LAND AT HIGH STREET, NEWTON ON TRENT, LINCOLNSHIRE

Gradiometer Survey

(Survey Ref: 1351297/NTL/PCA)

JANUARY 1998

Produced by

OXFORD ARCHAEOTECHNICS LIMITED

under the direction of

A.E. Johnson *BA(Hons)*

Commissioned by

Pre-Construct Archaeology (Lincoln)

on behalf of

Mr. H. Gelder

OXFORD ARCHAEOTECHNICS

Specialist Archaeological Field Evaluation

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SUMMARY

A geophysical evaluation programme comprising magnetometer (gradiometer) survey was carried out on c.0.3 ha of land at the rear of High Street, Newton on Trent, Lincolnshire (centred on SK 8335 4430) in advance of proposed housing development.

The survey was based upon the principle that past human activity and its associated debris usually creates slight but persistent changes in the local magnetic environment which can be sensed from the surface (using magnetometry).

Considerable ferrous debris was present in the topsoil.

Although sited in the vicinity of two Romano-British kilns, no features of demonstrable archaeological significance were recorded.

1. INTRODUCTION

1.1 Geophysical survey was commissioned by Pre-Construct Archaeology (Lincoln) on behalf of Mr. H. Gelder on land at the rear of High Street, Newton on Trent, Lincolnshire, in advance of proposed housing development. The location is shown on Fig. 1. The fieldwork was carried out in December 1997.

1.2 The survey area (centred on SK 8335 4430) comprises a paddock situated at the rear of properties fronting High Street (east side), and extending eastwards as far as the A 1133 Newton on Trent Bypass. The paddock was rough pasture; some clearance debris, bonfire sites and ferrous material were visible on the ground surface.

1.3 Although no sites or finds of archaeological significance are known from the survey area, two Romano-British pottery kilns were discovered in the vicinity during the construction of the bypass in 1983 (information from Pre-Construct Archaeology).

1.4 The present magnetometer (gradiometer) survey aimed to identify activity areas and characterise 'cut' features and structural remains of later prehistoric or subsequent periods. An explanation of the techniques used, and the rationale behind their selection, is included in an Appendix to the present report.

2. MAGNETIC SURVEY DESIGN

2.1 In order to avoid obvious modern sources of contamination, the survey area was sited at a distance of 3 m from the fenceline forming the southern boundary in order to minimise the effects from a water main, and 5 m from the western boundary (Fig. 2), giving a survey area of nominally 60 x 45 m (0.27 ha); the northwestern angle was truncated by the presence of a barn.

2.2 Detailed gridded magnetometer survey was carried out using a Geoscan Research FM 36 Fluxgate Gradiometer (sampling 4 readings per metre at 1 metre traverse intervals in the 0.1 nT range). The nanotesla (nT) is the standard unit of magnetic flux (expressed as the current density), here used to indicate positive and negative deviations from the Earth's normal magnetic field.

2.3 Field data were stored to 3.5-inch disks, and processed using Geoscan Research Geoplot and Oxford Archaeotechnics software.

2.4 Magnetometer data have been presented as grey scale and raw data stacked trace plots (Figs. 3 & 5); an interpretation of results is shown on Fig. 4.

3. SURVEY RESULTS

3.1 Despite clearance of obvious surface debris where practical prior to survey, the topsoil nevertheless contains a considerable amount of ferrous debris which tends to dominate the magnetometer plot.

3.2 At least three fleeting weak anomalies were recorded, however, suggesting possible intrusive linear features, one apparently stronger than the rest (shown as broken blue lines on Fig. 4); further diffuse anomalies are probably the result of variations in the depth of topsoil, although the possibility of one or two pits cannot be entirely discounted.

4. CONCLUSIONS

4.1 Magnetometer survey confirmed a considerable concentration of ferrous debris in the topsoil, and recorded some (weak magnetic) evidence for perhaps three possible linear features.

4.2 Against such a 'noisy' magnetic background it is possible that less substantial features, or those infilled with lower magnetically susceptible material would remain undetected.

4.3 It is anticipated, however, that had pottery kilns such as those discovered during the construction of the bypass, or any associated 'cut' features or structures, been present in the survey area they should have produced sufficiently strong magnetic anomalies to be visible to gradiometer survey despite the clutter of modern ferrous material.

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Magnetometer survey by Oxford Archaeotechnics Limited under the direction of A.E. Johnson *BA(Hons)*, with M. Ayers *BSc(Hons), MSc, PhD*.

APPENDIX - MAGNETIC TECHNIQUES: GENERAL PRINCIPLES

A1.1 It is possible to define areas of human activity (particularly soils spread from occupation sites and the fills of cut features such as pits or ditches) by means of *magnetic survey* (Clark 1990; Scollar et al. 1990). The results will vary, according to the local geology and soils (Thompson & Oldfield 1986; Gale & Hoare 1991), as modified by past and present agricultural practices. Under favourable conditions, areas of suspected archaeological activity can be accurately located and targeted for further investigative work (if required) without the necessity for extensive random exploratory trenching. Magnetic survey has the added advantages of enabling large areas to be assessed relatively quickly, and is non-destructive.

A1.2 Topsoil is normally more magnetic than the subsoil or bedrock from which it is derived. Human activity further locally enhances the magnetic properties of soils, and amplifies the contrast with the geological background. The main enhancement effect is the increase of *magnetic susceptibility*, by fire and, to a lesser extent, by the bacterial activity associated with rubbish decomposition; the introduction of materials such as fired clay and ceramics - and, of course, iron and many industrial residues - may also be important in some cases. Other agencies include the addition and redistribution of naturally magnetic rock such as basalt or ironstone, either locally derived or imported.

A1.3 The tendency of most human activity is to increase soil magnetic susceptibility locally. In some cases, however, features such as traces of former mounds or banks, or imported soil/subsoil or non-magnetic bedrock (such as most limestones), will show as zones of lower susceptibility in comparison with the surrounding topsoil.

A1.4 Archaeologically magnetically enhanced soils are therefore a response of the parent geological material to a series of events which make up the total domestic, agricultural and industrial history of a site, usually over a prolonged period. Climatic factors may subsequently further modify the susceptibility of soils but, in the absence of strong chemical alteration (e.g. during the process of podzolisation or extreme reduction), magnetic characteristics may persist over millions of years.

A1.5 Both the magnetic contrast between archaeological features and the subsoil into which they are dug, and the magnetic susceptibility of topsoil spreads associated with occupation horizons, can be measured in the field.

A1.6 There are several highly sensitive instruments available which can be used to measure these magnetic variations. Some are capable, under favourable conditions, of producing extraordinarily detailed plots of subsurface features. The detection of these features is usually by means of a *magnetometer* (normally a fluxgate gradiometer). These are defined as passive instruments which respond to the magnetic anomalies produced by buried features in the presence of the Earth's magnetic field. The gradiometer uses two sensors mounted vertically, often 50 cm apart. The bottom sensor is carried some 30 cm above the ground, and registers local magnetic anomalies with respect to the top sensor. As both sensors are affected equally by gross magnetic effects these are cancelled out. In order to produce good results, the magnetic susceptibility contrast between features and their surroundings must be reasonably high, thereby creating good local anomalies; a generally raised background, even if due to human occupation within a settlement context, will sometimes preclude meaningful magnetometer results. The sensitive nature of magnetometers makes them suitable for detailed work, logging measurements at a closely spaced (less than 1 metre) sample interval, particularly in areas where an archaeological site is already suspected. Magnetometers may also be used for rapid 'prospecting' ('scanning') of larger areas (where the operator directly monitors the changing magnetic field and pinpoints specific anomalies).

A1.7 *Magnetic susceptibility measuring systems*, whilst responding to basically the same magnetic component in the soil, are 'active' instruments which subject the sample area being measured (according to the size of the sensor used) to a low intensity alternating magnetic field. Magnetically susceptible material within the influence of this field can be measured by means of changes which are induced in oscillator frequency. For general work, measuring topsoil susceptibility *in situ*, a sensor loop of around 20 cm diameter is convenient, and responds to the concentration of magnetic (especially ferrimagnetic) minerals mostly in the top 10 cm of the soil. Magnetically enhanced horizons which have been reached by the plough, and even those from which material has been transported by soil biological activity, can thus be recognised.

A1.8 Whilst only rarely encountering anomalies as graphically defined as those detected by magnetometers, magnetic susceptibility systems are ideal for detecting magnetic spreads and thin archaeological horizons not seen by magnetometers. Using a 10 m interval grid, large areas of landscape can be covered relatively quickly. The resulting plot can frequently determine the general pattern of activity and define the nuclei of any occupation or industrial areas. As the intervals between susceptibility readings generally exceed the parameters of most individual archaeological features (but not of the general spread of enhancement around features), the resulting plots should be used as a guide to areas of archaeological potential and to suggest the general form of major activity areas; further refinement is possible using a finer mesh grid or, more usually, by detailing underlying features using a gradiometer.

A1.9 Magnetic survey is not successful on all geological and pedological substrates. As a rule of thumb, in the lowland zone of Britain, the more sandy/stony a deposit, the less magnetic material is likely to be present, so that a greater magnetic contrast in soil materials will be needed to locate archaeological features; in practice, this means that only stronger magnetic anomalies (e.g. larger accumulations of burnt material) will be visible, with weaker signals (e.g. from the fillings of simple agricultural ditches) disappearing into the background. Similar problems can arise when the natural background itself is very high or very variable (e.g. in the presence of sediments partially derived from magnetic volcanic rocks).

A1.10 The precise physical and chemical processes of changing soil magnetism are extremely complex and subject to innumerable variations. In general terms, however, there is no doubt that magnetic enhancement of soils by human activity provides valuable archaeological information.

A1.11 As well as locating specific sites, topsoil magnetic susceptibility survey frequently provides information relating to former landuse. Variations in the soils and subsoils, both natural and those enhanced by anthropogenic agencies, when modified by agriculture, give rise to distinctive patterns of topsoil susceptibility. The containment of these spreads by either natural or man-made features (streams, hedgerows, etc.) gives rise to a characteristic chequerboard or strip pattern of varying enhancement, often showing the location of former field systems, which persist even after the physical barriers have been removed. These patterns are often further amplified in fields containing underlying archaeological features within reach of the plough. More subtle landuse boundaries and indications of former cultivation regimes are often suggested by topsoil magnetic susceptibility plots.

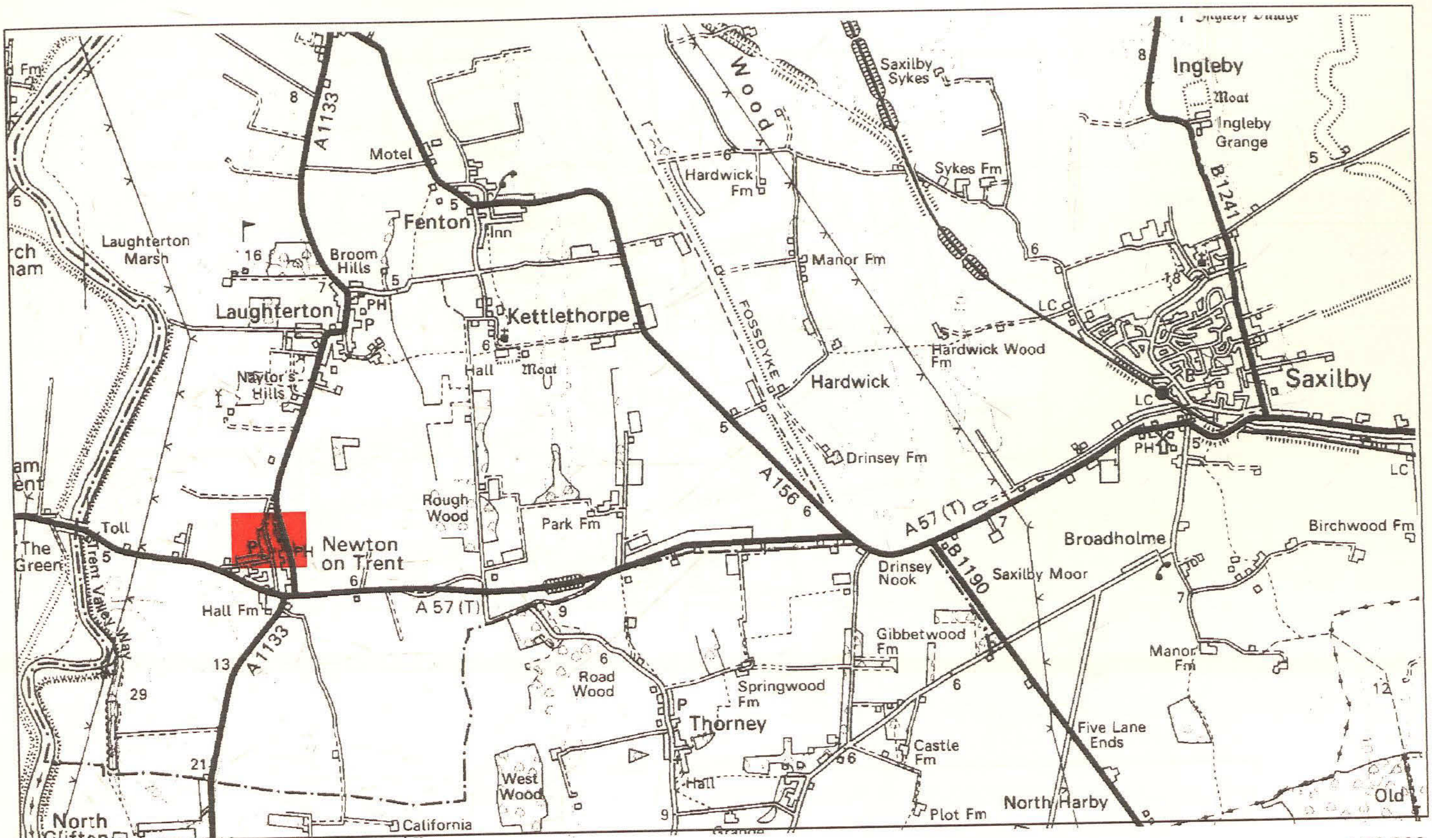
A1.12 Where a general spread of magnetically enhanced soils contained within a long-established boundary becomes admixed over a long period by constant ploughing, it can be diffused to such a point that the original source is masked altogether. Magnetically enhanced material may also be moved or masked by natural agencies such as colluviation or alluviation. Generally, it appears that the longer a parcel of land has been under arable cultivation, the greater is the tendency for topsoil susceptibility to increase; at the same time there is increasing homogeneity of the magnetic signal within the soils owing to continuous agricultural mixing of the material. Some patterns of soil enhancement derived from underlying archaeological features are, however, apparently capable of resisting agricultural dispersal for thousands of years (Clark 1990).

FIGURE CAPTIONS

Figure 1.	Location maps. Scale 1:50,000 and 1:5,000.
Figure 2.	Location of magnetometer survey grids. Scale 1:1000.
Figure 3.	Magnetometer (gradiometer) survey: grey scale plot (Geoscan Research Geoplot Licence No. GPB 885-6). Scale 1:500.
Figure 4.	Magnetometer (gradiometer) survey: interpretation (Geoscan Research Geoplot Licence No. GPB 885-6). Scale 1:500.
Figure 5.	Magnetometer (gradiometer) survey: stacked trace plot (raw data (Geoscan Research Geoplot Licence No. GPB 885-6). Scale 1:500.

Land at High Street, Newton on Trent, Lincolnshire

Magnetometer survey: grey scale plot



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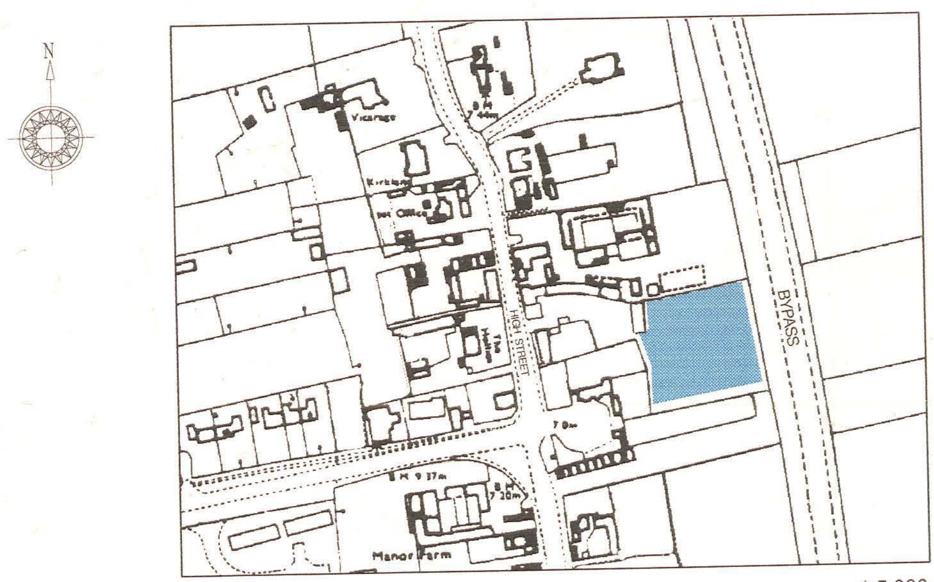
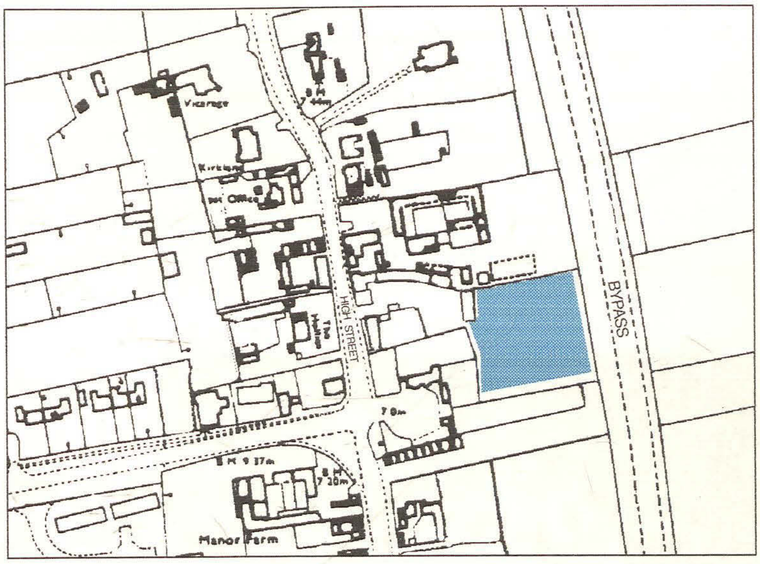


1:5,000

OXFORD ARCHAEOTECHNICS FIG. 1

Land at High Street, Newton on Trent, Lincolnshire

Magnetometer survey: location



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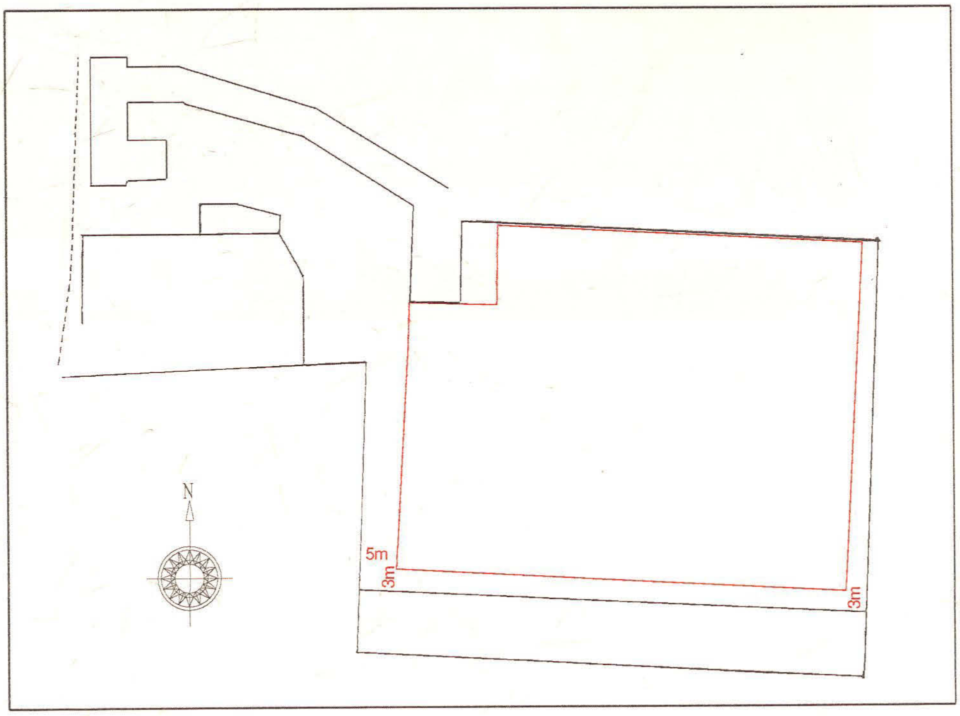
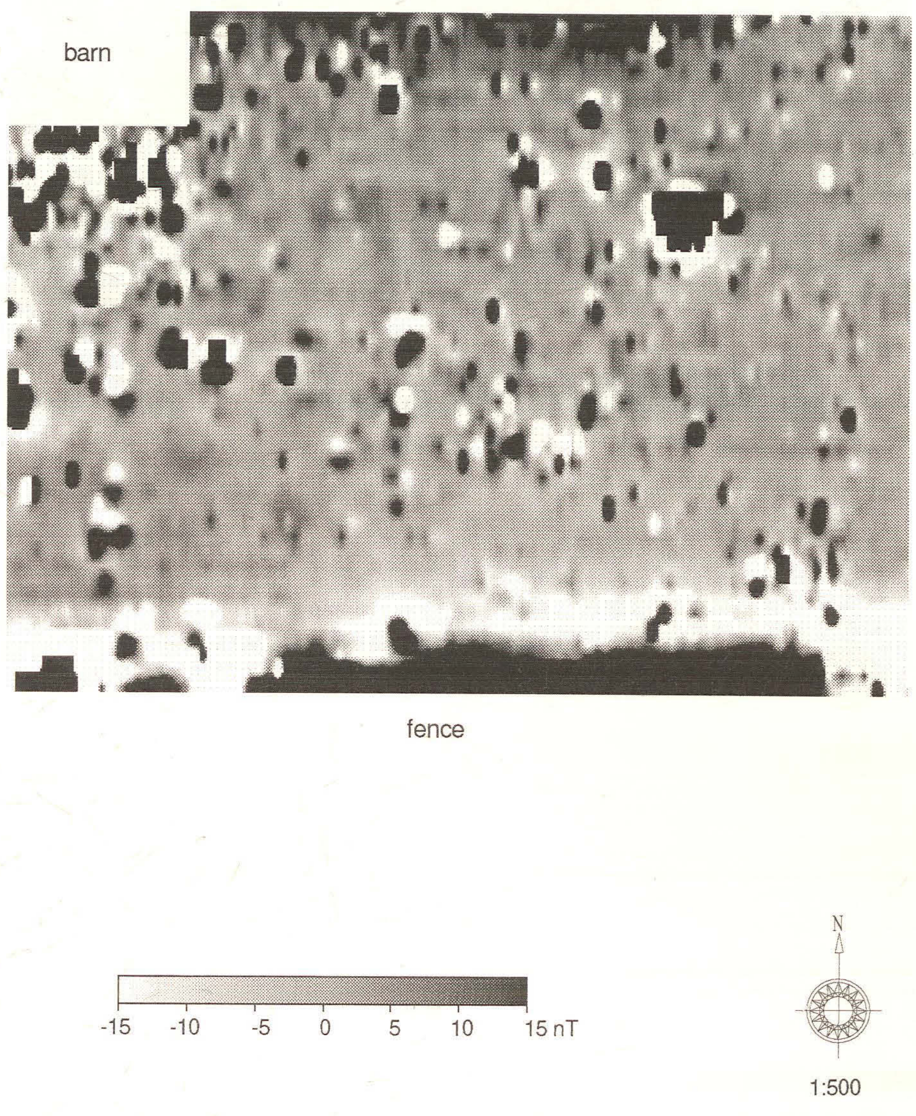


1:1,000

OXFORD ARCHAEOTECHNICS FIG. 2

Land at High Street, Newton on Trent, Lincolnshire

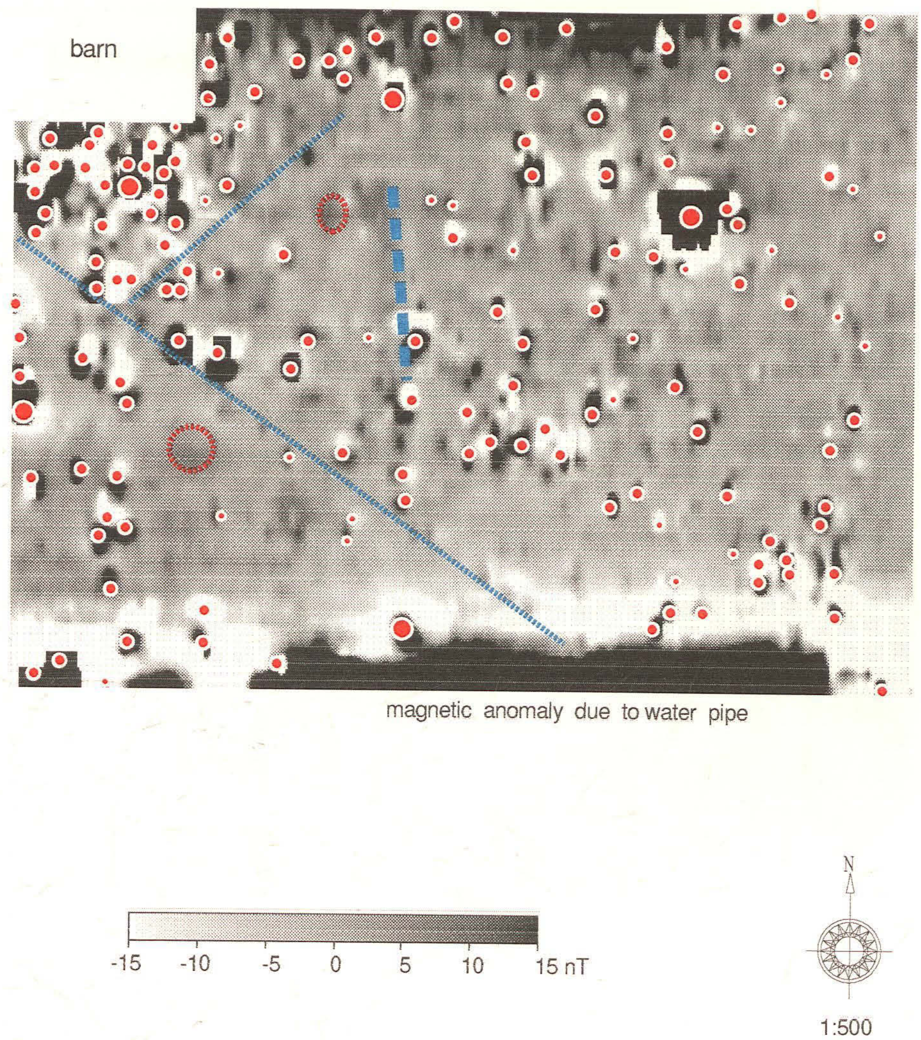
Magnetometer survey: grey scale plot



OXFORD ARCHAEOTECHNICS FIG. 3

Land at High Street, Newton on Trent, Lincolnshire

Magnetometer survey. Grey scale plot: interpretation



Interpretation

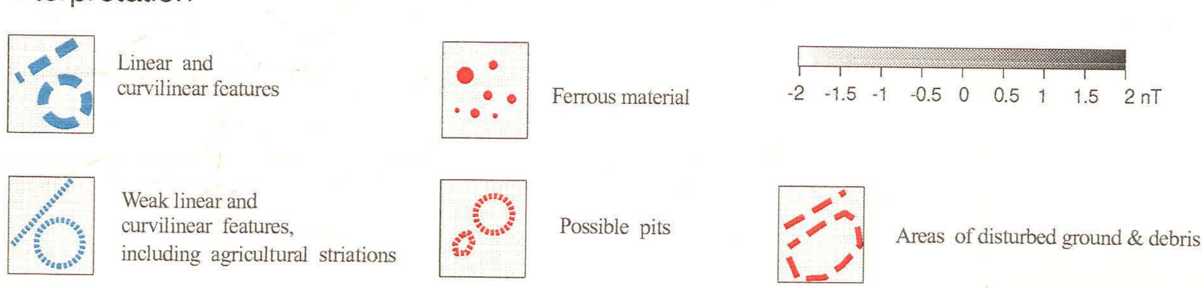


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FIG. 4

Land at High Street, Newton on Trent, Lincolnshire

Magnetometer survey: stacked trace plot (raw data)

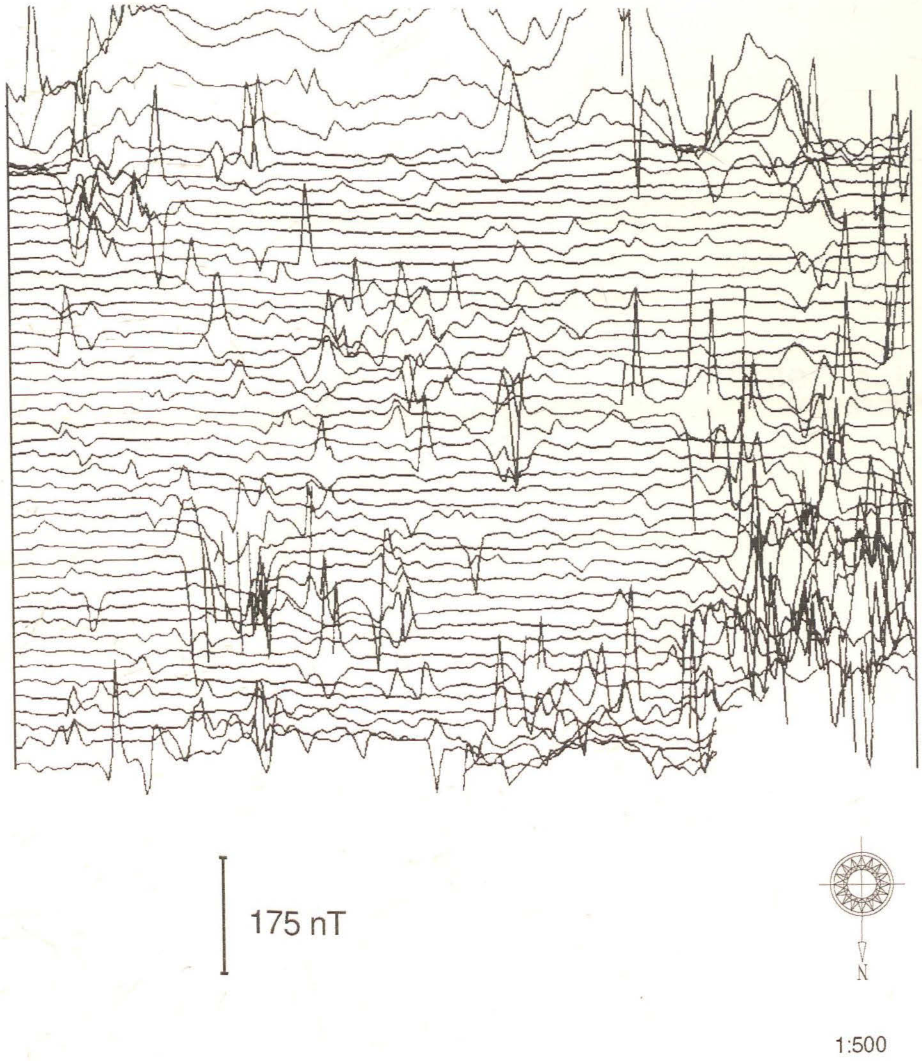

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FIG.5

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INTERNAL QUALITY CHECK

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Primary Author	ff	Date	30/1/98
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Further Corrections		Date	

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