GEOPHYSICAL SURVEYS OF AREAS OF LAND AT BRICKYARD FARM BOROUGHBRIDGE, N. YORKS.

6/063

A PROGRAMME OF RESEARCH CARRIED OUT ON BEHALF OF

HARROGATE BOROUGH COUNCIL

By

GeoQuest Associates

INTRODUCTION

This report presents the results of geophysical survey of an area of land to the North of Brickyard Farm near Boroughbridge in North Yorkshire which is under consideration for employment land allocation. The research was carried out on behalf of Harrogate County Council in accordance with a Brief prepared by the County Archaeologist for North Yorkshire.

The aim of the study was to test for the existence of archaeological features which would be affected by the proposed development in the area. The presence of archaeological features in the vicinity of the site had previously been confirmed by a survey carried out by Geophysical Surveys of Bradford prior to improvement work on the A1. This survey provided evidence of a Roman camp to the north-west of the site.

GEOLOGY, TOPOGRAPHY AND LANDUSE

The survey site is within a triangular area of land, bordered by Bar Lane to the south, a disused railway track to the west and the A1 to the east. Most of the area surveyed is arable land, with the exception of the south-western section which is used for pasture. The solid geology of the area consists of Permian sandstone.

THE GEOPHYSICAL SURVEY

Geophysical surveying provides a rapid method for the detection of subsoil features within archaeological landscapes. Two methods are most frequently used. *Geomagnetic* surveying employs a portable magnetometer to detect small perturbations in the Earth's magnetic field caused by changes in soil magnetic susceptibility or permanent magnetisation. The *resistivity* method, on the other hand, maps differences in soil electrical resistance which mainly reflect variations in water content.

The primary aim of the geophysical survey at Brickyard Farm was to prospect for evidence of past settlement, possibly associated with the nearby Roman camp. Such activity might include stone and timber buildings, field systems, rubbish pits and ditches each of which should be characterised by significant contrasts in magnetic susceptibility. Thus, geomagnetic surveying was chosen as an appropriate technique for this investigation.

Measurements of vertical geomagnetic field gradient were made over a regular grid using a Geoscan FM36 fluxgate gradiometer with ST1 sample trigger. A zig-zag traverse scheme was employed and data were logged in units of 20x20m at 1.0x1.5m intervals. Appendix A provides further information about the techniques employed.

The GeoQuest *InSite* Windows program was used to process the geophysical data and produce grey-scale images at a scale of 1:1000 showing the residual geomagnetic anomalies. The results are shown in Figure 2 on a basemap digitised from a 1:2500 plan supplied by Harrogate County Council.

DISCUSSION

General

Most of the study area was characterised by very weak geomagnetic anomalies. There was found to be a moderate scatter of compact, intense, dipolar anomalies which were mainly concentrated along the lines of fences. These anomalies can safely be attributed to ferrous debris such as parts of farm machinery and other discarded iron objects. The presence of these dipoles has not significantly affected the discrimination of more subtle anomalies of possible archaeological interest and has therefore been discounted in the subsequent archaeological interpretation of the data.

Approximately 100m north of Brickyard Farm, the survey data show an area of intense magnetisation out of the range of the instrument used. This area shows up as black and white banding in Figure 2 and was found to coincide with the course of the surface water culvert which is thought to run across the site.

As a first stage in the interpretation, the geomagnetic map has been classified into characteristic styles of geophysical terrain as follows:

Green Significant regions of anomalously high magnetic field gradient which might be associated with high susceptibility, soil-filled structures such as *pits* or *ditches*.

Blue Areas of anomalously low magnetic field gradient, corresponding to features of low magnetic susceptibility, such as concentrations of sedimentary sandstone rubble.

Red Dipolar anomalies (paired positive-negative); here, the smallest examples generally reflect iron objects with very high susceptibility, such as ploughshares, while the larger dipoles possibly mark areas of burning.

A geophysical interpretation is presented in Figure 3 which includes a key defining the colour used for each class of anomaly.

Interpretation (Figure 4)

The geophysical survey has detected the following features:

1 The western half of the area contains a parallel set of weak diffuse positive magnetic lineations, with a NNE alignment. The regular spacing and general appearance of these anomalies suggest that they are due to Medieval ridge and furrow. In the eastern side of the site a pattern of ridge and furrow is visible on the ground, although this was not evident in the geomagnetic survey data. In addition, an area of ridge and furrow was found to the north of the site by an earlier geophysical survey (Geophysical Surveys of Bradford) suggesting that the entire area may have been subject to Medieval cultivation.

2 Within the south-west of the site, a diffuse, linear positive anomaly (F4) can be seen traversing the ridge and furrow at right angles. Close examination of the geophysical image suggests that there is no interruption in the Medieval field system, hence F4 appears to be a distinct archaeological feature. Possible interpretations of this feature include a soil-filled ditch or a roadway metalled with a substance of relatively high magnetic susceptibility.

3 On the eastern side of the site the survey has detected another positive lineation (F6) which is approximately co-linear with F4, although different in character, having stronger magnetisation and containing an 15m length of strong magnetic dipoles. This feature could be a ditch, partly filled with a deposit with high magnetic susceptibility, such as burnt material.

4 The north-eastern area of the site contains a positive linear anomaly (F1), which is subparallel to the ridge and furrow and is therefore interpreted as a distinct subsoil feature. Its close proximity to the southern end of the Roman camp, suggests that it may be an associated feature, possibly a trackway providing access to the settlement.

5 To the east of F1 the survey results indicate a pattern of weak positive magnetic lineations (F2) which appear to form a series of nested rectangles with maximum dimensions of 25x15m. This anomaly is close to the limit of instrument sensitivity and is therefore difficult to interpret with confidence. It may provide evidence for a group of rectangular structures, possibly associated with the Roman camp, although a natural geological or pedological source cannot be ruled out.

6 The survey has detected a second anomaly, similar in character to F2, at the south-western end of the site (F5). This anomaly may provide tentative evidence for a rectangular structure and associated entrance pathway.

7 At the eastern end of F4, a pair of roughly circular diffuse positive anomalies has been detected (F3). These may be interpreted as pits filled with material of enhanced magnetic susceptibility.

CONFIDENCE RATINGS

The percentage levels of confidence which we assign to the features interpreted from the geophysical survey are as follows:

Ridge and furrow: Western area 90%
Pits/Ditches: F1 15%, F3 40%, F4 60%, F6 70%
Track: F1 60%, F4 20%
Enclosures: F2 10%, F5 30%

SUMMARY AND CONCLUSIONS

The results of this research can be summarised as follows:

1 The survey successfully detected relatively weak geomagnetic anomalies attributed to subsoil features of archaeological significance as well as strong dipolar anomalies caused by iron debris.

2 Evidence has been provided for Medieval farming activity on the site by the detection of ridge and furrow.

3 A pronounced geophysical lineation within the northwest limit of the surveyed area was detected and is interpreted as a possible roadway converging on the Roman camp. This feature may warrant further investigation.

4 At least three areas of soil-filled ditch features have been detected and identified as distinct from the Medieval cultivation in the area. Several of these ditches may also warrant further characterisation by a limited program of trial trenches.

Credits
Field survey: D.N. Hale, C. Lambert
Report: R. Grove, M.J. Noel
Date: 14/3/95

Note Whilst every effort has been taken in the preparation and submission of this report in order to provide as complete an assessment as possible within the terms of the brief, GeoQuest Associates cannot accept any responsibility for consequences arising as a result of unknown and undiscovered sites or artifacts.

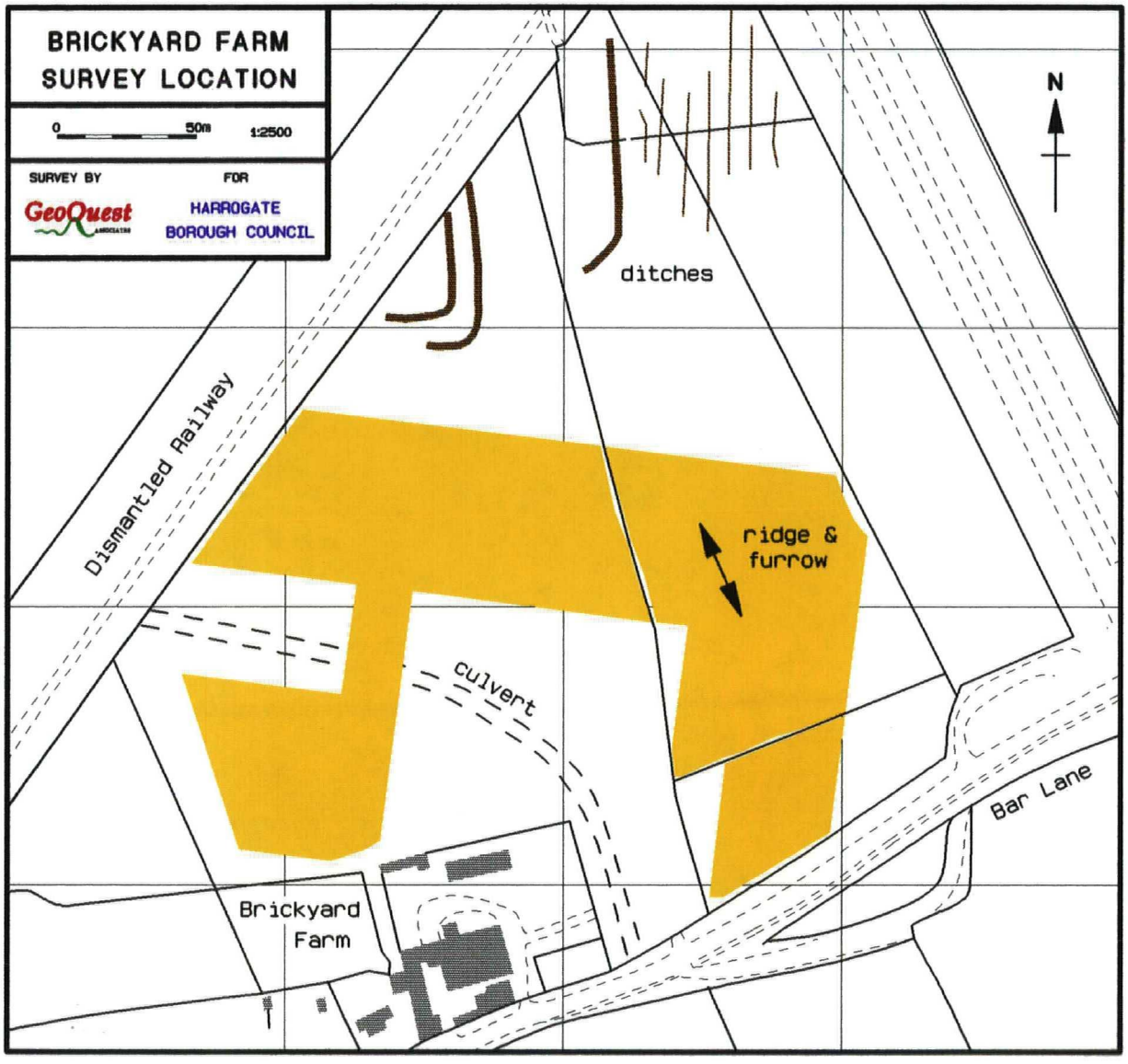

BRICKYARD FARM
SURVEY LOCATION
0
50m
1:2500
SURVEY BY
GeoQuest
FOR
HARROGATE
BOROUGH COUNCIL
N
ditches
Dismantled Railway
ridge &
furrow
culvert
Bar Lane
Brickyard
Farm

FIGURE 1

SNY 10943

FIGURES 2 – 4 REMOVED BEFORE SCANNING
(TOO LARGE) REFER TO ORIGINALS.

APPENDIX A

Theory of Geomagnetic Surveying

Geomagnetic prospecting detects subsurface features in terms of the perturbations or 'anomalies' that they induce in the Earth's magnetic field. In contrast to resistivity, seismic or electromagnetic surveying, no energy is injected into the subsoil and hence this is one of a class of *passive* geophysical techniques that includes gravity and thermal surveying. In an archaeological setting two types of magnetic anomalies can be distinguished:

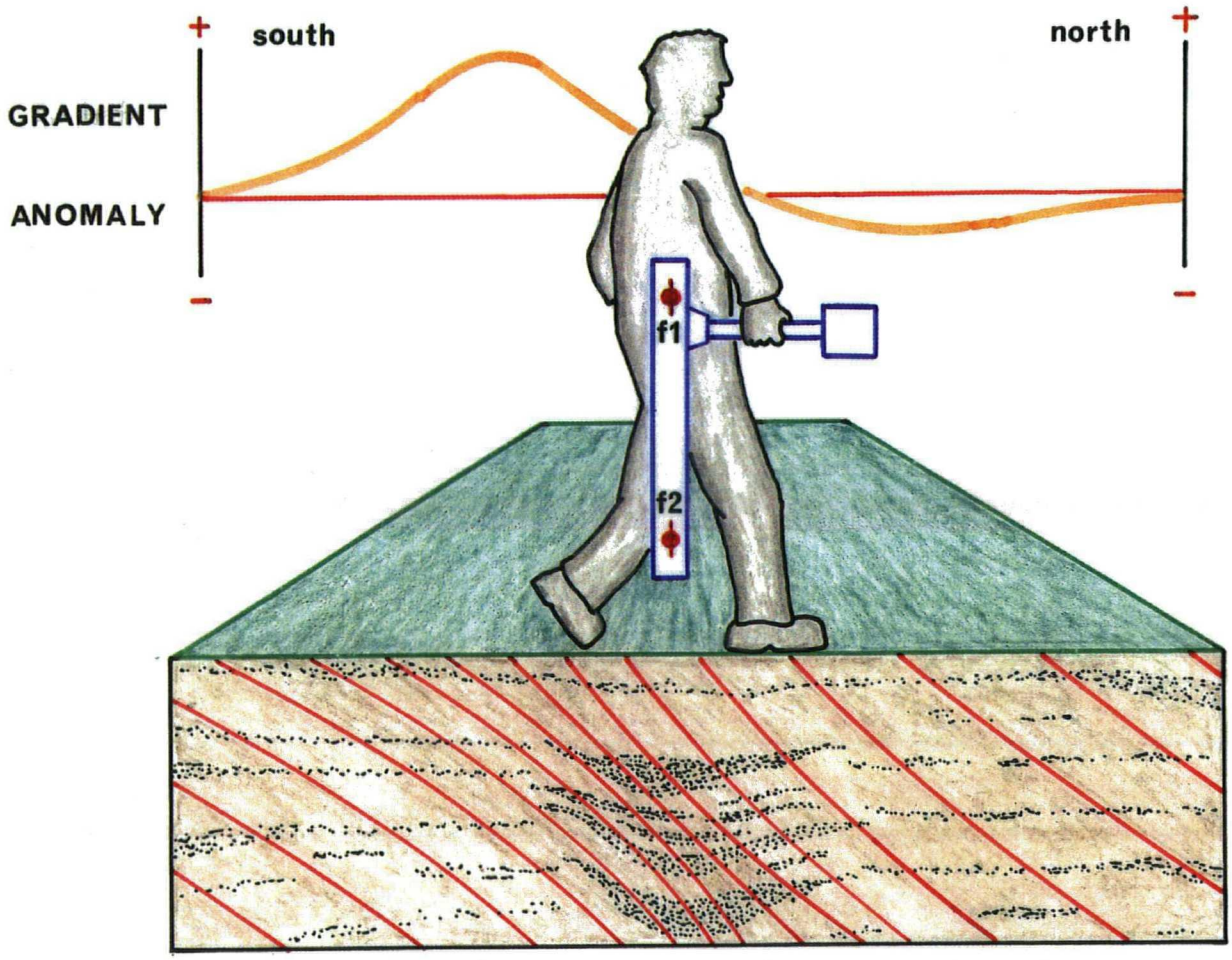
1 Anomalies arising from variations in *magnetic susceptibility* which will modulate the component of magnetisation *induced* in the subsurface by the Earth's magnetic field. For most archaeological sites, this is the dominant factor giving rise to geomagnetic anomalies. In general, susceptibility is relatively weak in sediments, such as sandstones and enhanced in ingeous rocks and soils, especially those which have been burnt or stratified with organic material.

2 Anomalies due to large, *permanently magnetised* structures. Such permanent magnetisation or 'remanence' arises when earth materials are heated to above ~600°C and cooled in the geomagnetic field. Thus kilns and hearths are often detected as strong permanent magnets causing highly localised anomalies that dominate effects due to background susceptibility variations. Remanence can result from other physical and chemical processes but these give rise to anomalies that are usually unimportant for geophysical prospecting.

There are several approaches towards the practical measurement of geomagnetic anomalies. In this study measurements were made using a Geoscan FM36 fluxgate gradiometer which records the change with height in the vertical component of the Earth's magnetic field, as shown overleaf. This method has the advantage of being insensitive to diurnal variations while the Geoscan instrument also benefits from an integrated data logger. Note that in mid northern latitudes the magnetic anomaly will be asymmetric with the main peak displaced to the south of the archaeological feature. Thus, a ditch filled with a soil of enhanced susceptibility, for example, will generate a positive anomaly to the south, mirrored by a weak negative anomaly north of the feature. When portrayed as an area map of grey tones this gives rise to a 'shadowing' or pseudo relief effect which must be borne in mind when making an archaeological interpretation.

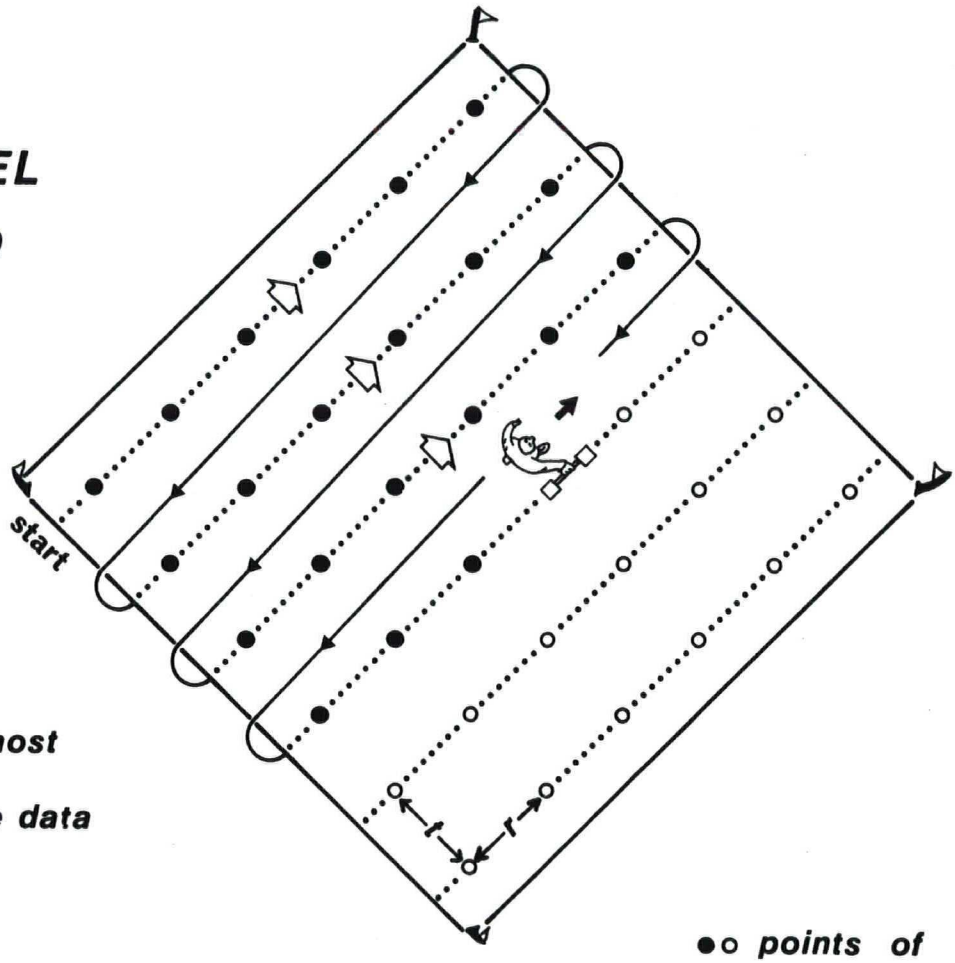
Two techniques can be used to survey gridded areas using the fluxgate magnetometer. In the parallel method the instrument is used to scan the area along traverses which are always in the same direction. This method minimises 'heading errors' due to operator and instrument magnetisation but is time consuming. The alternative zig-zag method is significantly faster and suitable for areas where anomalies are large compared to these and other sources of error.

MAGNETIC SURVEYING



SURVEY SCHEMES

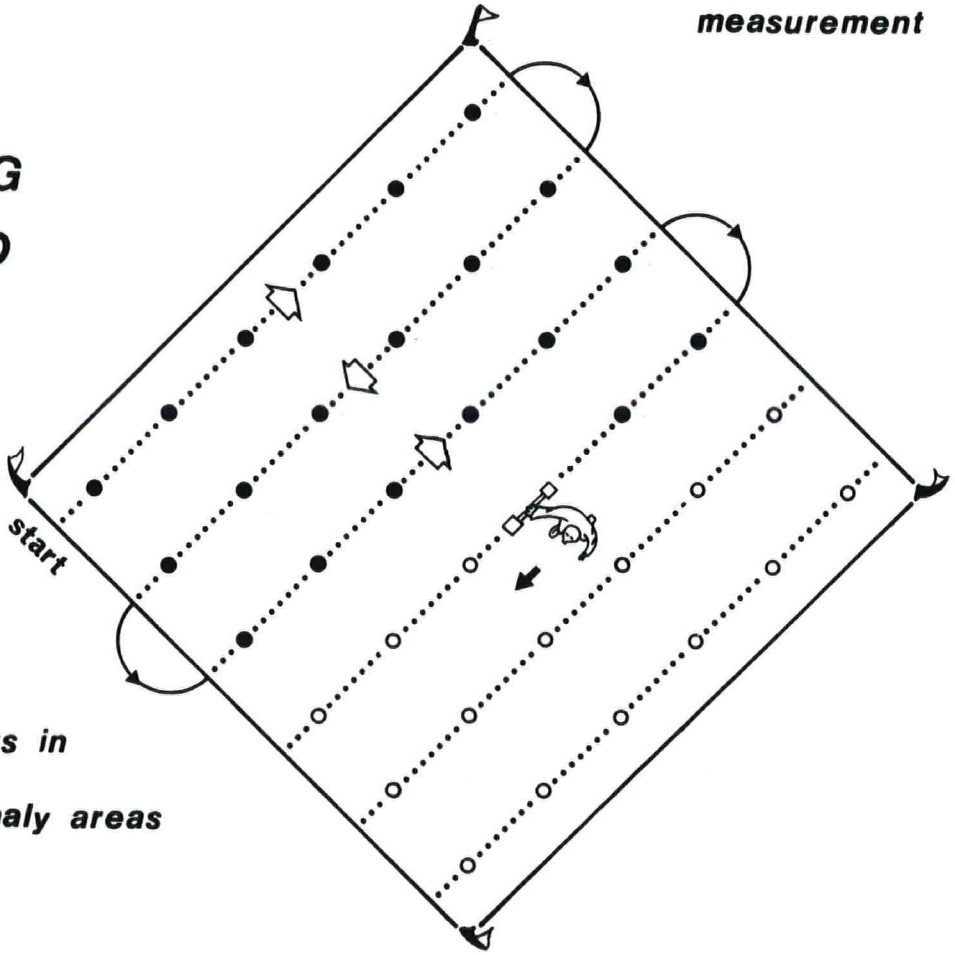
PARALLEL METHOD



slower but minimises most errors in the data

●○ *points of measurement*

ZIG-ZAG METHOD



suitable for rapid surveys in strong anomaly areas

NOTES

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