Alma Watchorn Park
Alfreton, Derbyshire

Detailed Gradiometer Survey Report

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Summary

A detailed gradiometer survey was conducted over land Alma Watchorn Park, near Alfreton in Derbyshire. The project was commissioned by Steve Olive with the aim of establishing the presence, or otherwise, and nature of detectable archaeological features on the site ahead of a proposed development.

The site comprises several pasture fields to the southwest of Alfreton, and is located on the southern flank of a low hill sloping from northwest to southeast, overlooking a stream and Damstead Wood in the base of the shallow valley. The survey area lies 300m northwest of the intersection of the A38 and the A61, with the other extents of the survey area defined by houses off Wingfield Road to the north, pasture fields to the west and south; the survey extended as far south as the stream at the base of the valley.

Detailed gradiometer survey was undertaken over all parts of the proposed development that were suitable for geophysical survey, a total of 5.8ha. The gradiometer survey was undertaken using Bartington Grad601-2 fluxgate gradiometer instruments, with data collected at 0.25m intervals along traverses spaced 1m apart.

The survey was successful in identifying anomalies of probable and possible archaeological interest, along with regions of magnetic disturbance and several modern services. Further ploughing trends thought to relate to ridge and furrow were also identified.

At the western extent of the site, clusters of pit-like anomalies are considered to be of possible archaeological interest, although it is also possible that these relate to natural features such as tree throws or infilled hollows. Further anomalies of possible archaeological interest are visible at the centre of the site, where a low mound exists, although extensive magnetic disturbance and strong ploughing trends have made conclusive interpretation difficult. A number of linear anomalies and regions of disturbance may relate to former boundaries. At the eastern extent of the survey area, rectilinear anomalies are thought to be of probable archaeological interest and it is possible that they represent the remnants of a former structure.

Ploughing trends typical of ridge and furrow can be seen clearly across the central and eastern portions of the survey area, although their relationship with the probable former boundaries is unclear. Their presence and strength of response has made interpretation of other anomalies nearby more difficult.

A modern service extends parallel with the southern boundary across the southwestern limit of the survey area and is oriented NE-SW before turning to a NW-SE alignment. A negative linear anomaly can be seen across the central portion of the site, apparently cutting the ridge and furrow, although this cannot be demonstrated conclusively; it is possible that it relates to a former boundary or perhaps a service trench.

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Acknowledgements

The detailed gradiometer survey was commissioned by Steve Olive, whose assistance is gratefully acknowledged in this regard.

The fieldwork was directed by Chris Swales and assisted by Jonathan Buttery. Ben Urmston processed and interpreted the geophysical data in addition to writing this report. The geophysical work was quality controlled by Dr. Paul Baggaley. Illustrations were prepared by Karen Nichols. The project was managed on behalf of Wessex Archaeology by Ben Urmston.

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1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology was commissioned by Steve Olive to carry out a geophysical survey of land at Alma Watchorn Park, near Alfreton, Derbyshire (**Figure 1**), hereafter "the Site" (centred on NGR 440280 355005). The survey forms part of an ongoing programme of archaeological works being undertaken ahead of proposed development at the Site.

1.1.2 The aim of the geophysical survey was to establish the presence/absence, extent and character of detectable archaeological remains within the survey area.

1.1.3 This report presents a brief description of the methodology followed, the detailed survey results and the archaeological interpretation of the geophysical data.

1.2 The Site

1.2.1 The survey area comprises pasture fields within Alma Watchorn Park, some 1.4 km southwest of the centre of Alfreton and 15 km from Mansfield (**Figure 1**). Detailed gradiometer survey was undertaken over all accessible parts of the Site, a total of 5.8 ha.

1.2.2 The Site occupies the southern flank of a low hill, overlooking a stream and Damstead Wood in the base of the shallow valley. The Site slopes from 115m above Ordnance Datum (aOD) at the northwestern corner to c. 100m aOD along the southeastern boundary. The survey area lies 300m northwest of the intersection of the A38 and the A61, with the other extents of the survey area defined by houses off Wingfield Road to the north, pasture fields to the west and south; the survey extended as far south as the stream at the base of the valley.

1.2.3 The solid geology underlying the Site is likely to comprise siltstones, mudstones and sandstones of the Middle Pennine Coal Measures; it is possible that alluvial deposits may be present in close proximity to the stream forming the southern boundary of the survey area. Soils derived from such geological parent material have been shown to produce magnetic contrasts acceptable for the detection of archaeological remains through magnetometer survey.

2 METHODOLOGY

2.1 Introduction

2.1.1 The detailed magnetometer survey was conducted using a Bartington Grad601-2 dual fluxgate gradiometer system. The survey was conducted in accordance with English Heritage guidelines (2008).

2.1.2 The geophysical survey was undertaken by Wessex Archaeology's in-house geophysics team between 11th and 14th February. Field conditions at the time of the survey were acceptable, with the survey area being under pasture.

2.2 Method

2.2.1 Individual survey grid nodes were established at 30m x 30m intervals using a Leica Viva RTK GNSS instrument, which is precise to approximately 0.02m and therefore exceeds English Heritage recommendations (2008).

2.2.2 The magnetometer survey was conducted using a Bartington Grad601-2 fluxgate gradiometer instrument, which has a vertical separation of 1m between sensors. Data were collected at 0.25m intervals along transects spaced 1m apart with an effective sensitivity of 0.03nT, in accordance with EH guidelines (2008). Data were collected in the zigzag method.

2.2.3 Data from the survey was subject to minimal data correction processes. These comprise a zero mean traverse function (±5nT thresholds) applied to correct for any variation between the two Bartington sensors used, and a de-step function to account for variations in traverse position due to varying ground cover and topography. These two steps were applied to all survey areas, with no interpolation applied.

2.2.4 Further details of the geophysical and survey equipment, methods and processing are described in **Appendix 1**.

3 GEOPHYSICAL SURVEY RESULTS AND INTERPRETATION

3.1 Introduction

3.1.1 The gradiometer survey has been successful in identifying anomalies of possible archaeological interest across the Site, along with a number of modern services. Results are presented as a series of greyscale and XY plots, and archaeological interpretations, at a scale of 1:2000 (**Figures 2** and **3**). The data are displayed at -2nT (white) to +3nT (black) for the greyscale image and ±25nT at 50nT per cm for the XY trace plots.

3.1.2 The interpretation of the datasets highlights the presence of potential archaeological anomalies, ferrous/burnt or fired objects, and magnetic trends (**Figure 4**). Full definitions of the interpretation terms used in this report are provided in **Appendix 2**.

3.1.3 Numerous ferrous anomalies are visible throughout the detailed survey dataset. These are presumed to be modern in provenance and are not referred to, unless considered relevant to the archaeological interpretation.

3.2 Gradiometer Survey Results and Interpretation

3.2.1 At the northwestern extent of the Site, pit-like anomalies **4000** are of possible archaeological interest, although there is no clear coherency to their distribution. This cluster of pit-like responses extends south to **4001**, where they become smaller and less frequent.

3.2.2 A second cluster of pit-like responses **4002** are visible along the western extent of the survey area. Their origins are not clear, but they are considered to be of possible archaeological interest.

3.2.3 At the centre of the westernmost field, parallel linear trends **4003** are oriented approximately N-S. Whilst these anomalies exhibit very little contrast with the magnetic background, it is possible that they relate to a former field boundary.

3.2.4 Modern service **4004** is oriented NE-SW, parallel with the nearby boundary. It extends across the southern extent of the westernmost field, before apparently turning under the boundary to extend NW-SE across the southern portion of the field immediately to the east.

3.2.5 Region of magnetic disturbance **4005** extends some way into the westernmost field from the eastern boundary, and it is possible that this relates to modern debris, such as demolition rubble, being used to consolidate the field surface. It is possible that elements of this anomaly relate to an electricity pylon.

3.2.6 Towards the northern extent of the survey area, strong ploughing trends **4006** can be seen. These are typical of the remnants of ridge and furrow.

3.2.7 Several bands of magnetic disturbance extend across the central part of the survey area, e.g. **4007**, and it is possible that these relate to service trenches or former field boundaries. Along the boundary to the north of **4007**, it is possible that elements of the response are associated with a modern service lying in close proximity to the boundary, although it is not possible to determine this conclusively.

3.2.8 Within an extended region of magnetic disturbance, rectilinear anomalies **4008** are of possible archaeological interest. These responses are of uncertain origin given the

extents of magnetic disturbance, however, and it is possible that they are modern or historic in date.

3.2.9 Strong ploughing trends **4009** are typical of ridge and furrow and are oriented parallel with the extant boundary to the west. Negative linear anomaly **4010** is consistent with the remnants of a field boundary oriented NE-SW, and apparently later in date than the ridge and furrow, although this relationship cannot be demonstrated conclusively. Further weak linear trends can be seen to the southwest and northeast, which may indicate a continuation of this anomaly; it is possible that **4010** relates to a service trench, although this is considered unlikely.

3.2.10 Ploughing trends **4011** consistent with ridge and furrow at visible to the south of **4010**, although the relationship is similarly unclear as with **4009**. Linear anomalies **4012** extend approximately N-S and may represent the remnants of a former field boundary extending across this part of the field.

3.2.11 To the east of **4012**, a region of increased magnetic response **4013** extends approximately N-S across the southern portion of the field, with a spur extending to the northeast. Although the origin of this anomaly is unclear, it is possible that it relates to a former field boundary or agricultural activity.

3.2.12 A cluster of short linear and pit-like anomalies **4014** can be seen towards the southeastern extent of the survey. The better defined anomalies are considered to be of probable archaeological interest, although others exhibit less contrast with the magnetic background and have been interpreted less confidently. Considered together, these anomalies may relate to a ditch or former boundary.

3.2.13 To the north of **4013**, linear anomalies **4015** may be of archaeological interest. They are oriented parallel with the ploughing trends, however, and it is possible that they relate to individual furrows containing more magnetically enhanced material.

3.2.14 Towards the northern extent of the survey area, a relatively quiet region of magnetic background **4016** can be seen. There appear to be fewer ploughing trends within this field, suggesting a different agricultural regime.

3.2.15 At the northeastern extent of the Site, linear anomaly **4017** lies to the west of a group of strong ploughing trends suggestive of ridge and furrow, and on a different orientation. Further east, a cluster of strong anomalies **4018** lies within a region of magnetic disturbance. Whilst the origins of these anomalies are unclear, it is considered that those with more rectilinear form are of probable archaeological interest. It is possible that the smaller and less well defined anomalies nearby relate to the magnetic disturbance or the clear responses associated with ridge and furrow that are coincident with **4018**.

4 CONCLUSION

4.1.1 The detailed gradiometer survey has been successful in detecting anomalies of probable and possible archaeological interest within the Site, in addition to regions of magnetic disturbance and several modern services.

4.1.2 A number of anomalies consistent with former field boundaries have been identified, predominantly on alignments similar to extant boundaries and are likely to represent former continuations of these boundaries. The presence of strong ploughing trends likely to relate to ridge and furrow are present throughout the central and eastern portions of the survey, although it is difficult to determine the relative sequence of these anomalies.

4.1.3 Several clusters of anomalies of probable and possible archaeological interest have been noted. At the northeastern extent of the Site, a cluster of rectilinear anomalies of probable archaeological interest may relate to a former structure, judging by the strong magnetic disturbance nearby.

4.1.4 Negative anomaly **4010** extending SW-NE across the central portion of the Site appears to continue in both directions as a series of parallel trends; further to the northeast, linear anomaly **4017** appears on the same orientation. Whilst the character of their responses differ, it is possible that these anomalies are associated. The anomalies are coincident with a shallow depression in the surface of the Site and it is considered likely that they are modern in origin.

4.1.5 Groups of anomalies towards the centre of the survey area, e.g. **4008**, are of uncertain provenance, although a low mound is visible coincident with these anomalies. Whilst it is conceivable that they relate to settlement activity; the extents of magnetic disturbance nearby make this interpretation tentative.

4.1.6 At the west and northwest of the Site, clusters of pit-like anomalies may be archaeological in origin although their responses are not conclusively archaeological in nature; natural features such as tree throws and infilled hollows could produce similar responses and it is possible that they are natural in origin.

4.1.7 The strong ploughing trends noted above are likely to indicate the truncation of archaeological deposits, should any be present. The enhanced appearance of some of the individual anomalies suggests that this may be the case, although it is possible that the truncation of geological material would lead to a similar result.

5 REFERENCES

English Heritage, 2008. *Geophysical Survey in Archaeological Field Evaluation*. Research and Professional Service Guideline No 1, 2nd edition.

APPENDIX 1: SURVEY EQUIPMENT AND DATA PROCESSING

Survey Methods and Equipment

The magnetic data for this project was acquired using a Bartington 601-2 dual magnetic gradiometer system. This instrument has two sensor assemblies fixed horizontally 1m apart allowing two traverses to be recorded simultaneously. Each sensor contains two fluxgate magnetometers arranged vertically with a 1m separation, and measures the difference between the vertical components of the total magnetic field within each sensor array. This arrangement of magnetometers suppresses any diurnal or low frequency effects.

The gradiometers have an effective resolution of 0.03nT over a ±100nT range, and measurements from each sensor are logged at intervals of 0.25m. All of the data are stored on an integrated data logger for subsequent post-processing and analysis.

Wessex Archaeology undertakes two types of magnetic surveys: scanning and detail. Both types depend upon the establishment of an accurate 20m or 30m site grid, which is achieved using a Leica Viva RTK GNSS instrument and then extended using tapes. The Leica Viva system receives corrections from a network of reference stations operated by the Ordnance Survey and Leica Geosystems, allowing positions to be determined with a precision of 0.02m in real-time and therefore exceed the level of accuracy recommended by English Heritage (2008) for geophysical surveys.

Scanning surveys consist of recording data at 0.25m intervals along transects spaced 10m apart, acquiring a minimum of 80 data points per transect. Due to the relatively coarse transect interval, scanning surveys should only be expected to detect extended regions of archaeological anomalies, when there is a greater likelihood of distinguishing such responses from the background magnetic field.

The detailed surveys consist of 20m x 20m or 30m x 30m grids, and data are collected at 0.25m intervals along traverses spaced 1m apart. These strategies give 1600 or 3600 measurements per 20m or 30m grid respectively, and are the recommended methodologies for archaeological surveys of this type (EH, 2008).

Data may be collected with a higher sample density where complex archaeological anomalies are encountered, to aid the detection and characterisation of small and ephemeral features. Data may be collected at up to 0.125m intervals along traverses spaced up to 0.25m apart, resulting in a maximum of 28800 readings per 30m grid, exceeding that recommended by English Heritage (2008) for characterisation surveys.

Post-Processing

The magnetic data collected during the detail survey are downloaded from the Bartington system for processing and analysis using both commercial and in-house software. This software allows for both the data and the images to be processed in order to enhance the results for analysis; however, it should be noted that minimal data processing is conducted so as not to distort the anomalies.

As the scanning data are not as closely distributed as with detailed survey, they are georeferenced using the GPS information and interpolated to highlight similar anomalies in adjacent transects. Directional trends may be removed before interpolation to produce more easily understood images.

Typical data and image processing steps may include:

- Destripe – Applying a zero mean traverse in order to remove differences caused by directional effects inherent in the magnetometer;
- Destagger – Shifting each traverse longitudinally by a number of readings. This corrects for operator errors and is used to enhance linear features;
- Despike – Filtering isolated data points that exceed the mean by a specified amount to reduce the appearance of dominant anomalous readings (generally only used for earth resistance data)

Typical displays of the data used during processing and analysis:

- XY Plot – Presents the data as a trace or graph line for each traverse. Each traverse is displaced down the image to produce a stacked profile effect. This type of image is useful as it shows the full range of individual anomalies.
- Greyscale – Presents the data in plan view using a greyscale to indicate the relative strength of the signal at each measurement point. These plots can be produced in colour to highlight certain features but generally greyscale plots are used during analysis of the data.

APPENDIX 2: GEOPHYSICAL INTERPRETATION

The interpretation methodology used by Wessex Archaeology separates the anomalies into two main categories: archaeological and unidentified responses.

The archaeological category is used for features when the form, nature and pattern of the anomaly are indicative of archaeological material. Further sources of information such as aerial photographs may also have been incorporated in providing the final interpretation. This category is further sub-divided into three groups, implying a decreasing level of confidence:

- Archaeology – used when there is a clear geophysical response and anthropogenic pattern.
- Probable archaeology – used for features which give a clear response but which form incomplete patterns.
- Possible archaeology – used for features which give a response but which form no discernible pattern or trend.

The unidentified category is used for features when the form, nature and pattern of the anomaly are not sufficient to warrant a classification as an archaeological feature. This category is further sub-divided into:

- Increased magnetic response – used for areas dominated by indistinct anomalies which may have some archaeological potential.
- Trend – used for low amplitude or indistinct linear anomalies.
- Ferrous – used for responses caused by ferrous material. These anomalies are likely to be of modern origin.

Finally, services such as water pipes are marked where they have been identified.