Cambourne 2 Cambridge

East of M11

Cambridgeshire

Geophysical Survey

Report no. 3192
September 2018

Client: Mott MacDonald Limited
Cambourne to Cambridge Better Public Transport Project
East of M11
Cambridgeshire

Geophysical Survey

Summary

A geophysical (magnetometer) survey, covering approximately 18 hectares, was undertaken within fields along the route of the proposed Cambourne to Cambridge Better Public Transport Project to the east of the M11 and west of Cambridge. The survey area has detected anomalies of archaeological interest, consisting of multiple enclosures and ditches of a possible Late Iron Age/Roman date. Anomalies associated with the course of a Roman Road may also have been detected, however, the road passes through areas of magnetic disturbance which have been caused from the location of the former University Rifle Range. Medieval ridge and furrow has been recorded along with a former field boundary and field drains. Modern service pipes and areas of magnetic disturbance have also been recorded.

Therefore based on the geophysical survey, the archaeological potential of the site is considered to be high in the west and medium elsewhere.
Contents

Report information ................................................................................................................ ii
Contents ................................................................................................................................ iii
List of Figures ...................................................................................................................... iv

1  Introduction .................................................................................................................. 1
   Site location, topography and land-use ........................................................................ 1
   Soils and geology ........................................................................................................ 1
2  Archaeological Background ......................................................................................... 1
3  Aims, Methodology and Presentation ....................................................................... 1
   Magnetometer survey .................................................................................................. 2
   Reporting ..................................................................................................................... 2
4  Results and Discussion ............................................................................................... 3
   Ferrous anomalies ...................................................................................................... 3
   Agricultural anomalies ............................................................................................... 4
   Archaeological and possible archaeological anomalies ......................................... 4
5  Conclusions .................................................................................................................. 4

Figures

Appendices
Appendix 1: Magnetic survey - technical information
Appendix 2: Survey location information
Appendix 3: Geophysical archive
Appendix 4: Oasis form

Bibliography
List of Figures

1. Site location (1:50000)
2. Survey location showing greyscale magnetometer data (1:4000 @ A3)
3. Overall interpretation of magnetometer data (1:4000 @ A3)
4. Processed greyscale magnetometer data; Sector 1 (1:1250 @ A3)
5. XY trace plot of minimally processed magnetometer data; Sector 1 (1:1250 @ A3)
6. Interpretation of magnetometer data; Sector 1 (1:1250 @ A3)
7. Processed greyscale magnetometer data; Sector 2 (1:1250 @ A3)
8. XY trace plot of minimally processed magnetometer data; Sector 2 (1:1250 @ A3)
9. Interpretation of magnetometer data; Sector 2 (1:1250 @ A3)
10. Processed greyscale magnetometer data; Sector 3 (1:1250 @ A3)
11. XY trace plot of minimally processed magnetometer data; Sector 3 (1:1250 @ A3)
12. Interpretation of magnetometer data; Sector 3 (1:1250 @ A3)
13. Processed greyscale magnetometer data; Sector 4 (1:1250 @ A3)
14. XY trace plot of minimally processed magnetometer data; Sector 4 (1:1250 @ A3)
15. Interpretation of magnetometer data; Sector 4 (1:1250 @ A3)
1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Mott MacDonald Limited to undertake a geophysical (magnetometer) survey on land to the east of the M11 and west of Cambridge, Cambridgeshire. This is in advance of a proposed new transport infrastructure. Guidance contained within the National Planning Policy Framework (MHCLG 2018) was followed, in line with current best practice (CIfA 2014; David et al. 2008). The survey was carried out between 20th – 24th August 2018.

Site location, topography and land-use

The survey areas are located to the south of the University of Cambridge (West University Site) and the A1303. Bounded to the north by campus buildings, sports pitches to the east and further farm land to the south and west. The survey areas are within open farm land and crosses 4 fields. The area totals approximately 18 ha and centred on TL 430 584. The height above Ordnance Datum (aOD) lies between 16m in the northwest to 9m in the east.

Soils and geology

The bedrock geology is mapped as mudstone of the Gault formation being sedimentary bedrock that formed approximately 101 to 113 million years ago in the Cretaceous Period. Superficial deposits have not been recorded (BGS 2018). The soils of the area are described as lime-rich loamy and clayey soils with impleaded drainage (CSAI, 2018).

2 Archaeological Background

A preliminary Heritage Assets report had been produced by Atkins Ltd (2017). This outlines the quantity and date of known archaeological areas along the survey areas which range from Palaeolithic find spots through prehistoric settlements, Roman earthworks, settlements, roads and possible villa sites. Early medieval remains appear limited to finds of Saxon coins and the origins of present day villages.

Medieval remains see more structures in the area either as a whole or with medieval parts surviving in standing buildings. Extant ridge and furrow count for most of the medieval earthworks although some relate to the known locations of medieval buildings (including a mill), defensive ditches, moated sites and possible civil war fortifications.

Post-medieval buildings are noted in the vicinity of the survey area either still standing or now demolished. Light industrial remains are characterised by extraction pits and isolated kilns.

Military sites are abundant in the area with RAF airfields, defensive structures and a cold war emergency planning centre at Shire Hall (MCB15106). An American Military Cemetery
(MCB15262) is on the northern side of the A1303, which is also a registered Historic Park and Garden (list entry 1001573).

Excavations to the north of the site at High Cross (CAU 2001, 2010) recorded some features indicative of Bronze Age activity but the majority being of Iron Age to early Roman, with also medieval/post-medieval ridge and furrow and field boundaries.

Additionally, CHER data (CHER MCB20898) and historic mapping identify the University’s Rifle Range, Newham, Cambridge. The range is visible on 1st Edition Ordinance Survey mapping dating from 1885.

3 Aims, Methodology and Presentation

The main aim of the geophysical survey was to provide additional information and to gather sufficient information to establish the presence/absence, character, and extent, of buried archaeological remains within the specific survey area and to inform further strategies should they be necessary.

To achieve this, a magnetometer survey covering all available parts of the PDA was undertaken (see Fig. 2).

The general objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

Magnetometer survey

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble R6 model). The survey was undertaken using Bartington Grad601 magnetic gradiometers. These were employed taking readings at 0.25m intervals on zig-zag traverses 1.0m apart within 30m by 30m grids, so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

Reporting

A general site location plan, incorporating the 1:50000 Ordnance Survey (OS) mapping, is shown in Figure 1. Figure 2 shows a more detailed site location plan (at a scale of 1:4000) with an overall interpretation, Figure 3, at the same scale. The processed and minimally
processed data, together with an interpretation of the survey results are presented in Figures 4 to 15 inclusive at a scale of 1:1250.

Technical information on the equipment used, data processing and survey methodologies are given in Appendix 1. Technical information on locating the survey area is provided in Appendix 2. Appendix 3 describes the composition and location of the archive. A copy of the completed OASIS form is included in Appendix 4.

The survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David et al. 2008) and by the Chartered Institute for Archaeologists (CIfA 2014). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty’s Stationery Office (© Crown copyright).

*The figures in this report have been produced following analysis of the data in processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.*

4 Results and Discussion (see Figs 4 to 15)

Ferrous anomalies

Ferrous anomalies, as individual ‘spikes’, or as large discrete areas are typically caused by ferrous (magnetic) material, either on the ground surface or in the plough-soil. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation, as modern ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling.

A linear ferrous response (F1) running through Areas 2-4 is similar to that of a pipeline. However this feature also corresponds with historic mapping and CHER data and locates Cambridge University’s Rifle Range (CHER MCB20898). The rifle range is shown on the 1st Edition Ordnance Survey mapping dating from 1885. Large dipolar responses such as those at F2 can be seen either side of the rifle range and are likely to be associated with flagpoles, as also marked on the old mapping and may represent concrete bases. The increased scattering of smaller ferrous responses alongside the rifle range may be bullet casings. The 1937-1961 map shows a rectangular building within Area 2 and running into the adjacent copse. This corresponds to some of the magnetic disturbance (F3).

Service pipes have been recorded in Area 1 in the northwest corner on a southwest to northeast alignment and also running through the middle of the area on a north to south alignment, the latter cutting through the archaeological features (see below).
Areas of magnetic disturbance along the limits of the survey areas, on the whole are due to metal fencing within the field boundaries.

**Agricultural anomalies**
Throughout the proposed scheme there is Historic Environment Record (HER) data which suggests evidence of ridge and furrow. The geophysical survey evidence has recorded parallel linear trends throughout the survey area which are associated with the above mentioned ridge and furrow cultivation. Those detected in Area 1 relate to cropmark evidence (monument ID: MCB09612). Ridge and furrow can also be seen in Area 3.

A former field boundary can be seen in the north of Area 1 and corresponds to old mapping dating from 1885 (NLS 2018), this also corresponds to the line of a drain on modern mapping. A drain, also corresponding to old mapping is visible in Areas 2 and 3.

**Archaeological and possible archaeological anomalies**
A concentration of archaeological features can be seen in Area 1 consisting of numerous enclosures, ditches and pits suggesting a Romano-British settlement. There are some very magnetically strong responses and some which have a weak magnetic signature. The stronger responses may be indicative of burning. Some of the rectilinear enclosures show internal divisions.

It is difficult to determine whether these features represent different phases of occupation or are contemporary. The weaker responses have been interpreted as possible archaeology and lie in the northeastern section of the settlement. It is likely that these are earlier in date.

The course of a Roman road runs through Area 3 as marked on the ordnance survey mapping. This road is Margary 23a, Arrington to Cambridge which runs from Ermine Street directly to Cambridge (Margary 1973). There is the hint of a ditch-like feature P1 but due to the ferrous responses from the former University Rifle Range it is difficult to say if this response is a road side ditch.

Possible ditch responses in Area 4 are tentative due to the ferrous disturbance in the area, but given the wealth of archaeology in the landscape it is possible they are of interest.

**5 Conclusions**
The survey area has detected anomalies of archaeological and possible archaeological interest in the forms of ditches, pits and enclosures the majority of which form a complex settlement system. A small length of possible ditch may be related to a Roman road-side ditch.
Medieval ridge and furrow cultivation has been recorded which is quite prominent in places and is recorded in the Cambridgeshire HER. An old field boundary and field drains have been recorded which correspond to old mapping.

Cambridge University’s former Rifle Range can be seen within Areas 2-4. Modern responses such as services pipes, magnetic disturbance and isolated ferrous debris can be seen throughout.

The archaeological potential of the survey area is considered to be high in Area 1 and medium elsewhere.
Fig. 1. Site location
Fig. 3. Overall interpretation of magnetometer data (1:4000 @ A3)
Area 1

Fig. 5. XY trace plot of minimally processed magnetometer data; Sector 1 (1:1250 @ A3)
Fig. 6. Interpretation of magnetometer data; Sector 1 (1:1250 @ A3)
Area 2

Fig. 7. Processed greyscale magnetometer data; Sector 2 (1:1250 @ A3)
Fig. 8. XY trace plot of minimally processed magnetometer data; Sector 2 (1:1250 @ A3)
Fig. 9. Interpretation of magnetometer data; Sector 2 (1:1250 @ A3)
Area 3

Fig. 10. Processed greyscale magnetometer data; Sector 3 (1:1250 @ A3)
Fig. 11. XY trace plot of minimally processed magnetometer data; Sector 3 (1:1250 @ A3)
Fig. 12. Interpretation of magnetometer data; Sector 3 (1:1250 @ A3)
Fig. 14. XY trace plot of minimally processed magnetometer data; Sector 4 (1:1250 @ A3)
Fig. 15. Interpretation of magnetometer data; Sector 4 (1:1250 @ A3)
Appendix 1: Magnetic survey - technical information

Magnetic Susceptibility and Soil Magnetism

Iron makes up about 6% of the Earth’s crust and is mostly present in soils and rocks as minerals such as maghaemite and haemite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms. Areas of human occupation or settlement can then be identified by measuring the magnetic susceptibility of the topsoil because of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

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 magnetic ferrous compounds to become concentrated 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. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough.

Types of Magnetic Anomaly

In the majority of instances anomalies are termed ‘positive’. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as ‘negative’ anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a ‘?’ is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:
**Isolated dipolar anomalies (iron spikes)**

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic ‘spiky’ trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

**Areas of magnetic disturbance**

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

**Linear trend**

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

**Areas of magnetic enhancement/positive isolated anomalies**

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an ‘iron spike’ anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

**Linear and curvilinear anomalies**

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

**Methodology: Gradiometer Survey**

The main method of using the fluxgate gradiometer for commercial evaluations is referred to as **detailed survey** and requires the surveyor to walk at an even pace carrying the instrument within a grid system. A sample trigger automatically takes readings at predetermined points, typically at 0.25m intervals, on traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation.
During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 0.5m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

The gradiometer data have been presented in this report in processed greyscale format. The data in the greyscale images have been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.
Appendix 2: Survey location information

An initial survey station was established using a Trimble VRS differential Global Positioning System (Trimble R6 model). The data was geo-referenced using the geo-referenced survey station with a Trimble RTK differential Global Positioning System (Trimble R6 model). The accuracy of this equipment is better than 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party.
Appendix 3: Geophysical archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS6 and AutoCAD 2008) files; and

- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the Cambridge Historic Environment Record).
Appendix 4: Oasis form
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Lat/Long Datum: Unknown
Height OD / Depth: Min: 9m Max: 16m

Project creators
Name of Organisation: Archaeological Services WYAS
Project brief originator: Mott MacDonald
Project design originator: Mott MacDonald
Project director/manager: E. Brunning
Project supervisor: C. Sykes

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Bibliography


