Fluxgate Gradiometer Survey

for

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at

Knapton Quarry,
North Yorkshire

Survey by the

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carried out on the

14th, 15th and 17th December, 1995

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CONTENTS

Summary

A fluxgate gradiometer survey was carried out by the Landscape Research Centre Ltd. on behalf of Stephen F. Shorthose, as part of an archaeological assessment of a proposed development at Knapton Quarry, North Yorkshire (See **Figure One**, below). The proposed development area was responsive to this form of survey, although a number of modern mounds and ridges were scattered over the survey area, causing a number of strong magnetic anomalies not of an archaeological origin). Ten anomalies of potential archaeological origin were observed and are discussed in detail below.

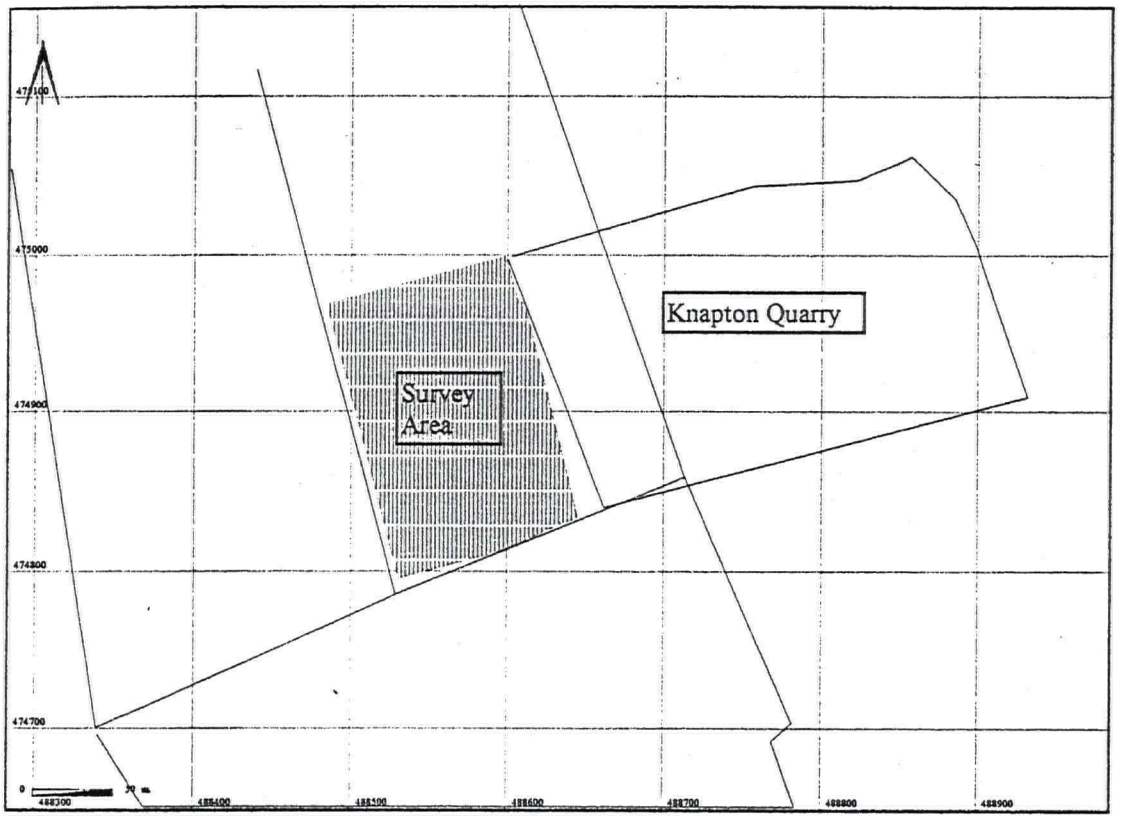

Figure One
This diagram shows the area covered by the fluxgate gradiometer survey (2.4 hectares). The area is shaded in red diagonal hatching. The grid is at 100 metre intervals.

Introduction

The subject of this report is the discussion of the results of a fluxgate gradiometer survey carried out on behalf of Stephen F. Shorthose. The site in question is a proposed extension to the existing quarry at Knapton, North Yorkshire. The fluxgate gradiometer survey was conducted using a *Geoscan Research* fluxgate gradiometer (model FM36), hereafter referred to as a magnetometer. The zigzag traverse method of survey was used. The survey was conducted by taking readings every 25cm along the north/south axis and every metre along the east/west axis (thus 3600 readings for every 30m grid). The data has been processed and presented using the programs GeoImage (a program dealing with the processing of geophysical data) and GSys (a program which can display, process and present digitised plans and images).

The survey was carried out on the 14th, 15th and 17th December, 1995. The personnel involved were James Lyall and Heather Clemence. The proposed site was 2.94 hectares in area and consisted of one field, bounded on the east by the existing quarry, and by field boundaries on the western, northern and southern edges. The field was covered in dead scrub up to 40cm in height, and the underlying geology was chalk and sand. A total area of 2.4 hectares was surveyed, as the eastern side of the survey area was bounded by large mounds of chalk and sand debris from the quarry. These mounds would have negated the use of the magnetometer, and thus an area down this edge of the proposed extension was not surveyed.

The site in its setting

Staple Howe, an Iron Age defended settlement, is situated in a wooded area (Knapton Plantation), 1260 metres to the east of the survey area. Three hundred metres to the north, the remains of an ancient field system as well as a possible Bronze Age round barrow are known from aerial photographs. Five hundred metres to the south east are part of the standing earthworks known as the Wold Entrenchments. These earthworks consist of one or two parallel ditches and banks, and they extend for kilometres across the Wolds. (See **Figure Two,** below).

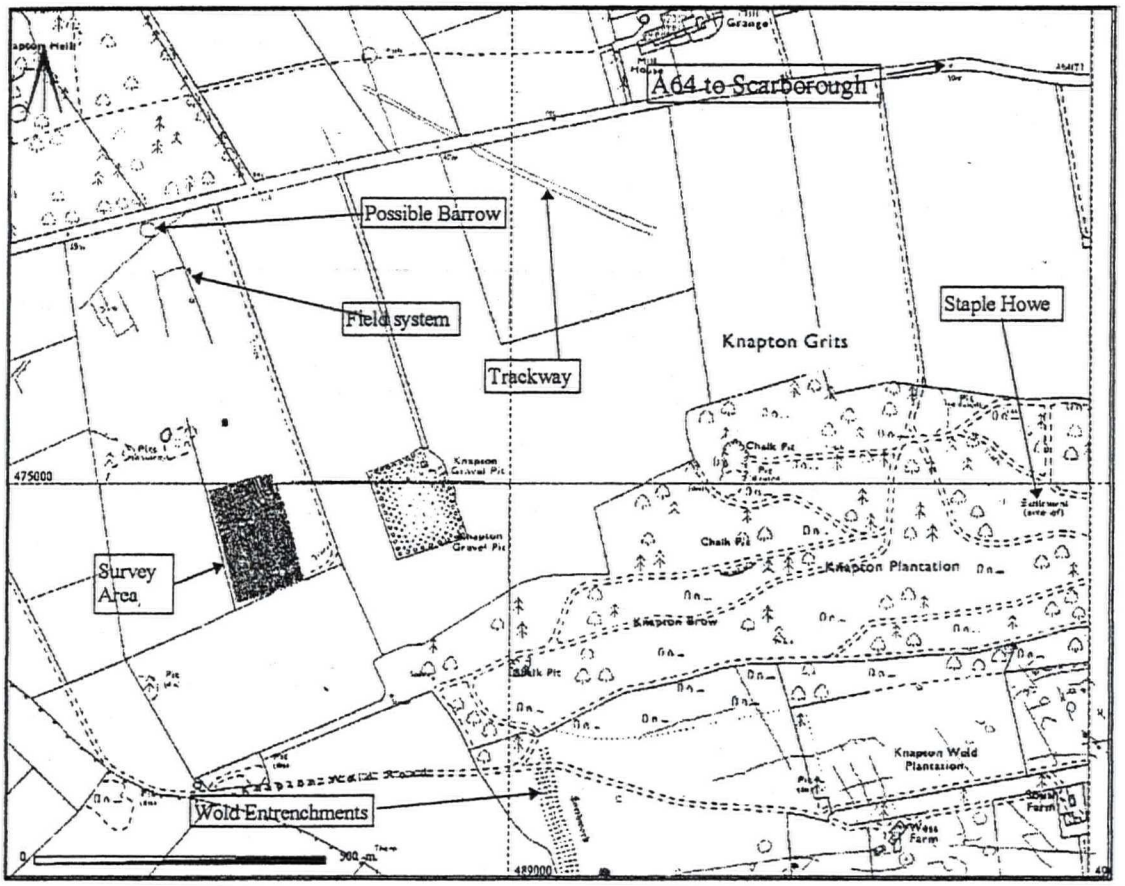

Figure Two
This diagram shows the survey area in its local setting. Note that the quarry now extends to the surveyed area

A north/west-south/east oriented trackway, also known from aerial photography, is situated 500 metres to the north east of the survey area.

The magnetometer data

The magnetometer data is displayed both as an image (**Figure Three**, below) and as a series of digitised interpretations (**Figures Four, Five, Six and Seven**).. **Figure Three** is presented as a greyscale image. The anomalies are the areas of lighter and darker grey, which indicate areas of higher and lower magnetic response. The results from the survey are discussed in detail below. **Figure Four** shows the position of all the anomalies. **Figure Five** shows the position of the anomalies caused by modern action. **Figure Six** shows the position of all the plough marks. **Figure Seven** gives the position of the anomalies which are potentially archaeological in nature.

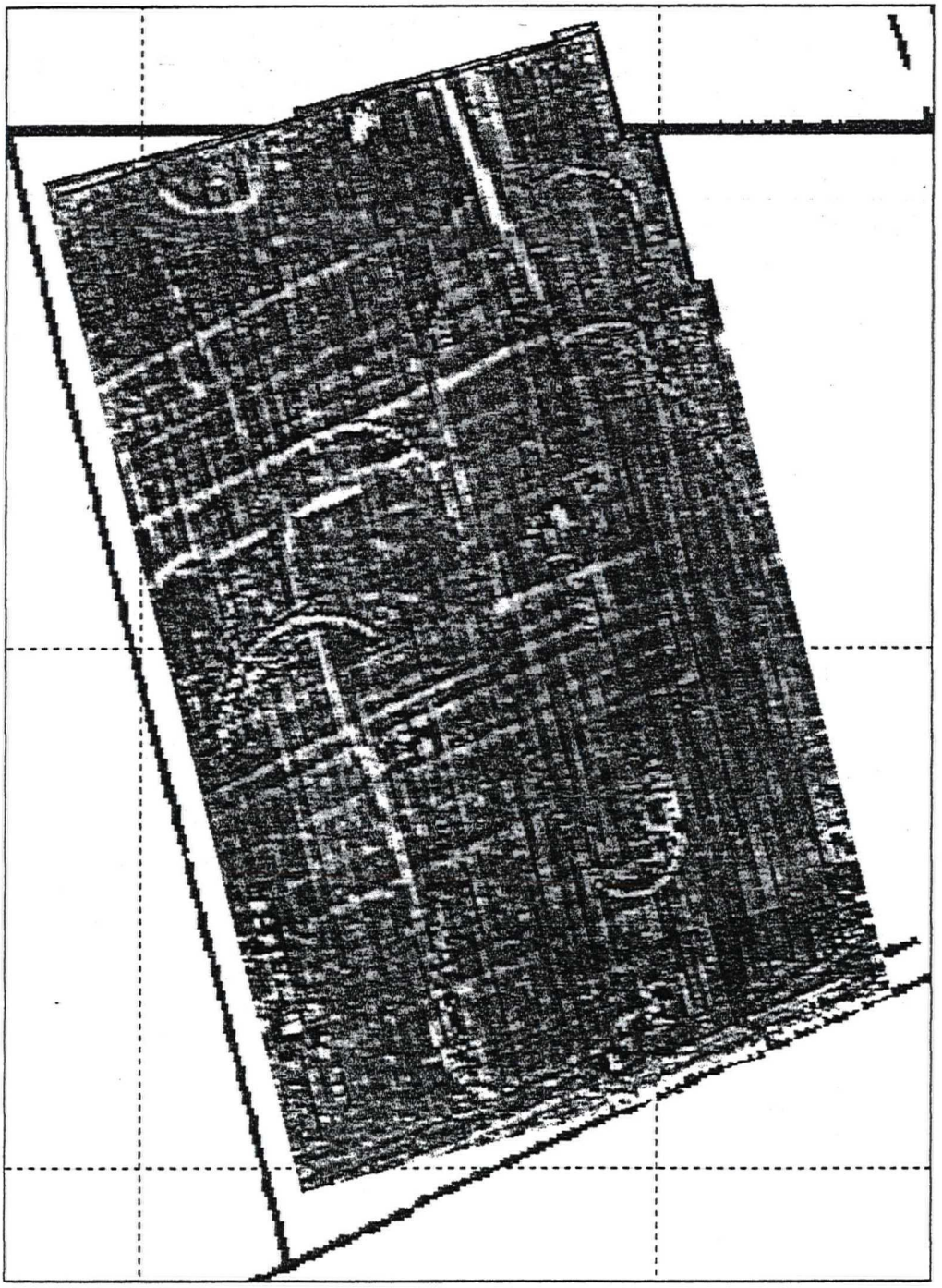

Figure Three
This diagram shows the results of the fluxgate gradiometer survey displayed as a greyscale image.

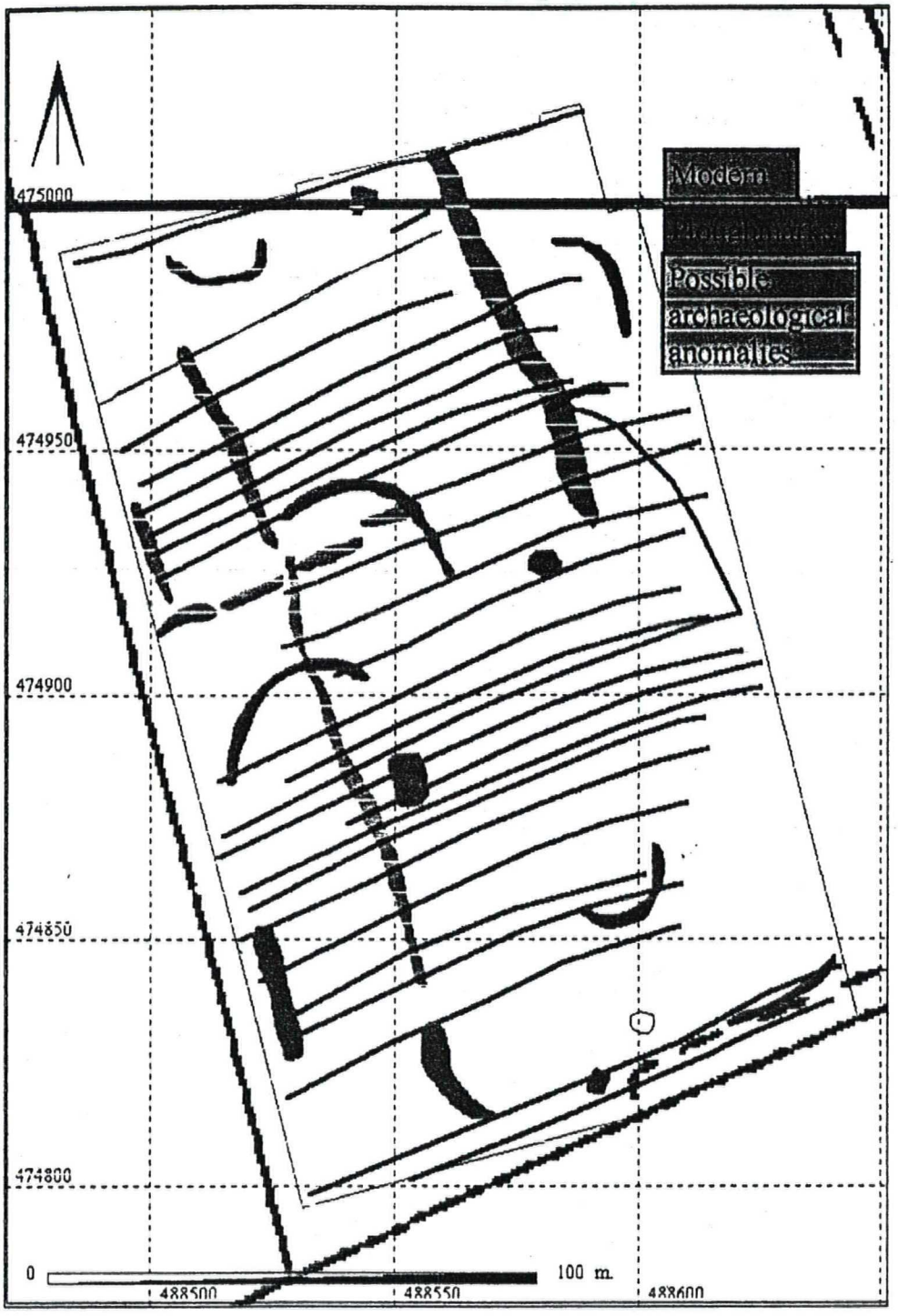

Figure Four
This diagram shows the position of all the interpreted anomalies. The survey area is shown by a red dashed line.

The anomalies have been divided into three categories. The first category is Modern, and is shown in green in the diagram above. The second category is Ploughmarks, and is shown in blue. The final category is the anomalies of potential archaeological origin, and is shown in red.

Modern Anomalies (A to N)
Fifteen modern anomalies occur on the image (**Figure Three**), and lettered A to N on the digitised interpretation (**Figure Five**, below).

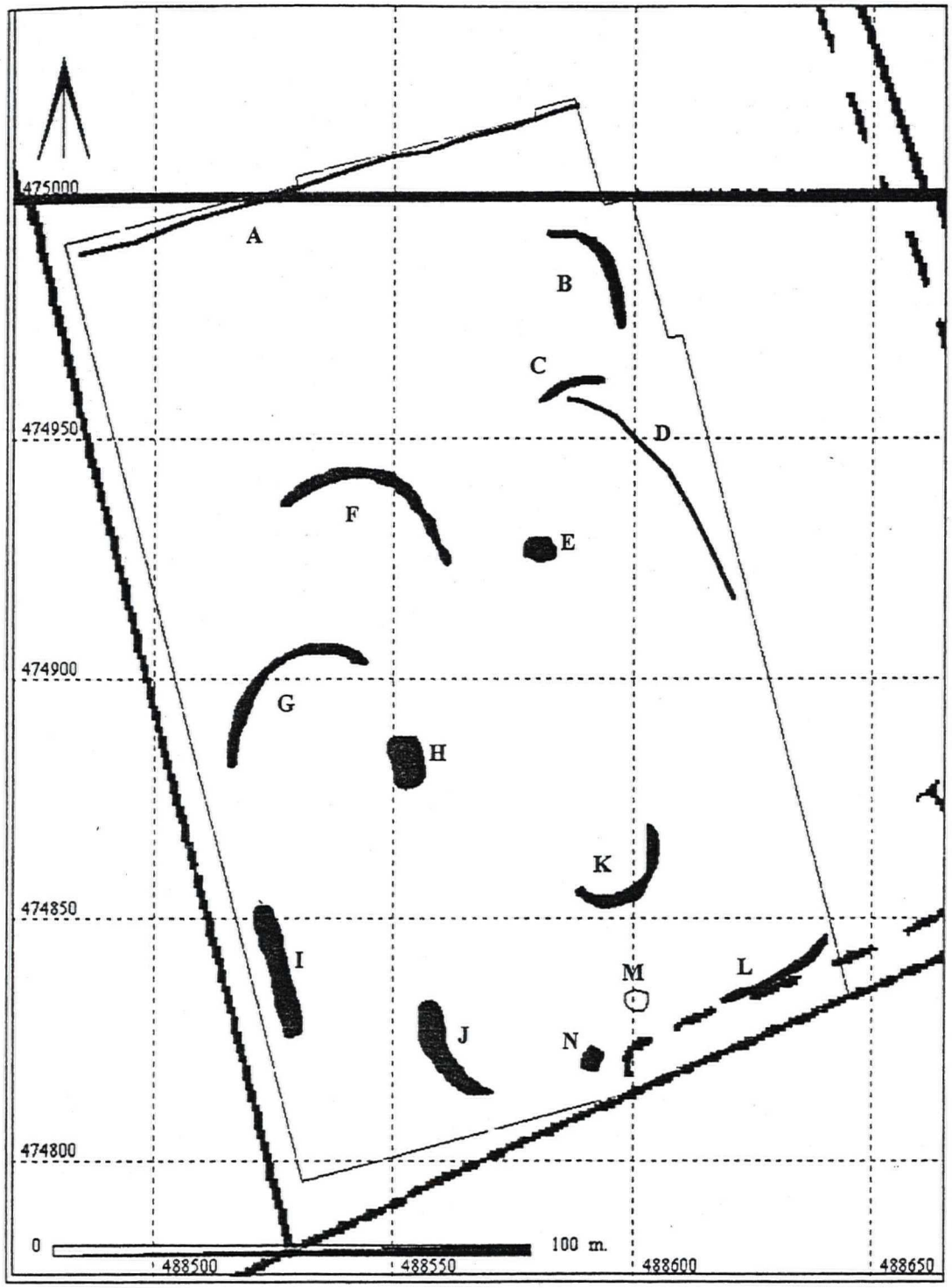

Figure Five
This diagram shows the position of the interpreted anomalies, and the letters assigned to each anomaly (A to N)

Anomaly A
This anomaly can be seen on the greyscale image as a thin dark line in the extreme north of the surveyed area. This line is the division between the survey area and a planted field to the north.

Anomalies B, C, F, G, J and K
These anomalies are caused by low, semi-circular ridges of soil, apparently caused by heavy machinery turning in soft underlying conditions. They are all modern in origin.

Anomalies E, H, I, M and N
These anomalies are caused by mounds of soil, apparently placed here recently. Anomaly I is caused by a series of these low mounds, oriented north/south. They are all modern in origin.

Anomaly D
Anomaly D is not visible on the surface, but is characteristic of a heavy machine track. This could have been caused by a large tractor or another large vehicle.

Anomaly L
Anomaly L is caused by the track at the south edge of the field.

Ploughmarks

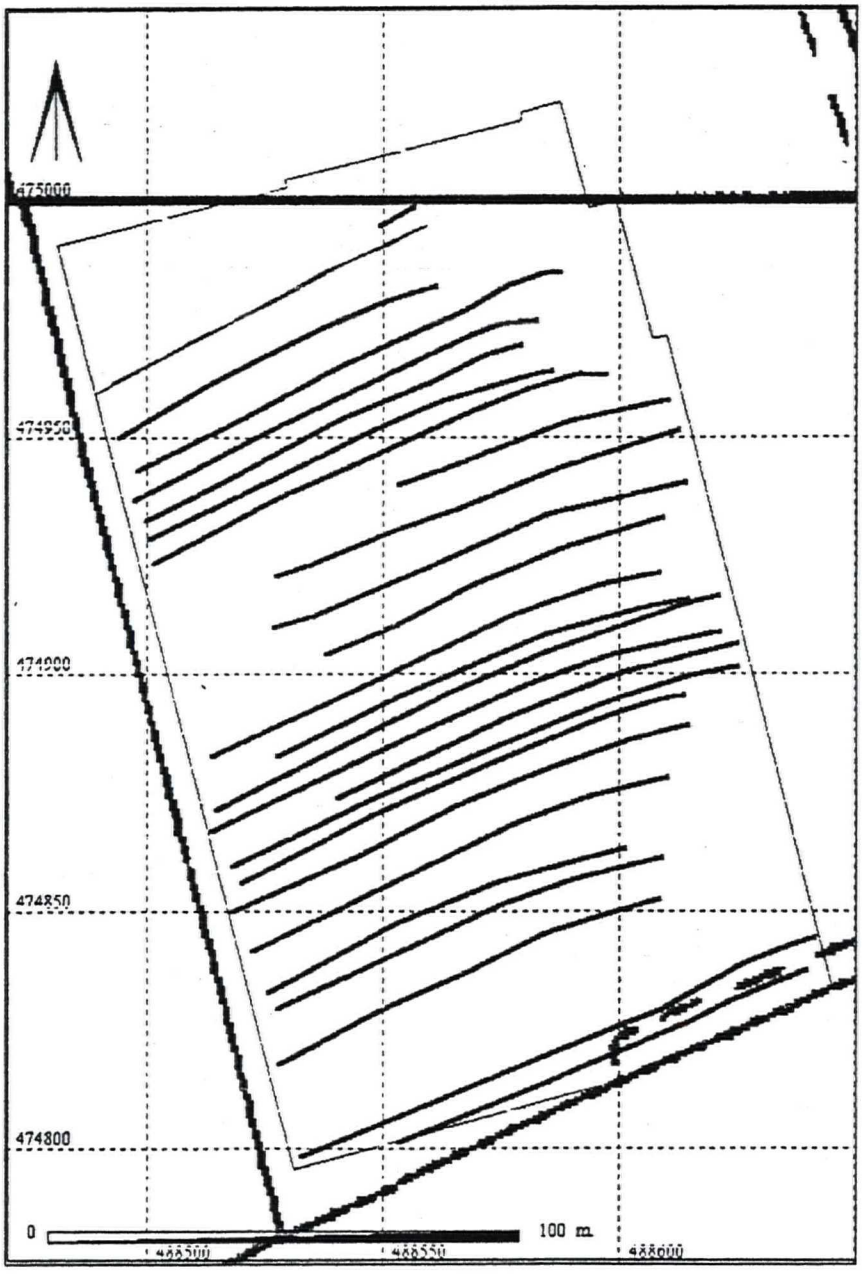

Figure Six
This diagram shows the position of the ploughmarks.

These anomalies will not be discussed in detail, only to mention that all of the ploughmarks have the same north/east-south/west orientation.

Anomalies of Possible Archaeological Origin

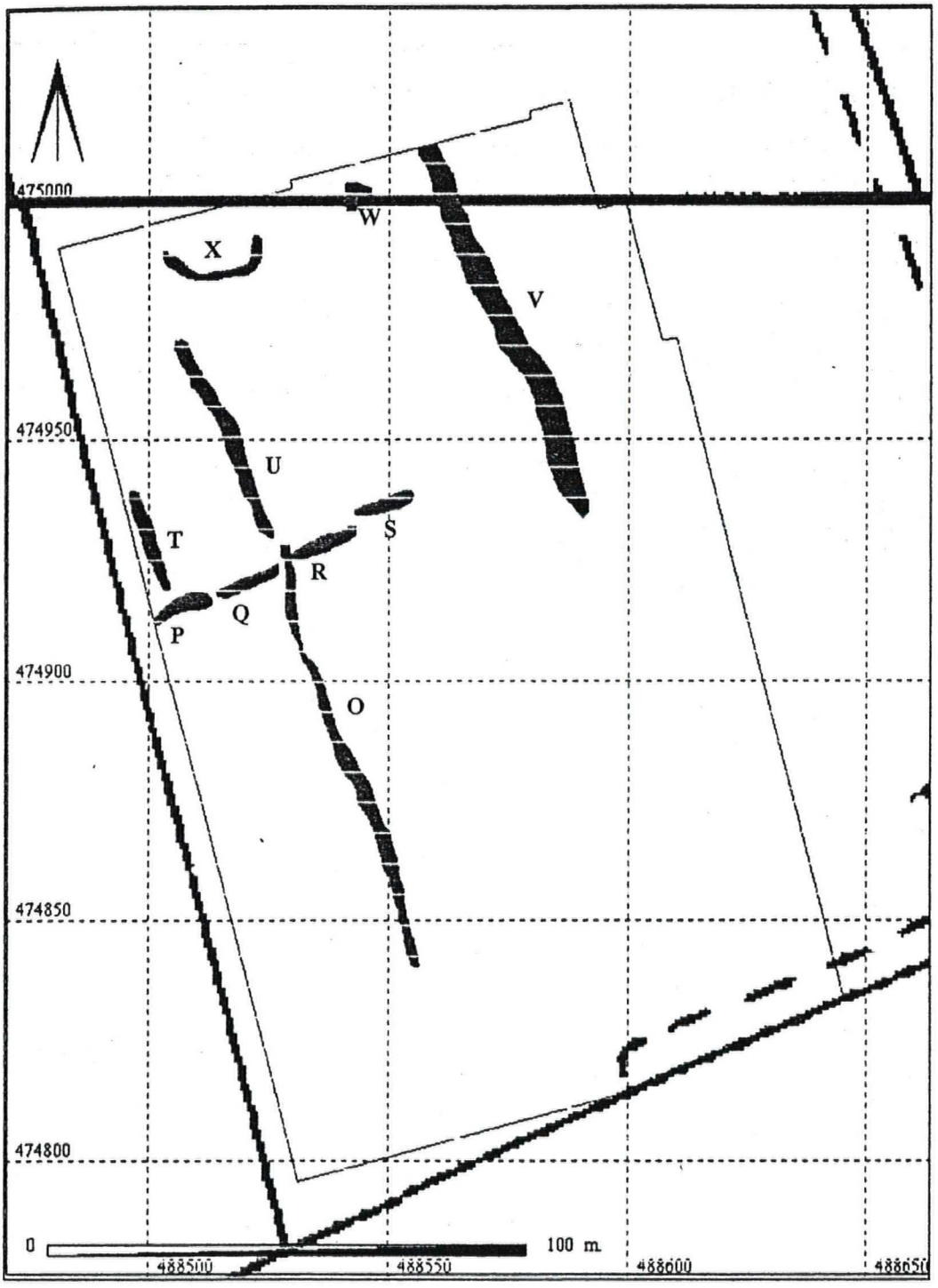

Figure Seven
This diagram shows the position of the anomalies of potential archaeological origin, and the letters assigned to each anomaly (O to X).

Anomalies O, T and U
These anomalies are roughly oriented on the line of the existing field boundary to the west, and may well mark the location of previous field boundary ditches. In particular, anomalies O and U may be part of the same feature.

Anomalies P, Q, R and S
As can be seen from **Figure Four**, these anomalies are on the same alignment as the ploughmarks. They have been classified as possibly archaeological in origin due to the different signal strengths when

compared with the ploughmark signals, giving a much stronger magnetic signal (See **Figure Three**). It is possible that these are the remains of rig and furrow ploughing, although their interrupted nature is unusual.

Anomaly V

This anomaly is a roughly north/south oriented linear anomaly. It is possible that this anomaly would continue in this orientation to join up with the field system cropmarks to the north (See **Figure Two**). If this were the case, then this anomaly could be interpreted as part of an older field system. However, the nature of the magnetic signal (high/low/high), could indicate that this anomaly may be a trackway. Also of interest is the changing magnetic response of this anomaly, weaker in the south, becoming steadily stronger to the north. This is caused by a change in the local geology, with the southern part of the feature cut into sand and the northern part cut into chalk, with the chalk geology being much more magnetically susceptible to gradiometer surveys.

Anomaly W

Anomaly W is a strong, localised anomaly. It is possible that this anomaly is caused by the presence of a pit, or even a pair of pits. It is not possible to say whether or not this could be a grave on the basis of magnetometer survey alone.

Anomaly X

Anomaly X (See **Figure Eight**, below) is a semi-circular anomaly, roughly 20 metres in diameter, situated in the extreme northern part of the survey. It is situated at the highest point of this part of the survey area, just before the land slopes down to the north and east. Its location and nature could indicate that this is part of a barrow ditch. The semi-circular shape of the anomaly may indicate that the feature is partially ploughed out. The cropmark of the potential barrow to the north (See **Figure Two**), is approximately 24 metres in diameter.

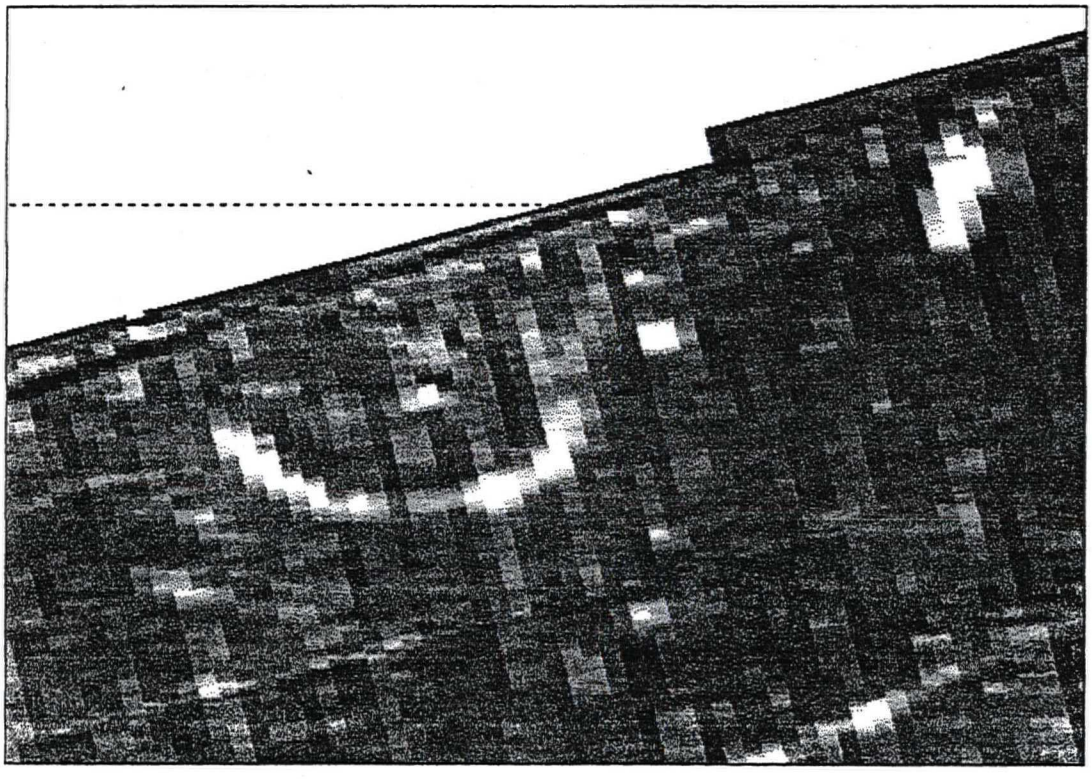

Figure Eight
Detail of possible plough damaged barrow, displayed as a greyscale image.

Conclusion

In conclusion, the site at Knapton Quarry, North Yorkshire, proved to be of a high magnetic susceptibility, with the chalk substrate in particular providing good magnetic responses. A number of modern disturbances were noted, along with a number of ploughmarks. Ten anomalies of possible archaeological origin were noted, with the potential trackway, pits and barrow in the northern part of the survey being of particular interest.

The plans should allow any archaeological investigation (if such is deemed to be necessary) of the area to concentrate in the specific areas believed to be significant. Please note that the United Kingdom latitudes are such that there can be a distortion of up to half a metre in position between the magnetic anomalies shown and the position of the actual features themselves. The greyscale image shows the size of the magnetic anomalies. Note that the measurements of the anomalies are not a direct correlation between the size of the anomaly and the size of the feature. The anomaly strength is a function of depth beneath the surface and magnetic response.

Report by James Lyall

Landscape Research Centre Ltd.

APPENDIX ONE

GRID NO	MINIMUM	MAXIMUM	RANGE	AVERAGE	STD. DEVIATION
1	-72	34	106	1	4
2	-51	157	208	-1	6
3	-278	173	451	1	12
4	-217	270	487	1	15
5	-21	37	58	-2	3
6	-26	105	131	-5	5
7	-34	40	74	-5	4
8	-26	53	79	-5	5
9	-13	11	24	-1	3
10	-35	49	84	2	6
11	-14	10	24	-2	3
12	-13	31	44	-2	3
13	-23	12	35	-2	3
14	-32	43	75	-2	5
15	-23	41	64	-3	4
16	-32	50	82	-2	5
17	-11	19	30	2	5
18	-22	94	116	0	6
19	-15	56	71	2	4
20	-80	149	229	-2	6
21	-400	81	481	0	12
22	-60	58	118	-3	5
23	-16	16	32	-3	3
24	-16	89	105	-1	4
25	-14	35	49	2	4
26	-14	27	41	2	3
27	-139	110	249	-2	8
28	-39	46	85	-2	5

TABLE ONE

The table gives the raw data and statistics in NanoTesla for each of the 28 grids. Values shown are the minimum value, maximum value, range, average value and the standard deviation for each grid.

Note that these are not absolute magnetic values in NanoTesla. A true magnetometer measures absolute values. A fluxgate gradiometer measures relative differences in magnetic values, based on a zero reference point established by the surveyors at the time of the survey.