Barnsdale Bar Quarry, Kirk Smeaton

Geophysical Survey Report

March 1996

West Yorkshire Archaeology Service

West Yorkshire Archaeology Service
14 St John's North, Wakefield WF1 3QA

WYAS R320, 25th March 1996

Barnsdale Bar Quarry, Kirk Smeaton

North Yorkshire

(SE 515 145)

Geophysical Survey

Contents

Barnsdale Bar Quarry, Kirk Smeaton

North Yorkshire

Geophysical Survey

1. Summary

Client
SECOR Ltd
Strelley Hall
Main Street
Strelley Village
Nottingham. NG8 6PE

Objectives
To carry out a geophysical survey over the area of the proposed eastern extension of the BFI quarry at Barnsdale Bar, Kirk Smeaton. The aim of the survey was to locate and define known cropmarks, and to sample the surrounding area in order to identify other possible archaeological features.

Techniques and Methods
A Geoscan fluxgate gradiometer with an ST1 sample trigger was used to take readings at 0.5m intervals on traverses spaced 1m apart over an initial 3.6 ha sample of the site, concentrated over the known cropmarks.

The data was downloaded in the field to a Compaq laptop portable computer and later processed on an Elonex 486.

The remaining area was scanned by gradiometer in traverses approximately 25m apart.

A Bartington MS2 magnetic susceptibility meter with field loop was used to take volume specific magnetic susceptibility readings at 20m intervals over the entire site.

A further 3 ha of detailed gradiometer survey was carried out in sample blocks after assessment of the results of the above surveys and scan.

Results and Conclusions
The gradiometer survey detected a number of linear and isolated magnetic anomalies, the location and pattern of which are consistent with an ancient system of boundary ditches and enclosures.

Magnetic susceptibility measurements show enhanced readings in low lying areas close to the magnetic anomalies, an indicator that the area has probably seen extensive human occupation.

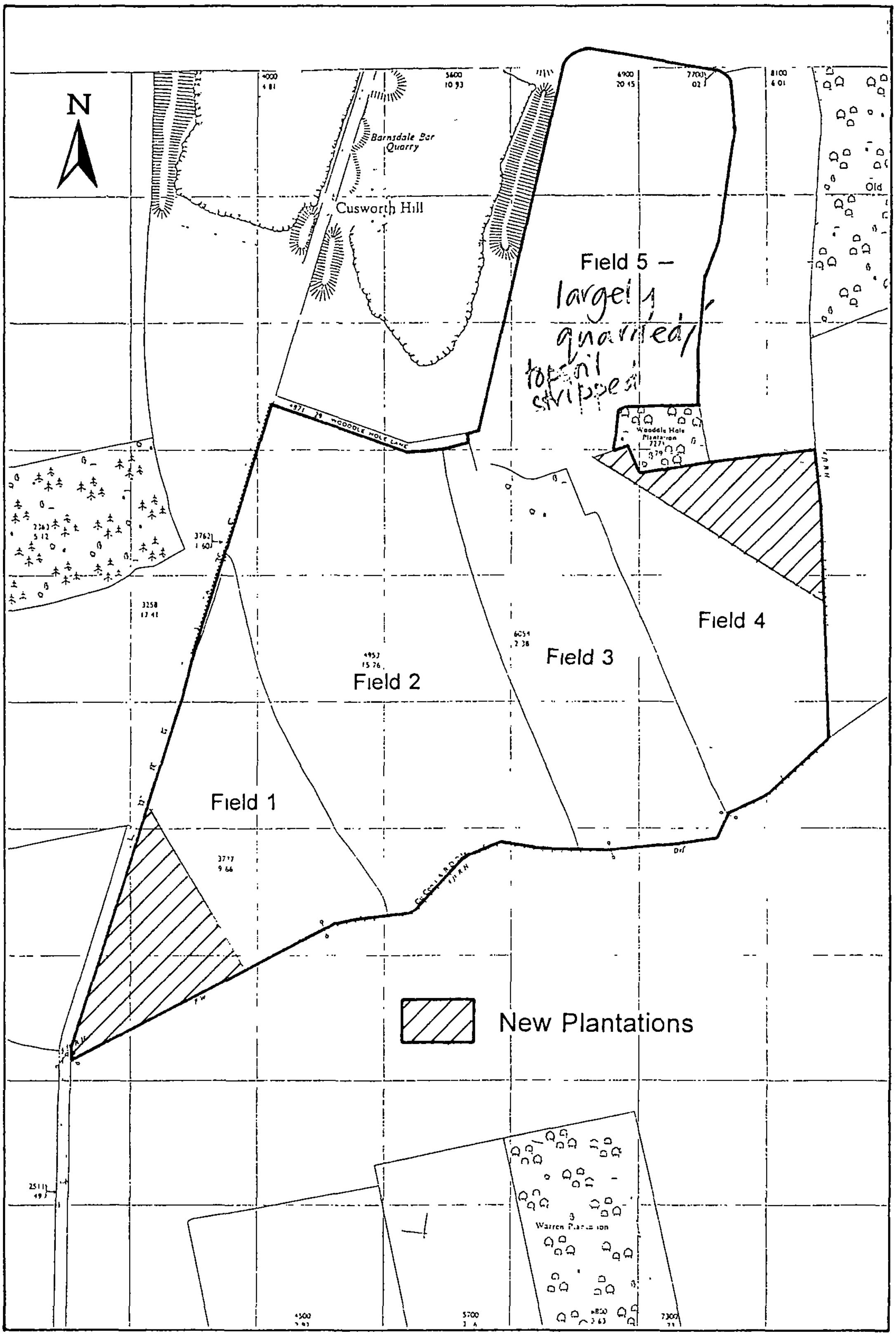

Fig. 1: Location plan of proposed quarry extension *Scale 1 5000*

2. Introduction and Archaeological Background

2.1 A geophysical survey (gradiometer and magnetic susceptibility) was commissioned by Mr K. Owen of SECOR Ltd over an area of proposed quarry at Barnsdale Bar, Kirk Smeaton, centred at SE515145.

2.2 Several archaeological sites have been identified within the surrounding landscape, mainly as cropmarks seen in aerial photographs. A number of these have been surveyed and excavated prior to other phases of quarrying in the area. The majority of the sites appear to form an extensive system of fields, trackways and enclosures of Iron Age or Romano-British date, however, finds of a possible Neolithic date have been recovered from the surface of a field to the west of the proposed extension (Boucher 1995).

2.3 Figure 1. shows the extent of the proposed quarry. Part of the proposed area to the north of Woodle Hall Plantation (Field 5 in Fig. 1) had already been quarried with the exception of approximately 1 ha, stripped of topsoil and considered unsuitable for survey. Part of Field 1 and Field 4 had been fenced off and replanted with young saplings (marked as Plantations on Fig. 1). These areas were also deemed unsuitable for gradiometer survey but magnetic susceptibility readings were taken.

2.4 The site is on an undulating landscape rising to the south. A dry valley cuts through Fields 3 and 4 running north-west to south-east with high ground to either side. One of the results of this is a ridge in Field 2 with slopes down to the west, north, and east. All the land surveyed by gradiometry was arable field. The areas of new plantation to the east and west of the site were sampled only with magnetic susceptibility.

2.5 The underlying geology is Magnesian Limestone. To the west of the area a red/brown subsoil of possible glacial origin had been observed in patches over the limestone and filling natural features (Boucher 1995, 2.3).

2.6 The surveys were conducted between 20/2/96 and 1/3/96.

3. Fluxgate gradiometry: technical information and methods

3.1 In general it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches, and the magnetic susceptibility of the geology into which these features have been cut that produces the most recognisable responses. Other features such as kilns and ovens can be more difficult to identify, although their responses are generally stronger than soil filled features. The highest responses are usually due to iron objects and these produce a characteristic response with a rapid change from positive to negative readings.

3.2 There are a number of methods employing the fluxgate gradiometer. The most basic of these is referred to as scanning and requires the operator to identify responses whilst covering the site in widely spaced traverses.

3.3 Detailed gradiometer survey employs the use of an ST1 Geoscan sample trigger and FM36 fluxgate gradiometer to take readings at 0.5m intervals on zig-zag traverses 1m apart within grids measuring 20m by 20m. This means that 800 readings are taken within each 20m grid square. This method was employed during the survey.

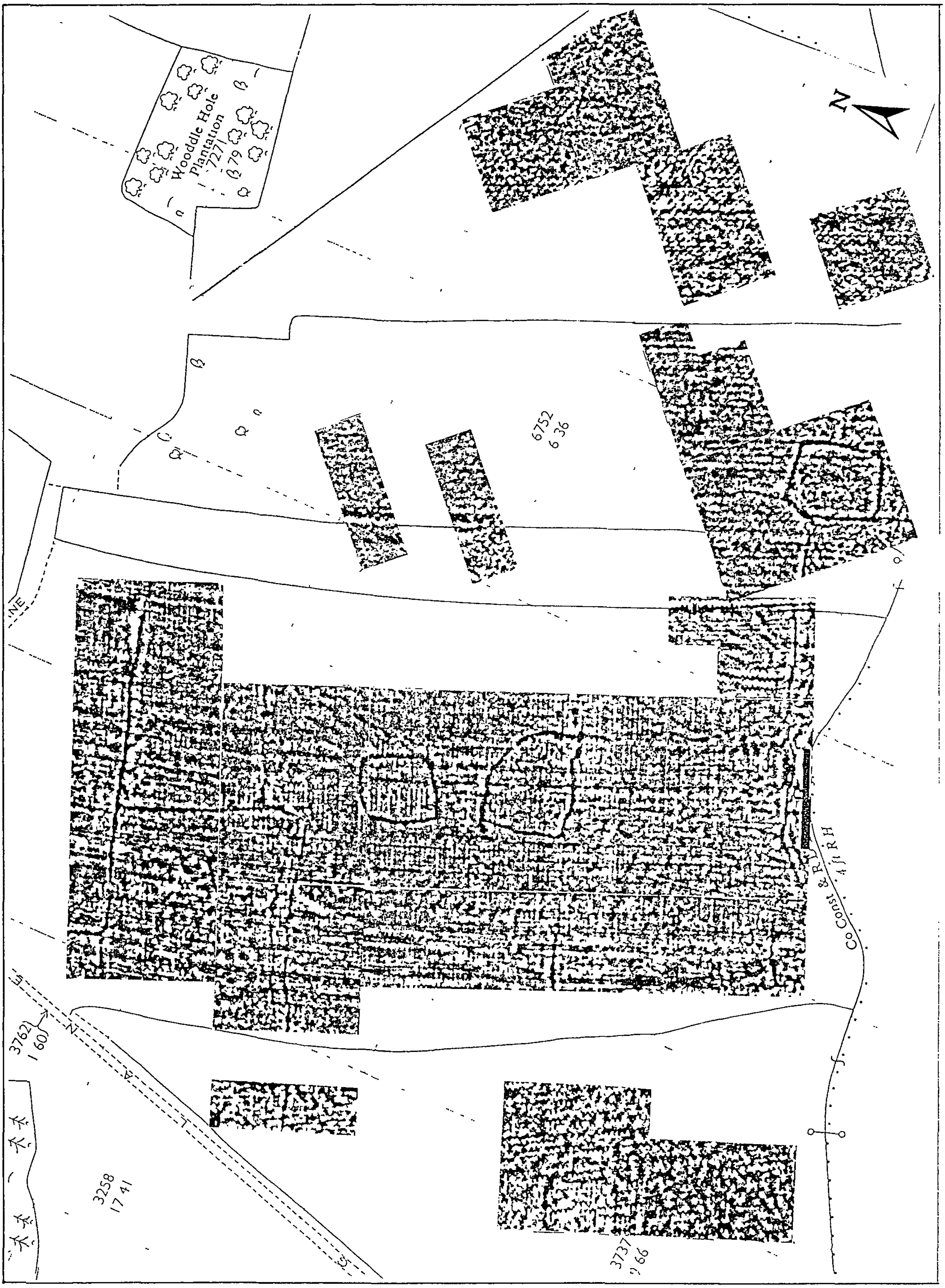

Figure 2: Location plan of gradiometer survey

Scale 1:2000

3.4 A baseline was laid out in Field 2, parallel with the extant field boundaries, running approximately north-west south-east and a grid made up of 20m by 20m squares laid out from this using a Geotronics Geodimeter Total Station, and tied in to permanent features in the landscape (see Fig. 2 for location of survey area). A detailed gradiometer survey was then carried out over a sample area as described above.

3.5 In-house Geocon software was used to interpolate the "missing" line of data so that 1600 readings in total were obtained.

3.6 The remaining area outside the sample was scanned with the gradiometer as described above (3.2) walking along traverses spaced approximately 25m apart.

3.7 The results of the initial sample, the scan, and the magnefic suscepfibility survey were used to place sample blocks in fields 1,3, and 4 for further detailed gradiometer survey. Linear anomalies idenfified in the first sample were in some cases followed by additional detailed survey in Field 2.

4. Magnetic Susceptibility: technical information and methods

4.1 Magnetic susceptibility is a measurement of the ease with which material can be magnetised. Material ploughed up into the topsoil from archaeological features often has a higher magnetic susceptibility to that of soil derived from the parent subsoil. This enhancement can be caused by anthropogenic activities such as burning or by decay of organic material, and is often indicative of human occupation.

4.2 The magnetic susceptibility of the topsoil can be measured directiy in the field using a field loop. This measures the volume specific magnetic susceptibility of the topsoil at the point where the reading is taken. Alternatively samples of the topsoil can be taken at each station and measured with laboratory apparatus, allowing the calculation of mass specific magnetic susceptibility.

4.3 In this case volume magnetic susceptibility readings were taken at 20m intervals using a Bartington MS2 magnetic susceptibility meter with field loop. As much of the site as possible was covered with the exception of the quarried area Field 5. A further 25 soil samples were taken at 60m intervals on the grid for mass specific measurement in the laboratory.

5. Results

5.1 The gradiometer data is presented as a grey-scale and an X-Y trace plot, at a scale of 1:500, as an appendix to the main report. The magnetic susceptibility data is shown as a colour plot in Figure 6. An interpretation of the results is presented in Figure 3. During the survey a number of flint pieces, and a sherd of pottery tentatively identified as Roman grey ware, were found on the surface. The locations of these find spots have been indicated in Figure 3.

5.2 Gradiometer Data

The gradiometer survey has detected a number of linear and isolated magnetic anomalies. With the exception of those believed to be due to recent cultivation, an interpretation of these has been presented in Figure 3. Two types of positive anomaly have been shown depending on the strength of response, those labelled as faint being typically less than 4nT. The anomalies

Figure 3 Interpretative presentation of the gradiometer survey results

referred to as pertubated are probably due to relatively modern intrusions such as field drains. Isolated responses have been divided into those with a clear positive signature and those with an accompanying negative reading. These latter responses, referred to as dipolar anomalies, are characteristic of extraneous metal near the surface, probably of modern origin.

Most of the site has been crossed by a pattern of weak, closely spaced, positive linear anomalies, roughly parallel to the field boundaries which are almost certainly the effects of ploughing. These are shown separately in Figure 4. The furrows in Field 2 are spaced further apart suggesting that the field has not been intensively ploughed and that the responses found there are due to a medieval ridge and furrow pattern.

Any anomalies detected by scanning were followed up by detailed survey.

5.3 Magnetic Susceptibility Data

The results of the field loop magnetic susceptibility survey can be seen as a colour plot in Figure 6. Several areas of enhanced susceptibility can be seen and an interpretation of these have been overlaid onto the gradiometer survey interpretation, Figure 3, for comparison purposes and will be discussed below. Measurements taken on soil samples in the laboratory supported the results obtained in the field.

6. Discussion

6.1 Most of the faint anomalies illustrated in Figure 3 seem to have no pattern and are probably caused by geological processes such as glacial deposits filling natural cracks and hollows of the underlying limestone.

6.2 Some of the stronger positive anomalies fall on the line of field boundaries known from earlier OS maps, and have been indicated as such on Figure 4.

6.3 The magnetic anomalies most likely to represent archaeological features are illustrated in Figure 5, and are discussed as follows:

6.3.1 The linear anomalies indicated are of sufficient strength and fall into such a pattern as to suggest a planned system of field boundaries and enclosures. The two sub-circular enclosures in the middle of Field 2 marked A and B correspond to the cropmarks seen on aerial photographs (Boucher 1995) although it is significant that a further small rectangular cropmark to the south of the enclosures has not been detected.

A further enclosure has been clearly defined at C. This appears to be related to a system of ditches spreading to the west and north-west. The shape of features at D and E suggest that these too may represent small enclosures. Indeed, the enclosure at D appears to be further enclosed within a larger field system.

6.3.2 Most of the isolated positive anomalies occur within these enclosures or in the area marked G on Figure 5, an area bounded by ditches on at least three sides. It would be reasonable to infer that the anomalies are responses from features internal to the enclosures such as pits or hearths.

6.3.3 A pair of parallel ditches some 6m apart were detected at F. This may represent a

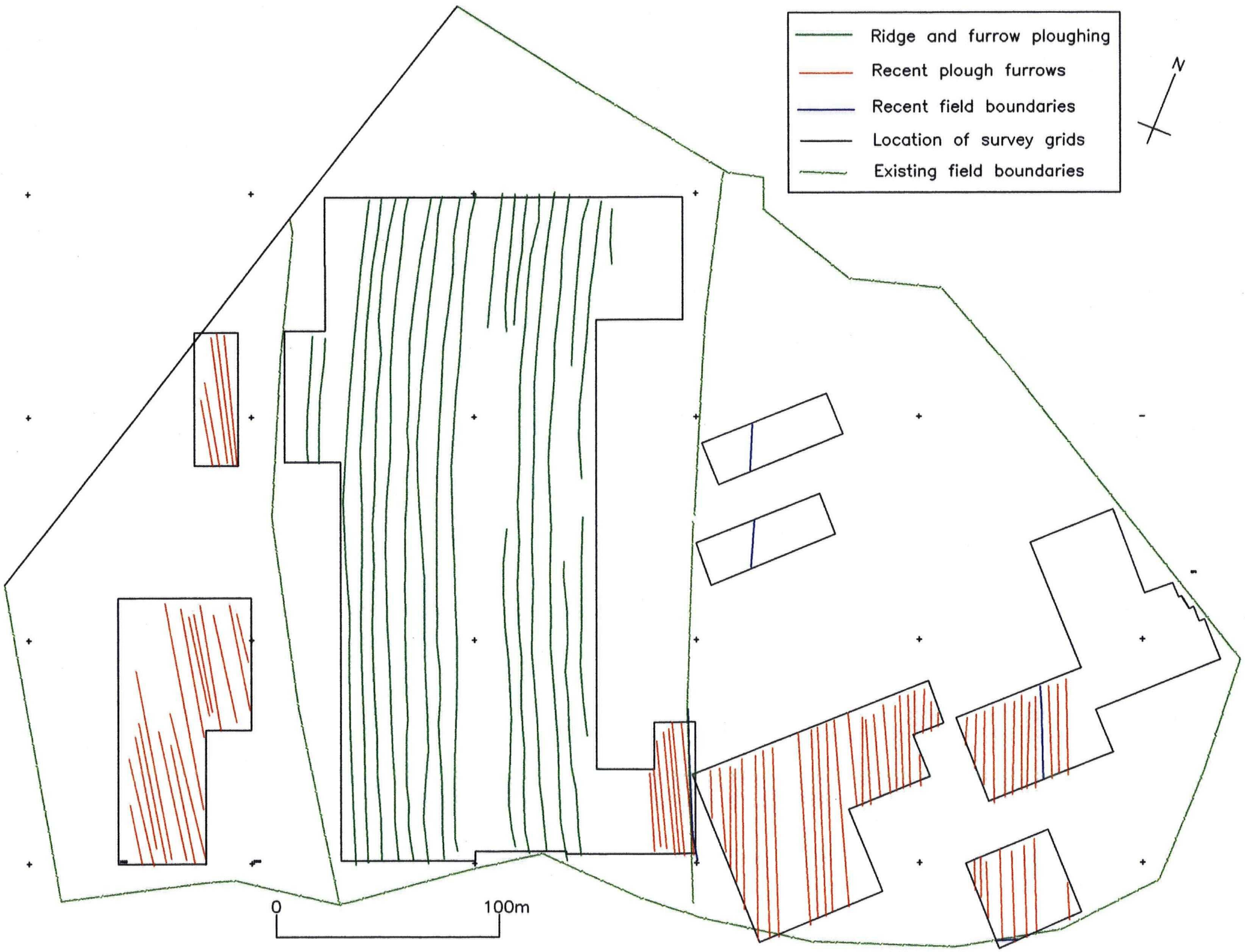

Figure 4 Agricultural features thought to post-date the Roman period

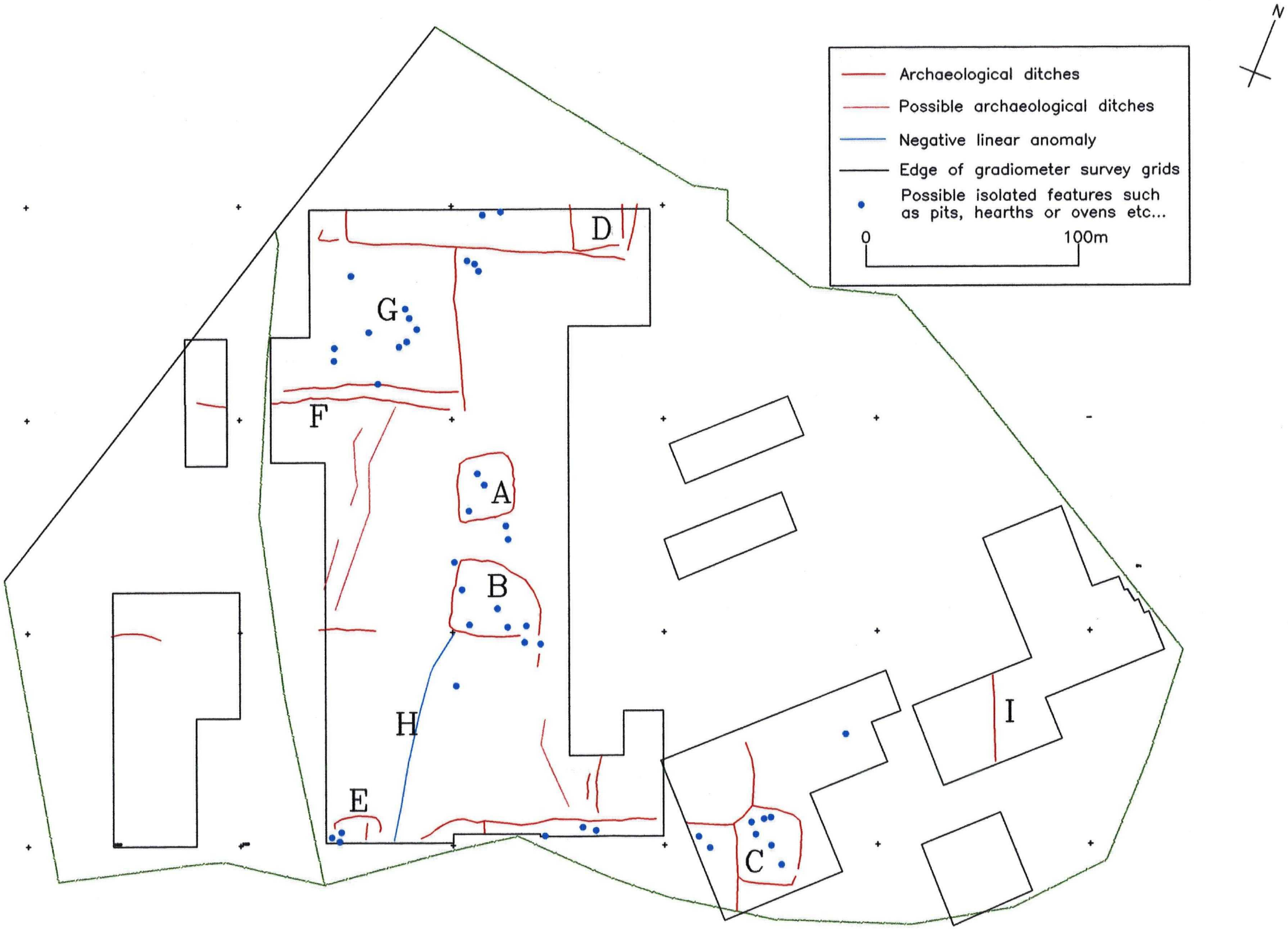

Figure 5 Interpretation of likely archaeological features

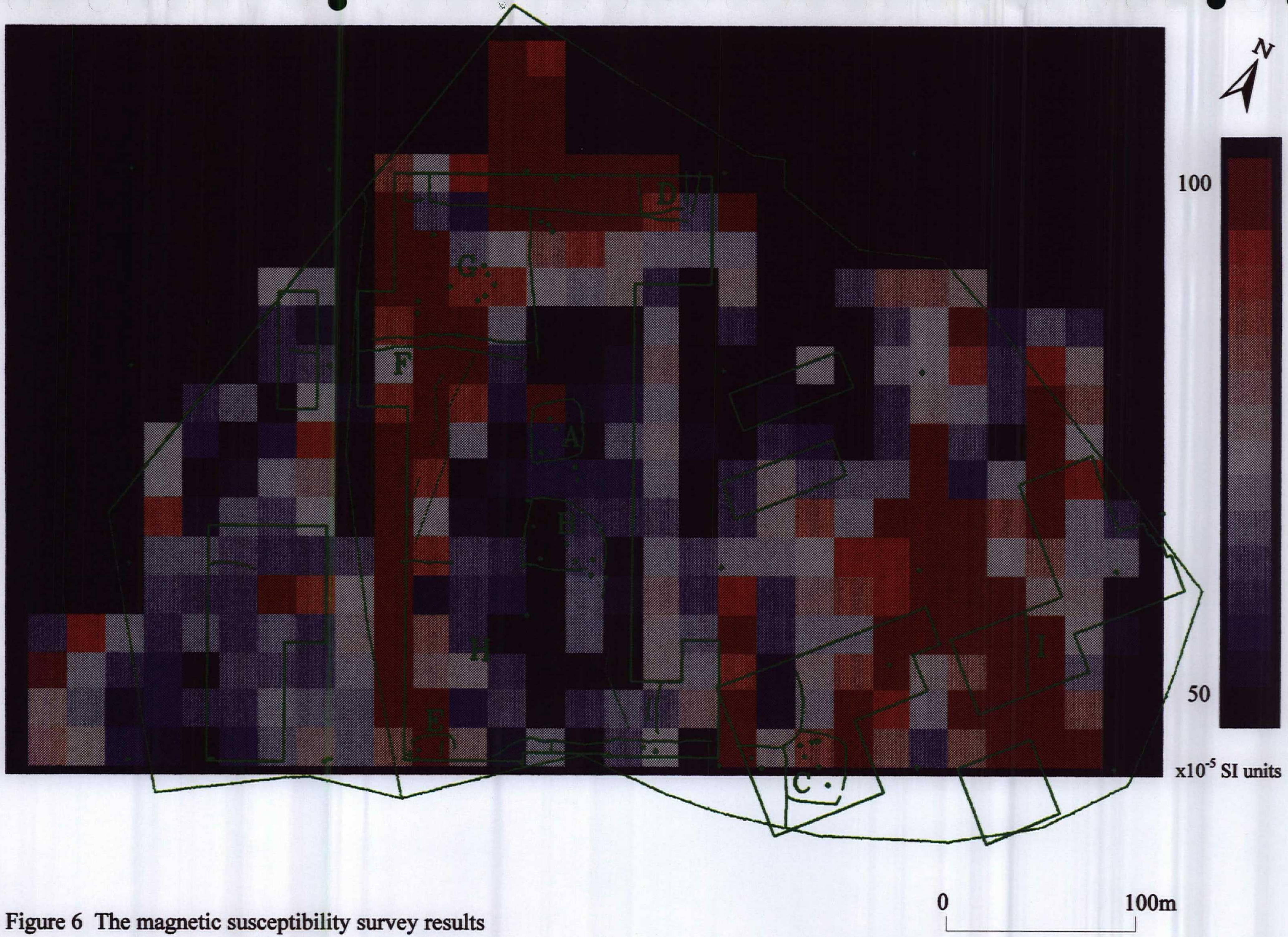

Figure 6 The magnetic susceptibility survey results

trackway, and if so it appears to respect the ancient field system.

6.3.4 It is unclear what the negative linear anomaly at H might be.

6.3.5 The linear anomaly at I runs parallel to the modern field systems and could possibly indicate the remaining ditch of an early field boundary.

6.4 An interpretation showing areas of enhanced magnetic susceptibility has been included in Figure 3. Any significance that might be attached to these locations are discussed as follows:

6.4.1 It is noticeable that the readings taken on the topsoil over the enclosures A and B are relatively low. This area is topographically on high ground, a central ridge in Field 2, and it may be that the topsoil is thin. There are areas of high magnetic susceptibility on either side of the ridge, areas 3 and 5, and it would be reasonable to infer that enhanced material had migrated into these areas through factors such as ploughing and soil creep. The resultant accumulation of enhanced soil would appear to have been arrested by the field boundaries on either side.

6.4.2 At the northern end of Field 2 there is a concentration of high readings in Area 4 and the adjacent part of Area 3. This area contained a number of positive anomalies from the gradiometer survey.

6.4.3 The area of high magnetic susceptibility readings, Area 8, is situated in the dry valley running through fields 3 and 4. Gradiometer survey and scanning in this area failed to find any clear archaeological features. Therefore, it is likely that the enhanced material has migrated into the valley from either one or both of the adjacent banks. There is clearly a source of potential magnetic susceptibility enhancement at Enclosure C, and high magnetic susceptibility readings were obtained to the east and west of the enclosure. The opposite bank also has areas of high readings, areas 9 and 10. No significant anomalies were detected nearby but most of the area was not surveyed because of the plantation.

6.4.4 There are two other isolated groups of high readings in Field 1. Area 1 is outside the gradiometer survey. Area 2 was partly surveyed but no significant anomalies were detected.

7. Conclusion

7.1 It is likely that most of the linear positive anomalies located by the gradiometer survey form part of a system of ancient field boundaries and enclosures. As most of the isolated anomalies are concentrated within these boundaries, it is probable that many of them are responses from archaeological features such as pits or hearths.

7.2 This contention is supported to some extent by the magnetic susceptibility survey. Enhanced material seems to have gathered in those low lying parts of the site which are near to areas of concentrated magnetic activity. Factors such as ploughing and natural movement of soil particles may have caused the enhanced topsoil to migrate from those areas of magnetic activity which are situated on higher ground.

7.3 The finds and the magnetic evidence suggests that the proposed quarry area contain at least three enclosures and an extensive field system of possible Iron Age or Romano-British date.

Acknowledgments

Project Management:	A. Boucher BSc
Geophysical Survey:	A. Webb BA, P. Cottrell MA, A. Hunter Blair, K. Speight, J. Sleap, R. Holbury BSc
Report:	P. Cottrell MA
Graphics:	A. Boucher BSc. A.Swann MAISS
Finds Report	A. Boucher BSc

Bibliography

Boucher, A., 1995 *Land at Barnsdale Bar Eastern Quarry Extension: Preliminary Archaeological Assessment* WYAS Report 303

Boucher, A., 1995 *Barnsdale Bar Quarry, Kirk Smeaton: Field Walking and Gradiometer Survey* WYAS Report 285

Appendix: Finds Report

Finds from Grid 409 (Centre SE 51661443)

One micro core, 30mm x 30mm x 30mm, cream flint showing signs of frost shattering on three surfaces.

One flake (15mm x 22mm x 4mm) cream flint similar to the above. Waste flake.

One bodysherd of grey ware (70mm x 65mm x 9mm) from a straight sided vessel. Roman in date; 2^{nd} - 4^{th} Century.

Finds from Grid 328 (Centre SE 51521454)

One backed blade/flake (17mm x 15mm x 6mm). Similar cream flint to those above. Possible proximal end of a snapped blade or core preparation flake.

Conclusion

Too few finds were recovered during the geophysical surveys to draw any definite conclusions. However, the flints are similar to those found on the site previously reported (Boucher, 1995 Barnsdale Bar Quarry, Kirk Smeaton: Field Walking and Gradiometer Survey).

SNY 11612 2x OVERSIZE PLOTS NOT SCANNED

SEE ORIGINALS