent marker pegs were left at two points (see accompanying Geodimeter plan), in the fence-line to the south **(A)** and beside an electricity pole in the field to the south **(B)** and each of the survey stages was tied to these.

Using the Ordnance Survey 1:2500 map series National Grid co-ordinates were obtained for the two pegs and the Geodimeter station positions (see Figure 3).

These co-ordinates are accurate to +/- 1m at 1:2500.

Appendix 3

Survey specification

Appendix 4

Gradiometer data plots