Castle Hill,

Almondbury,

West Yorkshire.

(SE 1528 1413 site centred)

Geophysical Survey

Contents

Summary

A geophysical survey was carried out within the fortified site and in the annexe area at Castle Hill, Almondbury, to enhance the archaeological record and to aid decisions relating to the management of the monument. Anomalies attributed to infilled excavation trenches were identified in the Middle and Outer Wards together with anomalies caused by modern service pipes and ridge and furrow ploughing. In the Annexe a possible sub-rectangular structure has been identified south of an anomaly thought to locate Varley's 'bothy'. Traces of a buried enclosing earthwork have also been identified.

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1. Introduction & Archaeological Background

1.1 A geophysical survey, combining both resistivity and magnetometry, was carried out by the West Yorkshire Archaeology Service at Castle Hill, Almondbury (see Fig. 1), as part of its service delivery to Kirklees Metropolitan District Council. The survey covered the fortified site, encompassing all areas within the designated Scheduled Ancient Monument (SAM No. 58), as well as the area attached to the north-east corner of the hillfort known as the Annexe (see Fig. 2).

1.2 Castle Hill is a distinctive plateau which dominates the village of Almondbury, south-east of Huddersfield. The summit of the hill covers an area of 3.7 hectares and is composed of a cap of hard Grenoside sandstone which protects the softer sandstones and shales beneath. At its highest point in the south-west the hill is 275m above sea level, sloping away steeply in the west towards the River Holme and less steeply in other directions.

1.3 The site was intermittently excavated by the late Dr. W. J. Varley between 1939 and 1972. He concluded that the site was first occupied *c.* 2150BC but that it soon fell into disuse before being re-occupied in *c.* 700BC when the first earthworks were constructed. By his chronology the site was again abandoned before the period of greatest expansion between 590BC and 431BC when increasingly complex ramparts and earthworks of stone, timber and soil were constructed. There then followed an hiatus in occupation of nearly two millennia, after much of the defences were destroyed by fire, before another earthwork was constructed in the mid 12th century. This utilised much of the surviving banking to create three baileys (wards). In the early 14th century there was an attempt to found a town on the hill but by about 1340 this too had been abandoned.[1]

1.4 Prior to the final phase of Varley's excavations experimental archaeological geophysical work was carried out by Dr. A. Aspinall of Bradford University. These were predominantly earth resistance surveys, most notably over the entire Outer Ward area, although magnetometer surveys were also carried out over small, selected areas. [2]

1.5 The main aim of the WYAS geophysical survey was, therefore, to augment the data obtained by Dr. Aspinall, thereby enhancing the archaeological record, and, as a consequence, providing information which might benefit the future management of the monument.

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[1]Varley's conclusions are currently being re-evaluated following the completion of the earthwork survey by the RCHME and the catologuing of the excavtion archives by the West Yorkshire Archaeology Service

[2]These surveys are currently unpublished but are being compiled by Dr. A. Aspinall and Mr. A. Boucher of Archaeological Investigations Ltd. for publication in Archaeological Prospection.

2. *Results & Discussion*

2.1 The gradiometer data are presented as greyscale and dot density plots superimposed on a 1:2000 Ordnance Survey digital map base in Figure 2. Greyscale and dot density plots of the gradiometer and resistance data with interpretational overlays are displayed at a scale of 1:625 in Figures 3 to 8. Large scale 1:500 plots, including X-Y traces, are shown in Appendix 5.

2.2 For descriptive purposes the results are presented according to the divisions ascribed by Varley, namely the Middle and Outer Wards and the Annexe.

2.3 **Middle Ward (Figs 3 & 4)**

2.3.1 There was a good correlation between the gradiometer and resistance data in the Middle Ward, with many of the geophysical anomalies being interpretable from surface features. At the time of the survey (July 12th - 14th 1995) a parch mark was visible immediately south of the pub car park which corresponds with an area of low resistance. This area also correlated with the clusters of strong, dipolar, isolated, magnetic anomalies (*'iron spikes')* identified in the gradiometer data. These anomalies probably result from the dumping of excess backfill, created from the expansion southwards of the car park in 1972, over an area that was formerly part of the bowling green. The area of backfilling is likely to be more freely draining relative to other parts of the ward therefore showing as a parch mark and as an area of low resistance.

2.3.2 A second correlation can be made between the magnetic linear, dipolar anomaly, **Am**, and the low resistance linear anomaly, **Ar**, visible at the eastern end of the ward. These anomalies are caused by a service pipe laid beneath the gravel path that runs immediately inside the rampart. A second pipe linking at an oblique angle can be observed in the magnetic data as Anomaly **Bm**.

2.3.3 At right angles to **Ar/Am**, and parallel with the southern edge of the ward, is a linear, high resistance/negatively magnetic anomaly, **Cr/Cm**. This is caused by another pathway, probably with a non-ferrous pipe either beside or beneath it.

2.3.4 In the south-western corner of the ward are two linear, low resistance anomalies, **Dr** and **Er**, which correlate with the shallow linear depressions (**ay**) recorded on the earthwork survey carried out by the Royal Commission on the Historical Monuments of England. The RCHME attribute these depressions to the settling of backfill in some of the trial trenches excavated by Varley which are known to criss-cross this corner of the ward. The positions of these two trenches are also indicated by the linear magnetic anomalies **Dm** and **Em**.

2.3.5 The RCHME also record faint striations on the same north-west to south-east orientation which are interpreted as the remnants of ridge and furrow ploughing. It is likely that the remaining low resistance anomalies correlate either with other backfilled trenches or to infilled furrows. The same interpretations probably apply to the two short, linear, positive magnetic anomalies shown in Figure 3.

2.3.6 The area of low resistance at the north-western edge of the ward reflects a spread of hardcore extending from the car park behind the hotel and the areas of very high resistance (not labelled) to outcropping geology.

2.4 Outer Ward (Figs 5 & 6)

2.4.1 The most obvious anomalies in the magnetic data are the clusters of dipolar responses, **Fm** to **Lm**. Anomaly **Fm** clearly corresponds to a square depression which has been interpreted in the earthwork survey as ‘an old excavation trench in which the backfill has settled’. Several other recorded earthworks correlate with magnetic clusters (see below) and most, if not all, are probably caused by infilled test pits or trial trenches. At best Varley’s record of the locations of his excavations is inconsistent and inaccurate so the fact that some of these earthworks/magnetic anomalies do not appear to relate to published excavation plans should not be taken to indicate that they are not the cause of the observed anomalies.

2.4.2 Two metres east of **Fm** is a second cluster, Anomaly **Gm**. The type and magnitude of the responses, as well as the shape and area of the cluster, is the same as for **Fm** although in this case there is no visible trace of it on the ground. It is possibly also a backfilled test pit/trial trench.

2.4.3 A further 25m east is a third cluster, **Hm**, measuring *c*. 10m by 4m. This may be another backfilled trench but again there is no topographic evidence to support this interpretation.

2.4.4 The next two clusters, **Im** and **Jm**, do correspond to earthworks (**bg** and **bh** respectively) which are again thought to be backfilled excavation trenches. No published record has been found for the postulated slit trench, **bg**, but, **bh**, roughly corresponds to the position of Trench 32 as marked on Varley’s 1973 trench plan.

2.4.5 Two other clusters, **Km** and **Lm**, on the north-western edge of the ward have also been identified. A similar interpretation, namely infilled excavation trenches, probably explains these anomalies.

2.4.6 Although it is thought likely that these clusters are probably all caused by the addition of magnetic or magnetically enhanced material into the backfilled spoil from Varley’s excavations it should be noted that some or all could equally be caused by infilled quarry pits, a possibility raised in the commentary on the results of the earthwork survey. The relatively large areas covered by most of these anomalies, and the magnitude of the responses, probably precludes an archaeological interpretation, although the two smallest clusters, **Jm** and **Lm,** could possibly be archaeological features such as rubbish pits or areas of localised burning.

2.5 The Annexe (Figs 7 & 8)

2.5.1 The earthwork survey has identified a slight ditch at the south-western edge of the survey area which is also identified in the resistance data as an intermittent area of high resistance (200-250 ohms), Anomaly **Lr**, that runs parallel with the existing dry stone wall. There are also two parallel projections perpendicular to this anomaly, one along the northern edge of the survey area and the second 9m to the south, neither of which are on the same alignment as the anomalies attributed to ridge and furrow ploughing described below. It is thought unlikely that this anomaly derives from the collapse of the adjacent stone wall into the ditch identified by the earthwork survey, as the electrodes did not come into contact with any stones buried near the surface during the course of the field work. However, a structural explanation cannot be ruled out.

2.5.2 At the opposite end of the annexe is a second high resistance linear anomaly (280-460 ohms), **Mr**, that follows the line of an earthwork bank. The gradiometer survey identified a positive linear response, **Mm**, with the same orientation and in a similar location. The high resistance is probably due to a combination of a feature buried beneath the existing bank and the bank itself while the magnetic anomaly could be caused by a ditch that has silted up after being filled with rubble, or a buried soil of high magnetic susceptibility, buried beneath a rubble revetment wall.

2.5.3 Along the south-east edge of the survey area a positive (2nT), curvi-linear anomaly, **Nm**, can be seen, that broadly follows the top of the scarp edge. It is interrupted at two points which coincide with the position of two of Varley's trenches, also identified by the RCHME earthwork survey. It continues on the same alignment further south with an additional break in response.

2.5.4 Four metres south of **Nm** is a high resistance linear anomaly, **Nr**, that continues, with two breaks, towards the south-west corner of the site. The first break coincides with that in the magnetic anomaly described above. It is likely that this high resistance anomaly is caused by a rubble feature with a build up of soil behind it producing a slightly lower resistance anomaly as well as a positive magnetic response. The gaps may be due to unrecorded trenches.

2.5.5 From Varley's excavations the most significant discovery inside the Annexe was a structure described as a two roomed 'bothy' with rubble walls and a rock cut floor. Although the precise location has been difficult to determine from the excavation plans the gradiometer survey shows a cluster of positive responses in the same area as the 'bothy' as located during Aspinall's earlier geophysical survey (*in prep*.). These anomalous responses imply that the more magnetically susceptible top-soil has been mixed with sub-soil when the trench was backfilled. It would be expected that the rubble walls of the 'bothy' would produce a higher resistance response than the background resistance of the soil matrix. The anomalies described below appear to reflect this distinction.

2.5.6 Immediately south of the area thought to be the location of the 'bothy' is a group of areas of high resistance, **Or**, forming a sub-rectangular pattern. Many of the areas have well defined linear edges and they may indicate the presence of structural remains and associated building rubble. Internal gaps in the anomalies suggest the possible structure may have been divided into at least three 'rooms', whilst external breaks suggest entranceways, particularly on the southern side.

2.5.7 The gradiometer survey has identified three isolated, positive anomalies, **Pm**, within this 'structure', varying in strength from 3.5nT to 5nT. These anomalies could indicate the presence of hearths.

2.5.8 Both the gradiometer and resistance surveys show striations running along the length of the annexe from north-east to south-west. These anomalies (c. 100 ohms and 7 to 8m apart) are caused by the practice, begun in the medieval period of ploughing in a series of relatively narrow strips using a plough capable of turning over the sod. Over many years, if the exact form of the original strip is maintained, a characteristic ridged topography will result. Even after the visible evidence of ridge and furrow has been removed by modern ploughing magnetic traces of the sub-surface remains can often be detected. This geophysical evidence supports Varley's assertion that the annexe was cultivated in the medieval period.

3. Conclusions

3.1 Overall there has been a good correlation between the gradiometer and resistance surveys. When the geophysics data is integrated with the results from the earthwork survey the interpretation of the geophysical anomalies is further refined. In this way it has become apparent that many of the anomalies were attributable either to backfilled excavation trenches or to relatively recent human practices such as ridge and furrow ploughing.

3.2 Much of the inner ward has been subject to varying degrees of landscaping or other forms of ground disturbance in the recent past. It seems unlikely that there any surviving archaeological remains in this part of the site.

3.3 The survival of ridge and furrow plough lines, albeit as extremely shallow earthworks, across most of the outer ward suggests that recent disturbance in this area might be minimal. From this it could be inferred that any earlier archaeological features might also survive. However, no anomalies of definite archaeological origin have been identified although several of Varley's test pits and trenches have been located.

3.4 In the Annexe the results are more positive. The probable location of Trench 17 in which Varley excavated the 'bothy' has been identified together with a much larger possible structure to the south which has internal anomalies consistent with the responses that might be expected from hearths or areas of burning. Other anomalies could indicate a buried earthwork around the scarp edge.

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

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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 cause 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, such as ditches, that were cut into the subsoil and/or bedrock and which have subsequently 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:

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 smithing activity by detecting hammerscale.

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.

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.

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.

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 During this survey a Geoscan FM36 fluxgate gradiometer with an ST1 sample trigger were used to take readings at 0.5m intervals on zig-zag traverses 1m apart within 20m by 20m grids such that eight hundred readings were taken in each grid. In-house software (Geocon 9) was used to process the data and Geoplot 2.1 (Geoscan Research) was used to present the data.

Appendix 2

Resistance Survey: technical infomation and methods

1. Technical Information

1.1 The electrical resistance of the earth is predominantly dependant on the amount and distribution of moisture within it. Buried features can affect this distribution so that contrasts between archaeological features and surrounding deposits can be measured. As resistance is predominantly dependant on the water content of features the most striking variation will occur between a masonry structure, which contains no water, and a water retentive subsoil. A less striking contrast can often be measured between the infill of a ditch feature and the sub-soil, as the material making up the infill is less compact than the surrounding soils, thereby retaining more water. In the same way a ditch infilled by stones may retain less water than the subsoil creating a small, but measurable, difference in resistance.

1.2 The method of measuring variations in ground resistance involves passing a small electric current (1mA) into the ground via a pair of electrodes (*current electrodes*) and then measuring changes in current flow (the potential gradient) using another pair of electrodes (*potential electrodes*). In this way, if a structural feature, such as a wall, lies buried in a soil of uniform resistance much of the current will flow around following the path of least resistance. This reduces the current density around the feature thereby increasing the potential gradient. It is the potential gradient that is measured to determine the resistance. In this case, the gradient would be increased over the wall giving a *positive* or *high resistance* anomaly.
In contrast, a feature such as a water retentive ditch will be less resistive to current flow thereby increasing current density and decreasing the potential gradient over the feature giving a *negative* or *low resistance* anomaly.

2. Methodology

2.1 For archaeological purposes one current and one potential electrode (the *remote* or *static* probes) are fixed firmly in the ground a set distance away from the area being surveyed. The other current and potential electrodes (the *mobile* probes) are mounted on a frame and are moved from one survey point to the next. Each time the mobile probes make a good contact with the ground an electrical circuit is formed between the current electrodes and the potential gradient between the mobile and remote probes is measured and stored in the memory of the instrument.

2.2 A Geoscan RM15 resistance meter and logger were used during this survey, with the instrument logging each reading automatically at 1m intervals. The mobile probe spacing was 0.5m with the remote probes 10-15m apart and at least 15m away from the grid under survey.

Appendix 3

Survey Information

Independent grids were set out in each of the three survey areas using an optical square and 60m tapes. The grids in the Middle and Outer wards were tied into the Ordnance Survey National Grid by surveyors from the RCHME whilst that in the annexe was triangulated into the field boundaries using a tape.

It should be noted that the Ordnance Survey co-ordinates for 1:2500 digital maps have an error of +/- 1.08m at a 99% degree of confidence.

Appendix 4

Geophysical Archive

The geophysical archive comprises:-

- archive disks containing the raw data, survey tie-in information and grid location information, the report text (Word 6), and compressed CorelDraw files of the illustrations

- a full copy of the report

Appendix 5

Geophysical Data Plots