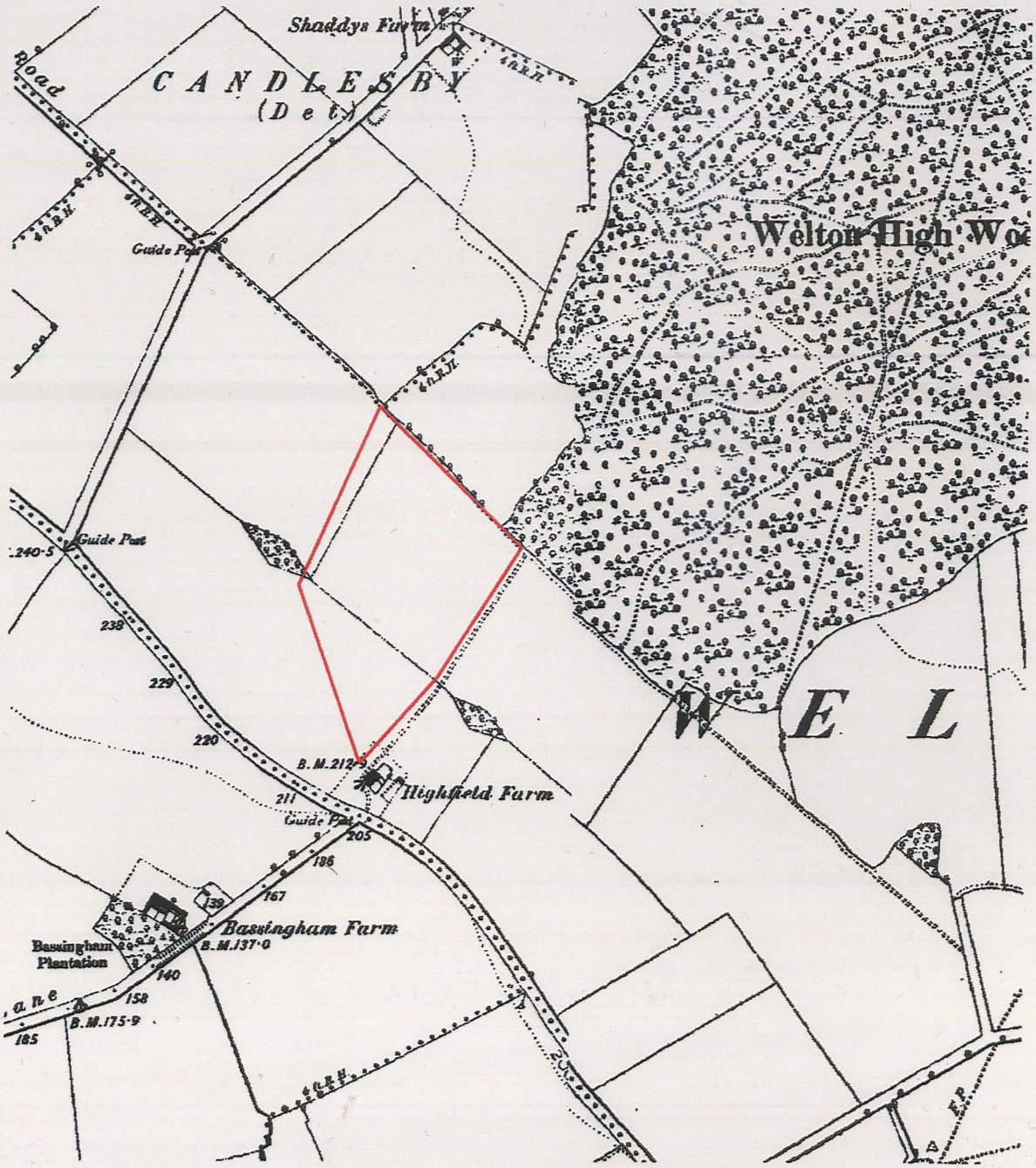
# FLUXGATE GRADIOMETER SURVEY: LAND ADJACENT TO HIGHFIELD QUARRY, WELTON LE MARSH LINCOLNSHIRE

**NGR: 545080 369350**




**REPORT PREPARED FOR HALLETEC ASSOCIATES**

**BY DAVID BUNN**

**SEPTEMBER 2004**

pre-construct geophysics

## Contents



## Illustrations



**Front cover:** 1st Edition O.S map (1891-92). 


pre-construct geophysics

Unit G, William Street Business Park, Saxilby, Lincoln, LN1 2LP
Tel/Fax: 01522 704900 e-mail: pcgeophysics@tiscali.co.uk
www.archaeology-geophysics.co.uk

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***Summary***

- *A fluxgate gradiometer survey was undertaken on land adjacent to Highfield Quarry, Welton le Marsh, Lincolnshire.*

- *The results of a 1ha survey undertaken in 2001 identified the potential for significant anomalies within the proposed development area, complimenting existing evidence relating to prehistoric and Roman occupation in the general vicinity of the site.*

- *The current survey has identified what appear to constitute significant archaeological anomalies; including traces of two enclosure systems with internal features such as pits and possible circular structures. These may date from the prehistoric and/or Romano-British periods. A number of other potential ditches were recorded in the southern part of the site.*

- *Random and/or amorphous magnetic variation was detected across the survey area. This probably refelects natural features produced in periglacial and alluvial environments.*


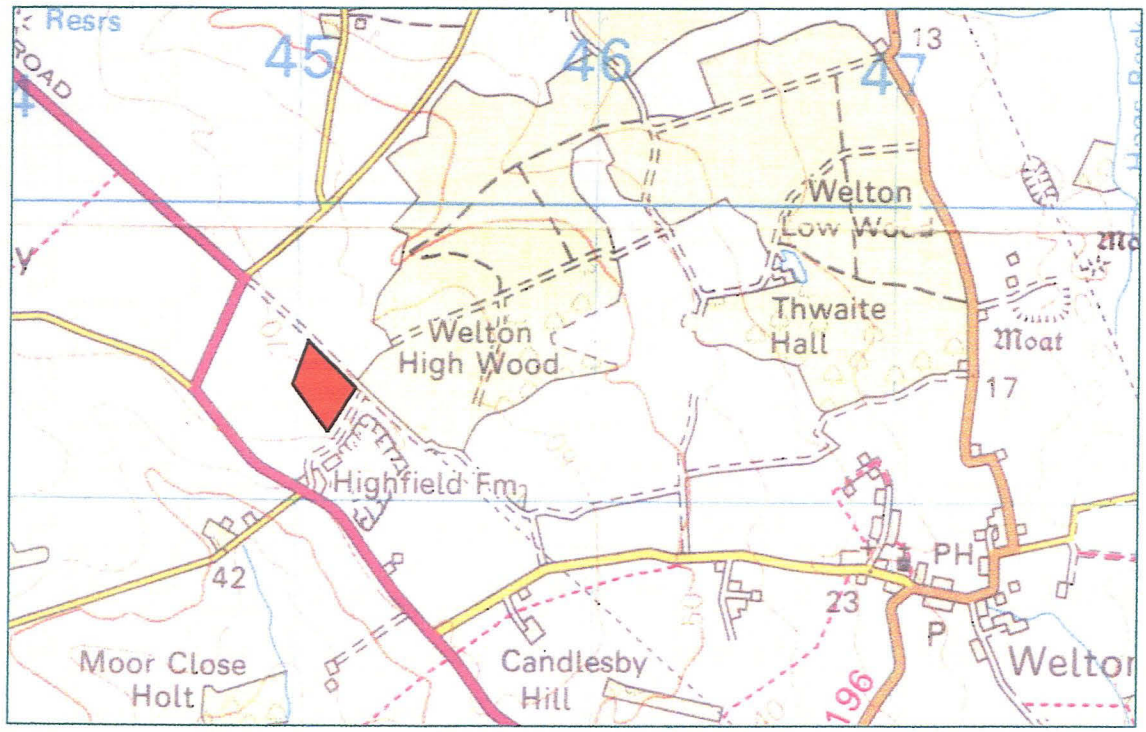


**Fig.1: Location of site 1:25000**


**Fig.2: Location of survey 1:2500**

## 1. 0 Introduction

Halletec Associates commissioned Pre-Construct Geophysics to undertake a fluxgate gradiometer survey of land at Welton le Marsh, Lincolnshire. This work was carried out to fulfil part of a recommendation by East Lindsey District Council for an archaeological evaluation of the site. Full planning permission is sought for the extension of an existing chalk quarry.

The survey methodology that is described in this report was based on the guidelines set out in the English Heritage document *'Geophysical Survey in Archaeological Field Evaluation'* (David, 1995.

## 2.0 Location and description

Welton le Marsh lies approximately 10km west of Skegness.

The site is situated to the east of the village on land adjacent to Highfield Quarry, which was formerly known as Highfield farm.

The area of the proposed quarry extends to approximately 6ha, and comprises a sub-rectangular unit of agricultural land on a north-east facing slope. An area of 5ha was surveyed (Fig.2).

The site is bounded to the south-east by a tack and hedge, beyond which lies an existing quarry. Welton High Wood lies to the east of the site, alongside a track, which forms the immediate north-eastern boundary. The western and northern edges of the survey area are unbounded.

The geology of the area comprises Cretaceous deposits of Welton and Ferriby Chalk. (B.G.S., 1996).

## 3.0 Archaeological and historical background

Several prehistoric burial mounds have been recorded within the general area, and the site lies close to the prehistoric Bluestone Heath Road (L.A.S., 2001). The track that forms the north-east edge of the site follows the line of a Roman Road that extended from Lincoln to Burgh le Marsh, and it is anticipated that elements of this road may lie within the site. Traces of a Roman settlement have been identified to the north-east of Welton High Wood.

During the Saxon period, the wapentake meeting place may have been at Candlesby Hill, which lies to the south-east of the site, and alongside the Bluestone Heath Road.

In 2001, a fluxgate gradiometer survey of c.1ha of land along the north-eastern boundary of the field identified potentially significant anomalies, including elements of an enclosure (Bunn and Palmer-Brown, 2002).

## 4.0 Methodology

Magnetic variation that is detectable within soils can often determine the nature and extent of past human activity. At British latitudes, the earth's magnetic field is approximately 50,000 nanoteslas (The nanotesla is the SI unit of magnetic flux, used in gradiometry to measure magnetic variation in relation to the Earth's magnetic field). Against this background, most archaeological features produce an enhancement of around 5-30 nanoteslas (nT). The strength of this magnetic variation depends largely on the composition of the geology. For example, limestone and chalk exhibits low magnetic susceptibility, and contrasts well against soils: conversely, strongly magnetic igneous rocks can mask subtle anomalies completely.

For the most part, soils tend to be more responsive to magnetic remote sensing than the geologies over which they lie. Ferrous oxides occur naturally in many drift deposits, particularly those derived from, or containing elements of, igneous rocks. Organic decomposition within topsoils can supplement the level of ferrous compounds, a process amplified by agricultural activities.

The fills of ditches and pits tend to increase soil depths, and hence magnetic strengths, relative to surrounding soils. The converse also applies.

Ferromagnetic substances such as iron induce a very high response to magnetic surveys, and are thus easier to identify. Perhaps of more significance to the archaeological prospector are the weaker ferrous oxides; the randomly orientated magnetic fields of these materials produce minimal magnetic variation in their natural state. Geology and soil type can determine this variance (see above). Specifically, clay soils are ferrous oxide rich, hence their characteristic red colouration. Clay has literally been a fundamental building block in human social development: firing increases its versatility, but also enhances the magnetic properties of its ferrous content. For kilns, this may be in the order of 1000-5000 nT. Similar processes occur during the formation of igneous rocks.

Invariably, most surveys detect discrete anomalies, either in groups, or randomly scattered across a site. In the absence of intrusive investigation, the nature and origin of these anomalies is often difficult to establish. Strongly magnetic dipolar anomalies usually reflect ferrous objects, such as ploughshares and horseshoes. Weaker examples may indicate ceramic materials such as brick and tile, often introduced onto the site during manure spreading. The strength of the magnetic variation derives from permutations of the size and depth of the feature/object and the magnetic susceptibility of the surrounding soil. Pit-like anomalies, usually positive, can be identical to naturally occurring depressions, and the potential of these can only be estimated when they are examined in context with other factors, such as the proximity of definite, or suspected archaeological remains.

The use of magnetic surveys to locate sub-surface ceramic materials and areas of burning, as well as magnetically weaker features, is well established, particularly on large green field sites. The detection of magnetic anomalies requires the use of highly sensitive instruments, in this instance the Bartington 601 Dual Fluxgate Gradiometer. This must be accurately calibrated to the mean magnetic value of each survey area. Two sensors, mounted vertically and separated by 1m, measure slight, localised

distortions of the earth's magnetic field. Cumulative readings can be stored, processed and displayed as graphic images.

| | |
|---|---|
| Instrument | Bartington 601 Dual Fluxgate Gradiometer |
| Grid size | 30m x 30m |
| Sample interval | 0.25m |
| Traverse interval | 1.0m |
| Traverse method | Zigzag |
| Sensitivity | 0.1nT |
| Processing software | Archeosurveyor v. 28.4.6 |
| Weather conditions | Warm, sunny |
| Area surveyed | 5.2 ha |
| Date of survey | 30/7/04-3/8/04 |
| Personnel | Peter Hetkoop |

**Table 1: Summary of survey parameters**

Central National Grid Reference 545080 369350

## 5.0 Results (Figs. 3-6)

**Results (Figs. 3-6)**

The results are presented graphically as figures 3-6, at a scale of 1:1250.

The survey recorded significant archaeological remains, including two clearly defined rectilinear enclosures complete with internal ditches and probable pits/areas of burning. Ancillary ditches were also detected, some of which appear to indicate traces of further enclosures.

The largest enclosure (c 65m x 50m, figure 6: anomaly1, highlighted in yellow) lies in the eastern half of the site (the eastern corner of the enclosure was recorded during the 2001 survey). Its morphology suggests a Late Iron Age/Romano-British origin. It is subdivided by an east to west aligned ditch (2) and encompasses magnetic anomalies that are typical of pits/areas of burning (clearest examples circled in red, figures 5 and 6). A possible access point lies along the northeastern edge (3). At least two curvilinear anomalies (4 and 5, red) lie within the enclosure and, given their location, an archaeological interpretation as partial hut circles is feasible. However, the greyscale images depict similar anomalies across much of the survey, and an archaeological origin for anomalies 4 and 5 is not a certainty.

A regular, extensive, curvilinear ditch (6) extends south-eastwards from the southern corner of the enclosure and continues to the edge of the current southeastern field boundary, beyond which lies a quarry.

The results indicate what could be a second enclosure, 7, attached to the western edge of 6, and it is possible that ephemeral anomalies (8, 9) signify further enclosure

features, although this interpretation is tentative: it is equally possible that the north to south-aligned elements of 8 indicate cultivation scores, examples of which occur along a similar alignment elsewhere (examples shown as blue).

A well-defined c. 40m x 30m simple enclosure, 10, was detected to the south-south-west of 1. Possibly earlier in origin (morphologically), this feature incorporates an internal curvilinear ditch (11), possible eastern/southern access points (12, 13) and a central group of pits/zones of burning (circled in red).

A number of linear/curvilinear anomalies were recorded in close proximity to 10. For the most part, these are magnetically weaker, but are sufficiently clear to suggest ditches that relate to the clearest enclosure. Some appear to comprise elements of two smaller enclosed areas (14, 15), complete with possible ditched accesses (16, 17) and potential pits (circled in red). It is tentatively proposed that the survey identified traces of a northerly continuation of one of these approaches (18: broken yellow line).

To the east and south of this complex, the results indicate irregular linear anomalies and zones of weak amorphous magnetic variation (green). The latter may be palaeochannels, (magnetically enhanced silty fills), an interpretation reinforced by the fan-like morphology of the southernmost example (19). However, a distinct ditch like linear anomaly (20) was detected at the narrowest point of 19. This is mirrored by a similar linear that lies to its south (21). It is possible that anomalies 19 and 20 reflect direct relationships between natural and archaeological features; a ditch created to improve a palaeochannel channel perhaps. Other potential ditches were detected in this part of the site (22, 23). Ditch-like linear anomalies were also detected close to the more northerly 'palaeochannel'. However, these are irregular and possibly of natural origin (examples shown as green).

Linear anomaly 24 is not convincing as a ditch and may reflect traces of cultivation, such as a plough score.

Magnetically stronger discrete anomalies occur (circled in pink, trace plot) in the northwest part of the survey, along (or close to) the alignment of a former field boundary (as depicted on the 1st Edition Ordnance Survey Map, see report cover). The survey may have detected a trace of a second boundary, as a linear (orange) that extends along the northern edge of a possible natural feature (see above, 19). The approximate positions of both boundaries are marked on figures 5 and 6 as broken orange lines.

With reference to the survey results alone, the provenance of stronger anomalies detected elsewhere is more ambiguous, although dipolar anomalies (examples circled in pink, figures 5 and 6) may reflect agricultural objects (ploughshares, horseshoes etc). High readings were recorded along the eastern edge of the field, and these probably reflect ferrous materials within a track and the close proximity of farm vehicles.

## 6.0 Conclusions

The survey identified traces of two clearly defined enclosures, as well as a third possible enclosure attached to an extensive boundary feature. The morphology of the

largest enclosure (1), which lies in the northern half of the site, suggests that it dates from the later prehistoric or Romano-British periods. Within its confines, a series of discrete and curvilinear anomalies may be evidence of domestic occupation, such as pits, burning and circular structures. Its southern boundary continues south-eastwards beyond the limits of the site. At least one further enclosure appears to abut this ditch.

The smaller enclosure (10) is potentially more ancient and, morphologically, could even be pre-Iron Age. It appears to be associated with two further enclosed features, possibly reflecting several phases of activity.

Potential ditches were detected in the southern half of the site, although these do not appear to form any cohesive pattern.

Random magnetic variation and irregularly shaped anomalies were recorded in many areas of the site. It would appear likely that many of these relate to alluvial and periglacial processes.

## 7.0 Acknowledgements

Pre-Construct Geophysics would like to thank Hallectec Associates for this commission.

## 8.0 References

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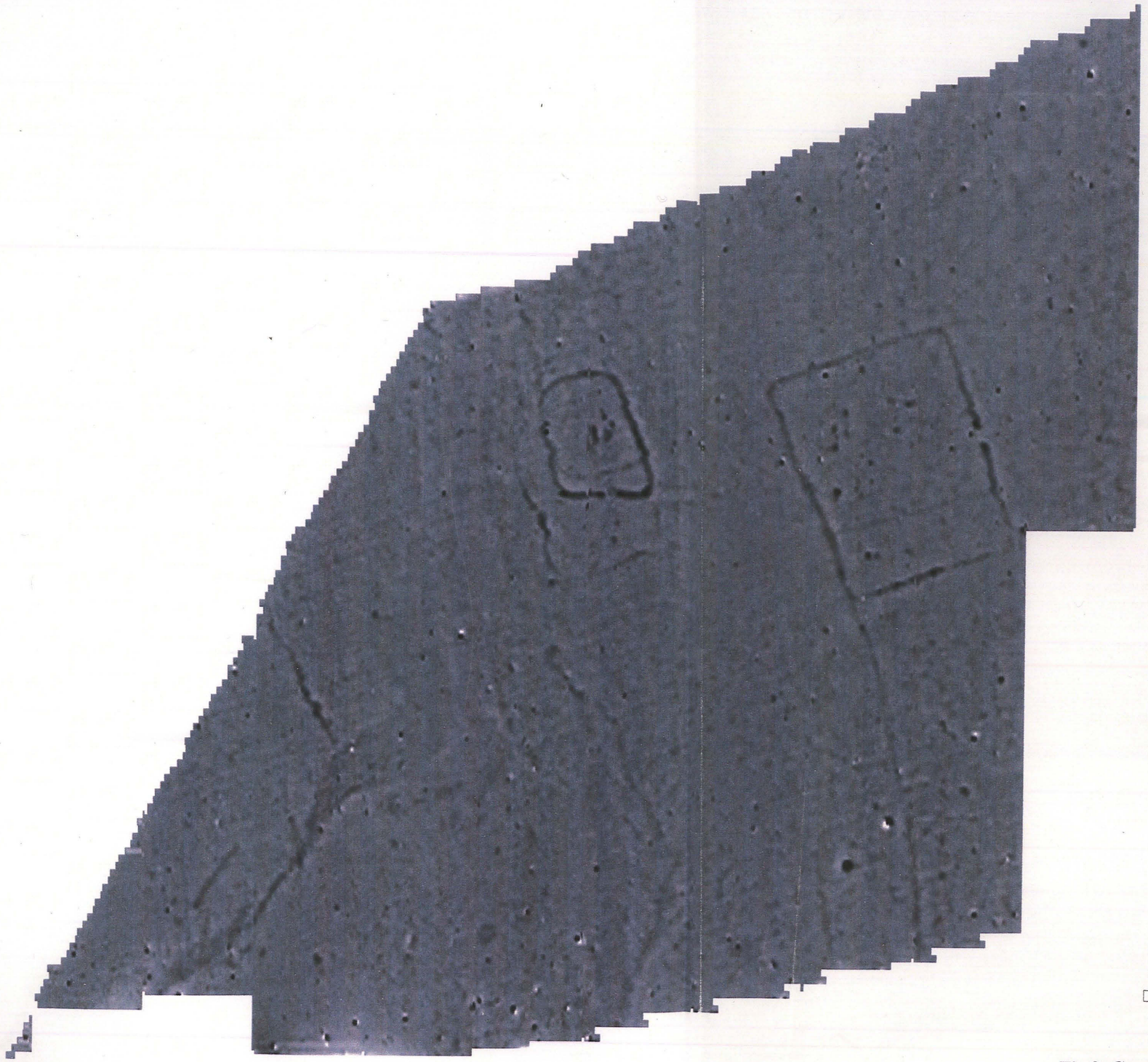
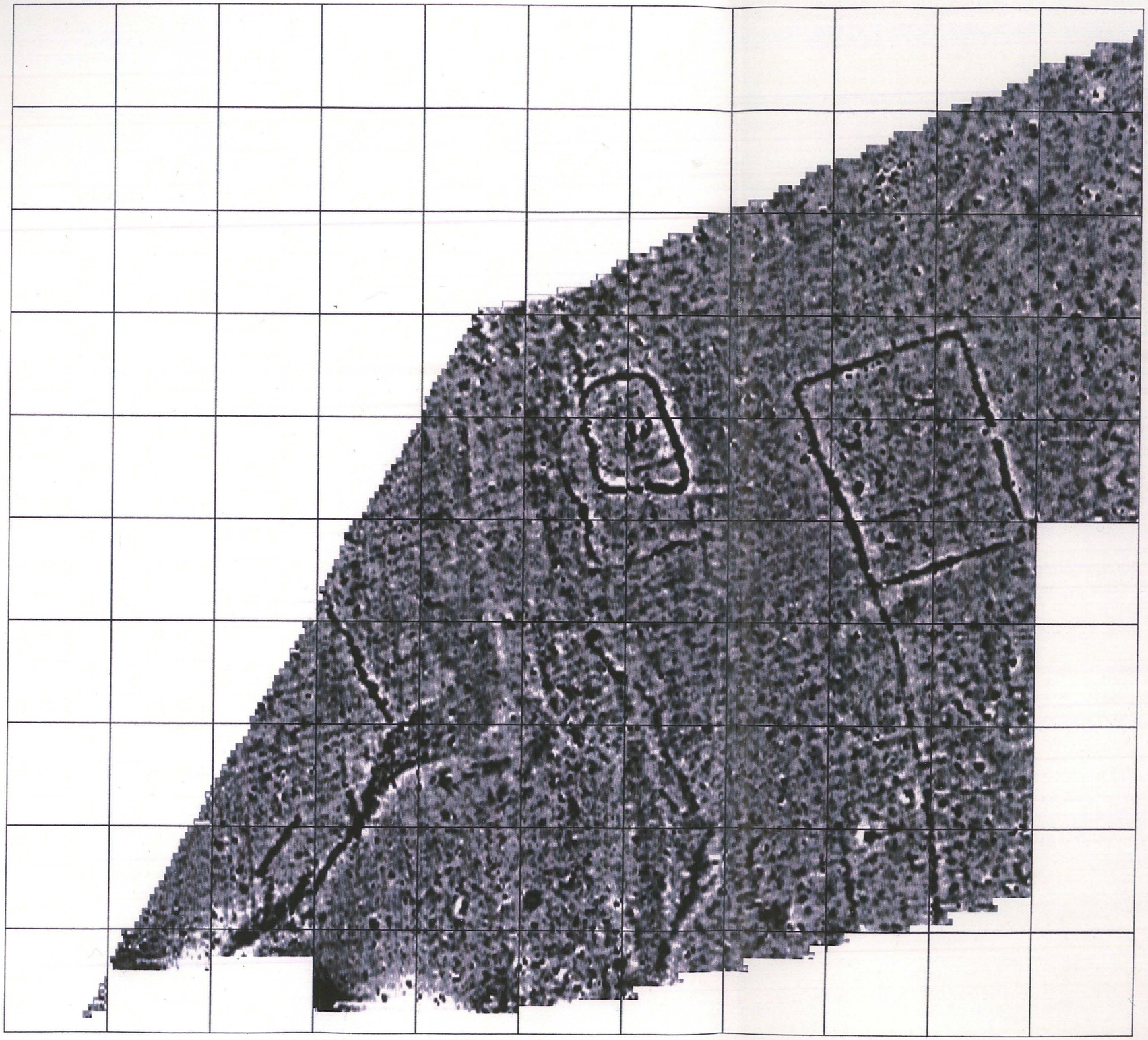



30m

-100.0 nT 100.0

**Fig 3: Greyscale image of unclipped data** 1: 1250

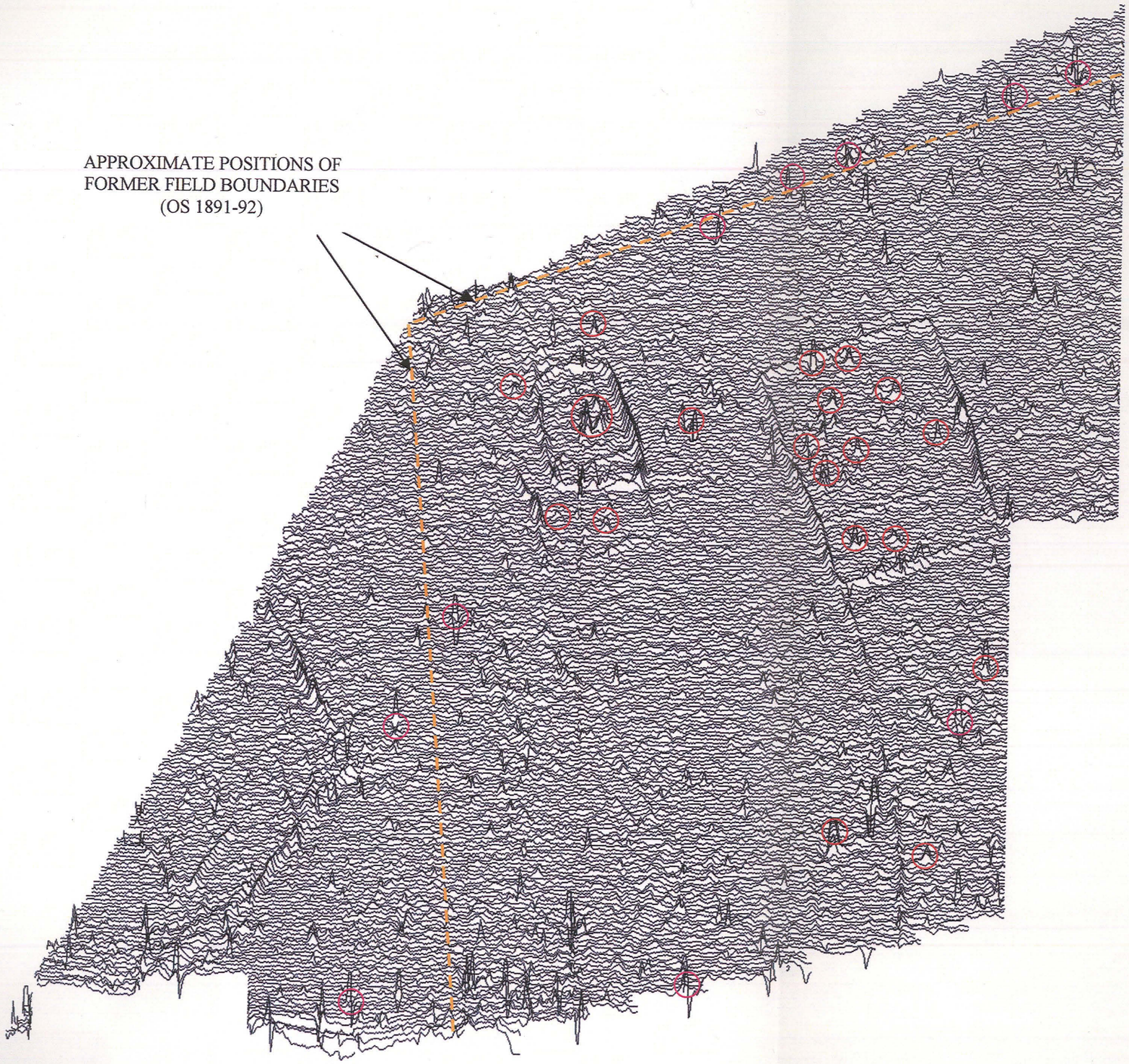


N

-2.0 nT 2.0

30m

**Fig 4: Greyscale image of processed data** 1: 1250




N

25nT

30m

**Fig 5: Trace plot** 1: 1250

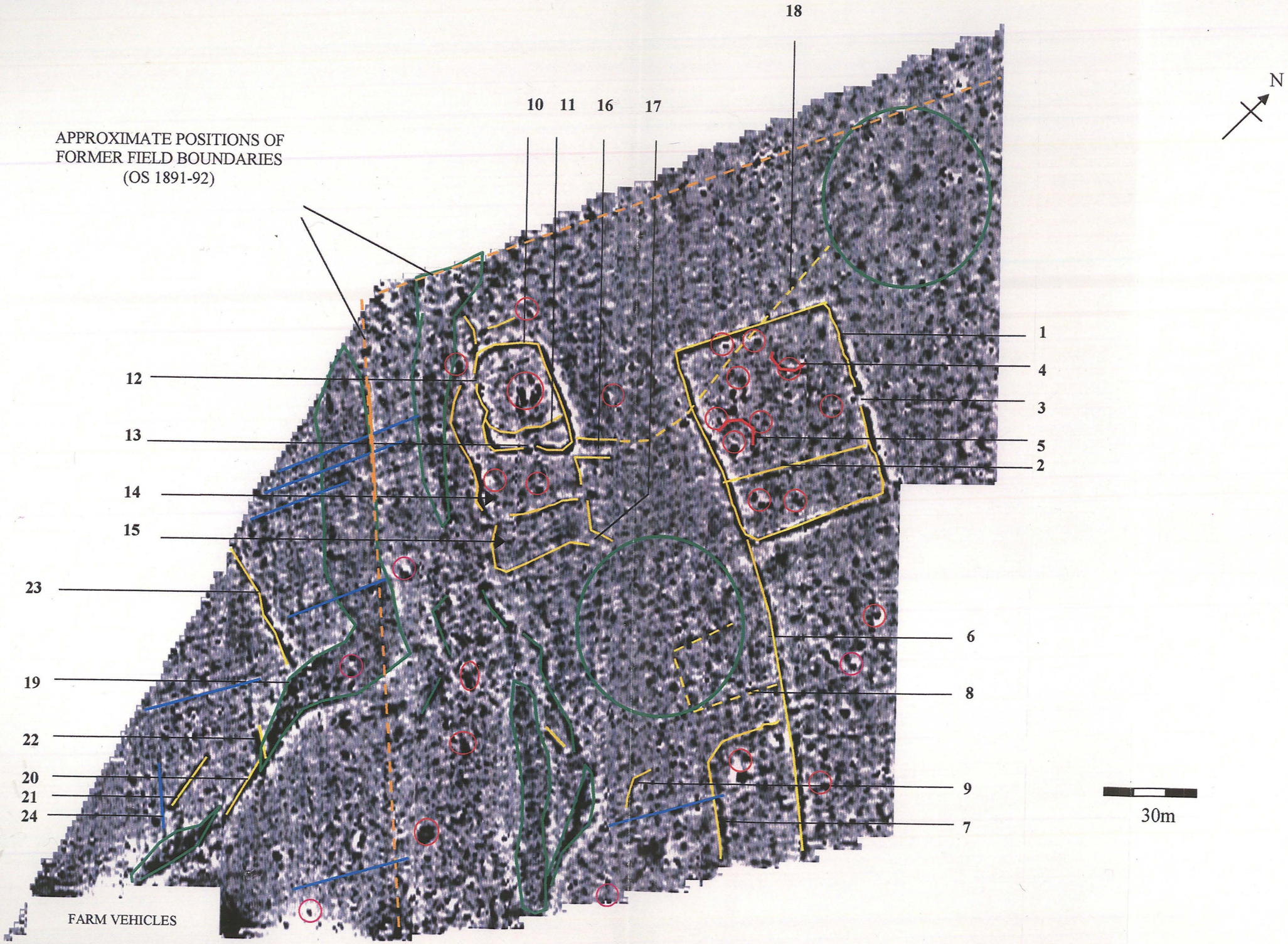



**Fig 6: Interpretive plan** 1: 1250