



INDEX DATA	RPS INFORMATION
Scheme Title A1(m) Redhouse to Ferrybridge road.	Details Geophysical survey of Areas 1+3.
Road Number A1(m)	Date
Contractor RPS	
County Yorkshire	
OS Reference SE 521043	
Single sided <input checked="" type="checkbox"/> Double sided <input type="checkbox"/> A3 <input type="checkbox"/> Colour 7	



**GEOPHYSICAL SURVEY OF AREAS 1
AND 3 ON A1(M) REDHOUSE TO
FERRYBRIDGE ROAD SCHEME**

Archaeological Survey Division

**GEOPHYSICAL SURVEY OF AREAS 1
AND 3 ON A1(M) REDHOUSE TO
FERRYBRIDGE ROAD SCHEME**

A PROGRAMME OF RESEARCH CARRIED OUT
ON BEHALF OF

RPS CLOUSTON

By

GeoQuest Associates

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INTRODUCTION

This report presents the results of geophysical surveys within two areas of land along the axis of the proposed A1(M) Redhouse to Ferrybridge Road Improvement Scheme in North Yorkshire (Figures 1 & 2). The research was carried out on behalf of RPS Clouston acting as archaeological consultants to the Highways Agency of the Department of Transport.

The geophysical surveys were conducted by GeoQuest Associates using methodology agreed through consultation with Maureen Bennell for RPS Clouston of Abingdon. Geophysical survey was judged desirable to test for archaeological features indicated by cropmarks seen in aerial photographs which suggested sites of prehistoric settlement in the vicinity of the roadline.

GEOLOGY, TOPOGRAPHY AND LANDUSE

Three sites were selected by RPS Clouston for geophysical survey:

Area 1: A complex of rectilinear cropmarks, suggesting an enclosure, on land bordered by the A1(M) and Jackson's Lane, Wentbridge.

Area 2: A set of cropmarks at Long Plantation, Stapleton Park.

Area 3: A polygonal cropmark, possibly indicating a further enclosure, 200m NE of the Golf Club at Havercroft Lane, Darrington.

Areas 1 and 3 bore young cereal crops at the time of survey. Area 2 had recently been ploughed and, as a result, the ground conditions proved unsuitable for geophysical survey. The solid geology beneath the study areas comprises Permian mudstones and Magnesian Limestone. These strata are obscured by superficial deposits and no outcrops are present.

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 geophysical surveys between Redhouse and Ferrybridge were designed to prospect for the remains of enclosure and field system ditches of possible prehistoric or

Romano-British date, together with any related features. Such archaeological remains should be characterised by significant contrasts in magnetic susceptibility which, under favourable conditions, will give rise to measureable geomagnetic anomalies. It was therefore considered that magnetic area survey would be a suitable technique for rapid and effective site evaluation.

At both sites, 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 1.0x0.5m 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 1:500 showing the residual geomagnetic anomalies. Data were filtered to enhance details of archaeological interest. These images are presented in Figures 3 and 6 on basemaps digitised from 1:2500 Ordnance Survey sheets.

DISCUSSION

General

Both study areas were found to be characterised by weak to moderately intense geomagnetic anomalies. No field drains, iron pipes or major concentrations of ferrous litter were found at either location and this has aided the discrimination of subtle anomalies of possible archaeological interest.

As a first stage in the interpretation, the geomagnetic maps have 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 Magnesian Limestone rubble*.

- Red** Scattered *dipolar anomalies* (paired positive-negative) whose most probable source in this context are iron objects with very high susceptibility, such as *ploughshares*.

Geophysical interpretations for Areas 1 and 3 are presented in Figures 4 and 7 which include keys defining the colour used for each class of anomaly.

Area 1

A major network of geomagnetic anomalies confirm the existence of the archaeological features recorded in air photographs (Figures 3, 4 & 5). Referring to the labels in Figure 5, the following features have been detected:

- 1 Two, or possibly three, sets of positive anomalies which appear to define the western part of a rectangular ditched enclosure centred on the proposed roadline (**enc2**). In view of their wide spacing (typically 10m) these anomalies are most likely to reflect several phases of one enclosure, rather than a multivallate, single period enclosure.
- 2 A break in the enclosure ditch is bridged by a weak and diffuse circular, positive anomaly which possibly indicates some form of entrance feature, such as arcs of postholes (**f8**).
- 3 Several indistinct but non-random geomagnetic anomalies are present within the enclosure and may provide evidence for pits or ditches associated with huts or internal partitions.
- 4 An exceptionally weak, curvilinear, positive anomaly north of **enc2** may provide evidence for a ring ditch, **f5**, with a diameter of about 8m.
- 5 Second and third ring ditches are more convincingly apparent at **f6** and **f7** and are again detected as weak, positive, arcuate anomalies.
- 6 The geophysical survey has revealed sets of meandering, positive anomalies which provide good evidence for further ditches west of the main enclosure, **enc2**. These can be clearly differentiated from a general NW-SE aligned texture caused by modern ploughing and broad, diffuse anomalies of probable geological origin.

Area 3

Survey of this Area has also revealed numerous anomalies of archaeological interest which again accord with features seen in air photographs (Figures 6, 7 & 8). Referring to the labels in Figure 8, the following have been detected:

- 1 A ditched, rectangular enclosure, with rounded corners, measuring approximately 30x40m, in the western half of the surveyed area (**enc1**). The enclosure appears to have an entrance midway along the eastern side. A break in the NW angle may also indicate an entrance although, unfortunately, this segment extends beyond the area mapped by the geophysical survey.
- 2 A weak, arcuate positive anomaly within the enclosure provides tentative evidence for a ring ditch or hut circle (**f1**).

- 3 The southern limb of **enc1** continues eastwards as a boundary ditch and is broken at **f2** which appears to comprise an entrance with curving ditch (or line of postholes?).
- 4 The slight change in geophysical texture east and external to **enc1** may signify a trackway passing the entrance referred to in 1 above.
- 5 Further ditches SW and SE of **enc1** have been detected as positive magnetic lineations. One of these may be associated with a ring ditch (**f3**).

CONFIDENCE RATINGS

The percentage levels of confidence which we assign to the features interpreted from the geophysical surveys of Areas 1 and 3 are as follows:

Enclosures: **enc1** 95%; **enc2** 90%
Entrances: To E side of **enc1** 80%; to NW side of **enc1** 50%
Other Ditches: Associated with **enc1** 85%; Associated with **enc2** 70%.
Ring Ditches: **f1, f2, f3, f5** 30%; **f6, f7** 50%; **f8** 60%.

SUMMARY AND CONCLUSIONS

The results of this research can be summarised as follows:

- 1 Geomagnetic anomalies in Areas 1 and 3 were moderately intense, reflecting reasonable susceptibility contrasts between subsoil features and their surroundings. The geophysical data within the study areas were not degraded significantly by the effects of surface iron contamination. Owing to unsuitable ground conditions it was not possible to survey RPS Area 2.
- 2 The geophysical survey data provide excellent evidence that networks of enclosure ditches, presumably of prehistoric date, survive in both Areas. Their degree of preservation appears to be good.
- 3 Several ring ditches were also detected by the geophysical survey providing further indications of prehistoric settlement and ritual activity in the study Areas.

Credits *Field survey:* D.N. Hale, C. Lambert
Report: M.J. Noel
Date: 9/1/95

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.

FIGURE 1

Map showing the location of the area surveyed at RPS Area 1 on the A1(M) Redhouse-Ferrybridge Improvement Scheme (yellow). Digitised from the 1:2500 OS map sheet.

A1 REDHOUSE-FERRYBRIDGE

SURVEY LOCATION: AREA 1

0 100m 1:2500

SURVEY BY

GeoQuest
ASSOCIATES

ON BEHALF OF

R P S CLOUSTON
THE ENVIRONMENTAL CONSULTANCY

ORIGINAL IN
COLOUR

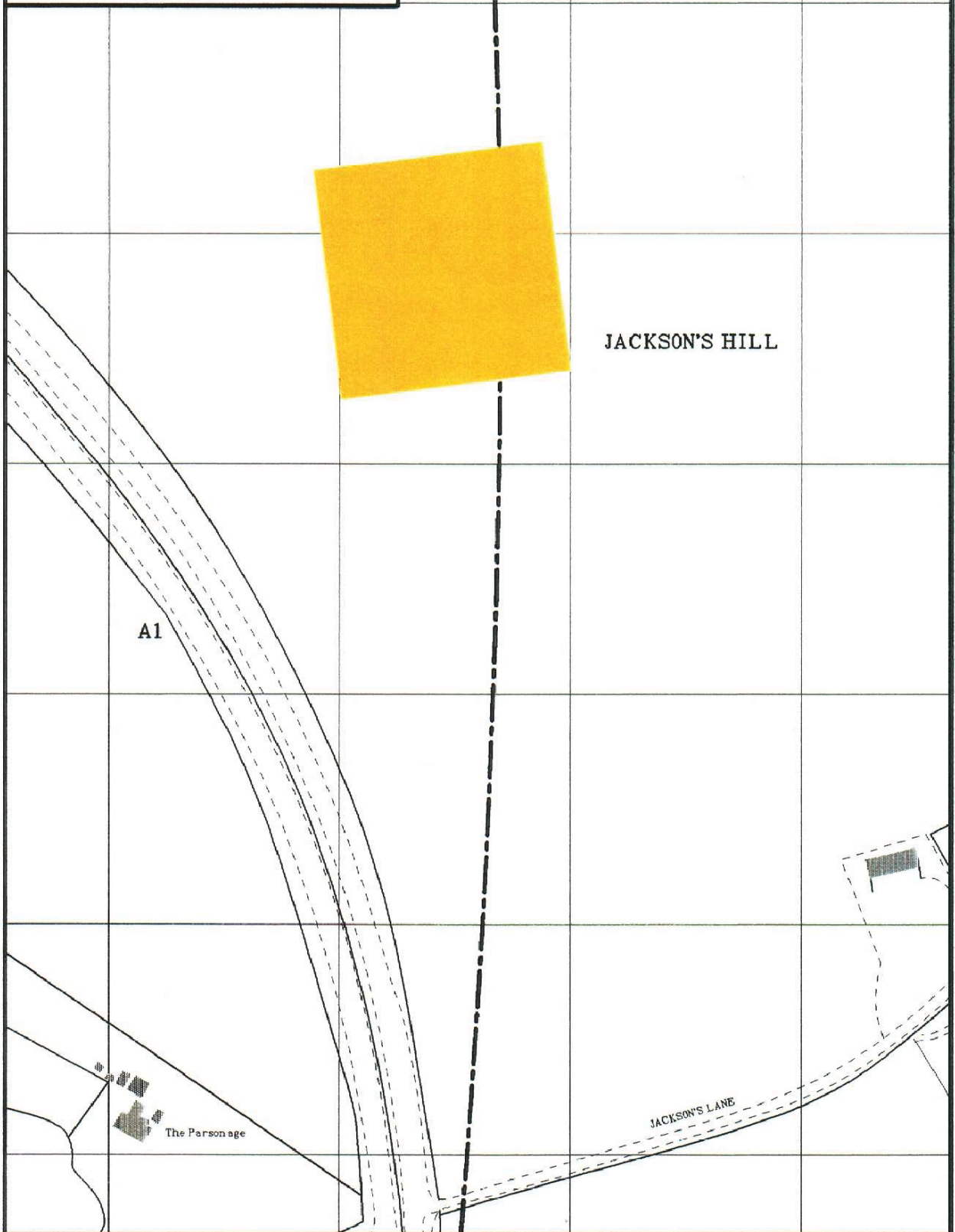
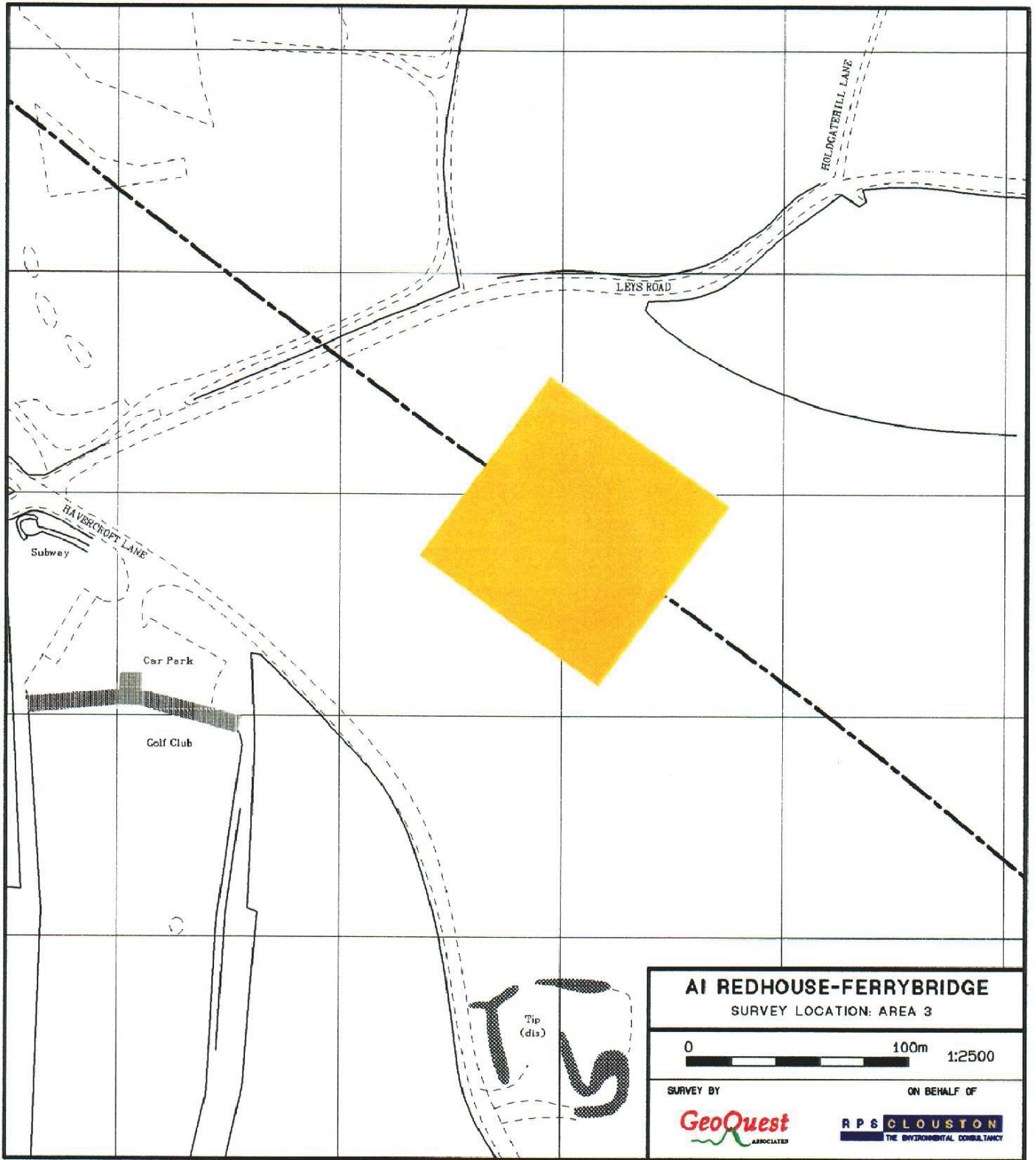


FIGURE 2

Map showing the location of the area surveyed at RPS Area 3 on the A1(M) Redhouse-Ferrybridge Improvement Scheme (yellow). Digitised from the 1:2500 OS map sheet.



AI REDHOUSE-FERRYBRIDGE
 SURVEY LOCATION: AREA 3

0 100m 1:2500

SURVEY BY **GeoQuest** ASSOCIATES ON BEHALF OF **RPS CLOUSTON** THE ENVIRONMENTAL CONSULTANCY

ORIGINAL IN
 COLOUR

FIGURE 3

Results of the geomagnetic survey of RPS Area 1. Positive anomalies are shown dark; negative anomalies light.

AI REDHOUSE-FERRYBRIDGE

SURVEY RESULTS: AREA I

0

100m

1:500



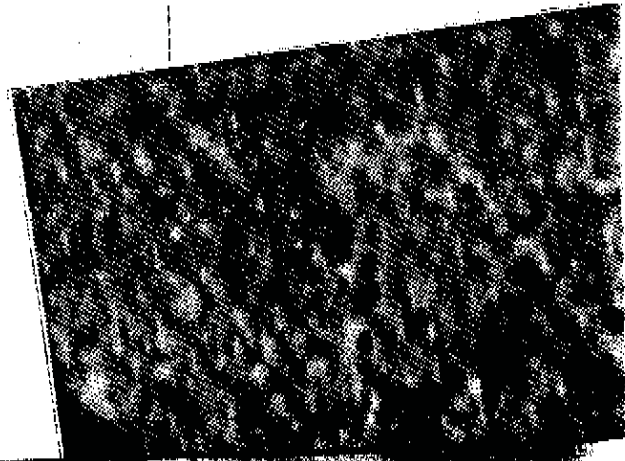
SURVEY BY

ON BEHALF OF

GeoQuest
ASSOCIATES

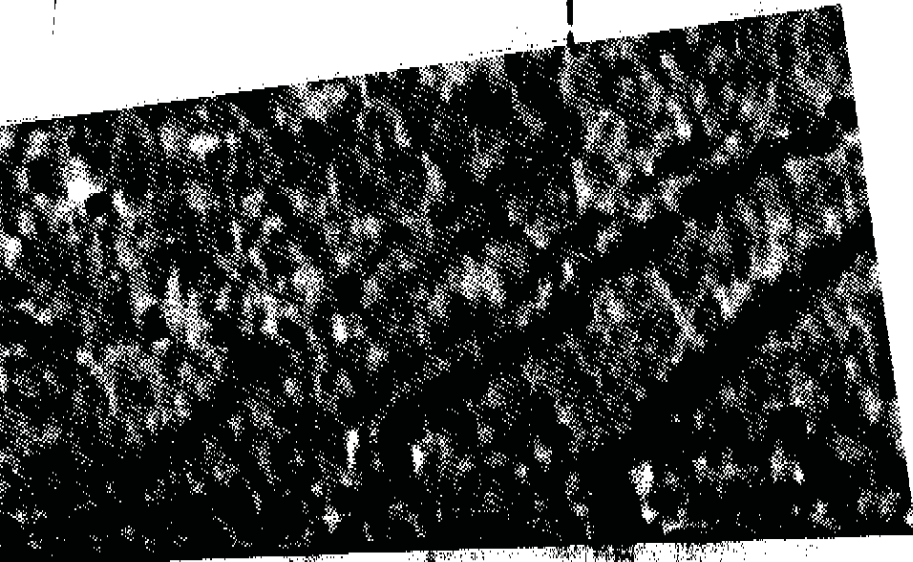
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THE ENVIRONMENTAL CONSULTANCY

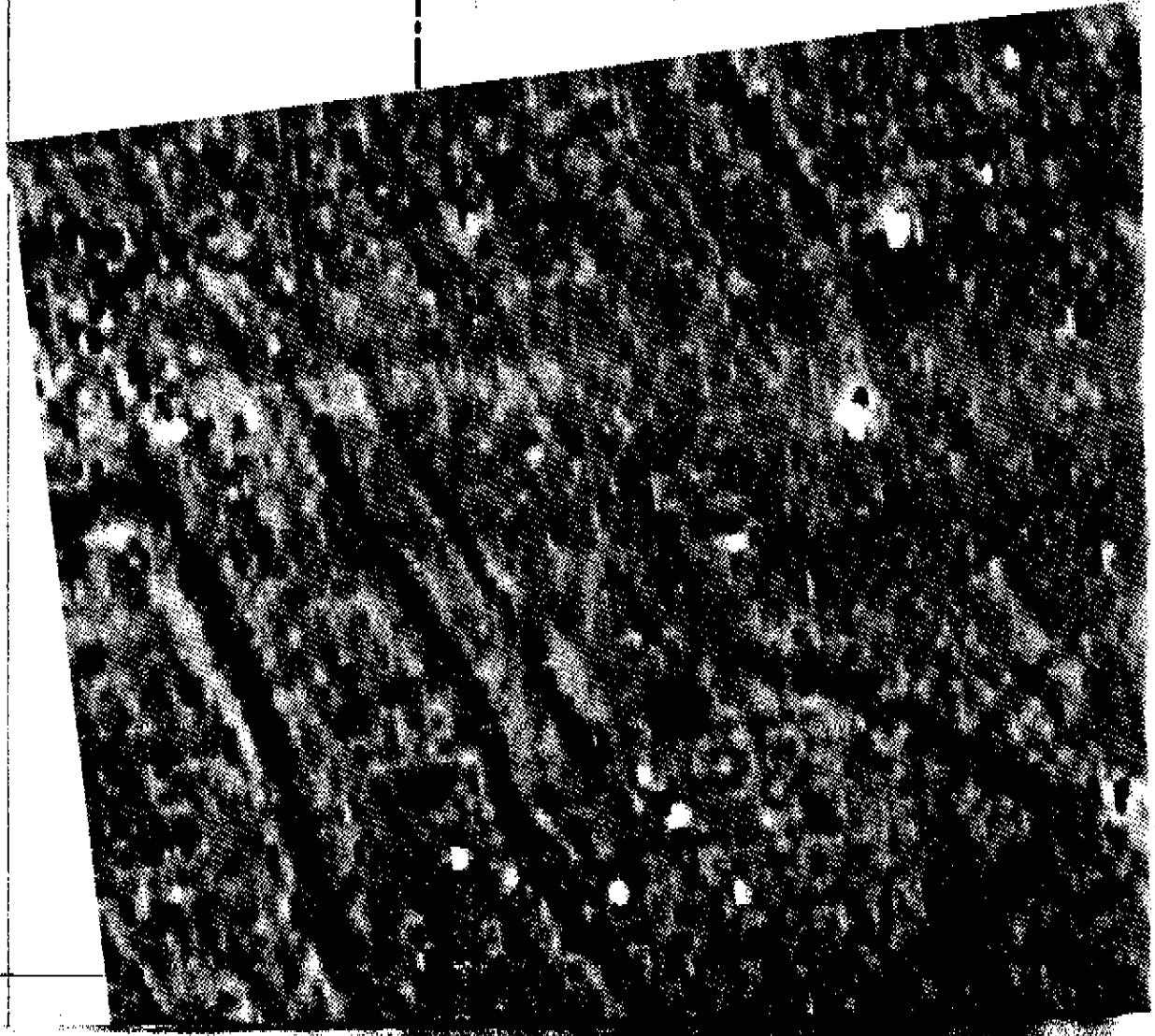
ORIGINAL AT A3

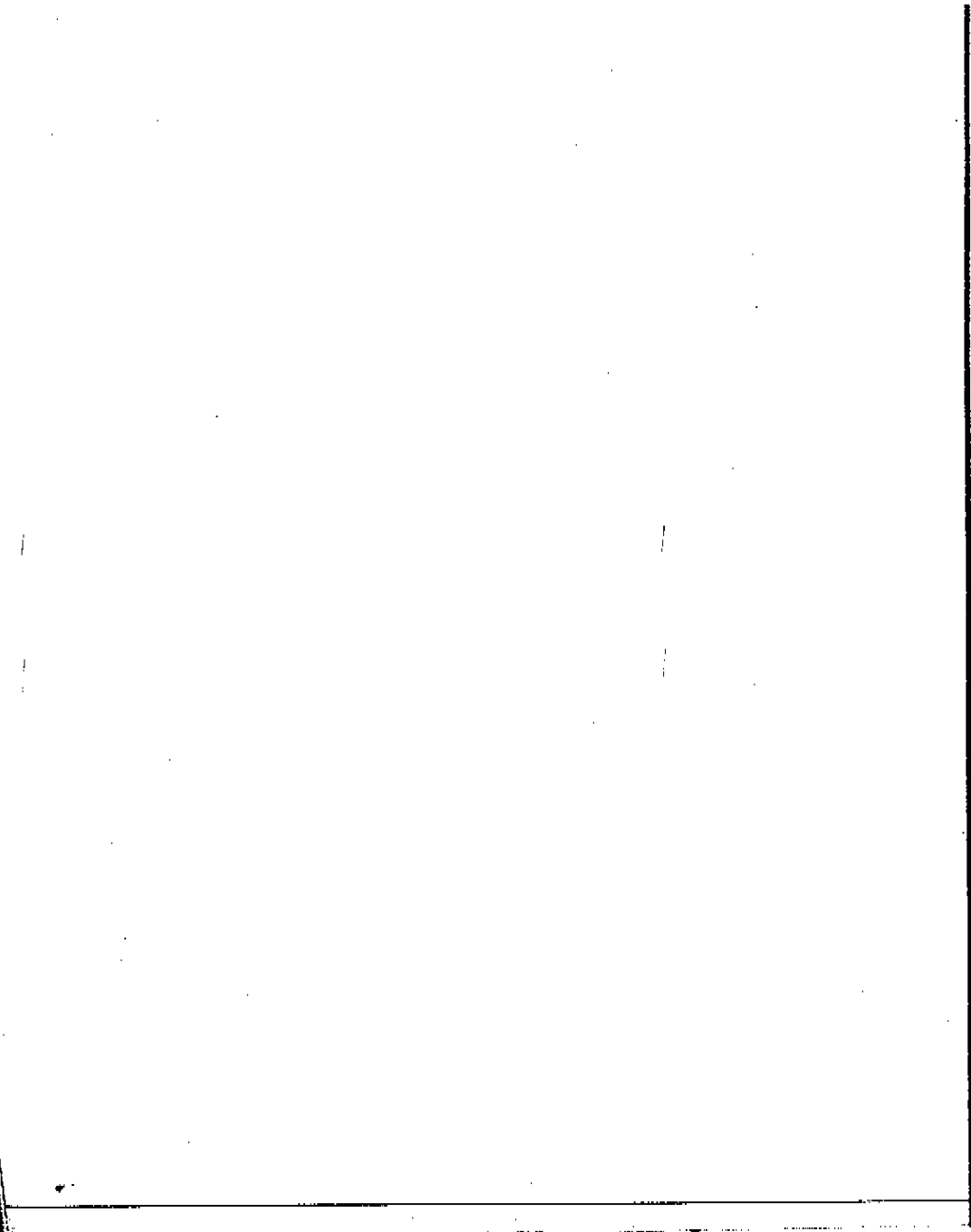
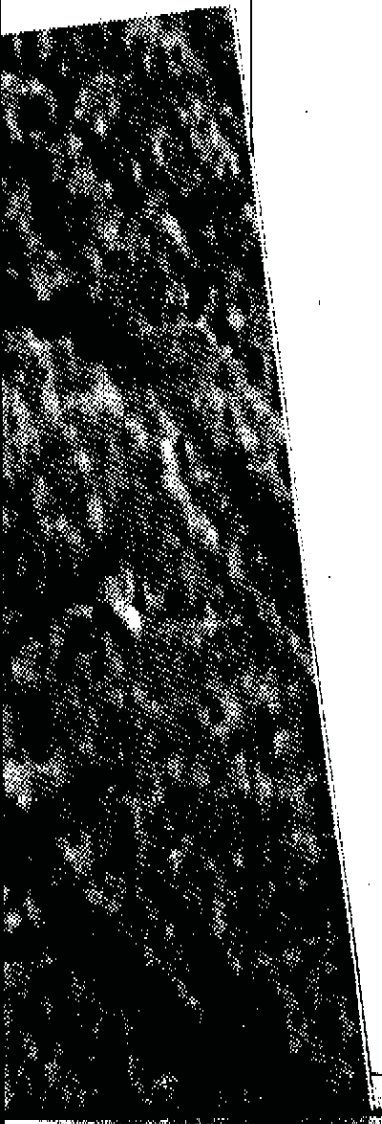


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JACKSON'S HI

ORIGINAL AT A3

A1

LL

FIGURE 4

Geophysical interpretation of the geomagnetic survey at RPS Area 1.
Refer to the key for an explanation of the symbols used.

AI REDHOUSE-FERRYBRIDGE

GEOPHYSICAL INTERPRETATION: AREA I

0 50m 1:1000

SURVEY BY

ON BEHALF OF



KEY



POSITIVE

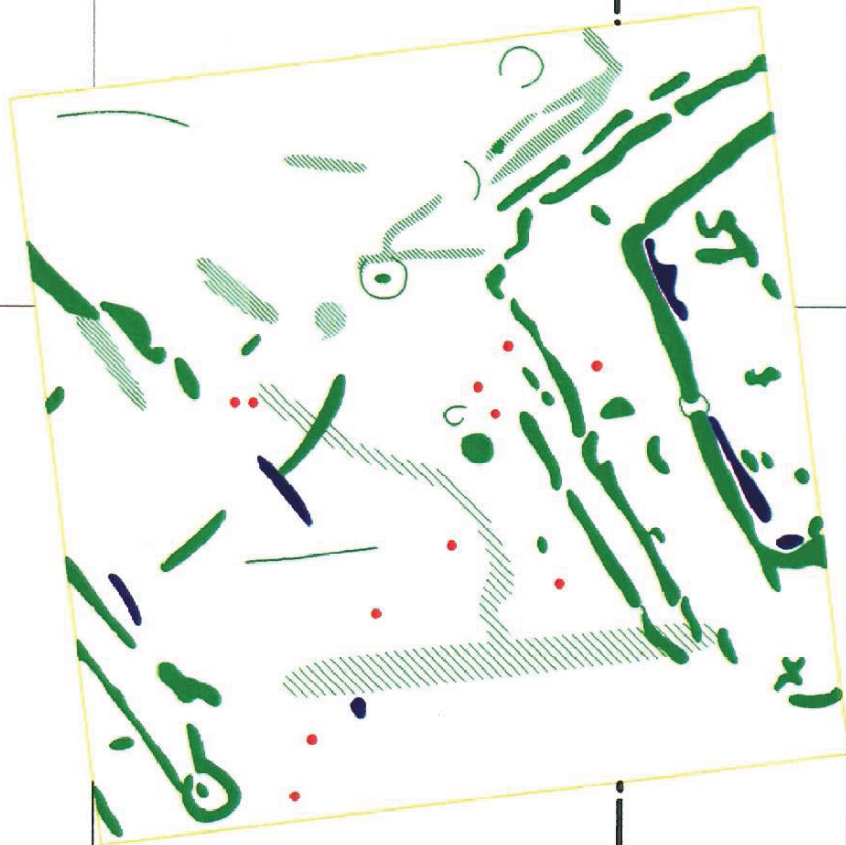


NEGATIVE



DIPOLE

ORIGINAL IN
COLOUR



JACKSON'S HILL

A1

FIGURE 5

Archaeological interpretation of the geomagnetic survey at RPS Area 1.
Refer to the key for an explanation of the symbols used.


AI REDHOUSE-FERRYBRIDGE

ARCHAEOLOGICAL INTERPRETATION: AREA I

KEY

 PITS/DITCHES

 STONEY

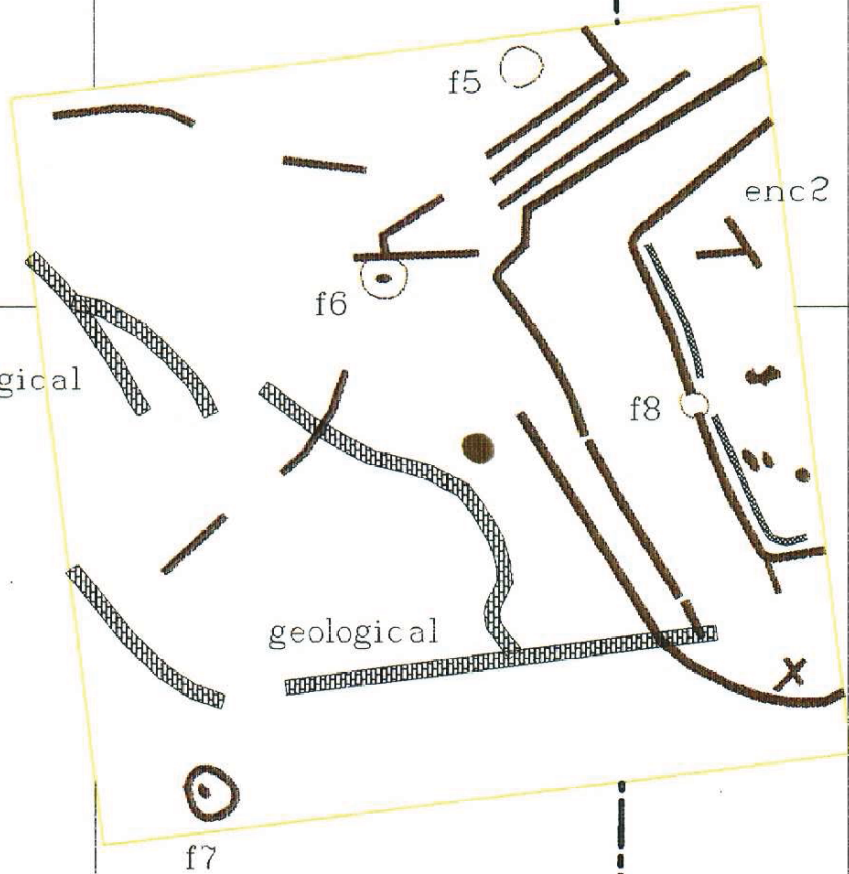
0  50m 1:1000

SURVEY BY

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ASSOCIATES

ON BEHALF OF

RPS CLOUSTON
THE ENVIRONMENTAL CONSULTANCY



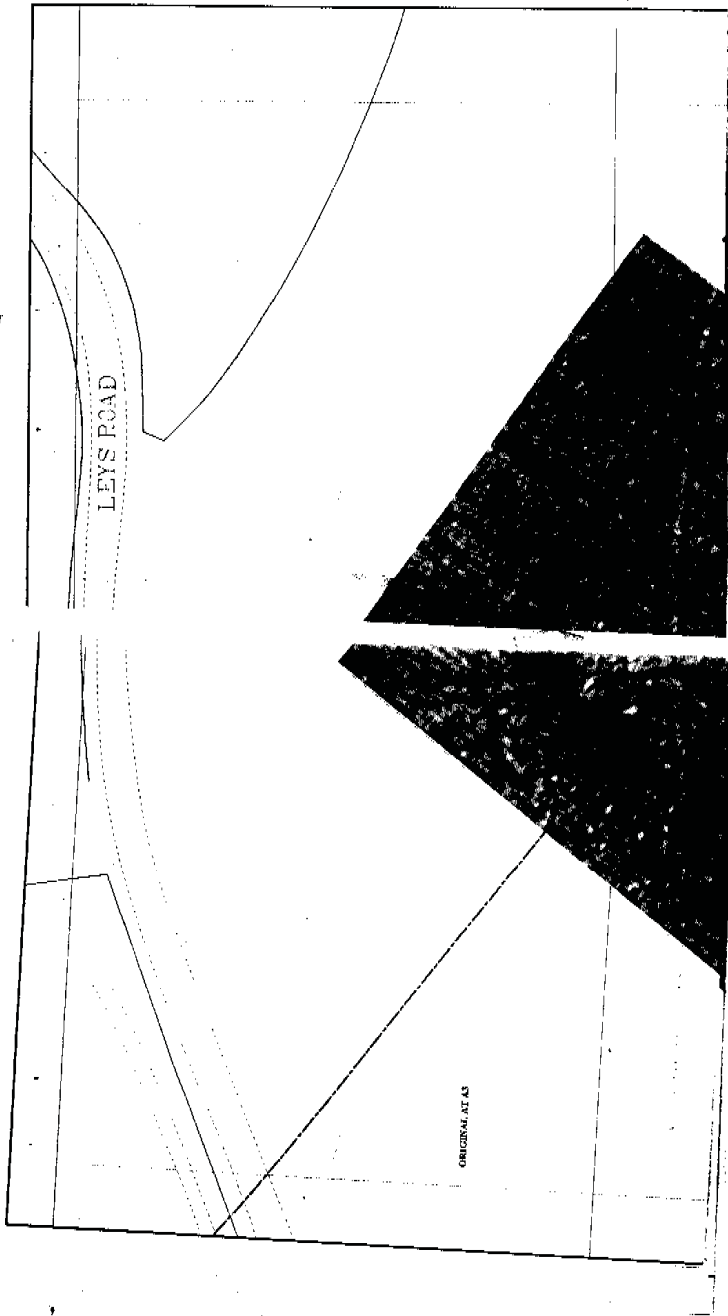
JACKSON'S HILL

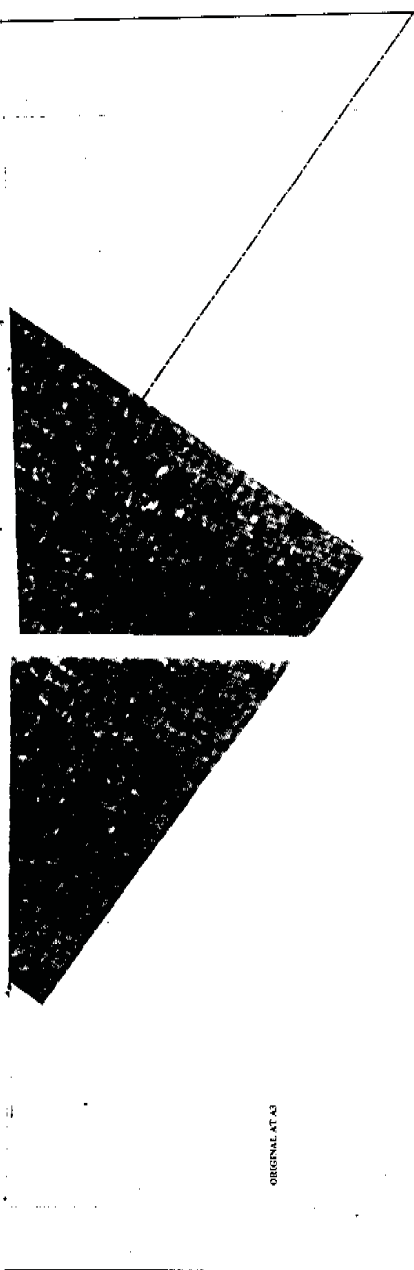
A1

ORIGINAL IN
COLOUR

FIGURE 6

Results of the geomagnetic survey of RPS Area 3. Positive anomalies are shown dark; negative anomalies light.





AI REDHOUSE-FERRYBRIDGE
SURVEY RESULTS: AREA 3



SURVEY BY

CN SERIAL# 3F

GeoQuest
ARCHITECTS

RPS CLOUSTON
THE ENGINEERING GROUP INC.

FIGURE 7

Geophysical interpretation of the geomagnetic survey at RPS Area 3.
Refer to the key for an explanation of the symbols used.



ORIGINAL AT A3

ORIGINAL IN
 COLOUR

FIGURE 8

Archaeological interpretation of the geomagnetic survey at RPS Area 3.
Refer to the key for an explanation of the symbols used.



ORIGINAL AT A3

ORIGINAL IN
COLOUR

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:

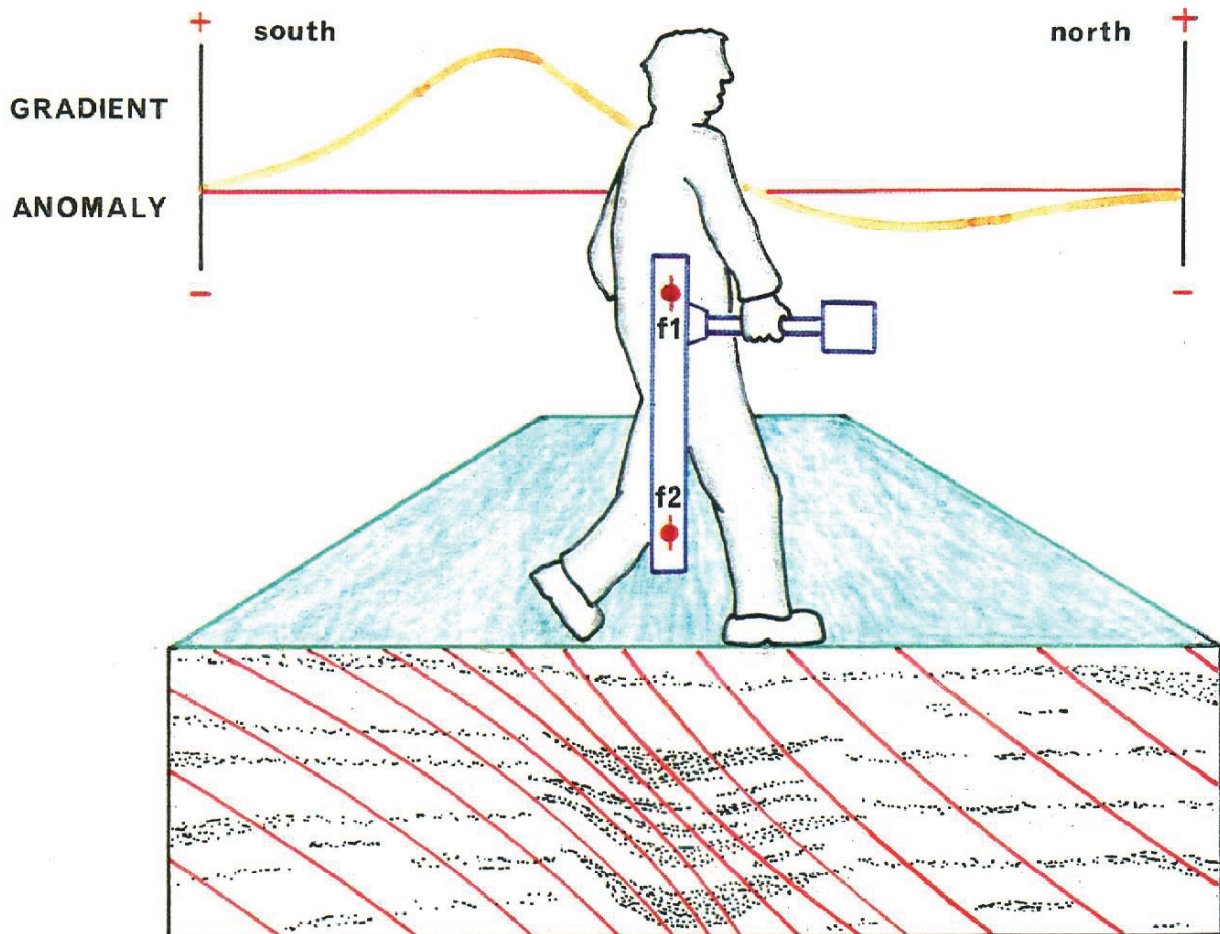
- 1 Anomalies arising from variations in *magnetic susceptibility* which will modulate the component of magnetisation *induced* in the subsurface by the Earth's magnetic field. For most archaeological sites, this is the dominant factor giving rise to geomagnetic anomalies. In general, susceptibility is relatively weak in sediments, such as sandstones and enhanced in igneous 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 $\sim 600^{\circ}\text{C}$ 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

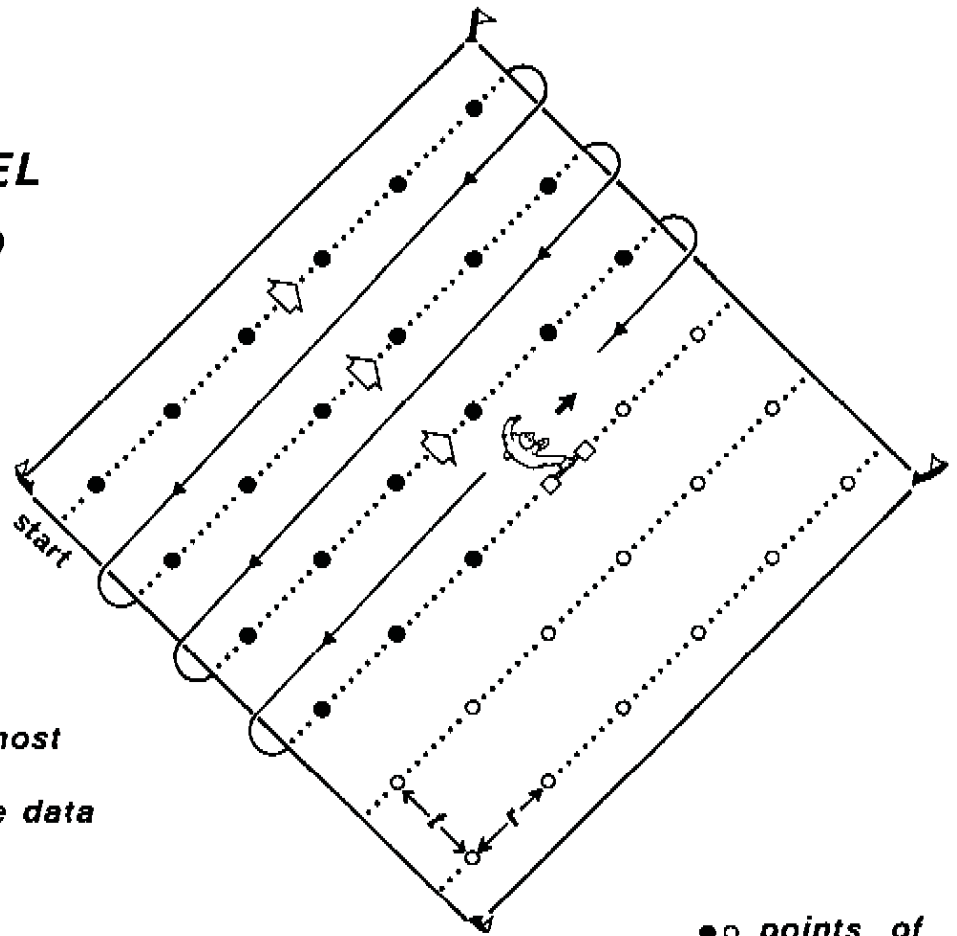
ORIGINAL IN
COLOUR



SURVEY SCHEMES

PARALLEL METHOD

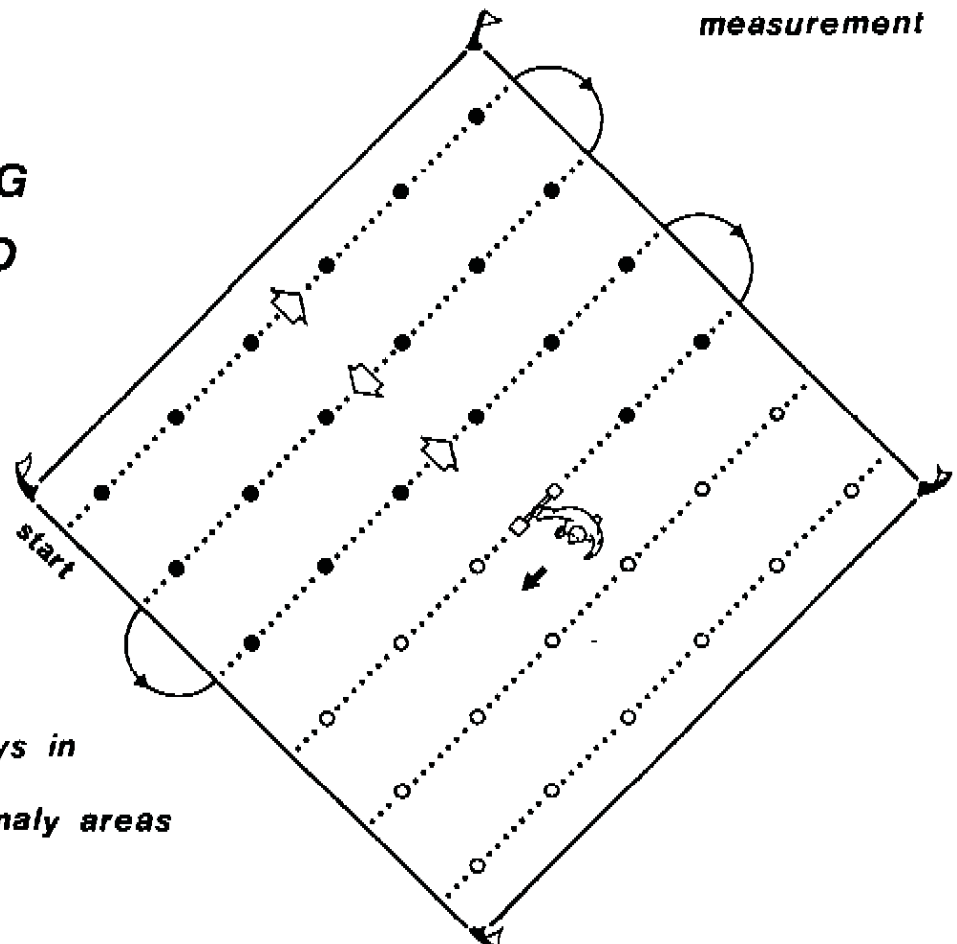
*slower but
minimises most
errors in the data*



●○ points of
measurement

ZIG-ZAG METHOD

*suitable for
rapid surveys in
strong anomaly areas*



NOTES

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