Historic England

Geophysics

Lower Farm, Nuneham Courtenay, Oxfordshire Report on Geophysical Surveys, April 1992, November 1994 and 1996

Andrew Payne and Mark Cole

Discovery, Innovation and Science in the Historic Environment

Research Report Series no. 225-2020

Research Report Series 225-2020

LOWER FARM, NUNEHAM COURTENAY, OXFORDSHIRE
REPORT ON GEOPHYSICAL SURVEYS, APRIL 1992, NOVEMBER 1994 AND 1996

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NGR: SP 5395 0059

ISSN 2059-4453 (Online)

SUMMARY

This report describes the results of a series of magnetometer surveys undertaken from 1992 to 1996 by the then Ancient Monuments Laboratory of English Heritage over a Roman pottery production site at Lower Farm, Nuneham Courtenay, Oxfordshire. The site was initially discovered during the laying of a water main prompting the wider geophysical investigation of the surrounding farmland. Over several stages of fieldwork, a total area of 12.7 hectares was surveyed resulting in a detailed plan of Roman enclosures, pottery kilns and trackways revealed with great clarity. The suitability of the underlying Jurassic geology in affording highly informative results from magnetometer survey was also amply demonstrated. These results, combined with field walking data obtained by Oxford Archaeology, clearly indicate that the industrial complex extends from Lower Farm where the pottery production activity was first recognised for at least 500m to the east and that the archaeological activity defined potentially also includes both a prehistoric and medieval component.

CONTRIBUTORS
The geophysical fieldwork was conducted by Mark Cole, Peter Cottrell, Neil Linford and Andrew Payne. The report text is based on an earlier interim report authored by Mark Cole describing the first two phases of geophysical survey up to 1994. Paul Linford helpfully provided support with data processing.

ACKNOWLEDGEMENTS
The authors are grateful to the landowner, the Oxford University Chest, their agents and tenant for their permission to undertake the various stages of fieldwork.

ARCHIVE LOCATION
Fort Cumberland, Portsmouth.

DATE OF SURVEY
Magnetometer survey was conducted over three weeks: 28th April to 1st May 1992, 31st October to 4th November 1994 and 18th to 22nd November 1996. A limited earth resistance survey was conducted during 5th and 6th August 1992 supplemented by collection of soil samples from both the topsoil and deeper auger holes for magnetic susceptibility measurements in the area of the initial 1992 magnetometer coverage. The report on the combined fieldwork was completed on 20th May 2020. The cover image shows a view of the survey area looking south-east from Lower Farm with electricity pylons in the arable fields to the east visible in the distance, © Des Blenkinsopp, geograph.org.uk/p/2814353.

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INTRODUCTION

Magnetometer survey was first undertaken at Lower Farm in the summer of 1991 (Bartlett and Turton 1991) following the discovery of large quantities of Roman pottery by the Oxford Archaeological Unit (OAU) during the laying of a Thames Water pipeline. Subsequent investigations by the OAU within the pipeline easement revealed evidence of a substantial industrial site producing the full range of Oxfordshire wares, including beakers, flagons, bowls and mortaria from the 2nd to 4th century (Booth *et al.* 1994). Only a very limited area was accessible for the magnetometer survey during the initial pipeline construction works and although no anomalies likely to represent kilns were located, the results suggested that a survey of the surrounding area would be profitable.

Due to the potential importance of the site, more extensive magnetometer survey was undertaken by the Ancient Monuments Laboratory (AML) of English Heritage during the summer of 1992 (Area A on Figure 1; Cole 1992). The results of this work amply demonstrated the suitability of the underlying Jurassic limestone geology for magnetometer survey, revealing a number of Roman kilns, pits and ditches together with potential evidence of both prehistoric and later medieval activity. Even at this initial stage of the survey coverage, the clarity of the magnetic response was such that integration of the geophysical results with those from the excavations along the pipeline easement was already starting to offer one of the most detailed plans then available of an Oxfordshire Roman kiln site (Keevill and Cole 1995).

The initial (1992) magnetometer survey was conducted within a block of surviving medieval pasture (Figure 1, Area A), but the results suggested that Roman activity might continue into the arable fields to the east. Given that the site was under consideration for scheduling, a clear priority was that a measure of its full extent be obtained. Magnetometer survey was therefore extended in two phases to investigate the surrounding fields and enhance the results of a programme of field walking undertaken by the OAU during 1995. The second phase of survey was conducted in November 1994 (Figure 1, Areas B, C and D; Cole 1996), followed by a further extension of Area C to the east as far as the A4074 in November 1996 which was not reported at the time. The extended surveys also offered an opportunity to assess any contrast in preservation which might be visible in the data between the pasture and surrounding arable fields.

The survey areas overlie Jurassic substrates of limestone and mudstone sedimentary bedrock of the Ampthill Clay and Littlemore Member formations above which slowly permeable seasonally waterlogged fine loamy over clayey, fine silty over clayey and clayey soils of the Wickham 2 (711f) association have developed (Geological Survey of Great Britain (England and Wales) 1971; Soil Survey of England and Wales 1983; British Geological Survey 2020).

METHOD

Identical methodology was followed during each episode of fieldwork. Separate survey grids of 30m x 30m squares were set out in each of the four fields surveyed using a Nikon DTM01 total station theodolite or optical square and tape measure combination, with each gridded area oriented so as to best fit the boundaries of the individual fields (Figure 1). The survey grid was located by measurements recorded in the field to buildings and field boundaries identified from the Ordnance Survey (OS) mapping. Each 30m square was then surveyed using Geoscan FM36 fluxgate gradiometers with measurements recorded at 0.25m intervals along traverses spaced 1.0m apart. The resultant data is presented in this report in the form of greyscale and graphical trace plots (see Figures 2-4).

Post-acquisition, the median value of each traverse was subtracted from all measurements on that traverse (Zero Median Traverse) to correct for heading errors and instrument drift. Polynomial surfaces were then fitted to and subtracted from the data in grids close to pylons to suppress the high magnitude signal caused by proximity to these large ferrous objects. A Fourier domain Butterworth band-reject filter was then applied to selected traverses where a strong periodic artifact had been introduced owing to the magnetometer operator walking with stride length of exactly 1 m. Finally, for selected grids traverse offset or "staggering", caused by a mismatch between the data logger sample trigger rate and operator pace, was corrected by shifting affected traverses to maximise cross-traverse correlation. A linear greyscale image of the magnetometer data after these operations is presented in Figure 2 superimposed on the OS base map. Trace plot and linear greyscale images of the minimally processed magnetometer data are presented in Figures 3 and 4 respectively.

RESULTS

A graphical summary of significant magnetic anomalies [**m1-75**] discussed in the following text superimposed on base OS map data is provided in Figure 5.

Area A – initial 1992 magnetometer coverage

A pattern of five main rectangular enclosures is resolved very clearly [**m1-5**], as a series of positive linear magnetic anomalies in a ladder arrangement with additional sub-divisions [**m6**] and a probable adjacent road or trackway [**m7**] along its western edge. That the site includes industrial activity is confirmed by the presence of a number of very strong anomalies indicative of kilns in a linear arrangement at [**m8**] and [**m9**] aligned with the west boundary of the enclosure system within which they are contained. The kiln group identified at [**m8**] and [**m9**] consists of 4-5 separate kilns ranging from 41 to 101 nT in peak positive

magnitude with further weaker associated magnetic anomalies ranging from 10-30 nT in peak positive magnitude. Other archaeologically significant anomalies associated with the enclosures are likely to be pits containing industrial or domestic waste, for example at [**m10-12**]. Additional strong magnetic anomalies suggesting other outlying kiln structures are present further to the west and south of the main grouping of kilns at [**m13**] and [**m14**] with maximum positive anomalies of 59-85 and 43 nT respectively**.** Two suspected kilns (at **a1** and **a2** on Figure 5) were augered and both produced large amounts of fired clay, charcoal enriched soil and pottery sherds at depths between 0.4-1.4m from the surface (Keevill and Cole 1995).

A series of ring-gully type anomalies have been detected in the north east corner of the survey area. Of these, [**m15**] and [**m16**] can be seen clearly whilst a third [**m17**] is indistinct. These appear to underlie the ditch system, although this cannot be confirmed on geophysical evidence alone. However linear ditches seen clearly cutting across the ring-gully response at [**m15**] suggests a group of anomalies of a different phase to and possibly predating the layout of the enclosure system. It is also evident that the row of circles [**m15-17**] in the north east part of Area A appear to be aligned with trackway [**m7**] to the south as well as the west enclosure system, suggesting some common influence on the layout of the respective features even if not clearly contemporary (perhaps representing successive phases of activity partly respecting the previous orientations).

Also very evident in the data from Area A, as well as on the ground itself, is the ridge and furrow system visible as a series of broad weak parallel linear anomalies [**m18**] and [**m19**] on variable orthogonal alignments. The magnetic response to this has been accentuated in selective areas by the enhancement of the soil derived from the underlying industrial activity. The magnetically enhanced soil is concentrated in the surviving ridges and has led to these being defined by strong positive magnetic anomalies, separated by weaker anomalies over shallower soil furrows. The differential depth of burial of the ditch system beneath the ridge and furrow is also indicated by the light and dark banding of the ditch anomalies, especially those running north-south.

In the north west part of the survey area, and coincident with the truncation of ridge and furrow, is a large area of mixed magnetic response [**m20**] within which some linear elements are visible suggestive of possible buried wall alignments and building demolition debris, possibly consistent with buried brick, tile and stonework. It is difficult to discern any distinct pattern within this zone but the mixed response suggests that this area might contain remains of former settlement of medieval or post-medieval origin perhaps related to formerly more extensive activity such as earlier farm buildings surrounding the present site of Lower Farm. The targeted earth resistance coverage in this area

only provided limited additional information to the magnetometer survey (Cole 1992).

A series of further parallel linear anomalies further to the north at [**m21**], on a similar orientation to the WSW-ENE orientated pattern of ridge and furrow as well as the layout of Lower Farm, may be related to the same activity suggested by [**m20**], perhaps an access route, although there is also a possibility that this may represent a further element of the Roman enclosure systems associated with the pottery production activity.

Area B (surveyed 1994)

Three incomplete sub-circular anomalies [**m22-24**] have been detected with magnitudes of response up to 8nT. This clarity suggests that, rather than being a partial representation of more complete ring ditches, these anomalies do indeed reflect their true extent. As the open sides of all of these anomalies face eastward, a possible interpretation might be that they represent wind-breaks against the prevailing westerly winds (Cole 1996).

Adjacent to [**m22-24**], and slightly to the west, irregular shaped areas of raised magnetic response [**m25**] have been detected that may well represent shallow quarrying activity, possibly for clay for use in pottery production, more recent ground disturbance related to the pipeline construction or alternatively a response to localised variation in the underlying geology.

Area C (surveyed in 1994 and extended in 1996)

A series of ditches to the south west at [**m26**] and [**m27**] form an extension of the SSW-NNE orientated enclosure system [**m1-5**] mapped to the west in Area A. Beyond [**m26**] and [**m27**] to the north east there appears to be a reorientation of the enclosure system where it becomes aligned with the main east-west axial routeway, visible as a prominent series of gradually diverging linear anomalies [**m28**] extending across the whole of Area C but becoming narrower and following a more curvilinear course to the west where it crosses into Area A at [**m29**].

Extending from the activity previously mapped in Area A, a second ladder system of enclosures [**m30-40**], mapped as a series of linear anomalies of varying magnitude, can be seen positioned on each side of the central east-west road [**m28**] although the majority of the activity is concentrated to the south of [**m28**] with a lower density of enclosures [**m41-44**] to the north mainly situated towards the western end of [**m28**]. The main network of enclosures has numerous partitions and sub-divisions that exhibit some variation in form between distinct sections of the ladder arrangement.

Within the enclosure system [**m30-44**] numerous additional kiln-like anomalies have been detected, apparently clustered into as many as 10 discrete groups [**m45-55**] with further, more isolated, single outlying examples [**m56-59**]. These anomalies all share the same characteristic form with intense positive signals generally ranging from between 35 and 100 nT in maximum magnitude of response similar to the kilns in Area A that were confirmed by augering in 1992 (Cole 1992; Keevill and Cole 1995). These distinctive groups of industrial features are fairly evenly spread out across the enclosure complex and generally located near the edges or corners of the associated ditched enclosures containing them. The stronger peaks are generally associated with adjacent groups of weaker positive magnetic anomalies that are likely to represent pits and dumps containing burnt material related to the main kiln structures or perhaps less well preserved or earlier kilns that were decommissioned and taken out of use. The response to the ditches is also exaggerated in the immediate vicinity of the suspected kilns, presumably due to their local in-filling with soil which has been strongly enhanced magnetically as a result of its association with the industrial activity. A component of this increased magnetic response may also be due to an accumulation of ceramic debris within the ditches.

Further outlying ditched boundaries extend north from [**m28**] at [**m60**] and [**m61**] towards the north east limit of Area C, but these ditches appear not to be so clearly associated with enclosures containing industrial activity.

A tapering curvilinear enclosure [**m62**], with two possible narrow entrances and a small number of internal pits, appears along the course of the trackway [**m28**], but was only partially resolved in the 1994 coverage and therefore initially suggested a bifurcation of [**m28**]. To the south of [**m62**] there is an interruption in the layout of the main east west ladder system of enclosures, possibly related to a secondary trackway [**m63**] passing through enclosures [**m30**] and [**m31**] to the south. The possible trackway at [**m63**] appears to mark a discontinuity in the arrangement of the enclosures to the west and the east although the overall ladder system does continue further to the east of [**m31**] and [**m32**] broadly parallel to the main trackway boundary [**m28**].

To the west of [**m63**] the enclosure system consists of a large sub-rectangular outer enclosure [**m30**] with its north side formed by the main trackway [**m28**], curvilinear corners to the north east and south east and a possible double-ditched boundary to the east possibly representing a secondary trackway [**m63**] connecting to [**m28**]. The western part of the enclosure system [**m30**] is notable for containing a smaller internal central sub-square enclosure [**m64**] with an obvious entrance to the east. A weakly defined negative anomaly [**m65**] towards the western side of the interior of [**m64**] may hint at the possible survival of an internal masonry structure. Also located within the western part of the enclosure system at [**m30**] are a series of sub-circular ring-gullies [**m66-68**] that are likely to be of a different phase to the enclosure ditches, several of

which appear to cross through these weak annular anomalies. Anomalies [**m66-68**] may relate to the same earlier phase of Roman activity recorded in the limited excavations along the pipeline easement undertaken in 1992 (Keevill and Cole 1995) and the group of probable ring-gullies mapped by the magnetometer survey at [**m15-17**] in Area A in 1992. It is also possible that [**m66-68**] represent a pre-Roman phase of activity.

Immediately to the east of enclosure [**m64**] a further series of internal sub-divisions of the main rectangular enclosure [**m30**] are visible containing a group of four kilns [**m46**] but there is a large separation between this fairly isolated group of kiln anomalies and their counterparts further to the north and east. The kilns at [**m46**] are the only evidence of these in the westernmost part of the ladder system, suggesting zonation of activities and the possibility that the western part of the ladder layout was perhaps reserved for settlement activity of a more domestic nature.

Enclosures [**m31-33**] to the east become thinner in overall width with more linear sub-divisions and a greater concentration of industrial activity [**m51-53**], with potentially as many as 7-8 individual kiln anomalies. Further to the east, as the main trackway [**m28**] broadens out and diverges, there is a change in the orientation of enclosures [**m34-40**] to more of an east west axis. The trend of industrial anomalies being concentrated in the corners and along the edges of the enclosure partitions continues however, although there appears to be a lower concentration perhaps indicating a gradual fall-off in the level of activity towards the east. The response to the ditches of the enclosure systems appears to tail off completely to the east before reaching the boundary of the survey with the A4074 road, but some ditches do appear to extend beyond the current survey area to the south.

There is no obvious evidence for any buildings or foundations within the entire survey area, perhaps with the exception of the indistinct negative anomaly [**m65**] in the western part of the interior of the sub-square enclosure at [**m64**] despite the favourable geology for magnetic survey (cf Cottrell and Payne 1993). This suggests, perhaps, that if there are traces of Roman buildings surviving at the site they may be fairly insubstantial, possibly timber built, or simply may not have been encountered thus far.

The magnetic response to significant archaeological anomalies is of a similar magnitude within areas of the site under prolonged arable cultivation (Area C) in comparison with the unploughed pasture field to the west (Area A). In addition, the response to ridge and furrow in Area C is much reduced thereby improving the clarity of the response. However, faint traces of ridge and furrow can still be made out to the centre of Area C, for example at [**m69**], accompanied by much weaker and vaguer traces elsewhere (shown as parallel

dashed lines on Figure 5) despite it having been completely levelled by subsequent cultivation.

The survey has been affected by modern ferrous material, most obvious where a service pipe [**m70**] cuts southeast-northwest through Area C with a further intersecting linear ferrous anomaly towards the southern edge of the survey at [**m71**]. Particularly strong disturbance created by the electricity pylons in the south and east of the survey area is also evident at [**m72**] and [**m73**].

Area D (surveyed 1994)

In general the magnetic response in this area is much more subdued compared to the greater intensity of activity mapped to the north. There is a very subtle curvilinear ditch anomaly [**m74**] to the north east, which if complete, would be approximately 30m in diameter. This could potentially represent a ring ditch but more likely relates to part of the general more widespread pattern of enclosures that are better defined to the north and west. Towards the western boundary of Area D very faint indications of further rectilinear ditched enclosure systems [**m75**] have been detected in the form of weakly resolved positive linear magnetic responses. These are are likely to represent an extension of the pattern of SSW-NNE orientated enclosures more fully defined to the west in Area A and in the south-west extremity of Area C to the north.

CONCLUSIONS

The naturally high iron oxide content of the local soils derived from the underlying Jurassic geological deposits has provided ideal conditions for highly informative magnetometer results. A detailed plan of a major Roman industrial site has been revealed in great clarity. The distinct pattern of enclosures and trackways mapped by the initial survey in 1992 can now be seen to be only a part of a far more extensive system running across the arable fields to the east at least as far as the A4047 road, some 500m distant from the initial recognition of the Roman pottery production activity during the pipeline construction near Lower Farm in 1992, but showing signs of fading out towards this eastern boundary. Detail of many more kiln sites has been recovered, revealing an apparent focusing into as many as 10 discrete groups within the field to the east. A number of further ring ditches, of various morphologies, have also been mapped possibly indicating related habitation structures or perhaps earlier phases of later prehistoric activity most likely of Iron Age date.

The extent of the activity revealed by the geophysics corroborates the distribution of the main concentrations of surface scatters of Roman pottery recorded by field-walking undertaken by the OAU in 1995 (Keevill 1996). Analysis of the geophysical results combined with those from fieldwalking suggests that the Roman activity may extend yet further beyond the east and

south limits of the present magnetometer survey coverage but the density of linear anomalies does appear to be reducing considerably towards these edges and it is therefore likely that the main and most significant portion of the site has now been delimited.

The regularity of the enclosures suggests a well-planned and structured layout to the activity at the site. There are also indications that the enclosure layout may have developed and expanded in several parts and phases as suggested by the variations in the alignment of the ditches across the enclosure complex. The phased development of the ladder system may perhaps relate to gradual expansion of the settlement and its industrial base as demand for pottery production increased, in keeping with evidence from limited excavation along the pipeline easement in Area A in 1992 that also indicated two distinct phases of Roman activity in the western part of the site that continued into the fourth century (Keevill and Cole 1995).

Together the excavations and geophysical survey have produced one of the most detailed plans of an Oxfordshire Roman kiln site to date. The later production was on a very large scale (as indicated by at least 12 separate production areas of kilns and associated activity revealed by the overall magnetometer surveys) and was organised within a system of regular enclosures and trackways. Distinct zones of activity are apparent with kiln groups generally concentrated together in marked separate clusters near the corners or edges of enclosures often set apart by some distance from the neighbouring group. It is possible that this plan may indicate distinct patterns of ownership or tenure of the various kiln groups reflected in how the site was laid out and the pattern of kiln groups dispersed over a wide area in their own separate enclosures.

The data recorded from limited excavation combined with the more extensive geophysical and field-walking evidence clearly demonstrates the complementary nature of the combined techniques for an enhanced understanding of the site. The excavation produced a wealth of artefactual detail, as well as revealing many of the workshop features which typify an Oxfordshire kiln site (Keevill and Cole 1995, 195-197). Excavation could not however give any indication of the overall character and disposition of the site such as indicating that the excavated Roman ditches were part of a wider system of enclosures. It was only possible to gain a wider perspective on the site through the ability of magnetometer survey to rapidly and non-destructively provide a firmer context and understanding of the archaeological activity at Nuneham Courtenay first revealed by the pipeline construction in 1992.

LIST OF ENCLOSED FIGURES

REFERENCES

Bartlett, A D H and Turton, B 1991 *'Report on magnetometer survey at Lower Farm, Sandford-on-Thames, Oxfordshire 1991 (unpublished report)'*.

Booth, P, Boyle, A and Keevill, G D 1994 'A Romano-British Kiln Site at Lower Farm, Nuneham Courtenay, and Other Sites on the Didcot and Wootton to Abingdon Water Mains, Oxfordshire'. *Oxoniensia*, 53, 00-99.

British Geological Survey 2020. "1:50,000 Online Geology of Britain Viewer." Retrieved 03/04/2020, from http://mapapps.bgs.ac.uk/geologyofbritain/home.html

Cole, M A 1992 *'Nuneham Courtenay, Oxon. Report on geophysical survey, April 1992'*. Ancient Monuments Laboratory Report Series, 57/92.

Cole, M A 1996 *'Lower Farm, Nuneham Courtenay, Oxon. Interim report on geophysical surveys, 1992-4'*. Ancient Monuments Laboratory Report Series, 4/96.

Cottrell, P and Payne, A W 1993 *'Kingscote, Gloucestershire. Interim report on geophysical survey, September 1993'*. Ancient Monuments Laboratory Report Series, 103/93.

Geological Survey of Great Britain (England and Wales) 1971 Abingdon, England and Wales Sheet 253, Drift edition. One inch geology map series. Ordnance Survey, Chessington, Surrey.

Keevill, G D 1996 *'Lower Farm, Nuneham Courtenay, Oxfordshire (SP 539005). Report on the evaluation of a Romano-British kiln site'*. Oxford Archaeological Unit, unpublished report, March 1996.

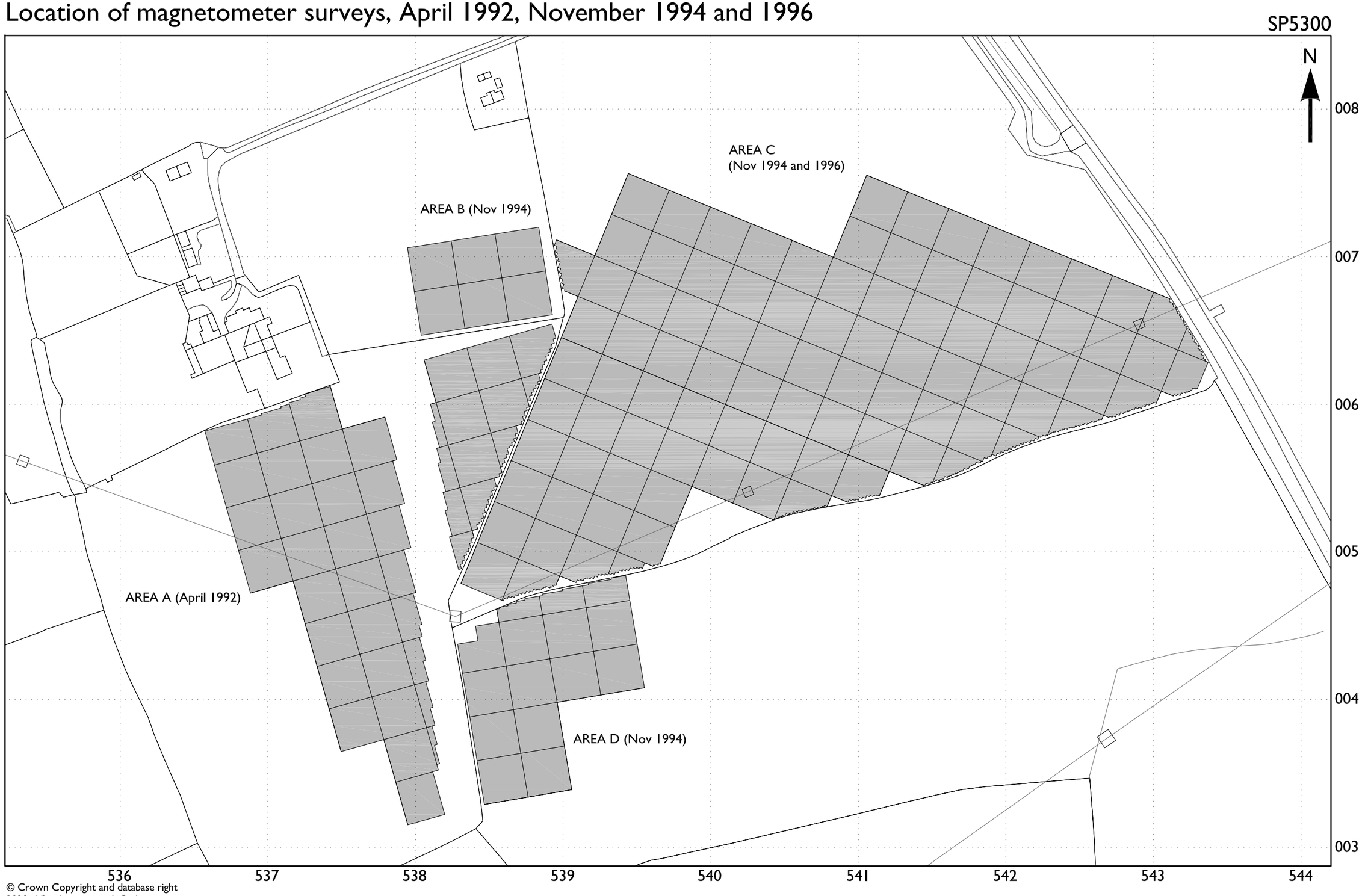
Keevill, G D and Cole, M A 1995 'Archaeology, geophysics and management: Lower Farm, Nuneham Courtenay, Oxfordshire' *in* Beavis, J (ed), *Science and Site: Archaeological Sciences Conference 1993* London.

Soil Survey of England and Wales 1983 1:250,000 Soil Map of England and Wales, Sheet 6, South East England. Harpenden: Soil Survey of England and Wales.

Figure 1

LOWER FARM, NUNEHAM COURTENAY, OXFORDSHIRE

Location of magnetometer surveys, April 1992, November 1994 and 1996



0 150m

1:2500

30m magnetometer survey grids

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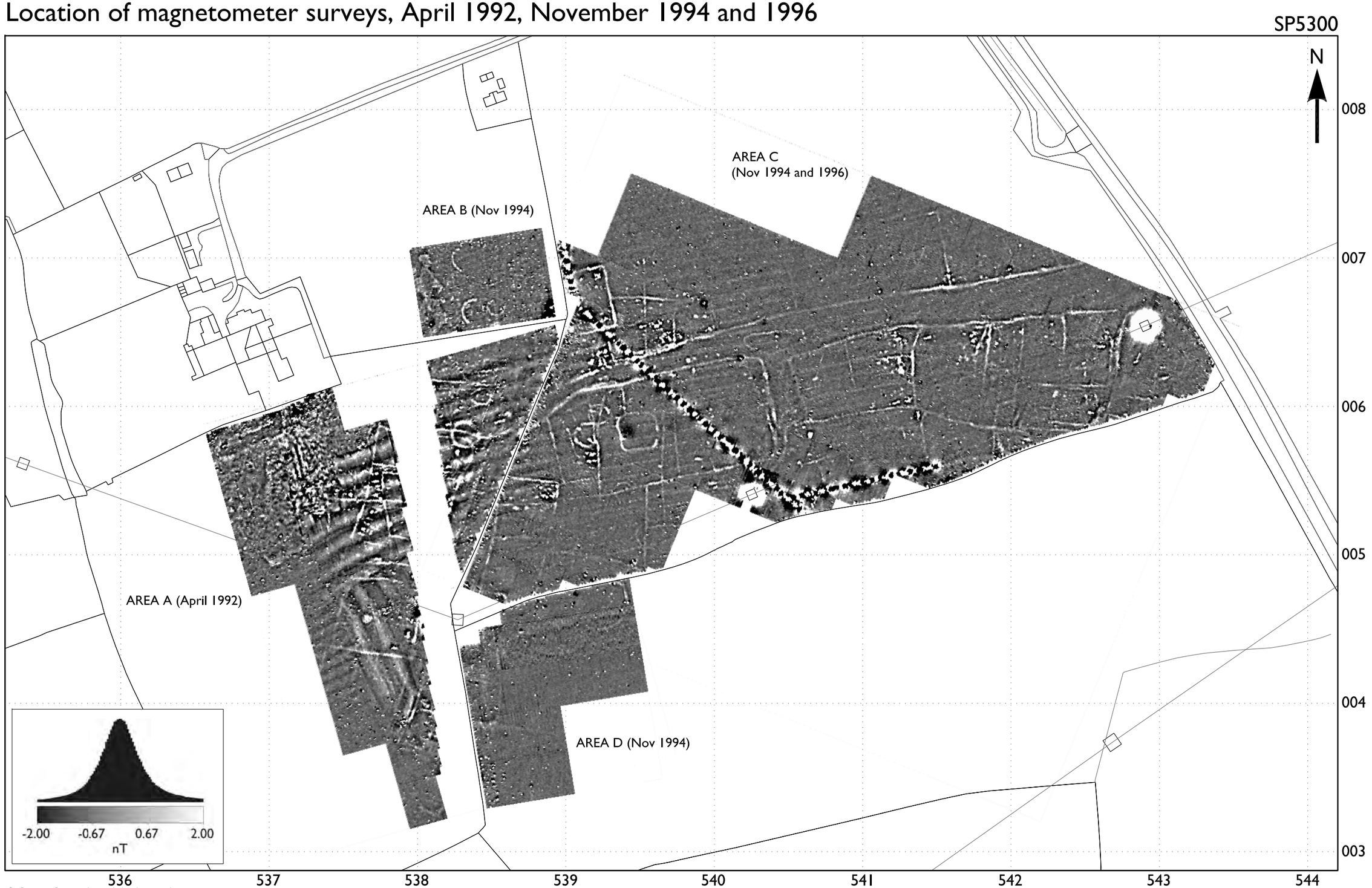
Figure 2

LOWER FARM, NUNEHAM COURTENAY, OXFORDSHIRE

Location of magnetometer surveys, April 1992, November 1994 and 1996



0 150m

1:2500

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Figure 3

LOWER FARM, NUNEHAM COURTENAY, OXFORDSHIRE
Magnetometer Surveys, April 1992, November 1994 and 1996

Trace plot of range truncated (-120 to 120 nT)
minimally processed magnetometer data

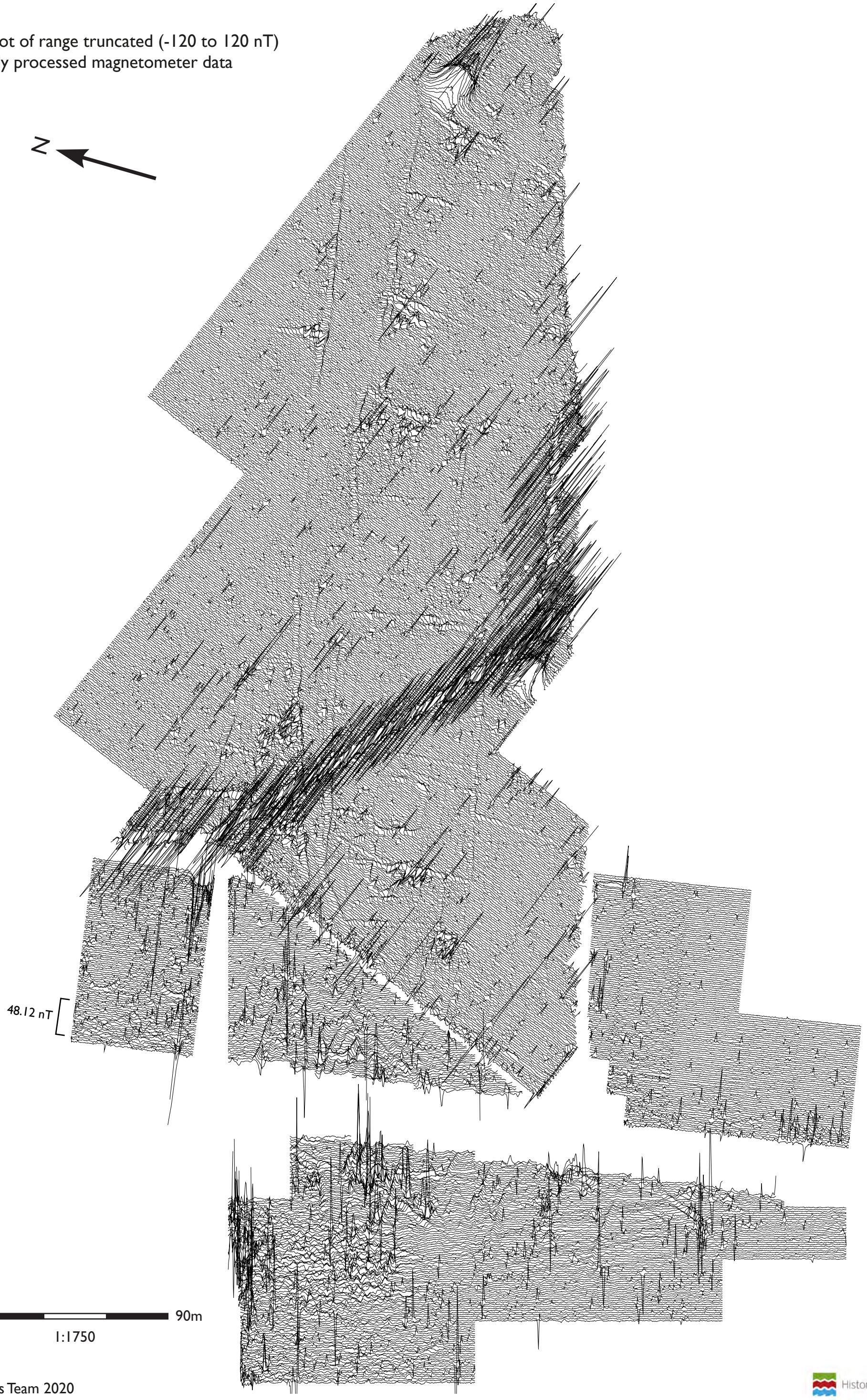

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Figure 4

LOWER FARM, NUNEHAM COURTENAY, OXFORDSHIRE
Magnetometer Surveys, April 1992, November 1994 and 1996

Linear greyscale image of minimally processed magnetometer data

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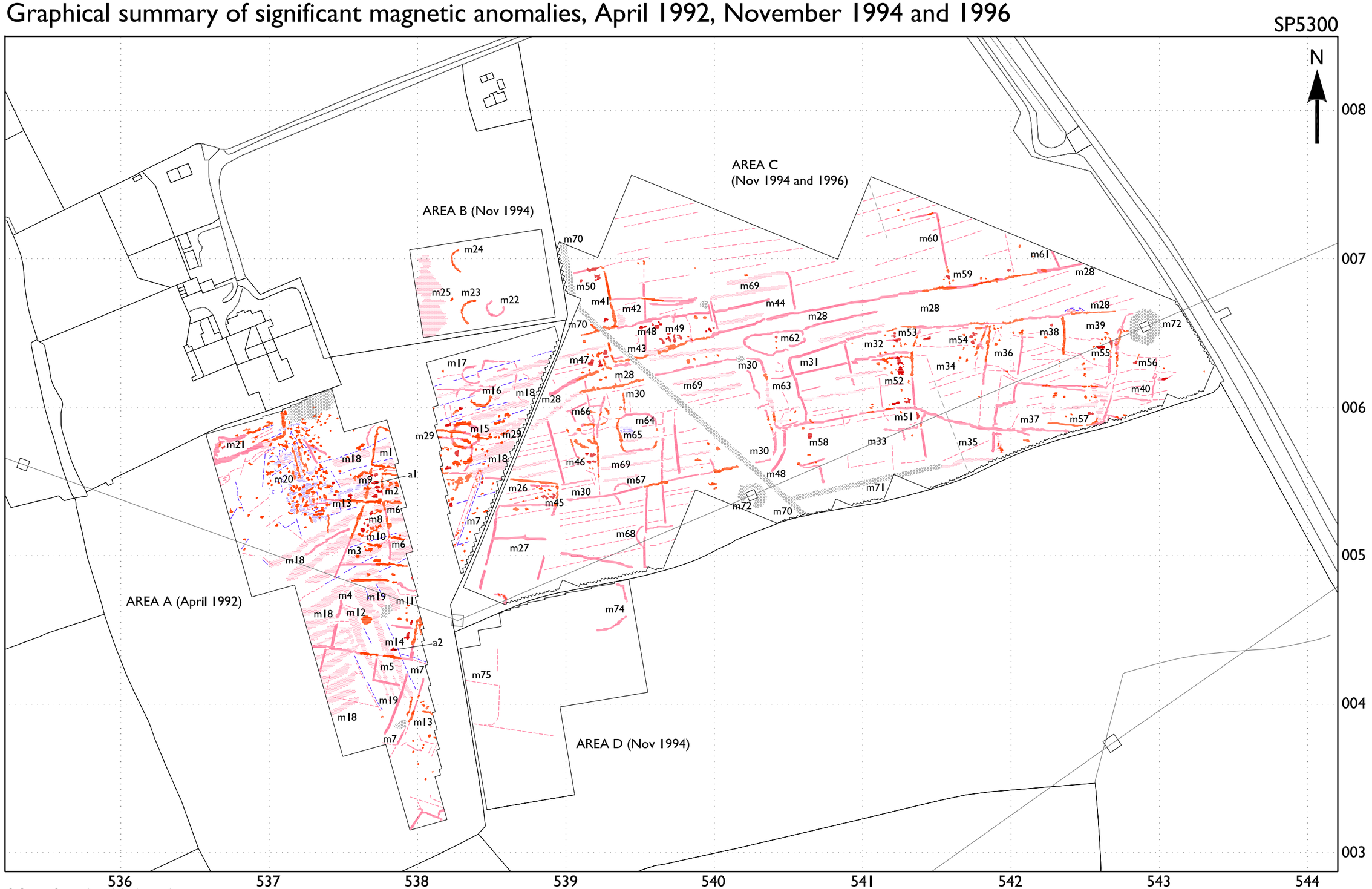
Figure 5

LOWER FARM, NUNEHAM COURTENAY, OXFORDSHIRE

Graphical summary of significant magnetic anomalies, April 1992, November 1994 and 1996



0 150m

1:2500

positive magnetic
negative magnetic
strong positive magnetic
raised magnetic
magnetic noise
weak linear trends (parallel responses are related to former ridge and furrow)

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