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FRILFORD, OXFORDSHIRE

(Manor Farm, Marcham)

TOPSOIL MAGNETIC SUSCEPTIBILITY MAPPING & MAGNETOMETER (GRADIOMETER) SURVEY

SURVEY REF: 2560602/FRO/CUM

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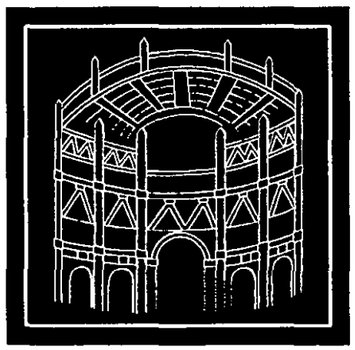
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COMMISSIONED BY Mr. & Mrs. W. CUMBER

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OXFORD ARCHAEOTECHNICS

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Amphitheatre: Trajan's Column, Rome. c.AD 113

SPECIALIST ARCHAEOLOGICAL FIELD EVALUATION

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SUMMARY

Topographic and magnetic survey (using a combination of 10 m topsoil magnetic susceptibility mapping and selective magnetometry) was undertaken on the site of the Roman amphitheatre and associated religious complex close to the former Noah's Ark Inn, Frilford, near Abingdon, Oxfordshire (centred on NGR 444000 196350) in conjunction with an ongoing excavation and research programme by Oxford University Department of Continuing Education.

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.

A total area of 13 ha was investigated. The plan and precise location of the amphitheatre, two nearby buildings, part of the northern temenos wall of the temple known to underlie the Noah's Ark site and an enclosure previously identified from the air were determined by geophysics prior to excavation, and additional information was provided including a small ring and a series of pits and hollows which were confirmed by excavation to be of Bronze Age - late Iron Age date. Survey within the field northwest of the amphitheatre, close to a known late Roman and Anglo-Saxon cemetery, identified an extensive area of former activity, including substantial pit forms, hollows, and possible structures (including possible sunken-floored buildings) defined on the south and east sides by small enclosure ditches. Sherds of Roman pottery (including samian ware) were evident on the field surface at this location.

1. INTRODUCTION

1.1 Geophysical and topographic survey was commissioned by Mr. And Mrs. W. Cumber, of Manor Farm, Marcham, Abingdon on their land at Frilford, Oxfordshire in conjunction with an excavation and research programme being undertaken by Oxford University Department of Continuing Education (OUDCE). The fieldwork was carried out at various dates in May - August 2001and May - June 2002.

1.2 The survey area, centred on NGR 444000 196350, covered the western parts of two large arable fields, lying on either side of the roughly east-west farm track, situated east and north of the former Noah's Ark Public House, Frilford, c.1.5 km west of the village of Marcham, Oxfordshire. The location is shown on Fig. 1.

1.3 The site lies on Jurassic limestone (Corallian Ridge). Some local topographic variation is evident: the south field retains traces of a small silted combe, within which the amphitheatre had been constructed, and the 'bowl' of the amphitheatre survives as a slight topographic hollow. In the extreme southwestern angle of the northern of the field lies a hollow area which appears to be a silted former quarry pit. Otherwise the land slopes gently southeastwards towards the River Ock, some 200 m distant. At the time of survey the southern field was set-aside and the northern field was stubble.

1.4 Land in the vicinity of the Noah's Ark Inn has been the subject of archaeological interest since the middle of the 19th century, when stone quarrying uncovered a late Roman and Anglo-Saxon cemetery close to the west side of the main (A338) road (centred on 443820 196470), some 200 m north of the public house. Excavations in 1937 - 38 and 1964 within the northern part of the narrow field immediately east of the Noah's Ark revealed the remains of two stone buildings, one identified as a Romano-Celtic temple, of late 2nd - early 3rd century date, which probably continued in use into the 5th century AD, and the other circular, both of which overlay round houses and pits of a later prehistoric (Iron Age) settlement site; the excavations also uncovered a late Roman coin hoard and an isolated Anglo-Saxon grave (Bradford & Goodchild 1939: Harding 1987). Subsequent aerial reconnaissance has added considerably more detail not only to the known temple complex (including the walled precinct (*temenos*) within which the temple lay, and the sites of further possible structures within it) but has also confirmed the presence of at least two large enclosures containing curvilinear and linear cropmarks and pitting, together with an amphitheatre and possible associated rectilinear building. Two small trial trenches across the amphitheatre revealed a stone revetment to the arena, probably with a timber predecessor; both phases were undated (Hingley 1985). Significant quantities of building debris (including stone, mortar, tile and *tesserae*) assumed to relate to a Romano-British occupation site, were recorded from the field surface between the temple complex and the amphitheatre (Hingley 1985). North of the farm track, fieldwork in the period 1978 - 1984 identified an area of occupation debris on either side of the modern road north and east of the known cemetery site, together with a large stone quarry (Hingley 1985). Various surface spreads of occupation debris observed in the vicinity of Noah's Ark, and covering a total area approaching 30 ha in extent, probably represent several discrete foci of archaeological activity of both prehistoric and Roman date (Henig & Booth 2000).

1.5 The extremely straight line of the A338 Oxford - Wantage road between Grove and Frilford is believed to follow the course of the Roman road to Alchester (Bradford & Goodchild 1939; Margary 1973, route 164). The Noah's Ark complex lies close to the crossing of the River Ock, at the junction of the Alchester road with possible branches to both the northwest and east, the latter apparently running just south of the existing farm track (Hingley 1985:Fig. 3).

1.6 The objectives of the survey within the southern field were to accurately map the location of the known amphitheatre, the rectilinear building to its southwest, and the easterly of the rectilinear enclosures, to provide the magnetic and topographic context for the known features, and to provide survey control to accurately site the excavation trenches. Within this field a total area of 7.5 ha was investigated by topsoil magnetic susceptibility mapping, followed by 3.9 ha gradiometer survey (within which 0.6 ha was surveyed in greater detail). The excavated temples, the centre of the *temenos*, and the larger of the two rectilinear enclosures which lie within the narrow field adjacent to the Noah's Ark Inn have been scheduled as an Ancient Monument and were not included in the survey. Within the northern field, where there was no specific archaeological evidence (although field observation has shown scatters of Roman pottery), an area of 5.5 ha was investigated by topsoil magnetic susceptibility mapping and 4.3 ha by gradiometer survey, extending westwards as far as the A338 (Oxford - Wantage) road, and southwest as close as practicable to the present Noah's Ark buildings. The combined survey area, totalling some 13 ha, was also mapped by EDM Total Station to provide topographic information upon the physical setting of the archaeological remains.

1.7 The magnetic survey comprised a combination of topsoil magnetic susceptibility field sensing and magnetometry. An explanation of the techniques used, and the rationale behind their selection, is included in an Appendix to the present report. The survey was conducted according to the *Standards and Guidance for Archaeological Field Evaluation* (1993, revised 1994) of the Institute of Field Archaeologists and follows the standards for the conduct and reporting of geophysical survey in field evaluations set out by English Heritage Ancient Monuments Laboratory (David, A. 1995. *Geophysical survey in archaeological field evaluation*, Research and Professional Services Guideline No.1, English Heritage, 1995) (hereafter abbreviated as AML 1995).

2. SURVEY DESIGN

2.1 The survey grid was tied in with the National Grid by EDM Total Station. Following the AML 1995 guidelines, the 10 m geophysical grid is internally accurate to ± 10 cm, and locatable on the OS 1:2500 map to the nearest metre (AML 1995:Part I, 3.2).

2.2 Although the two survey areas are referred to separately (Southern and Northern Areas) for convenience when describing the magnetometer (gradiometer) results, both topographic data and magnetic data across both areas have been fully integrated.

2.3 The topographic survey was undertaken using a Geodimeter 600S 5' (servo-driven) Total Station employing an active prism (Autolock) system. Permanent ground anchors have been established at four survey stations (Fig. 10). The exact height AOD has not been precisely established, but has been interpolated from contours on the OS map.

2.4 The equipment used for the direct topsoil magnetic susceptibility survey was a Bartington Instruments MS2 meter with an 18.5 cm loop. *In situ* magnetic susceptibility readings were taken on a 10 metre grid, an interval proven to give a high probability of intersection with the magnetic signal from a wide range of archaeological sites, particularly occupation and industrial sites from the later prehistoric period onwards. The 10 m grid configuration also favours the detection of ploughed-out earthworks and former field systems, which can occasionally be located as areas of more weakly magnetic soils or areas of contrasting magnetic soils. A 10 m resolution, although perfectly satisfactory for defining general areas of activity, will inevitably intersect locally with soils showing marked magnetic contrasts. It is more important to pay attention to the general trend/pattern than to concentrate upon specific magnetically enhanced 'hotspots', even though the latter may eventually prove to relate to the positions of underlying archaeological features. A total area of 13 ha was investigated using this technique.

2.5 Detailed gridded survey was carried out over a total area of 8.2 ha using a Geoscan Research FM 36 Fluxgate Gradiometer (in the 0.1 nT range), sampling 4 readings per metre at 1 metre traverse intervals. 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. In addition, a further 0.6 ha within the southern field over the amphitheatre and the adjacent building were investigated by more closely-centred gradiometer survey (sampling 4 readings per metre at 0.5 m traverse intervals) in order to provide more detailed information. The gradiometer grids were set out on a northwest-southeast axis across the building, permitting oblique traverses across the known layout, to give the clearest overall images.

3. SURVEY RESULTS

TOPOGRAPHIC SURVEY (Figs. 5 & 7)

3.1 Understanding of the topsoil magnetic susceptibility patterning is frequently dependent upon the manner in which magnetic dispersal is influenced by the local topography and subsequent landuse. Agriculture tends to truncate archaeological horizons, dispersing and admixing material from underlying sites, and can also contribute to colluvial deposition in hollows, thereby locally masking the potential for topsoil magnetic susceptibility survey. By recording both underlying natural forms and areas subsequently modified by archaeological activity, topographic survey allows both the context of areas of magnetically enhanced topsoils and specific buried remains or silted ditches/pits/hollows etc. to be interpreted more readily.

3.2 Within the southern field, comparison between the topographic and topsoil magnetic susceptibility maps (Fig. 7) clearly shows that the Frilford amphitheatre lies at the head of a small natural combe and that the majority of archaeological associated with areas of topsoil enhancement to its southwest lie on gently sloping ground situated above an alluviated zone approaching the River Ock to the south. The topographic plot also shows some slight suggestion of what may be remnants of former minor channel forms.

3.3 Topographic survey within the northern field suggests that the broad shallow depression visible immediately north of the Noah's Ark Inn had a series of associated terraced 'cuts', which are particularly noticeable on the north and northeast, indicating a probable former quarry pit.

TOPSOIL MAGNETIC SUSCEPTIBILITY MAPPING (Figs. 6 & 7)

3.4 1295 *in situ* magnetic susceptibility readings were recorded, covering an area of 13 ha. Susceptibility is reported in SI: volume susceptibility units (x 10^{-5}), a dimensionless measure of the relative ease with which a sample can be magnetized in a given magnetic field.

3.5 *In situ* topsoil susceptibility measurements ranged between 5 and 117 (x 10^{-5}) SI units. The mean for the survey was 49.5 SI units and the standard deviation calculated against the mean was 22 SI units. Soil magnetic contours are shown at 5 SI intervals on the colour contour map.

3.6 The topsoil magnetic susceptibility map shows three relatively distinct foci of topsoil enhancement, each of which has been confirmed by gradiometer (magnetometer) survey to overlie significant archaeological features and horizons.

3.7 The most northerly block of topsoil magnetic enhancement, centred on NGR 443950 196520, directly overlies a broadly rectilinear pattern of linears, pits and probable structural elements of probable Romano-British date (see 3.29 below).

3.8 A second focus of topsoil enhancement lies immediately north of the hollow in the southwest angle of the northern field, centred on 443850 196410, overlying an are containing numerous substantial anomalies, probably large pit-like features, together with several linear elements (see 3.32 below).

3.9 Similar strong magnetically enhanced topsoil patterning is visible in the southern field, confined to the west and southwest of the amphitheatre, centred on NGR 444000 196250, and conforming well to the underlying distribution of archaeological features revealed by subsequent gradiometer survey (see 3.17 below) and confirmed by excavation. Within this general area of increased magnetic susceptibility there are a number of minor foci of enhancement resulting from dispersal from both underlying archaeological horizons and the truncation of the tops of archaeological 'cut' features by the plough, the nature of which is likely to be predominantly, although not exclusively, occupation levels (i.e. these deposits will have been magnetically enhanced by the inclusion of burnt and / or exotic material). The shallow depth of the topsoil over the natural limestone, shown by the recent excavations to decrease towards the west of the field, would have allowed a considerable volume of archaeological material to be admixed and dispersed into the cultivation soils.

3.10 In contrast, the topsoil magnetic susceptibility drops markedly in the vicinity of the amphitheatre and the combe in which it lies. Whilst this may be a true reflection of the relatively low level of archaeologically significant material, as a 'public building' the area would not be expected to yield large quantities of everyday occupation debris (fired clays, areas of burning etc.), there is always the possibility in low-lying areas that some colluvial build-up may cause attenuation of the magnetic signal. Similarly the land lying below the 57 m AOD contour shows a low level of soil susceptibility, commonly associated with alluvial deposits which are capable of masking archaeological horizons from magnetic survey. With these caveats, it is felt that the topsoil magnetic susceptibility map generally provides an accurate indicator of areas where former occupation and activity were concentrated.

MAGNETOMETER (GRADIOMETER) SURVEY

3.11 The location of the 30 m survey grids is shown on Figs. 1 & 2. A broad overview and interpretation of the results, with additional detail of the close-centred survey over the amphitheatre and building in the southern area, is shown on Fig. 8.

Southern Area (Figs. 3 & 9)

3.12 An area totalling 3.9 ha was investigated by detailed magnetometer (gradiometer) survey (1 m traverse interval), with additional detail provided by 0.6 ha of close-centred survey (0.5 m traverse) (Fig. 8).

3.13 Magnetic anomalies were relatively moderate in strength, the majority being in the range -3 to +3nT.

3.14 The magnetometer (gradiometer) responded very favourably to the local soils and substrate, defining both structural and 'cut' elements. Relatively deeply buried features such as the stone revetment, bank and entrances of the amphitheatre are clearly visible. In most cases where negative anomalies were recorded, excavation has confirmed the presence of limestone walling.

3.15 The amphitheatre is visible as a series of concentric positive and negative anomalies. For reasons not yet clear, the 'tail' of the bank shows for the most part as a positive anomaly, whilst the inner revetment wall, as expected, is represented by a negative anomaly. There are four other distinct structural elements visible: opposing entrances on the east and west sides, the location of a stone-built square 'cell' on the south side, and what appears to be a similar stone element lying opposite on the northern side. A curious semi-circular negative anomaly visible to the west of the southern 'cell' gives the appearance of the presence of low magnetic susceptibility material, possibly further stonework or a body of clay or similar material, either embedded in or underlying the bank.

3.16 The overall diameter of the amphitheatre, measuring from the 'tail' of the bank, is approximately 60 m, with an arena approximately 40 m in diameter, although as the retaining wall is relatively deeply buried some magnetic 'displacement' of the gradiometer image may be anticipated.

3.17 Situated some 10 m beyond the southwestern edge of the amphitheatre lies what appears to be a rectilinear structure on a northwest-southeast alignment, which shows as a negative magnetometer anomaly suggesting the presence of limestone walling measuring 10 m (northwest-southeast) x 5 m (northeast - southwest), although the pattern is incomplete and may suggest that the walls have been partly ploughed-out.

3.18 A cruciform-plan building measuring a maximum of 35 m (east-west) x 20 m (north-south) lies c.50 m southwest of the amphitheatre. The gradiometer plot shows an area of apparently insubstantial walling on the northeast side of this building, which excavation has shown to be a secondary addition.

3.19 Situated some 15 m northwest of the cruciform building lies a small square (5 m sides) structure aligned westsouthwest-eastnortheast. Numerous positive anomalies recorded between this structure and the amphitheatre suggest the presence of pits of various sizes, the largest up to 3 m in diameter. A pair of very distinctive and magnetically similar pits are visible at a distance of 20 m and 40 m southsouthwest of the amphitheatre; they may be associated with a magnetic 'scar' showing as a slight positive anomaly extending along the line of these pits which intersects with a perpendicular linear which runs tangentially to the southern edge of the amphitheatre.

3.20 Some 50 m west of the cruciform building within an area of high topsoil magnetic susceptibility, the magnetometer tentatively identified negative anomalies interpreted as possible stone walling, confirmed by excavation in 2002 as the location of a Roman building.

3.21 Moving westwards across the field, where the limestone bedrock lies relatively closer to the surface, the opportunity for seeing remnants of limestone walling and footings with the magnetometer (gradiometer) decreases, although a well defined negative anomaly within the western angle of the field, traced for a distance of over 50 m on a roughly east-west alignment, and interpreted as the northern wall of the temple *temenos*, locally produced a good negative anomaly.

3.22 Within the southwest angle of the survey area two positive linears, each traced for over 30 m, form a right angle on a northwest-southeast / northeast-southwest alignment. The angle is not completely closed, giving a possible entranceway some 5 m in width on the east side. The southeast section has an intercutting relationship with a 10 m diameter slightly irregular ring form lying approximately 20 m south of the possible entrance. Excavation in this area has provisionally identified these features as being of Bronze Age -Iron Age date.

3.23 Three substantial anomalies representing pit-like features of considerable size, perhaps measuring up to 5 x 2 m, are grouped closely together on the western edge of the survey area immediately north of the angular enclosure. These are strongly magnetic anomalies containing material suggestive of remnant magnetism, either derived from re-deposited magnetically enhanced material or from *in situ* burning.

3.24 Much of the survey area, extending west of the amphitheatre contains various silted pits and hollows, some of which are likely to represent tree clearance, whilst others clearly have archaeological potential.

3.25 At least three, possibly more, extremely weak parallel lineations spaced c.15 m apart, cross the field on a roughly north-south alignment. The most westerly can be traced southwards from the field edge to a point just north of the cruciform building; the central linear extends southwards, underlying the cruciform building, and follows a slightly irregular course as far as the southern edge of the survey area; the eastern linear runs parallel for a distance of c.75 m before veering southeastwards. All three linears continue into the northern field. They clearly predate elements of the modern field layout and seemingly also the Romano-British building, and may therefore represent elements of the prehistoric landscape.

3.26 The gradiometer has proved capable of recording even relatively shallow intrusions on the site, some of which have proved ephemeral when excavated, although it cannot be expected to detect smaller pits and postholes, which are inevitably elusive at 1m traverse separation survey.

Northern Area (Figs. 4 & 9)

3.27 An area totalling 4.3 ha in a broadly L-shaped survey area was investigated by detailed magnetometer (gradiometer) survey (1 m traverse interval). The survey was extended eastwards to provide context for the setting of the amphitheatre, despite the dearth of anomalies, indicative of archaeological features, recorded here.

3.28 The gradiometer plot shows a considerable number of distinct magnetic anomalies within the western part of the field, alongside the modern road, grouped essentially into two zones which both correspond well with areas of high topsoil magnetic susceptibility, and are therefore likely to represent underlying features associated with former occupation.

3.29 The most northerly group is centred within the angle of two c.50 m long slightly curving linears, perhaps representing ditches or (less likely) robbed wall trenches. Their southeastern angle contains two clusters of predominantly magnetic anomalies within roughly 30 x 20 m rectilinear patterns abutting the two sides of the apparent enclosure. Although these groupings are predominantly positive anomalies (i.e. intrusive elements) there is a suggestion, particularly within the northern grouping, for what may be stonework or other spreads of less magnetic material. During the course of the survey work, Roman pottery (including three samian ware bases) were visible on the field surface. The assertive rectilinear nature of the groundplan together with these

surface finds would tend to suggest a Roman origin. This area also contains numerous, and occasionally substantial, pits or hollows, the largest of which are up to 5 m in maximum extent which might be associated with the angular enclosure.

3.30 A curving linear (ditch) extending southeastwards from the southern arm of the enclosure was traced for a distance of some 50 m. As this linear appears to acknowledge the enclosure it is likely to be a contemporary feature. Close to the southern end of this ditch, a further extremely regular linear was identified running on a southwest-northeast trend, which was traced for at least 100 m.

3.31 There are several other positive linear anomalies in this area, running generally on a north-south and southwest-northeast trend, the most obvious being a substantial linear (ditch) extending northeastwards from the site of a former infilled quarry within the southwest angle of the field.

3.32 The second concentration of magnetic anomalies lies within the southwestern angle of the field in the vicinity (within a 50 m radius) of the probable former quarry pit, its edges defined by a number of scar-like 'cuts' which appear to be former terraces, retaining pockets of soil. Numerous anomalies representing infilled pits and hollows, together with several linears, which appear to be infilled ditches, were recorded immediately north of this former quarry. These anomalies appear to form a distinctive grouping, although their proximity to the former quarry may throw doubts upon their antiquity. It is possible that some of them are either structures with sunken floors or the remains of walled buildings enclosing material with high magnetic susceptibility. The assertive nature of the positive magnetic anomalies and the distinctive local signals suggest that burning episodes have contributed to this strong magnetic patterning.

3.33 Apart from the usual roadside clutter, this area is surprisingly free of ferrous debris, which might tend to rule out a modern origin for either the postulated quarry or the associated features.

3.34 Within the western part of the survey area several ephemeral linear anomalies on a north-south trend were recorded, which are similar to, and possibly continuations of, those identified by magnetometer within the southern area, which have so far proved elusive to excavation.

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The project was co-ordinated by A.P. Johnson *BA, PhD, MIFA.*

APPENDIX 1 - 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 map and location of magnetometer (gradiometer) survey grids. Scale 1:50,000 and 1:5,000. Based upon OS 1:50,000 Map 164 and OS Superplan data.

Figure 2. Magnetometer (gradiometer) Survey. Overview: grey shade plots at 1:5,000 and 1:2500 scale.

Figure 3. Magnetometer (gradiometer) Survey. Southern Area: grey shade plot. Scale 1:1250.

Figure 4. Magnetometer (gradiometer) Survey. Northern Area: grey shade plot. Scale 1:1250.

Figure 5. Topographic contours and magnetic anomalies. Scale 1:2500.

Figure 6. Topsoil magnetic susceptibility survey: colour contour plot. Scale 1:2500.

Figure 7. Topsoil magnetic susceptibility survey: colour contour plot, topographic contours and major archaeological features. Scale 1:2500.

Figure 8. Overview with broad interpretation of the principal features revealed by magnetometer (gradiometer) survey, scale 1:2500.
Inset: 'close-centred' (0.5 x 0.25 m spacing) survey showing detail of amphitheatre (scale 1:1000) and building (scale 1:500).

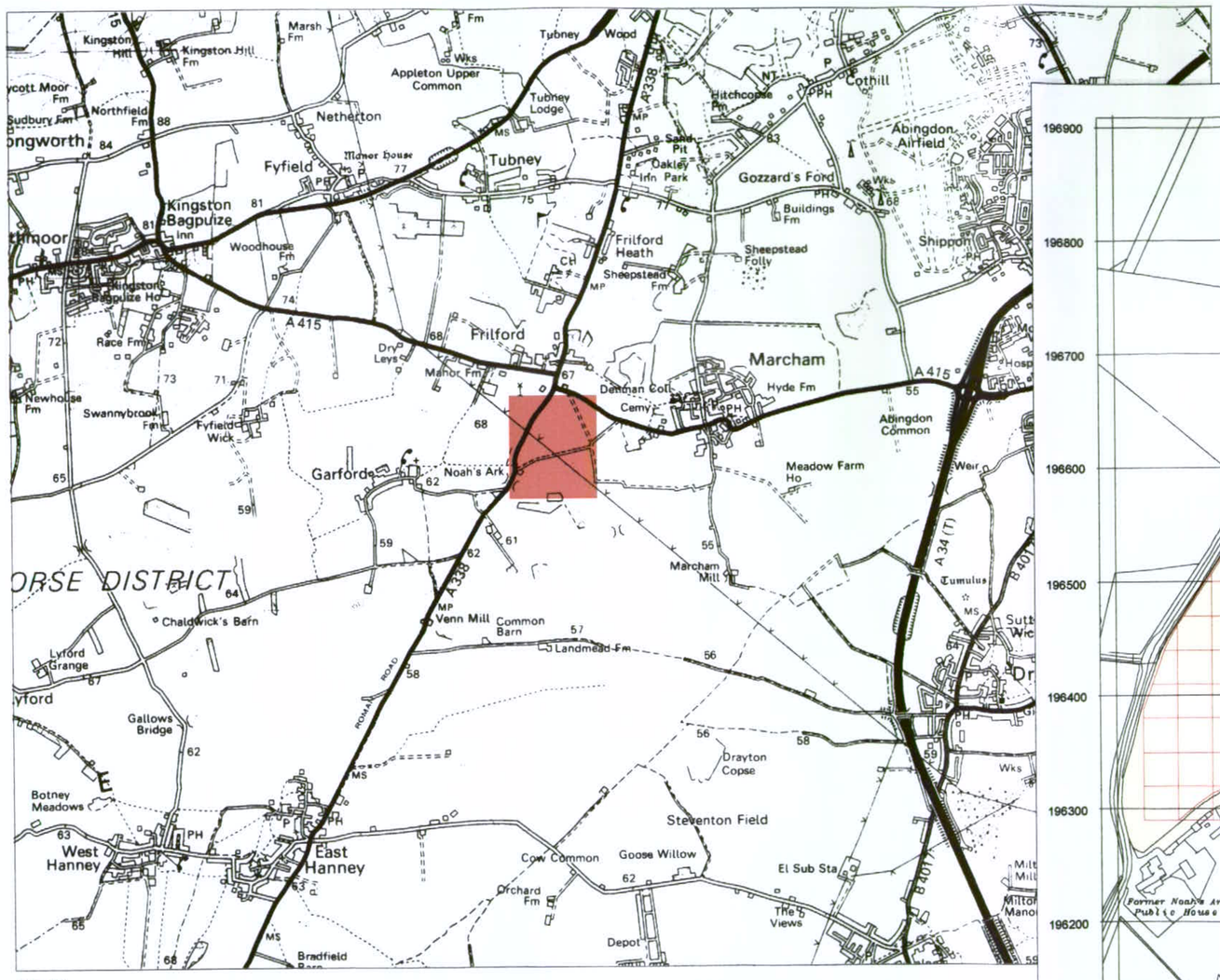
Figure 9. Magnetometer (gradiometer) Survey: stacked trace plot. Scale 1:1250.

Figure 10. Survey control: locations of ground anchors and RO locations used for geophysical survey.

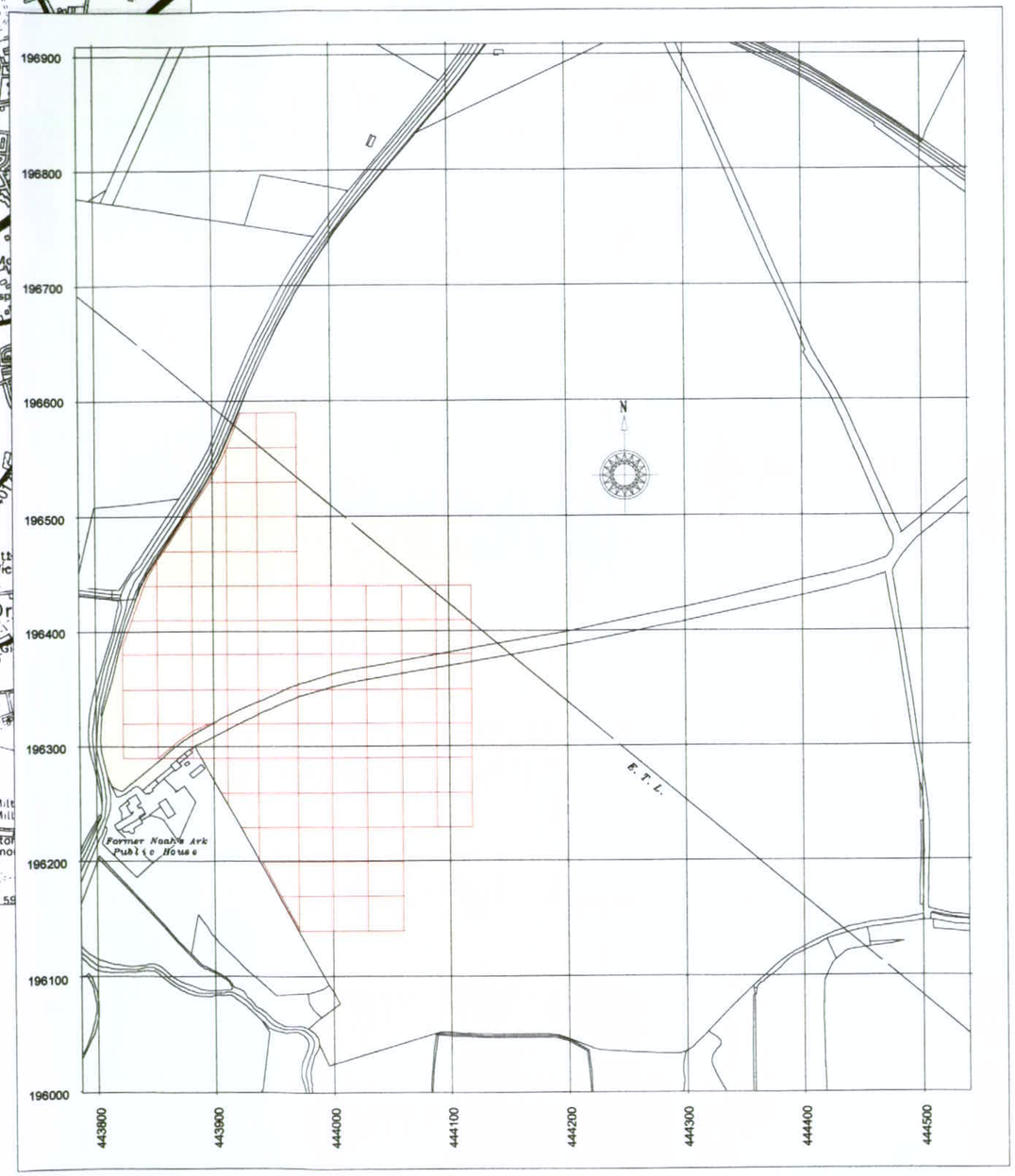
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Frilford, Oxfordshire

Archaeological Geophysical Survey: location



1:50,000



1:5,000

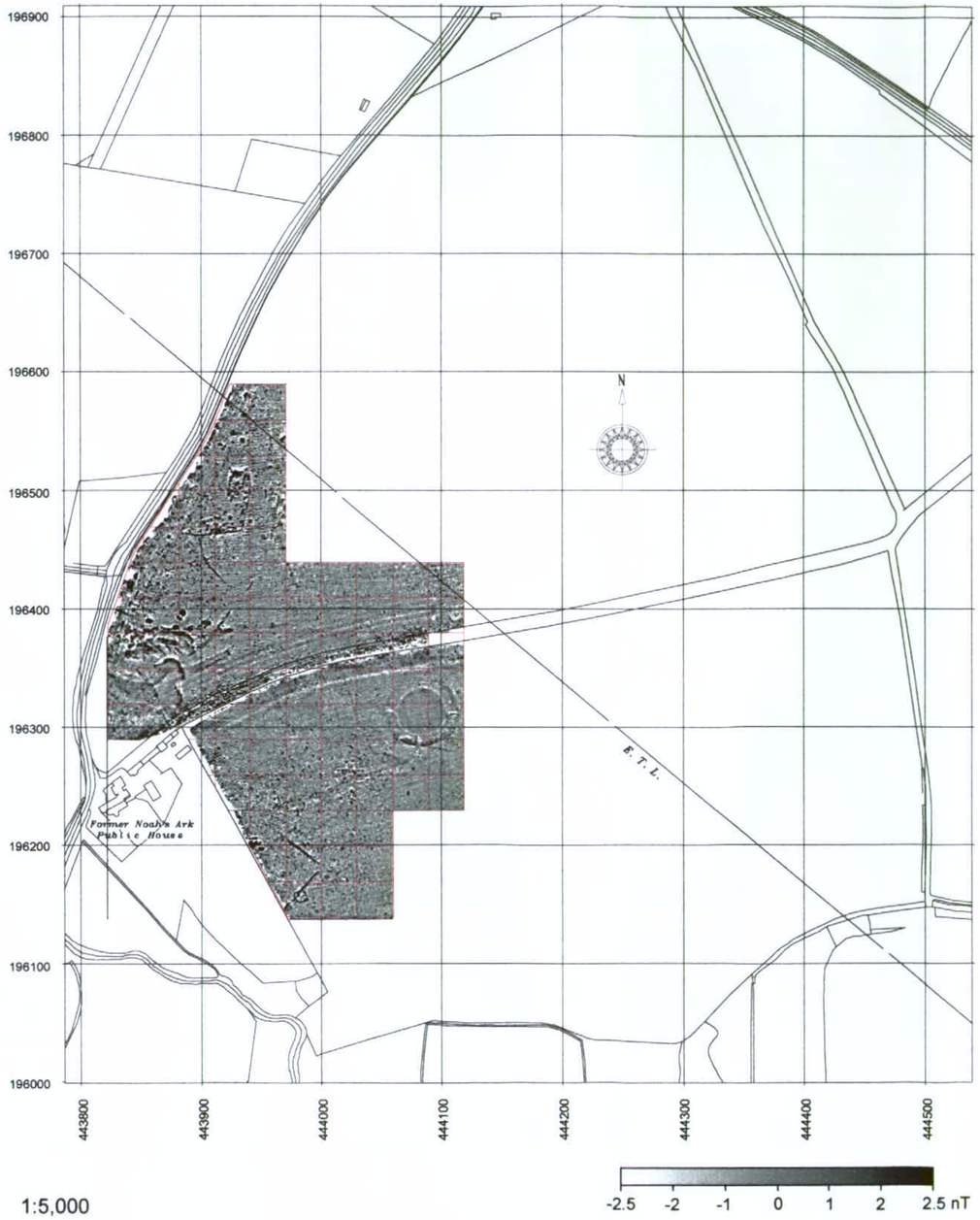
Topsoil magnetic susceptibility survey

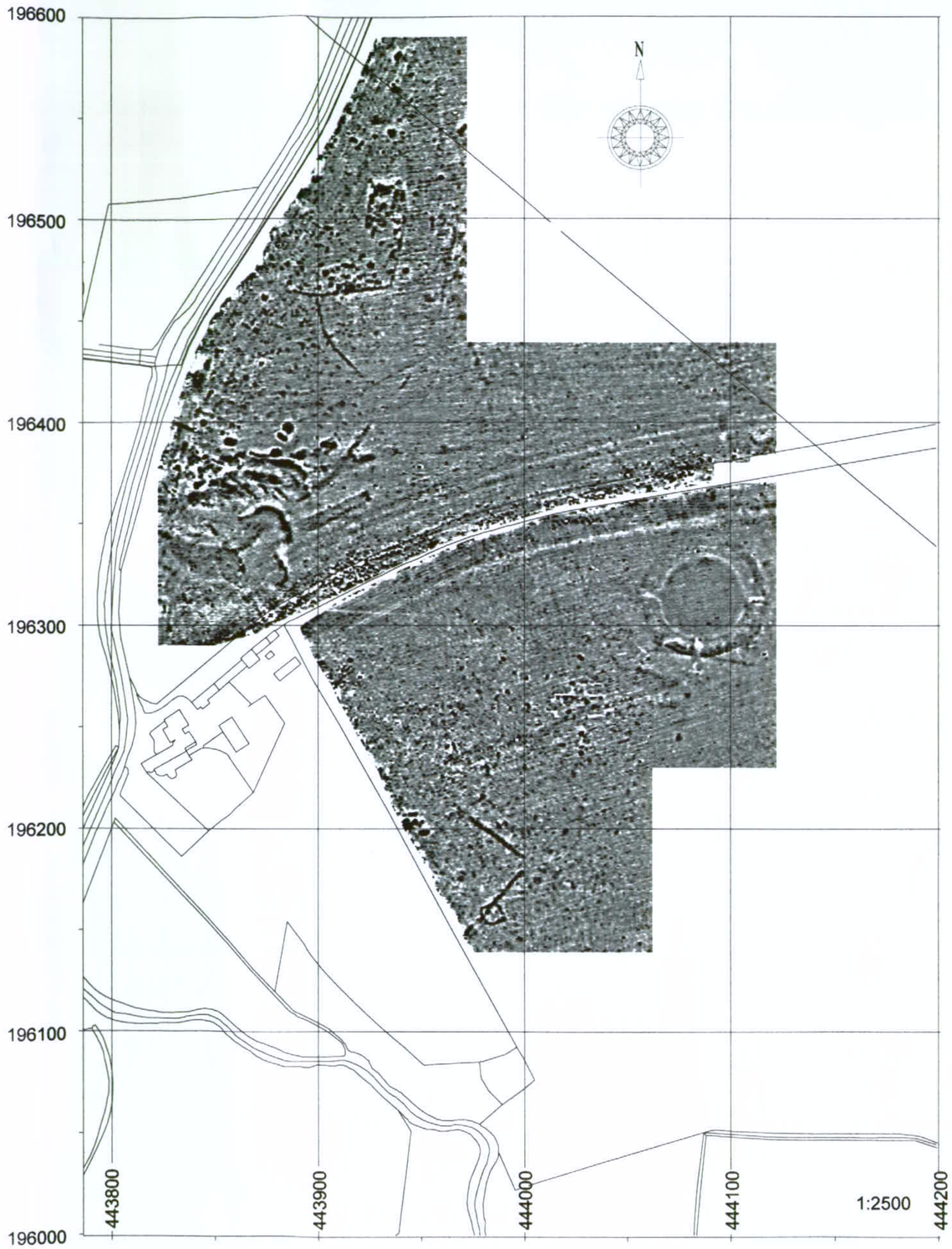
Magnetometer survey area (30 metre grids)

Frilford, Oxfordshire

Archaeological Geophysical Survey: overview

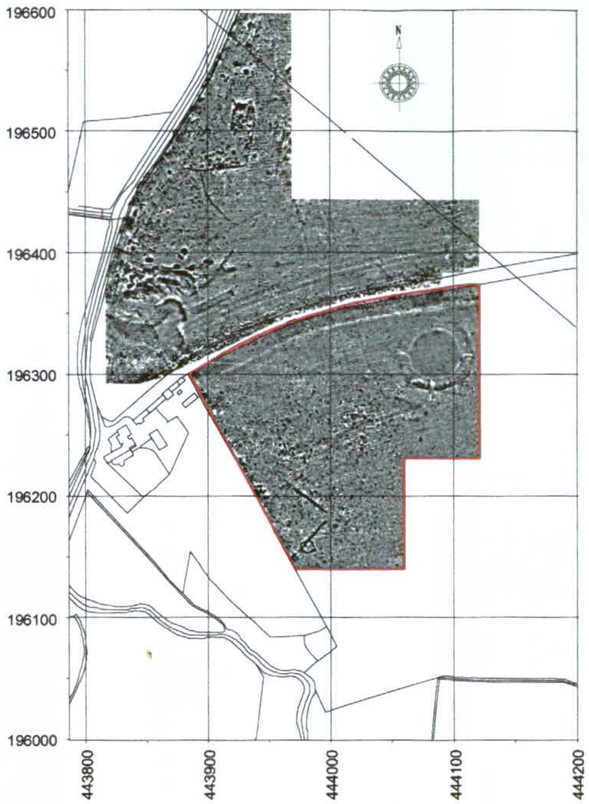
Gradiometer grey shade plots at 1:5000 & 1:2500 scale





Frilford, Oxfordshire

Magnetometer (gradiometer) grey shade plot



1:5000

SOUTHERN AREA



30mGrid

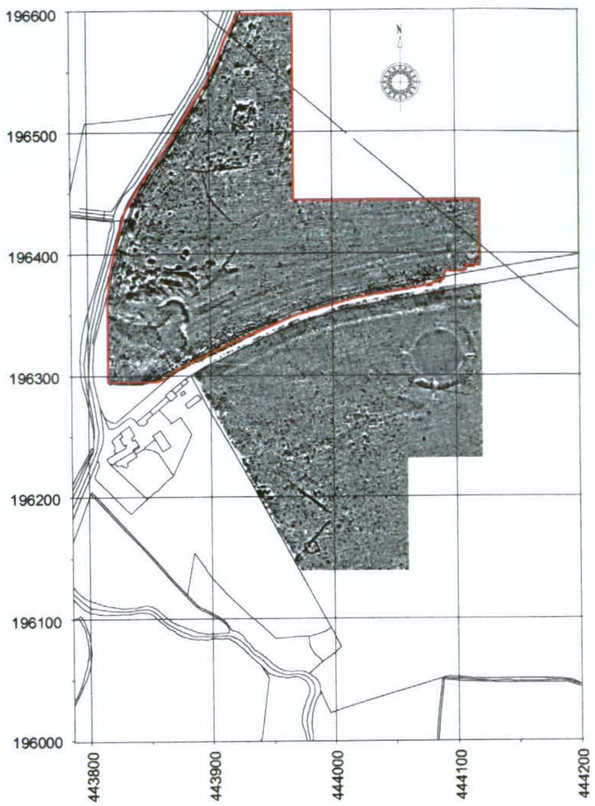
N

1:1250

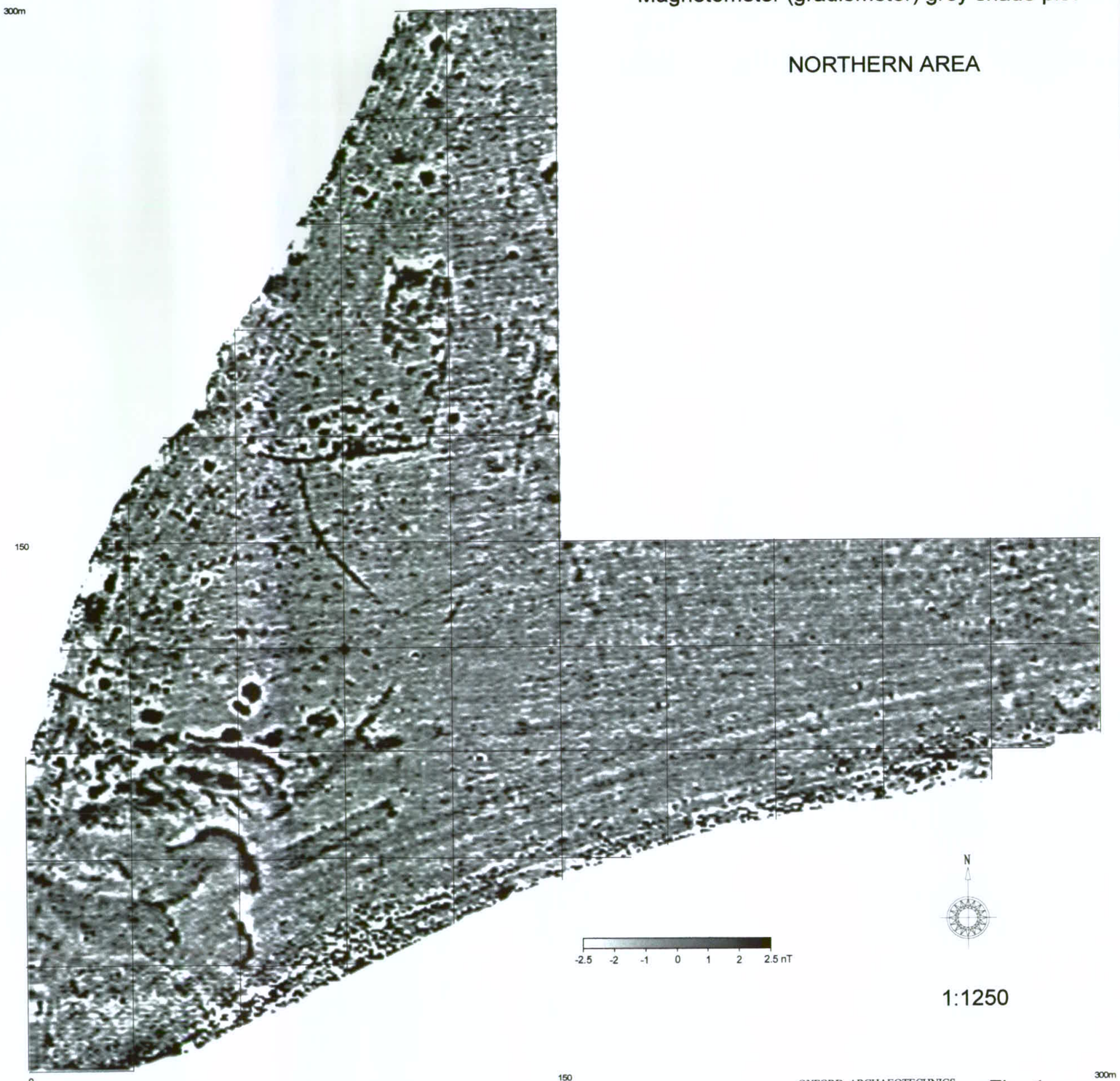
Frilford, Oxfordshire

Magnetometer (gradiometer) grey shade plot

NORTHERN AREA



1:5000



1:1250

30m Grid

OXFORD ARCHAEOTECHNICS

Fig. 4

Frilford, Oxfordshire

Magnetometer (gradiometer) survey

Topographic contours and magnetic anomalies

Contour interval 0.5m

62m

60m

60m

58m

N

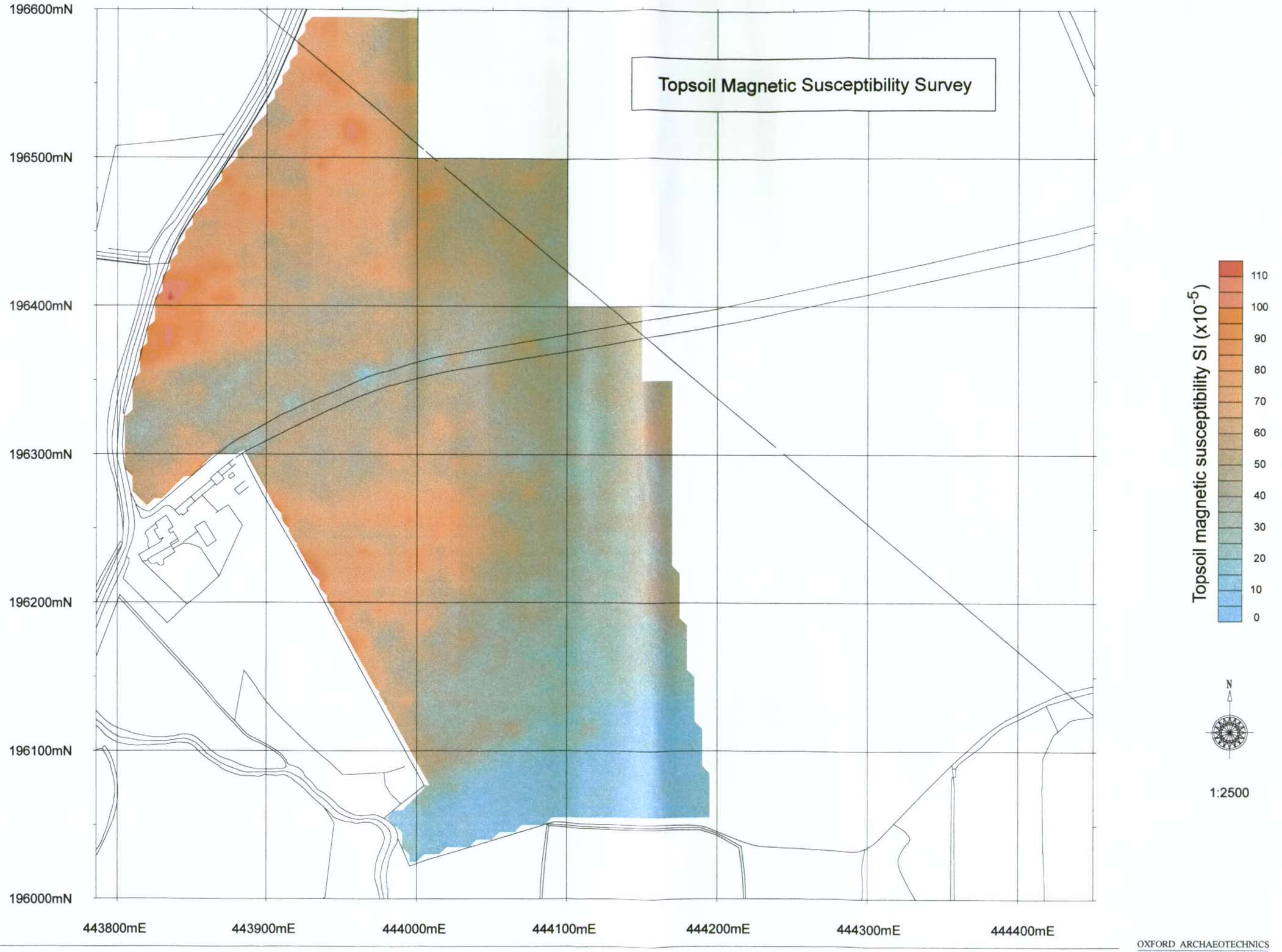
1:2500

-2.5 -2 -1 0 1 2 2.5 nT

OXFORD ARCHAEOTECHNICS

Fig. 5

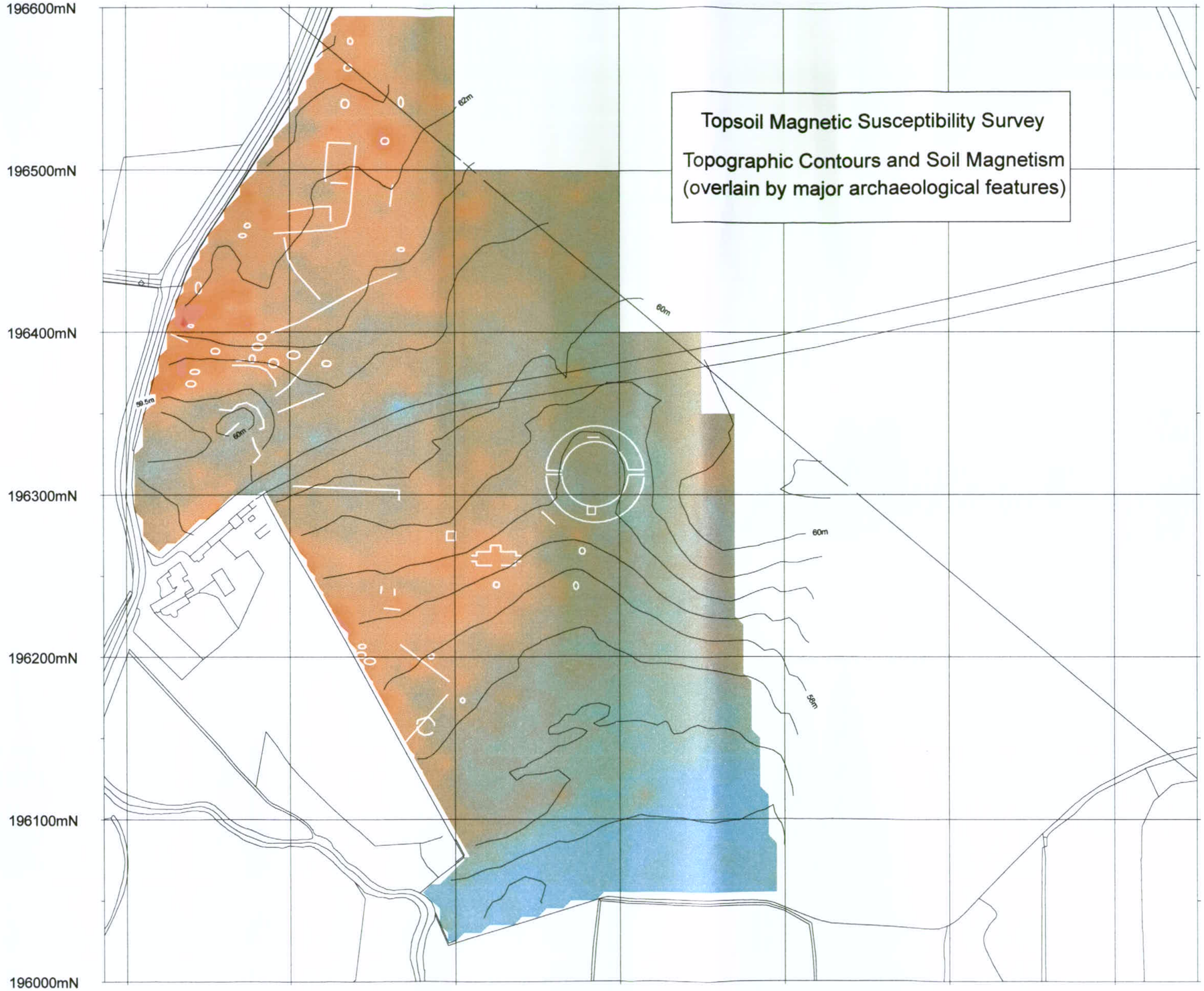
Frilford, Oxfordshire



OXFORD ARCHAEOTECHNICS

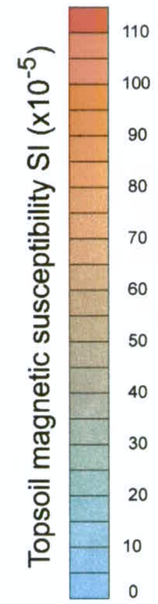
Fig. 6

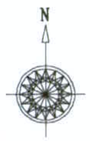
Frilford, Oxfordshire



Topsoil Magnetic Susceptibility Survey

Topographic Contours and Soil Magnetism
(overlain by major archaeological features)





1:2500

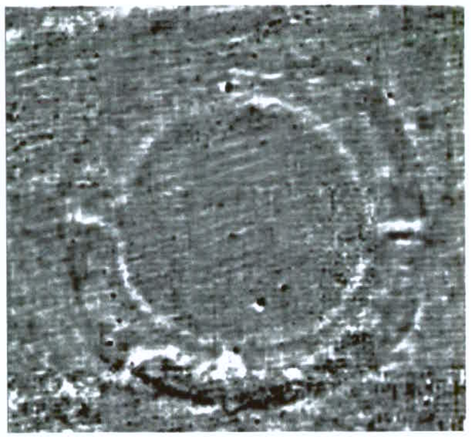
OXFORD ARCHAEOTECHNICS

Fig.7

Frilford, Oxfordshire

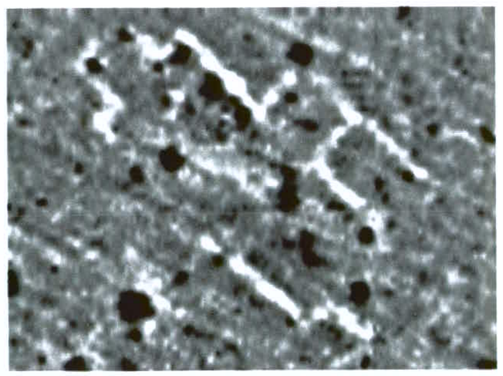
Overview with broad interpretation of the principal features revealed by magnetometer (gradiometer) survey (right) and 'close centred' (0.5 x 0.25m spacing) survey (below)

detail of amphitheatre 1:1000



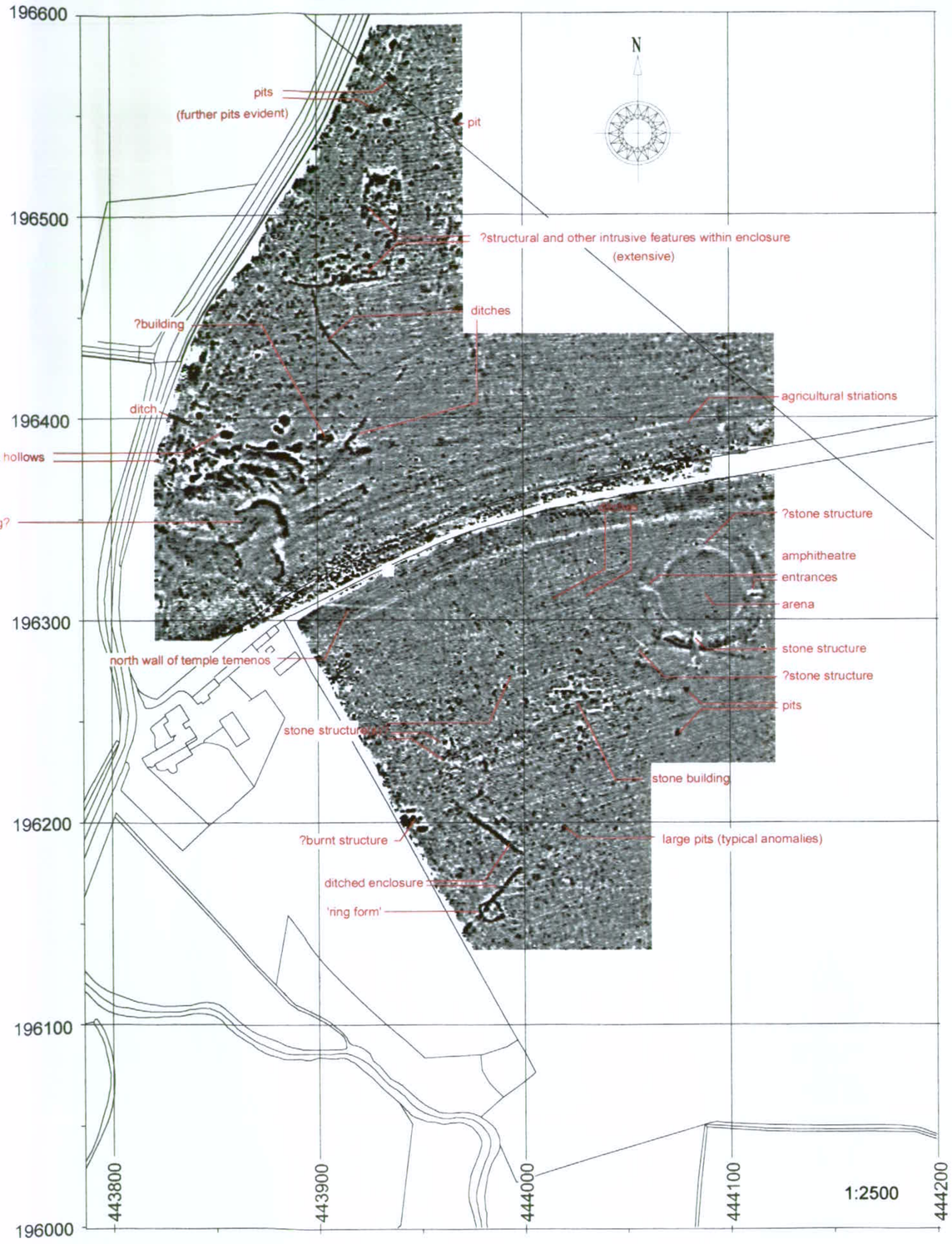


detail of building 1:500

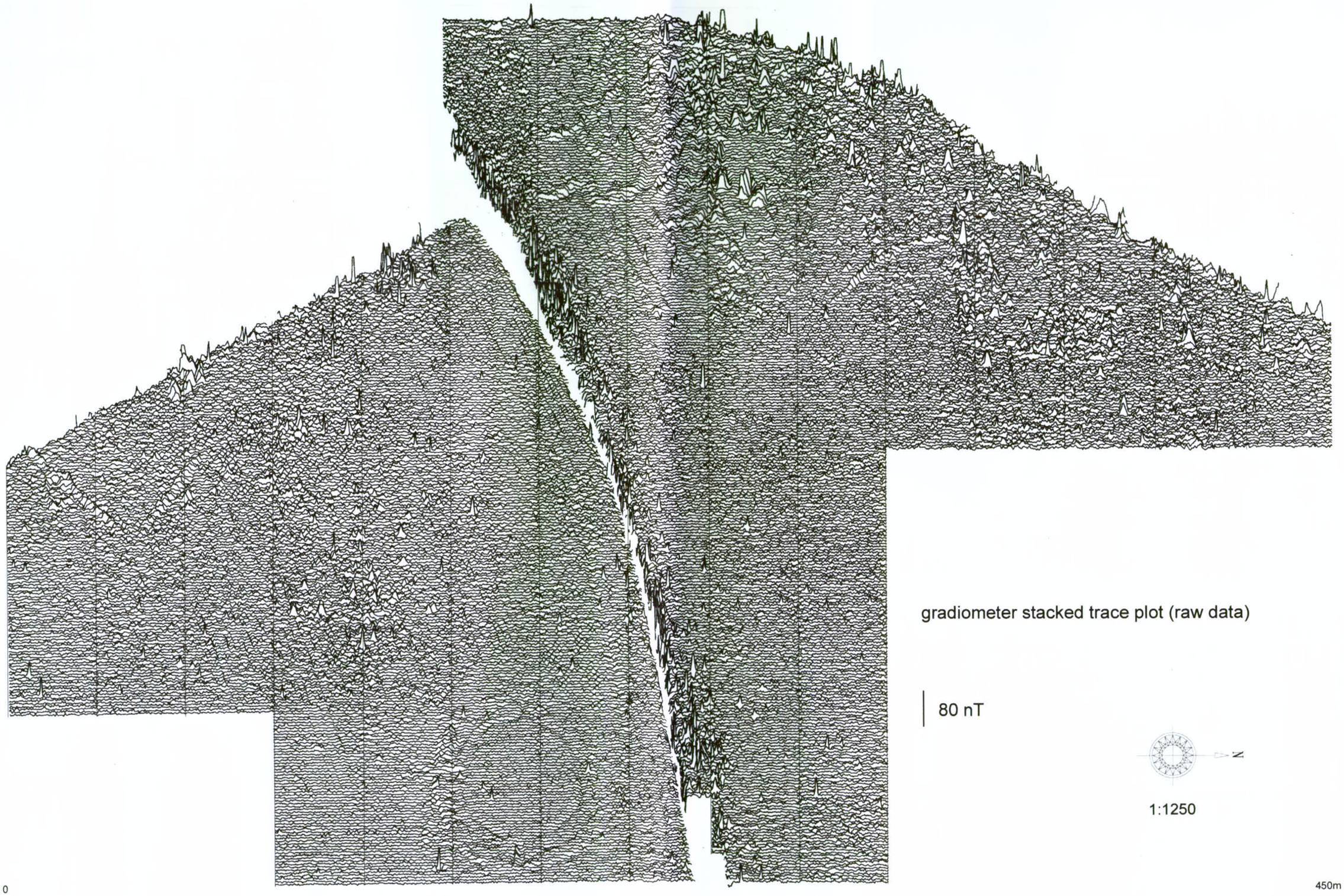








Frilford, Oxfordshire



gradiometer stacked trace plot (raw data)

80 nT

N

1:1250

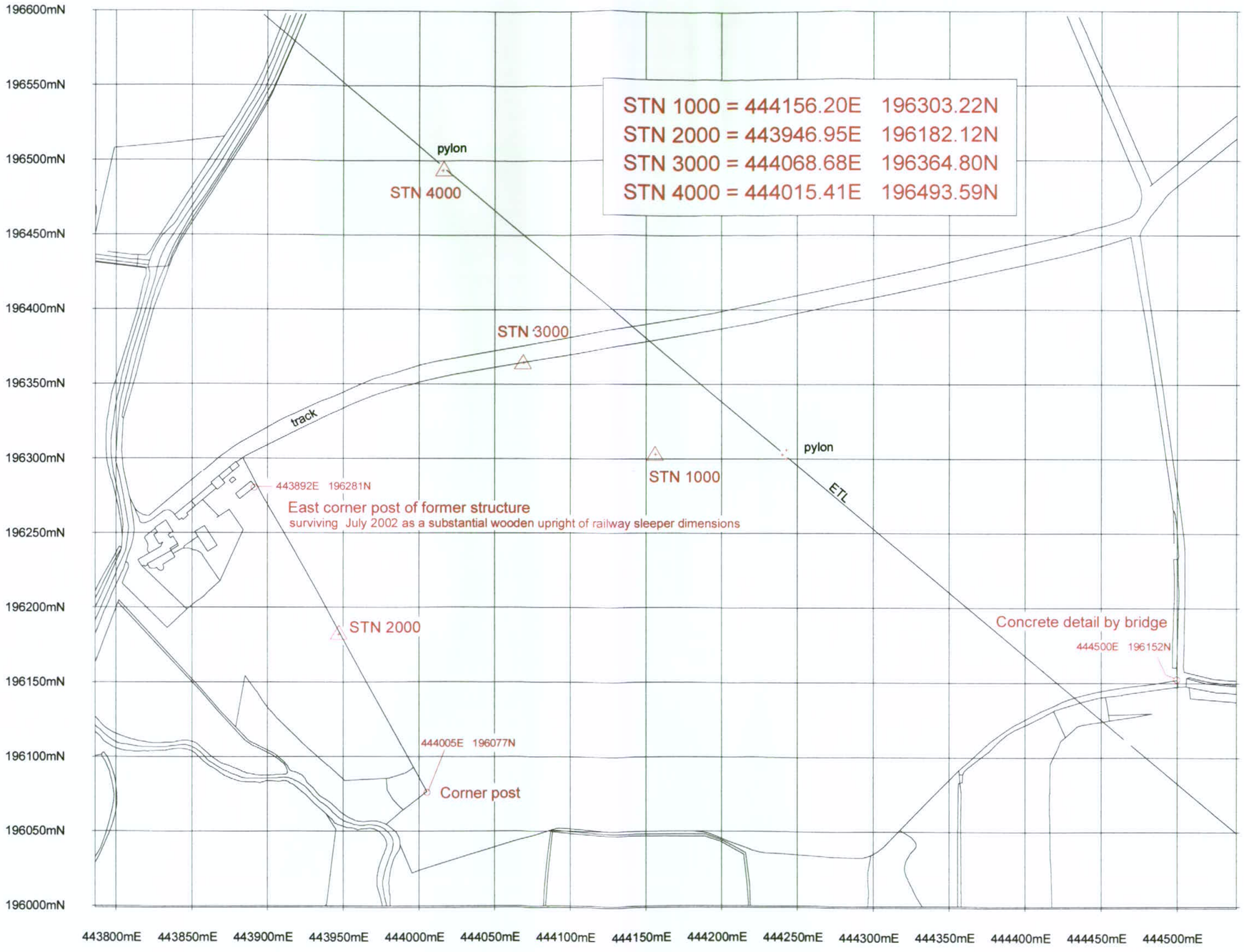
0

450m

OXFORD ARCHAEOTECHNICS

Fig. 9

Survey Control: location of ground anchors and RO locations used for geophysical survey



INTERNAL QUALITY CHECK

Survey Reference 2560602/FR01/CWH	
Primary Author	Date 17/07/02
Checked By APJ	Date 17.07.02
Checked By	Date
Further Corrections	Date

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July 2002