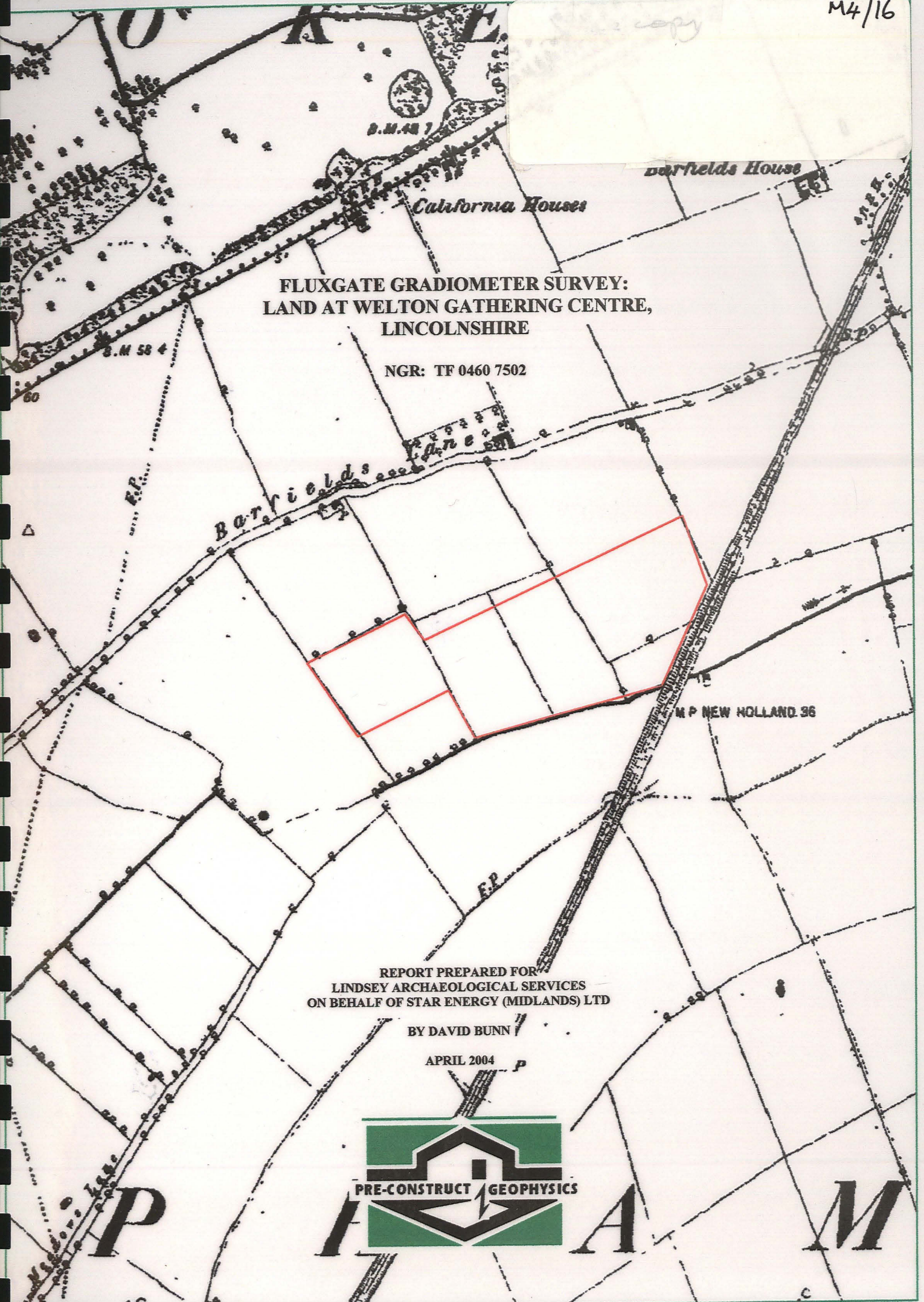


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**FLUXGATE GRADIOMETER SURVEY:  
LAND AT WELTON GATHERING CENTRE,  
LINCOLNSHIRE**

NGR: TF 0460 7502



REPORT PREPARED FOR  
LINDSEY ARCHAEOLOGICAL SERVICES  
ON BEHALF OF STAR ENERGY (MIDLANDS) LTD

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APRIL 2004



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Front cover: 1<sup>st</sup> Edition O.S map (1890-1891). Database Right Landmark Information Group and Ordnance Survey Crown Copyright. All rights reserved.



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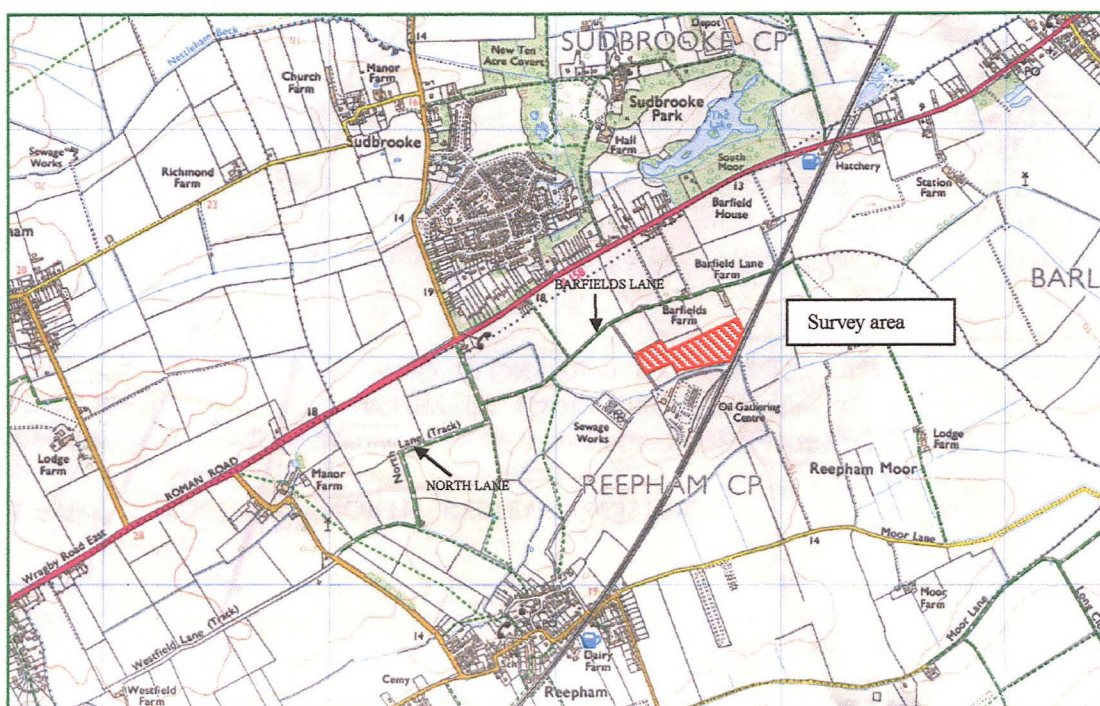
Conservation  
Services

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Highways & Planning  
Directorate

## Summary

- A fluxgate gradiometer survey was undertaken on land to the north of Welton Gathering Centre, Lincolnshire
- Most of the magnetic variation recorded at the site appears to indicate ridge and furrow, land drains and alluvial deposits
- A number of potentially significant anomalies were recorded, particularly in the western areas of the site. These may represent ditches and pits



**Fig.1: Location of survey Scale 1:25000**

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## 1.0 Introduction

Lindsey Archaeological Services (LAS), on behalf of Star Energy (Midlands) Ltd, commissioned Pre-Construct Geophysics to undertake a fluxgate gradiometer survey of land to the north of Welton (Oil) Gathering Centre, Lincolnshire. This work was carried out as part of an archaeological evaluation of the site, conducted to fulfil the recommendations of West Lindsey District Council. Star Energy propose to extend the existing gathering centre northwards onto adjacent land.

The survey methodology 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 (Figs. 1-2)

Sections 2 and 3 include information extracted from a desk-based assessment provided by LAS (Tann, 2003).

Welton Gathering Centre, which is used by Star Energy for activities associated with oil drilling, is situated approximately 4km to the northeast of Lincoln on land between the villages of Sudbroke and Reepham. The proposed development site, which extends to c. 5ha, lies to the immediate north of the existing works. Three fields (1-3: two pasture and one arable) are affected by the development proposal (Fig.2). Field 1 (pasture) contains visible traces of northwest to southeast aligned ridge and furrow ploughing. A slight south-facing slope characterises the topography of fields 2 and 3, the southern boundary of which is defined by a stream. A small copse and a recently constructed pipeline lie in the southern part of field 3. These areas were not surveyed.

With the exception of the southern parts of fields 2 and 3, which contain alluvium, there are no recorded drift deposits across the site. The solid geology comprises Oxford Clay (Fields 2 and 3) and Kellaways Formations (Field 1) (BGS, 1999).

Central National Grid Reference: TF 0460 7502.

## 3.0 Archaeological and historical background (Figs. 1-2)

Cropmarks of prehistoric enclosures and pits lie in the fields southeast of the junction of Barfields Lane and North Lane. Further cropmark features are recorded to the north of Barfields Lane, but these are confused by medieval ridge and furrow. Cropmarks of possible hut circles have been recorded to north of Reepham village, and an enclosure is recorded to the SW. It is possible that some of these remains include Romano-British features. To the east of the existing Gathering Centre, LAS found part of a quern stone during an archaeological walkover in October 2003. Although this is an isolated and undated find (with a possible date range from Iron Age to medieval) it may derive from a presently unknown occupation site.

Roman remains include a burial to the north of Wragby Road (350m to the north of the site) and a possible villa at Sudbroke.



Cropmarks indicate that medieval or later ridge and furrow extending across fields east of North Lane and north of Barfields Lane. Earthwork remains of ridge and furrow are visible in the fields south of Barfields Lane, including Field 1. It is possible that 'Barfields' is a reference to ridge and furrow, although it is more likely that it refers to barley production

#### 4.0 Methodology

Detailed area survey using a fluxgate gradiometer is a non-intrusive method of evaluating the archaeological potential of a site. The gradiometer detects magnetic anomalies created by areas of high or low magnetic susceptibility. These variations are caused by changes in the composition of the subsoil or the underlying geology. Archaeological features result from man-made alterations to the soil and they may also incorporate intrusive materials such as brick and stone. These features can create detectable magnetic anomalies. In addition, activities that involve heating and burning can generate magnetic anomalies, as will the presence of ferrous metal objects.

The anomalies detected by a fluxgate gradiometer survey can often be resolved into entities sharing morphological characteristics with features of known archaeological provenance. This enables the formulation of an informed, but subjective, interpretation.

Magnetic variation between archaeological or naturally occurring features and natural geological strata can result from:

- their relative depth or density of fill
- the magnetic properties of materials introduced as a result of human activity (e.g. rubble, stone, brick/tile, ferrous metal etc.) in contrast to those within surrounding natural deposits
- magnetic enhancement associated with areas of burning
- the magnetic properties of localised, naturally deposited minerals, such as those occurring in the fills of palaeo-channels.

The area survey was conducted using two *Bartington Dual 601* fluxgate gradiometers that were calibrated set to record four readings per metre (a sample interval of 0.25m). The zigzag traverse method of survey was used, with 1m wide traverses across 30m x 30m grids. The sensitivity of the machine was set to detect magnetic variation in the order of 0.1 nanoTesla.

Data from the survey was processed using *Geoplot* (v. 3.0). It was desloped (a means of compensating for sensor drift during the survey) and clipped to reduce the distorting effect of extremely high or low readings caused by discrete pieces of ferrous metal. The results are plotted as greyscale, trace and interpretive images (Figs. 3-11).



The site was surveyed by David Bunn, George Bunn and Peter Heykoop on 19th and 20th of February 2004.

Instruments	Bartington Dual 601 fluxgate gradiometers
Grid size	30m x 30m
Sample interval	0.25m
Traverse interval	1.0m
Traverse method	Zigzag
Sensitivity	0.1nT
Processing software	Geoplot (v. 3.0)
Weather conditions	sunny
Area surveyed	c.5ha

**Table 1: Summary of survey parameters**

## 5.0 Results (Figs. 3-11)

### Field 1 (Fig.3)

Strong magnetic variation was recorded along the western edge of the survey (broken purple line). This reflects the close proximity of an existing pipeline that extends northwards from the gathering centre (*pers. comm*, G. Tann). Similar, though weaker, variation along the southern and eastern boundaries was induced by barbed wire fences. Discrete dipolar anomalies (circled pink) probably signify miscellaneous iron objects (e.g. horseshoes, ploughshares etc).

Magnetic traces of the upstanding ridge and furrow were not detected due to the traverse direction of the survey, although the enhanced data suggests that the field may contain other remains. Ditch-like linear and curvilinear anomalies were recorded in the southern part of the field (red lines). A number of possible pits and/or discrete areas of burning were also detected in this locality (circled in red). A relative lack of variation in the remaining area may be the result of masking by ridge and furrow and, as such, traces of significant activity may lie undetected.

### Field 2 (Figs.4-7)

A strong magnetic response was recorded at the southwest corner of the field, close to the existing gathering centre (boxed in pink). Nothing was noted on the surface in this area, although it almost certainly indicates modern (buried) ferrous material.

The survey detected a distinct zone of variation that extends along the southern edge of the field (boxed in blue). The resolution of many anomalies within this area suggests that they could reflect ditches or pits/burning: examples of the latter are circled in red. For the most part, however, it seems more likely that these features are of natural origin - as traces of a former alignment of the stream, alluvial deposits and/or silty materials dredged from the stream. At the time of survey, it was noted



that the ground was lower, wetter and stickier in this area, particularly in the southeast corner of the field.

A number of linear anomalies were detected. Some align in parallel fashion at regular intervals along a west-northwest to east-southeast alignment (clearer on the raw data image, prior to destriping). It is possible that they indicate ceramic land drains, albeit closely spaced (c. 7m); consultation with the landowner has revealed that Fields 2 and 3 contain multiphase drainage systems. They do not easily relate to the current boundary that separates Fields 2 and 3, which appears to truncate the linears. This suggests an earlier origin, possibly as undisturbed traces of furrows (of ridge and furrow) and/or drains that were laid along the furrows before levelling. This would account for the relatively narrow spacing.

Potentially significant anomalies were detected in the western half of the Field 2. Some resolve as faint traces of linear features, possibly ditches (red). Others are potential pits (circled red). These anomalies are ill defined and the interpretation is offered with caution; the linears may be traces of land drains.

A diffuse curvilinear anomaly (red) was detected at the eastern side of the field. This occurs within a zone of random magnetic variation that may have archaeological significance.

Magnetic variation in the central northern part of the survey area is probably associated with modern ferrous material. It may relate to a former field boundary, as depicted on the 1<sup>st</sup> edition OS map, dated 1890-91 (see report cover). It is also possible that this zone of variation includes traces of a Lancaster bomber that is known to have crashed in the mid-part of the field (*ibid*).

#### Field 3 (Figs.8-11)

Most of the linear anomalies probably share an origin with similar features in Field 2, possibly as buried traces of ridge and furrow ploughing and/or land drains. Magnetically similar features that extend perpendicularly to these probably do indicate land drains. The southernmost example corresponds to a recently constructed drain (*ibid*) and its lack of resolution may indicate a plastic composition. The clearer linear anomalies probably represent ceramic pipes.

## 6.0 Conclusions

Most magnetic anomalies appear to relate to ridge and furrow, drains and natural features. Extant ridge and furrow in Field 1 was not recorded, possibly as a result of the survey traverse direction. Within this field, a number of linear and discrete anomalies may be significant as potential ditches and pits (it should be noted that the ridge and furrow may be masking other features).

Similar, though more ephemeral, anomalies were recorded in Field 2. The archaeological significance of these is unclear; some may be traces of drains.



The relatively close spacing of many linear anomalies in Fields 2 and 3 suggests ridge and furrow, although some of this patterning could be associated with drains that extend along earlier furrows.

A zone of magnetic variation along the southern edge of Field 2 probably relates to an adjacent stream.

## 7.0 Acknowledgements

Pre-Construct Geophysics would like to thank Lindsey Archaeological Services and Star Energy for this commission.

## 8.0 References

Clark, A. J. 1990 *Seeing beneath the soil*. London, Batsford.

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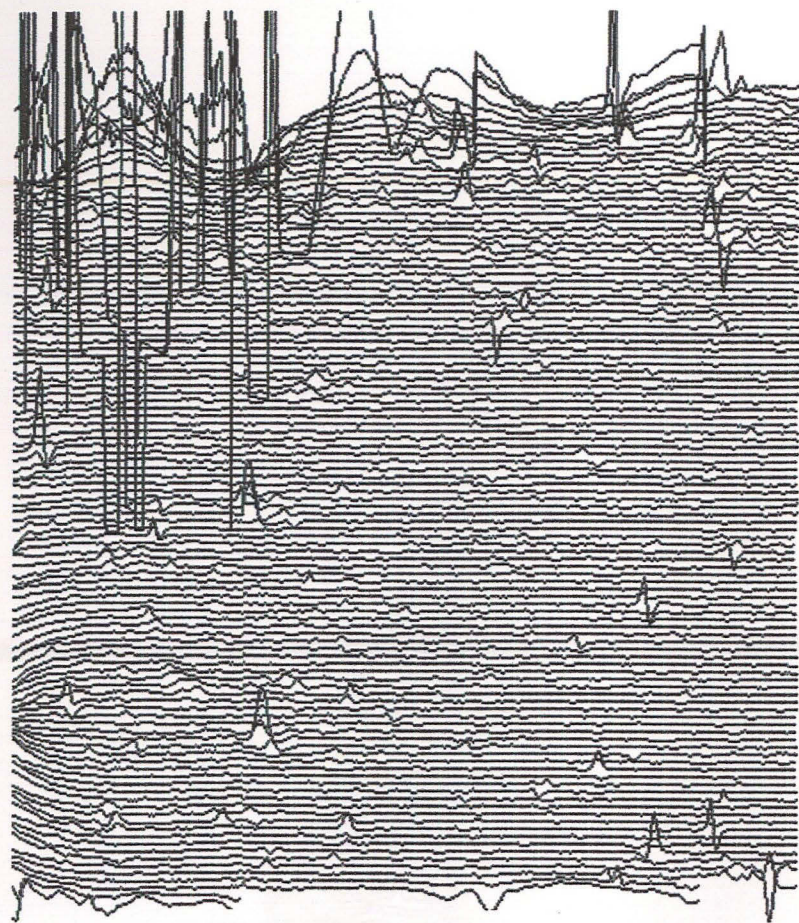
Tann, G 2003 *Proposed Extension of Welton Gathering Centre, Reepham, Lincs. Archaeological Desk - Based Assessment*. Lindsey archaeological Services, Unpublished report.



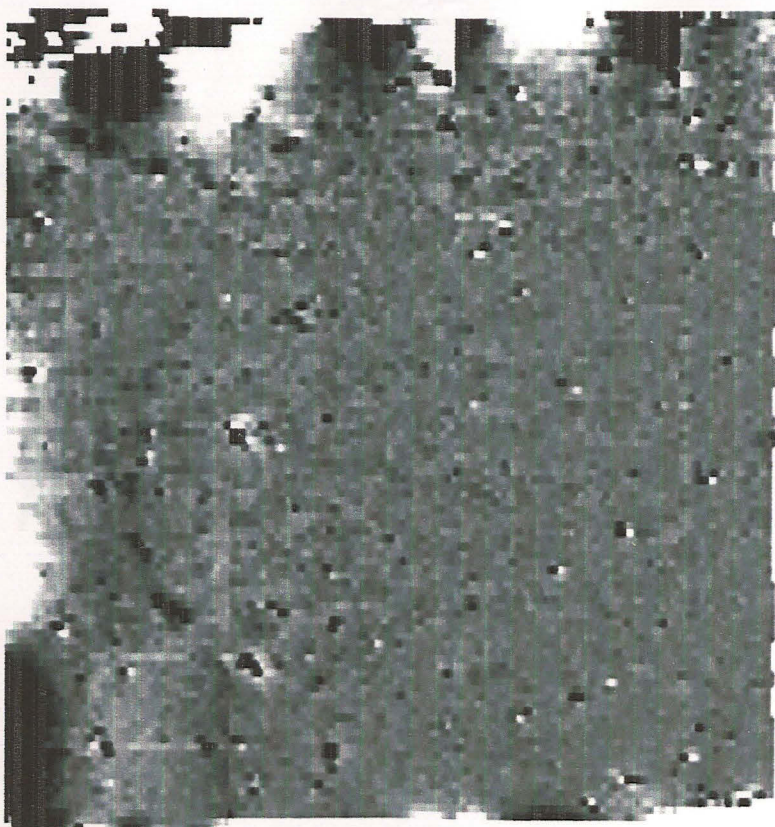


Fig.2: Location of survey 1:2000



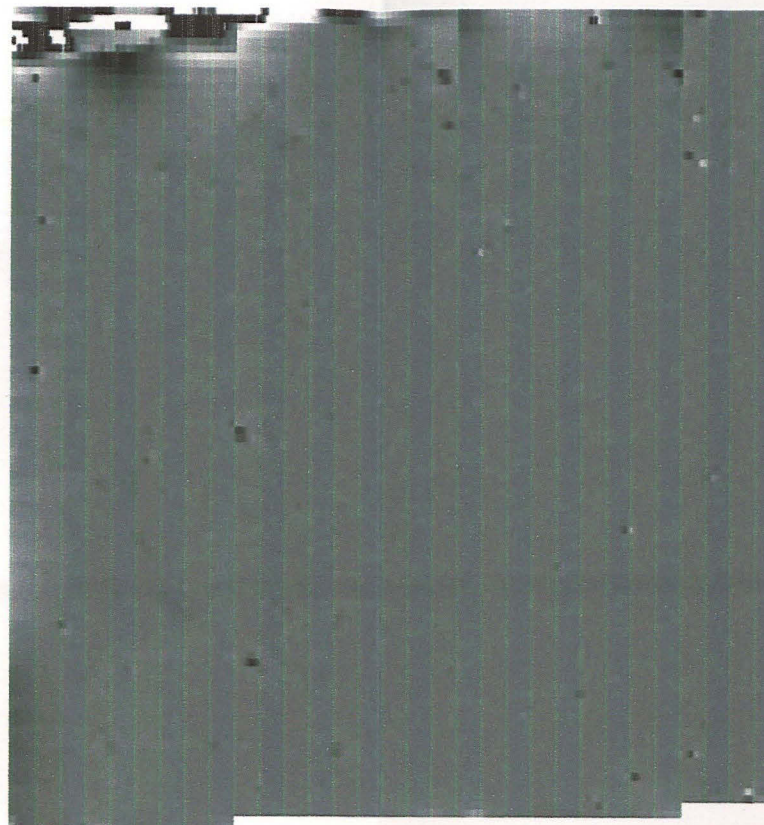


TRACE PLOT  
(HIDDEN LINE ON)



GREYSCALE: ENHANCED

43nT



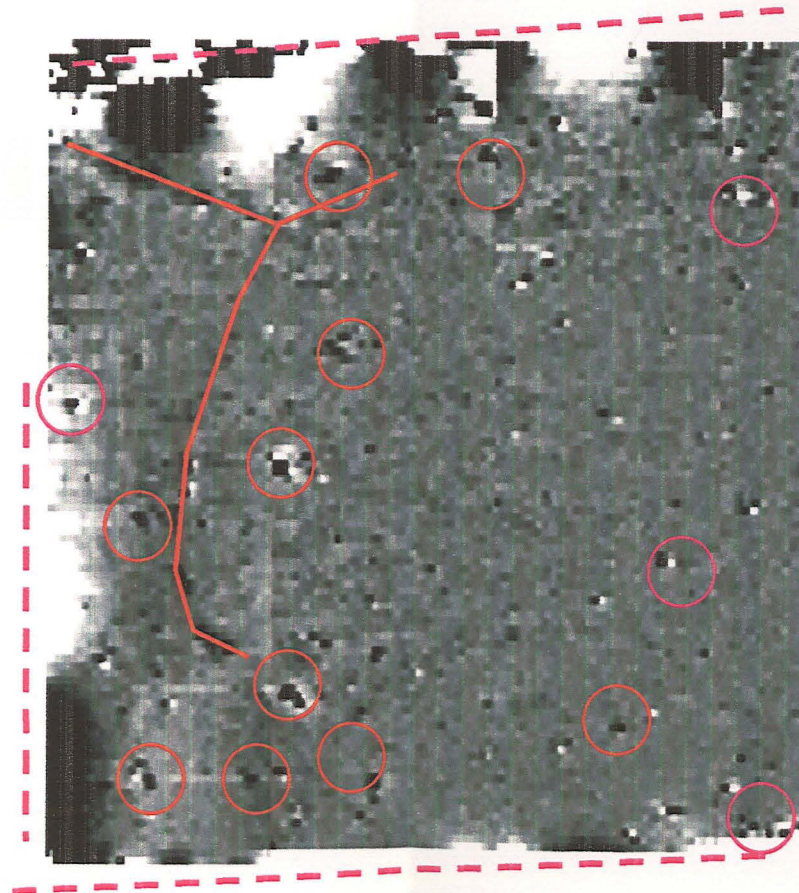
GREYSCALE: RAW DATA

46.52  
nT  
-45.96



30m

3  
nT  
-3



INTERPRETIVE PLAN

**KEY**

- Significant and potentially significant linear anomalies- enclosure ditches, tracks
- Possible pits, slight traces of burning
- Ferrous litter including brick/tile.
- Zone of probable natural magnetic variation
- Probable land drains
- ?ridge and furrow/land drain
- Service, fence

Fig. 3:Field 1-Trace, greyscale and interpretive images 1:1000



FIELD 2



Fig. 4: Field 2-trace plot of the unclipped data

1:1000

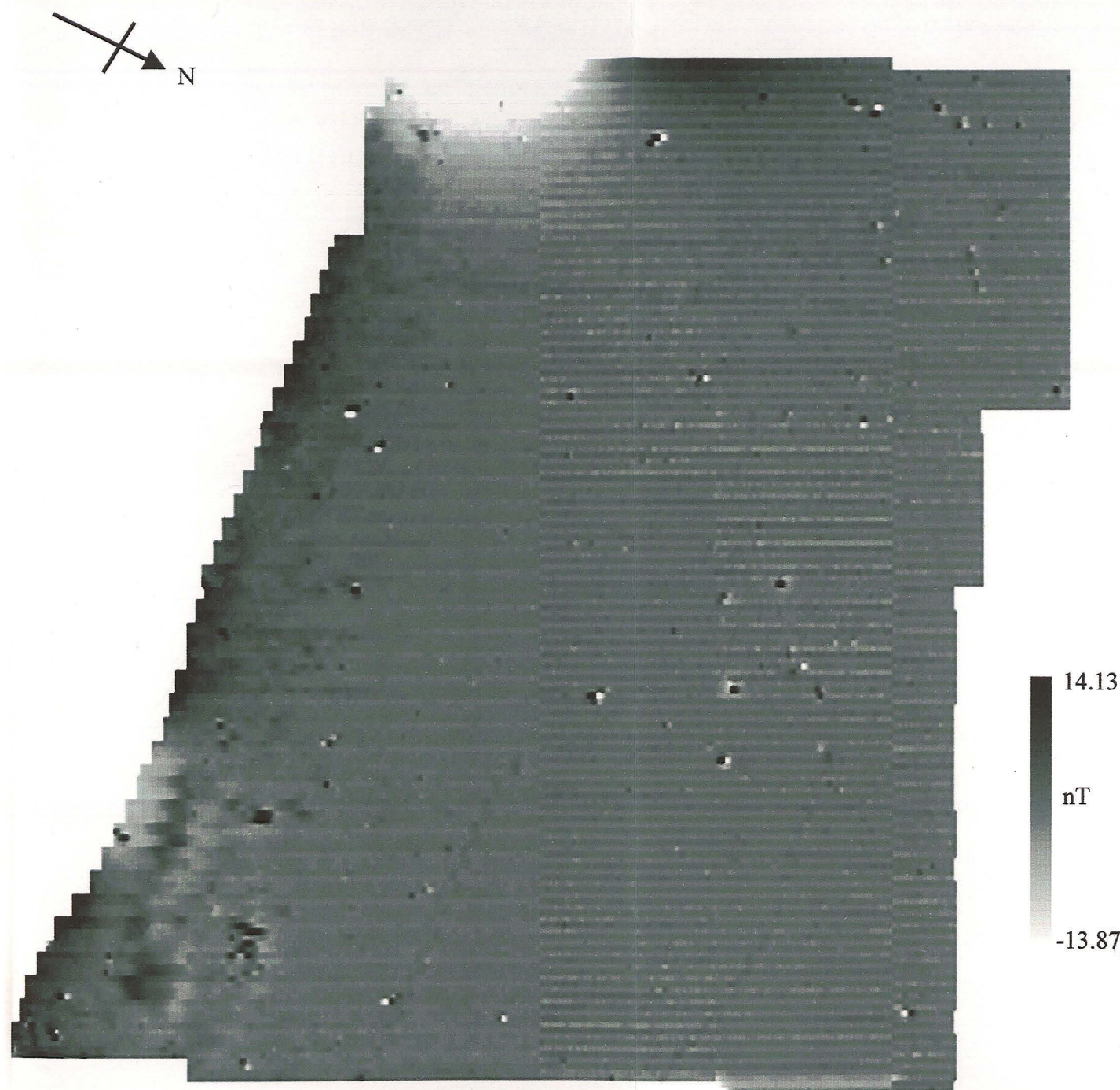
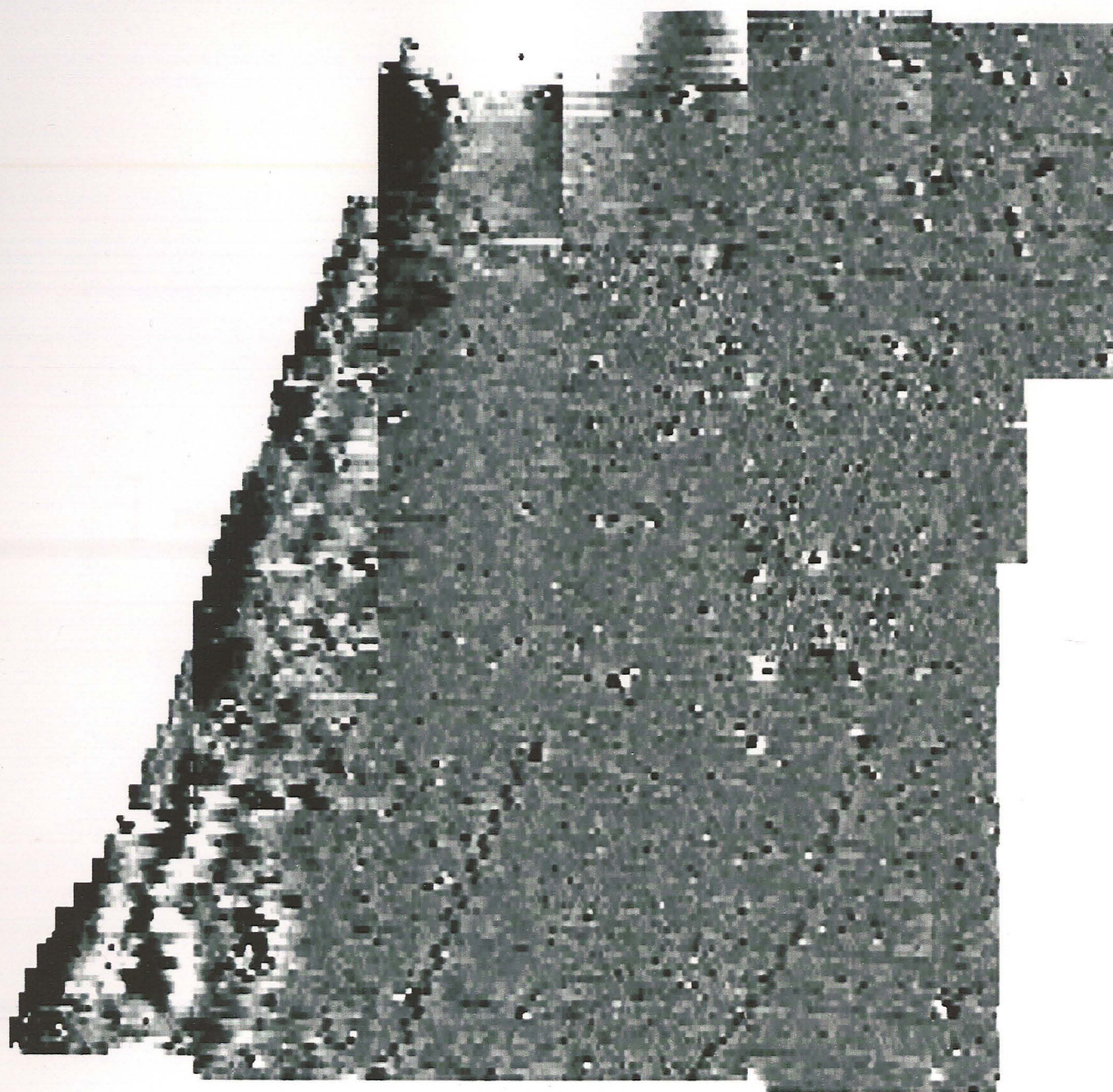


Fig. 5: Field 2-greyscale image of the raw data





30m

Fig. 6: Field 2-greyscale image of the raw data

1:1000

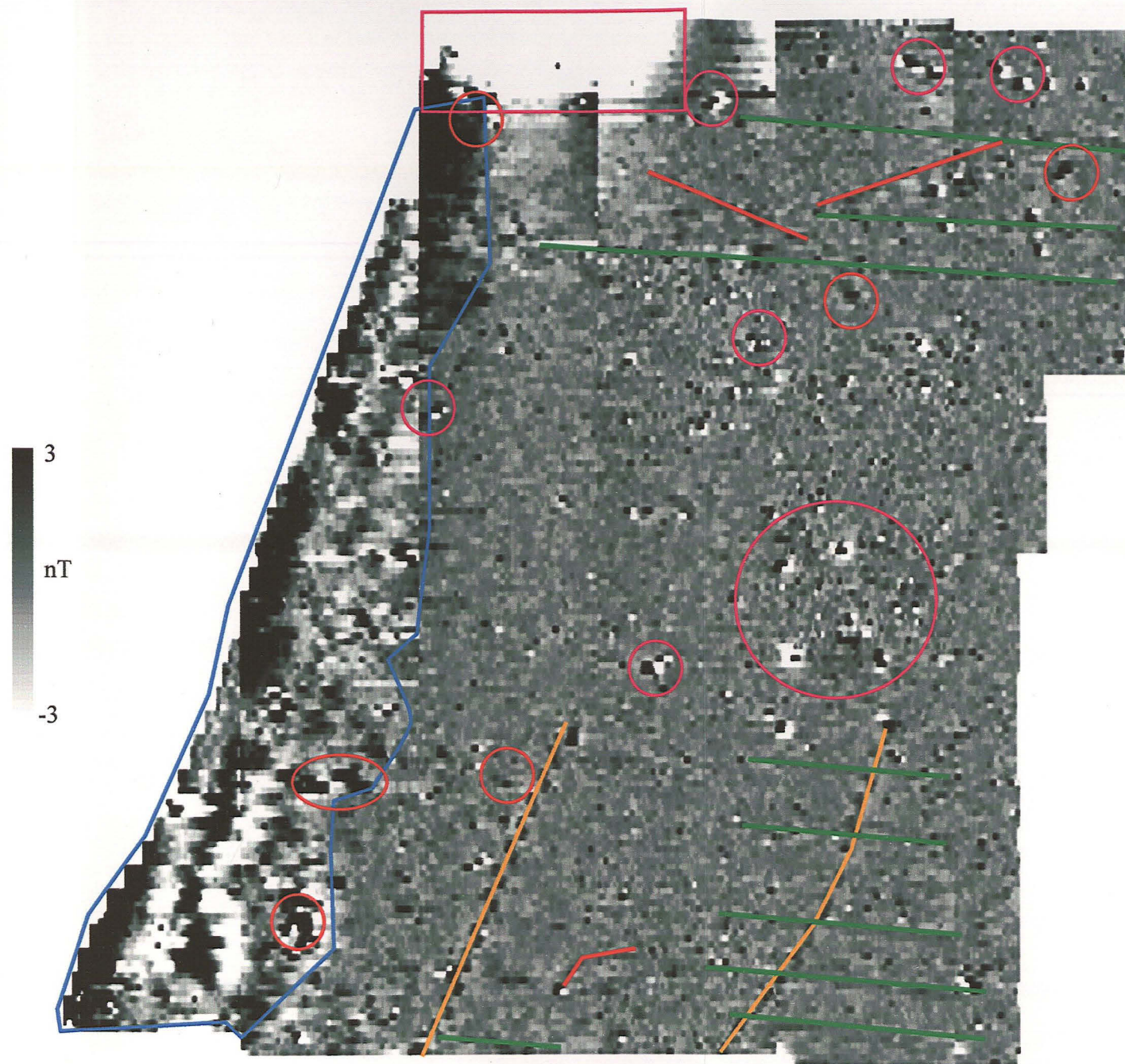









Fig. 7: Field 2-Interpretive plot

KEY

-  Significant and potentially significant linear anomalies- enclosure ditches, tracks
-  Service, fence
-  Possible pits, slight traces of burning
-  Ferrous litter including brick/tile.
-  Zone of probable natural magnetic variation
-  Probable land drains
-  ?ridge and furrow/land drain



FIELD 3

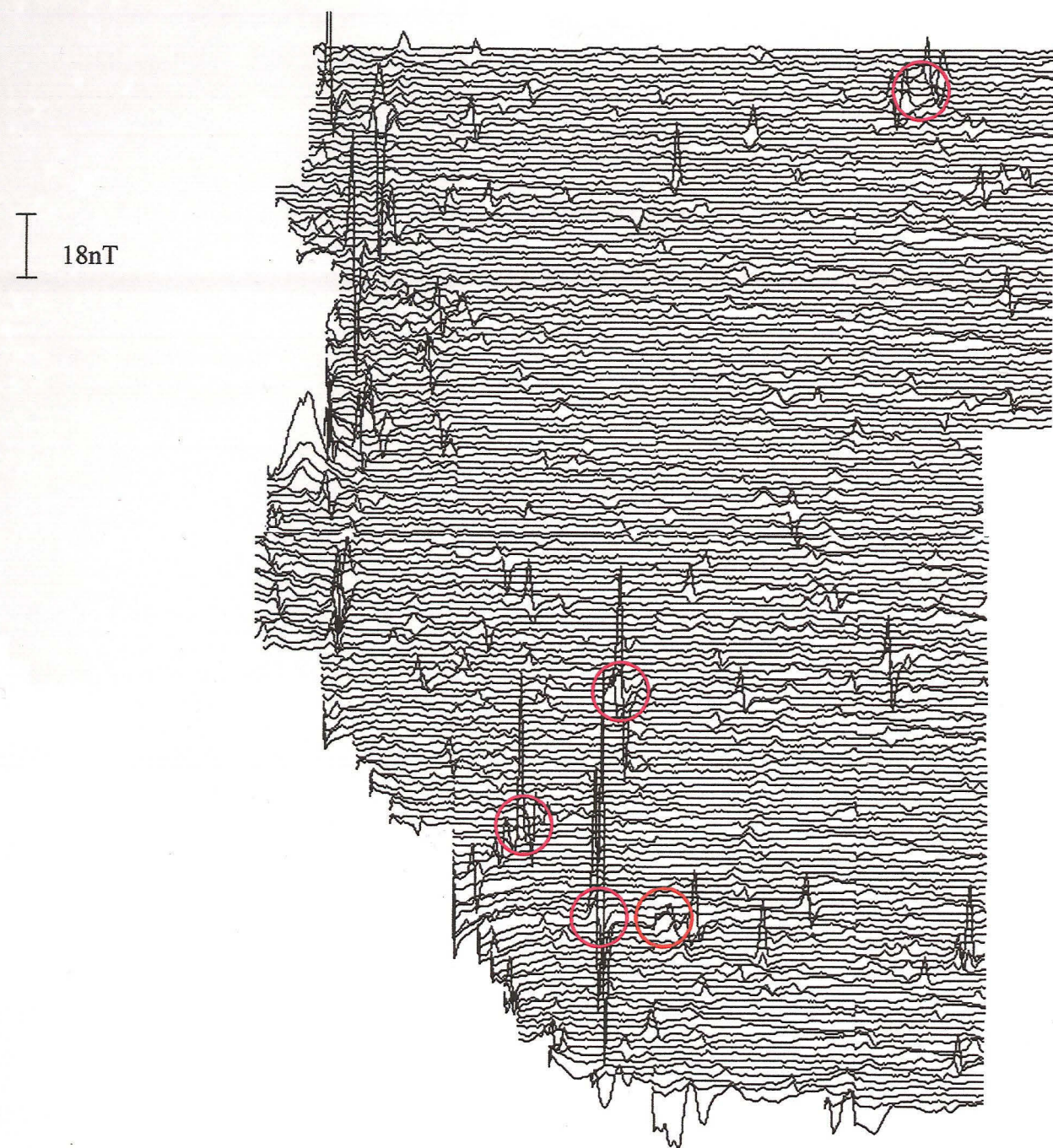
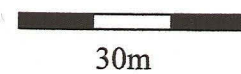
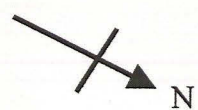


Fig. 8: Trace plot of the unclipped data



1:1000



Fig. 9: Greyscale image of the raw data



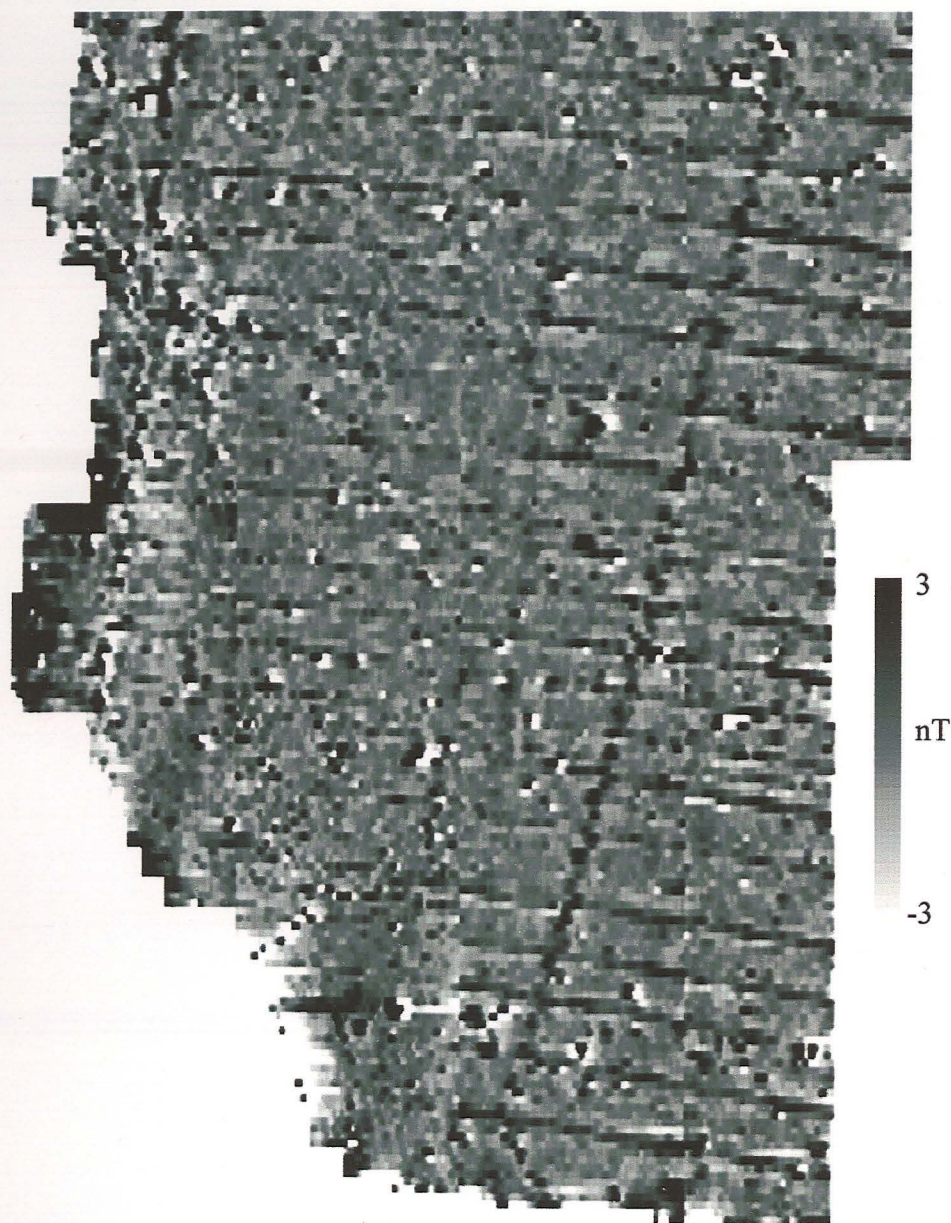


Fig. 10: Field 3-greyscale image of the raw data

1:1000

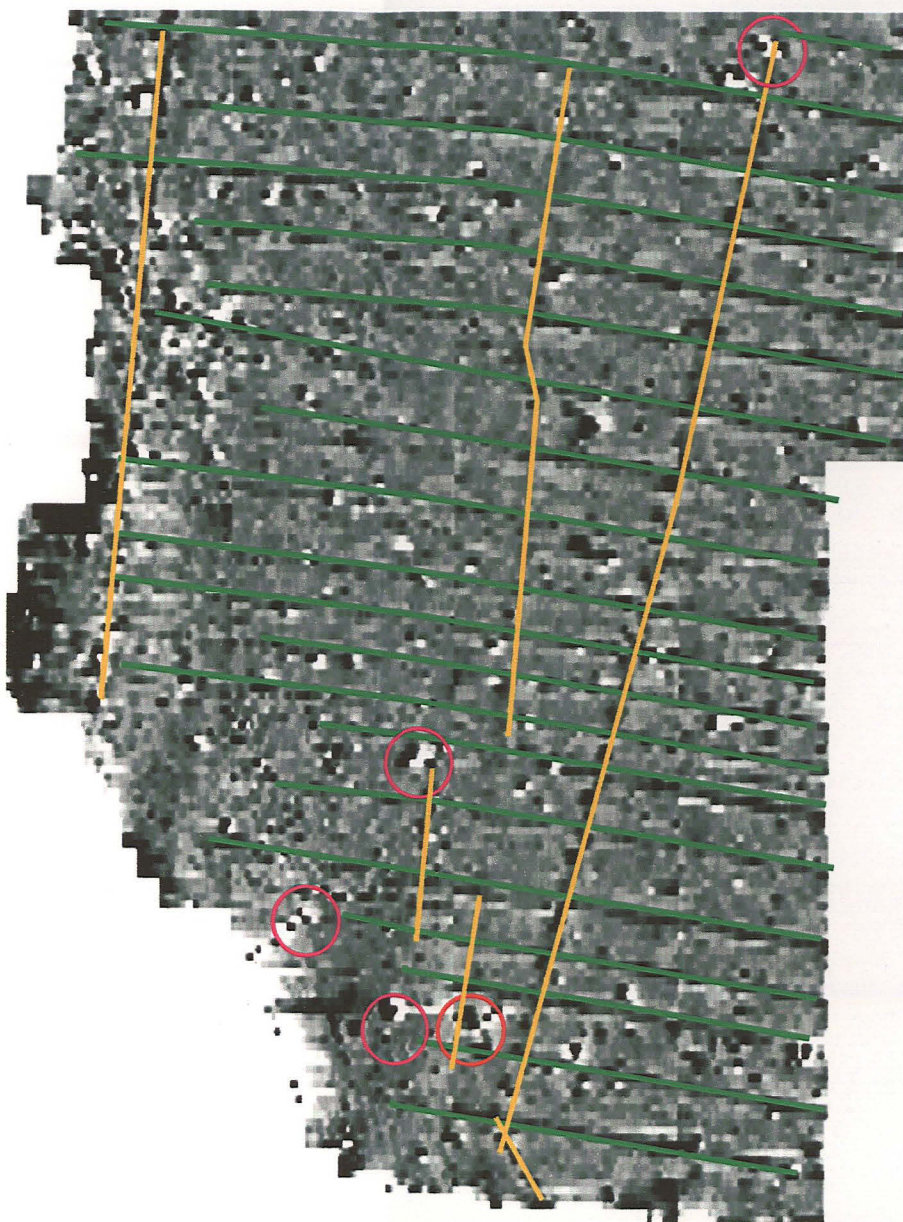


Fig. 11: Field 3-interpretive plot

