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**GEOPHYSICAL SURVEY
REPORT 99/44**

**WELBOURN CASTLE
Lincolnshire**

Client:

WELBOURN PARISH COUNCIL

04 MAY 99

99/7.
EVENT L11487 L11488
SOURCE L16262
PRN 60941 L160941

SITE SUMMARY SHEET

**99 / 44 Welbourn Castle
Welbourn, Lincolnshire**

NGR: SK 49680 35432

Location, topography and geology

Welbourn is situated approximately 8 miles to the south-west of Sleaford, Lincolnshire. The survey area lies near the centre of the village in a field known as Castle Hill. The area is a raised piece of land with a pronounced topographic high at the northern / north western edge. The soils at the site are likely to be slowly permeable fine loamy or fine silty over clayey soils. The underlying geology is reported as drift over Jurassic and Cretaceous clay or mudstone (SSEW, 1983).

Archaeology

The archaeological brief for the geophysical work describes the site as either the remains of a twelfth century 'motte' or a 'ring work' enclosing a defended manor house. A twelfth century document indicated that the site was being walled in stone, although details of the buildings are not mentioned. A document dated 1288 indicates that a wall surrounded the court which was surmounted by a small tower, along with a ditch which is said to be in the court. The domestic timber buildings and offices consisted of a hall with two chambers, a kitchen, brewhouse, oxhouse, cowshed, sheep fold and a garden. In less than 100 years the whole site was abandoned and was said to be 'entirely without buildings'. It was not certain if the buildings were within the mounded moated area or within a possible bailey area to the south west (Orr, 1998).

Aims of Survey

Geophysical survey was carried out to determine the archaeological potential of the field known as Castle Hill. Both resistance and gradiometer surveys were undertaken in an effort to establish the position and nature of any features of archaeological potential.

Summary of Results *

The resistance and gradiometer surveys have provided clear archaeological information although in some places the interpretations appear at odds. The resistance data identify a number of spreads of high resistance along with a series of linear anomalies. It is likely that this data can be linked to the position of structural and wall type remains. The gradiometer data has provided good evidence for industrial or burnt features. The magnetic data also apparently identifies wall remains, although the correlation with the resistance is only partial.

*** It is essential that this summary is read in conjunction with the detailed results of the survey.**

SURVEY RESULTS

99 / 44 Welbourn Castle
Welbourn, Lincolnshire

1. Survey Area

- 1.1 Both resistance and gradiometer surveys were carried out at Welbourn Castle.
- 1.2 Figure 1 shows the position of the areas undertaken for the two techniques. The area for the gradiometer is slightly smaller due to the vegetation at the edge of the field.
- 1.3 The survey grid was set out by **GSB Prospection** and tied in using an EDM system. The grid was tied into station points used by **Lindsey Archaeological Services** for an elevation survey of the same piece of land.

2. Display

- 2.1 The results are displayed as X-Y traces, dot density plots and grey scale images. These display formats are discussed in the *Technical Information* section, at the end of the text.
- 2.2 The remaining figures display raw and processed data plots and interpretation diagrams of the survey results at scales of 1:500 and 1:1000.

3. General Considerations - Complicating factors

- 3.1 In general, the ground conditions were suitable for survey. The vegetation cover was sparse throughout the castle, although some areas at the edge of the survey were overgrown and could not be surveyed.
- 3.2 No physical obstacles were present within the survey area.

4. Results of the Resistance Survey

- 4.1 The resistance data were collected over all the available land within the moated area. The broad range of resistance data shows relative lows to the north and south, with a broad band of high resistance central to the survey. These changes are not simply a product of topographical variation.
- 4.2 The data from the southern edge of the area correlates well with the earthwork evidence i.e. parallel low resistance anomalies run approximately east-west across the site. A band of slightly elevated resistance values lies between these lows and it is possible that some stone work is situated within this bank. To the north of these linears is a narrower high resistance anomaly. This high resistance is likely to represent a wall, whose orientation deviates significantly at the eastern end. A second high resistance anomaly runs approximately parallel and 8m to the north

of the presumed wall. A significant high resistance anomaly lies between these two possible walls near the centre of the survey.

- 4.3 The central eastern part of the data set is relatively quiet, although two potentially significant high resistance anomalies lie adjacent to the eastern edge of the site. One of them clearly abuts the defensive bank.
- 4.4 The central and western parts of the survey contain the highest resistance values. Despite this very little archaeological detail can be identified in the raw data plot. However, after removing the background, either using a low pass or directional filter discrete features can be identified. The majority of the anomalies are high resistance and presumably identify lengths of wall or rubble spreads.
- 4.5 There is a definite northern edge to the potential area of structures. However, within this north eastern zone is a circular high resistance anomaly that may relate to the documented tower known to exist in the 13th century.

5. Results of the Gradiometer Survey

- 5.1 The gradiometer survey covered a slightly smaller area than the resistance survey, due to increased vegetation at the edges of the field.
- 5.2 The data set, as with the resistance survey, provides a wealth of detail. Surprisingly few responses characteristic of ferrous noise were noted – the majority of these are likely to represent small amounts of metal in the topsoil. A single broad area of noise was found, and this is likely to be a result of modern dumping. In general the magnetic response follows the same broad pattern as the resistance data, but differs in detail. As with the resistance data several zones can be identified.
- 5.3 The southern zone is magnetically quiet, with only faint responses recorded from the earthworks. To the north of the earthworks are a series of low magnetic responses. Although the responses are fragmentary they appear to correlate with one of the presumed walls identified by the resistance technique (see Section 4.2). Such a magnetic response, although unusual in Britain, has been noted on sites where occupation has been intense. In such a scenario the soils surrounding an inherently low susceptibility stone wall are magnetically significantly enhanced – a low gradiometer response is therefore generated over the wall.
- 5.4 If the argument is correct in equating the low magnetic response with buried walls, then a few other possible walls may be inferred from the magnetic data. Curiously, apart from the case described in Section 5.3, none of the other low magnetic anomalies correspond with possible walls identified using the resistance technique. Of particular note is the circular feature, c. 15m in diameter, which may be interpreted as a buttressed structure. A wall apparently joins the circular feature to the linear wall.
- 5.5 The eastern part of the gradiometer survey contains the strongest anomalies within the data set. Three anomalies have been noted on the interpretation diagram as being 'industrial' in character. In this case it is likely that the anomalies result from heating to high temperatures, perhaps within an oven or a kiln. Other linear and possible pit type anomalies have been found in the eastern part of the survey.

- 5.6 The data from the western part of the site are significantly different in character from the other areas. Strong, positive results indicate a potential range of structures within this zone. In fact the magnetic responses largely coincide with the high resistance anomalies noted in Section 4.4 above.

6. Conclusions

- 6.1 The two techniques have provided many anomalies of possible archaeological interest. The interpretation of the data would suggest that a number of zones are apparent within the site.
- 6.2 At the southern edge a series of defensive features have been found and these largely correlate with the earthwork evidence.
- 6.3 The western part of the site contains many anomalies that are believed to be indicative of structural responses. It is possible that evidence has been found for the circular tower known from documentary sources.
- 6.4 The eastern part of the area, although generally containing fewer anomalies, has a number of industrial or burnt features. It is possible that they represent ovens or similar features.

Project Co-ordinators: Dr C F Gaffney and J Gater
Project Assistants: D Shiel & A Shields

Date of Survey: 15th March 1999
Date of Report: 26th April 1999

References:

- Orr, K 1998, Archaeological Brief For Geophysical Survey: Welbourn Castle, Welbourn, Lincolnshire
- SSEW 1983, *Soils of England and Wales. Sheet 4, Eastern England*. Soil Survey of England and Wales.

TECHNICAL INFORMATION

The following is a description of the equipment and display formats used in **GSB Prospection (GSB)** reports. It should be emphasised that whilst all of the display options are regularly used, the diagrams produced in the final reports are the most suitable to illustrate the data from each site. The choice of diagrams results from the experience and knowledge of the staff of **GSB**.

All survey reports are prepared and submitted on the basis that whilst they are based on a thorough survey of the site, no responsibility is accepted for any errors or omissions.

Instrumentation

(a) Fluxgate Gradiometer - Geoscan FM36

This instrument comprises of two fluxgates mounted vertically apart, at a distance of 500mm. The gradiometer is carried by hand, with the bottom sensor approximately 100-300mm from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is conventionally measured in nanoTesla (nT), or gamma. The fluxgate gradiometer suppresses any diurnal or regional effects. Generally features up to one metre deep may be detected by this method. Readings are normally logged at 0.5m intervals along traverses 1.0m apart.

(b) Resistance Meter - Geoscan RM4 or RM15

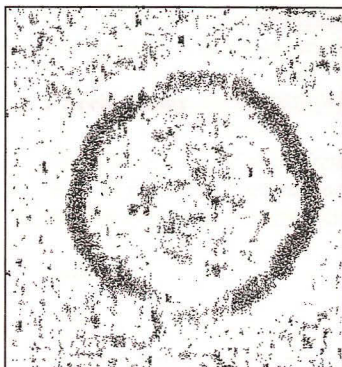
This measures the electrical resistance of the earth, using a system of four electrodes (two current and two potential.) Depending on the arrangement of these electrodes an exact measurement of a specific volume of earth may be acquired. This resistance value may then be used to calculate the earth resistivity. The "Twin Probe" arrangement involves the pairing of electrodes (one current and one potential) with one pair remaining in a fixed position, whilst the other measures the resistance variations across a fixed grid. The resistance is measured in Ohms and the calculated resistivity is in Ohm-metres. The resistance method as used for area survey has a depth resolution of approximately 0.75m, although the nature of the overburden and underlying geology will cause variations in this generality. The technique can be adapted to sample greater depths of earth and can therefore be used to produce vertical "pseudo sections". In area survey readings are typically logged at 1.0m x 1.0m intervals.

(c) Magnetic Susceptibility

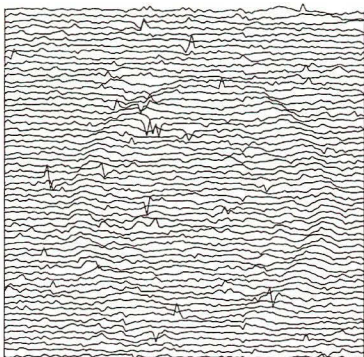
Variations in the magnetic susceptibility of subsoils and topsoils occur naturally, but greater enhanced susceptibility can also be a product of increased human/anthropogenic activity. This phenomenon of susceptibility enhancement can therefore be used to provide information about the "level of archaeological activity" associated with a site. It can also be used in a predictive manner to ascertain the suitability of a site for a magnetic survey. The instrument employed for measuring this phenomenon is either a field coil or a laboratory based susceptibility bridge. For the latter 50g soil samples are collected in the field. Sampling intervals vary widely but are often at the 10m or 20m level.

Display Options

The following is a description of the display options used. Unless specifically mentioned in the text, it may be assumed that no filtering or smoothing has been used to enhance the data. For any particular report a limited number of display modes may be used.

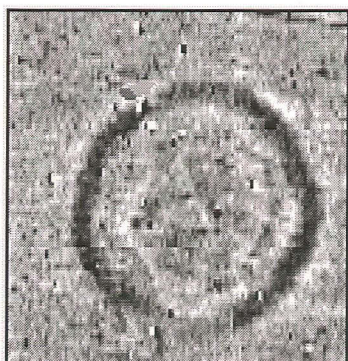


(a) **Dot-Density** In this display, minimum and maximum cut-off levels are chosen. Any value that is below the minimum will appear white, whilst any value above the maximum will be black. Any value that lies between these two cut-off levels will have a specified number of dots depending on the relative position between the two levels. The focus of the display may be changed using different levels and a contrast factor (C.F.). Usually the C.F. = 1, producing a linear scale between the cut-off levels. Assessing a lower than normal reading involves the use of an inverse plot. This plot simply reverses the minimum and maximum values, resulting in the lower values being presented by more dots. In either representation, each reading is allocated a unique area dependent on its position on the survey grid, within which numbers of dots are randomly placed. The main limitation of this display method is that multiple plots have to be produced in order to view the whole range of the data. It is also difficult to gauge the true strength of any anomaly without looking at the raw data values. This display is much favoured for producing plans of sites, where positioning of the anomalies and features is important.



(b) **X-Y Plot** This involves a line representation of the data. Each successive row of data is equally incremented in the Y axis, to produce a stacked profile effect. This display may incorporate a hidden-line removal algorithm, which blocks out lines behind the major peaks and can aid interpretation. Advantages of this type of display are that it allows the full range of the data to be viewed and shows the shape of the individual anomalies. Results are produced on a flatbed plotter.

This display joins the data values in both the X and Y axis. The display may be changed by altering the horizontal viewing angle and the angle above the plane. The output may be either colour or black and white.



(c) Grey-Scale

This format divides a given range of readings into a set number of classes. These classes have a predefined arrangement of dots or shade of grey, the intensity increasing with value. This gives an appearance of a toned or grey scale.

Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values. While colour plots can look impressive and can be used to highlight certain anomalies, grey-scales tend to be more informative.

Terms commonly used in the graphical interpretation of gradiometer data

Ditch / Pit

This category is used only when other evidence is available that supports a clear archaeological interpretation e.g. cropmarks or excavation.

Archaeology

This term is used when the form, nature and pattern of the response is clearly archaeological but where no supporting evidence exists. These anomalies, whilst considered anthropogenic, could be of any age. If a more precise archaeological interpretation is possible then it will be indicated in the accompanying text.

? Archaeology

The interpretation of such anomalies is often tentative, with the anomalies exhibiting either weak signal strength or forming incomplete archaeological patterns. They may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.

Natural

These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e.g. palaeochannels or magnetic gravels.

? Natural

These are anomalies that are likely to be natural in origin i.e geological or pedological.

Areas of Magnetic Disturbance

These responses are commonly found in places where modern ferrous or fired materials are present e.g. fencelines, pylons or brick rubble. They are presumed to be modern.

Areas of Increased Magnetic Response

These responses show no visual indications on the ground surface and are considered to have some archaeological potential.

Ferrous Response

This type of response is associated with ferrous material and may result from small items in the topsoil or larger buried objects such as pipes. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.

Ridge and Furrow

These are regular and broad linear anomalies that are presumed to be the result of ancient cultivation. In some cases the response may be the result of modern activity.

Ploughing Trend

These are isolated or grouped linear responses. They are normally narrow and are presumed modern when aligned to current field boundaries or following present ploughing.

Linear Trend

This is usually a weak isolated linear anomaly of unknown cause or date.

List of Figures

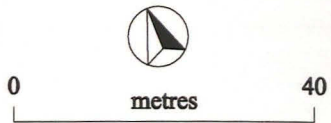
Figure 1	Location of Survey Areas	1:1000
Figure 2	Summary Interpretation	1:1000

Resistance Data

Figure 3	Greyscale	1:500
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Magnetic Data

Figure 6	X-Y trace & Dot density	1:500
Figure 7	Greyscale	1:500
Figure 8	Interpretation	1:500

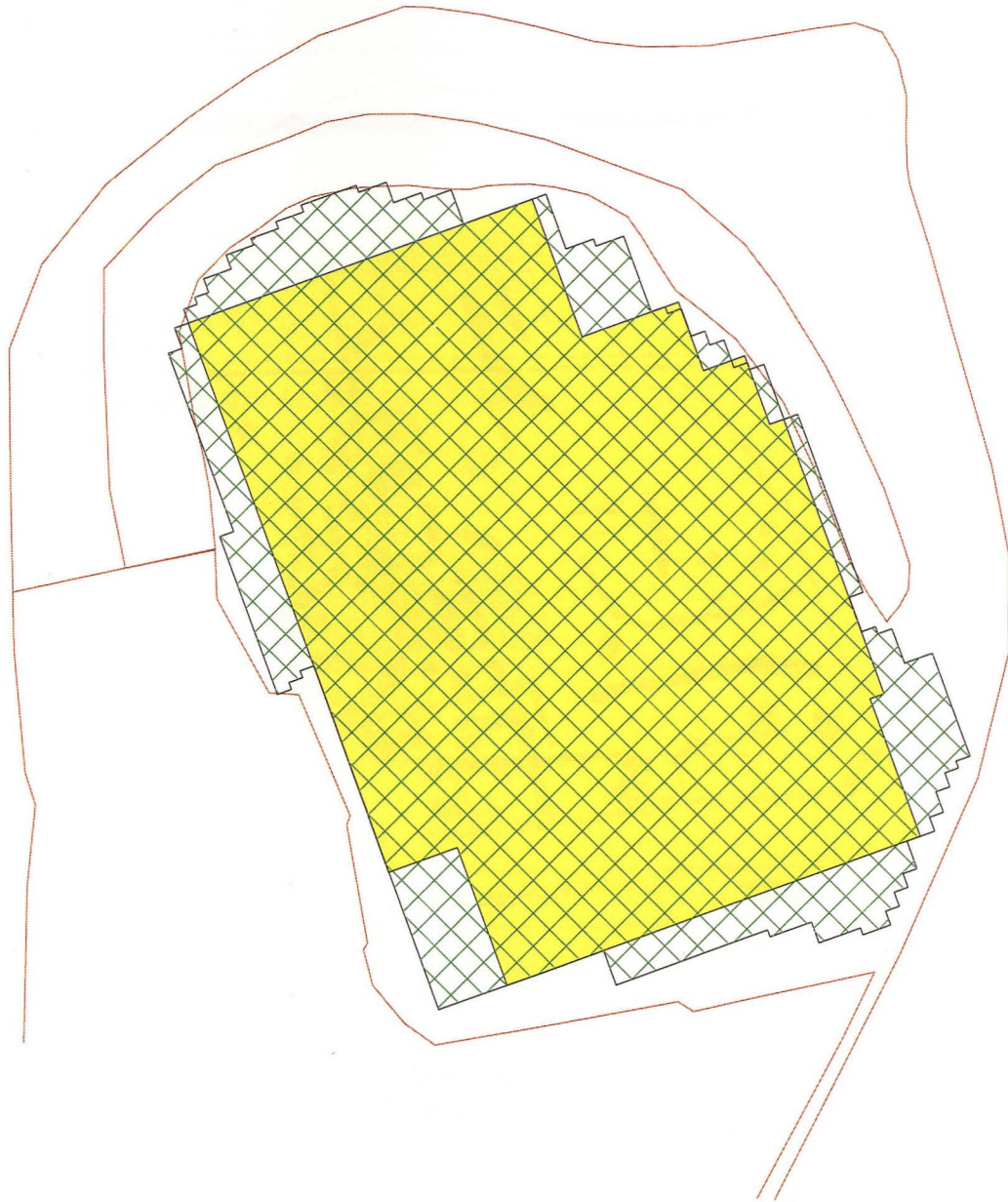


GSB PROSPECTION

PROJECT: 99/44 WELBOURN CASTLE

TITLE: Location Diagram

Based on a plan supplied by
Lindsey Archaeological Services



 Gradiometer Survey

 Resistance Survey

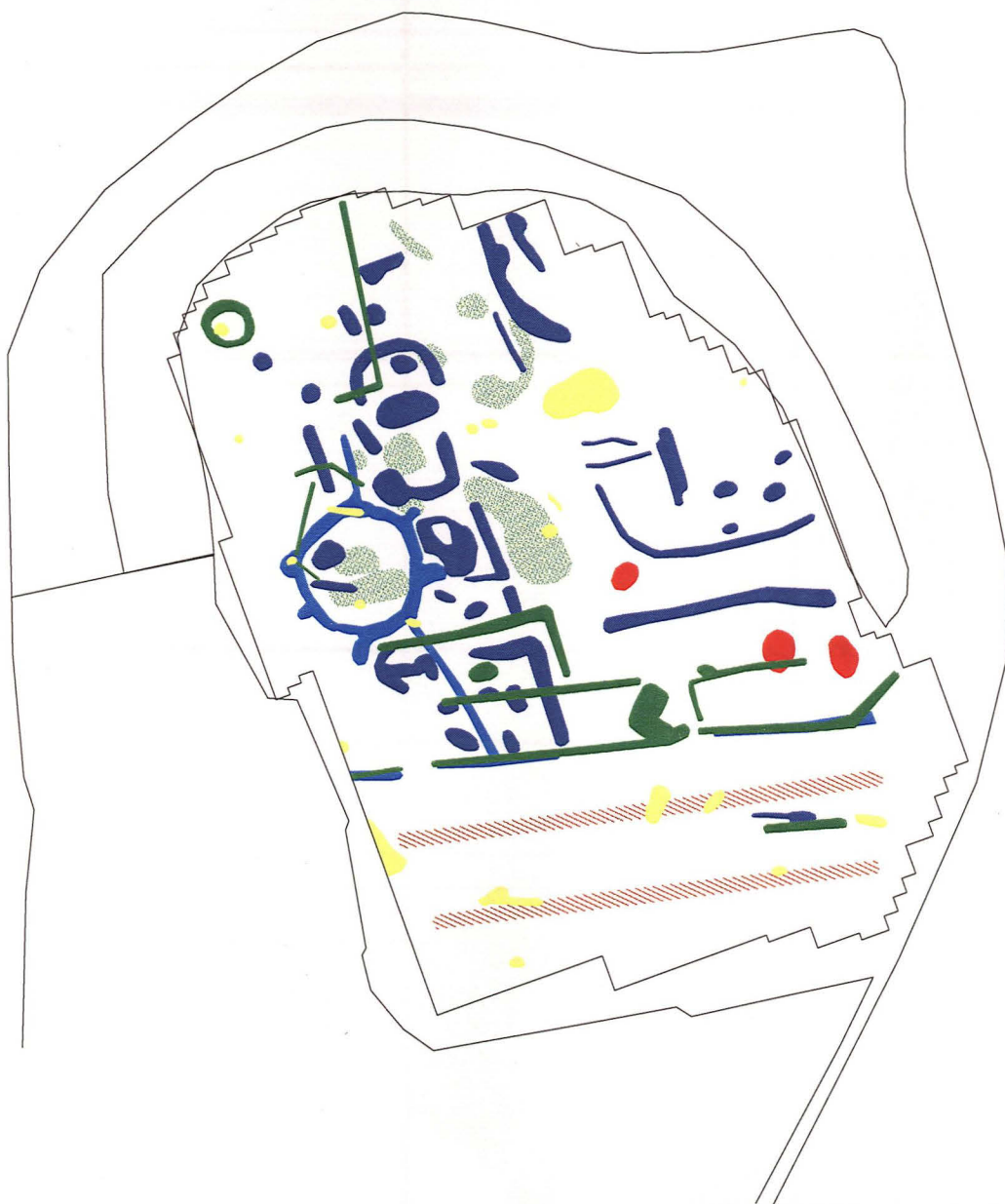
Figure 1

GSB PROSPECTION





PROJECT: 99/44 WELBOURN CASTLE

TITLE: Summary Interpretation

Based on a plan supplied by
Lindsey Archaeological Services



Gradiometer Data

- | | |
|---|---|
|  ?Archaeology |  ?Industrial |
|  Low Magnetic Response ?Wall |  Ferrous |

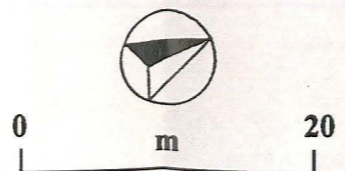
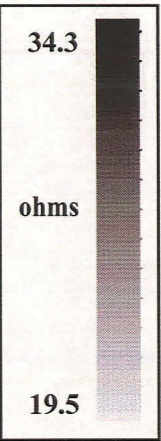
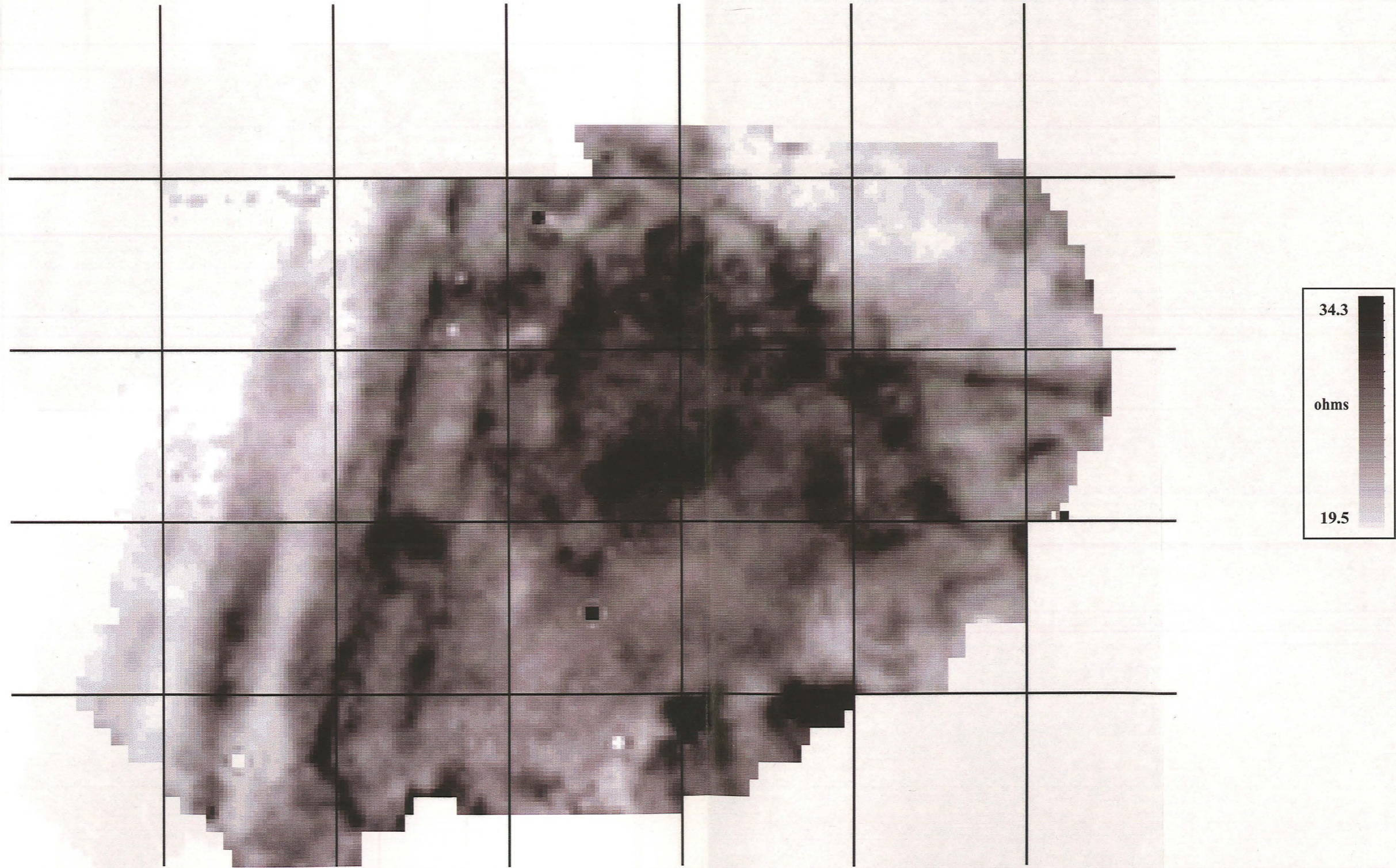
Resistance Data

- | | |
|--|--|
|  High Resistance ?Walls |  Earthworks |
|  High Resistance ?Rubble Spread | |

Figure 2

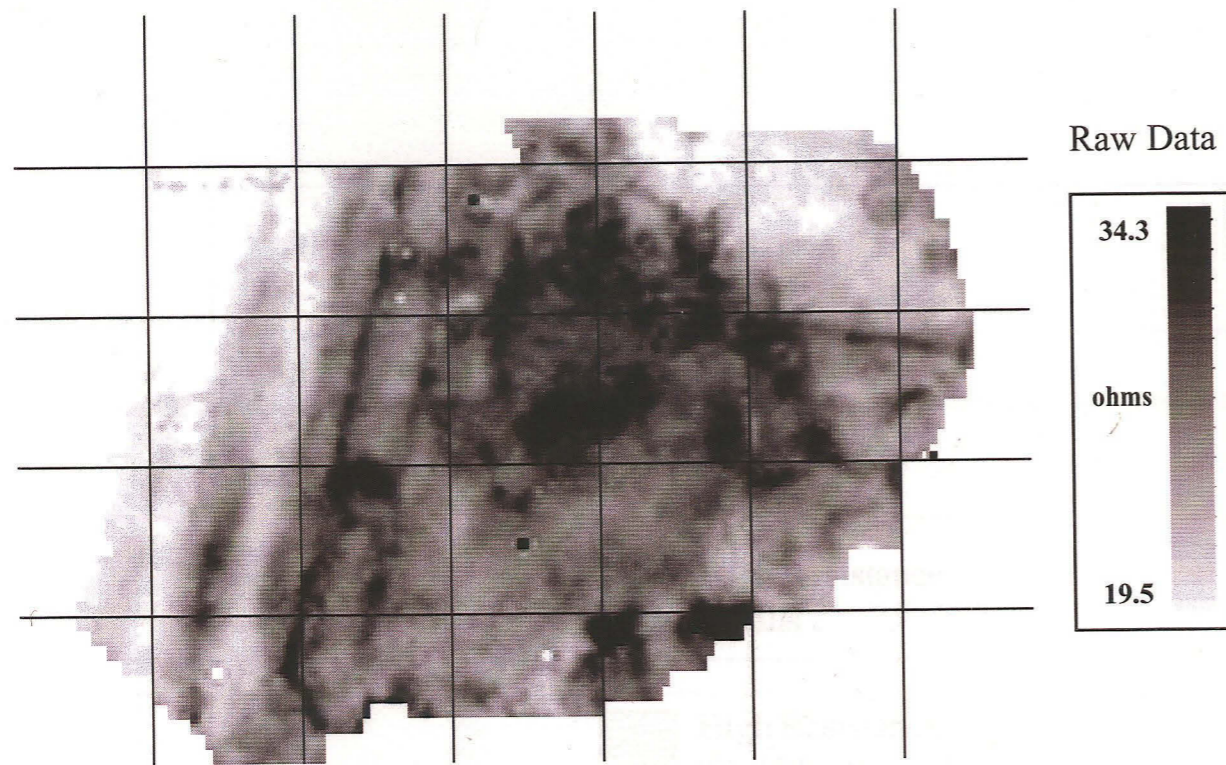
WELBOURN CASTLE

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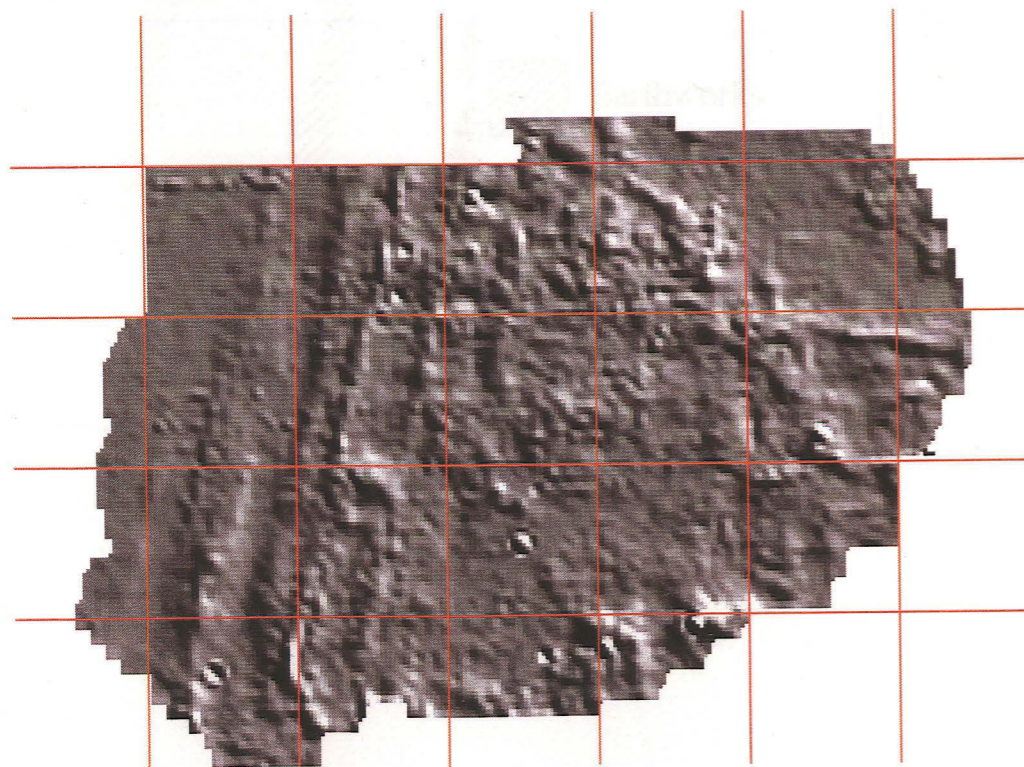
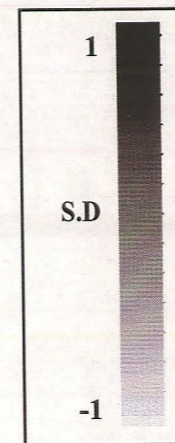


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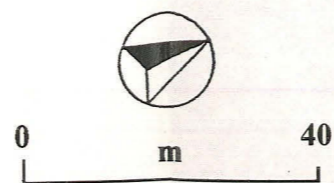
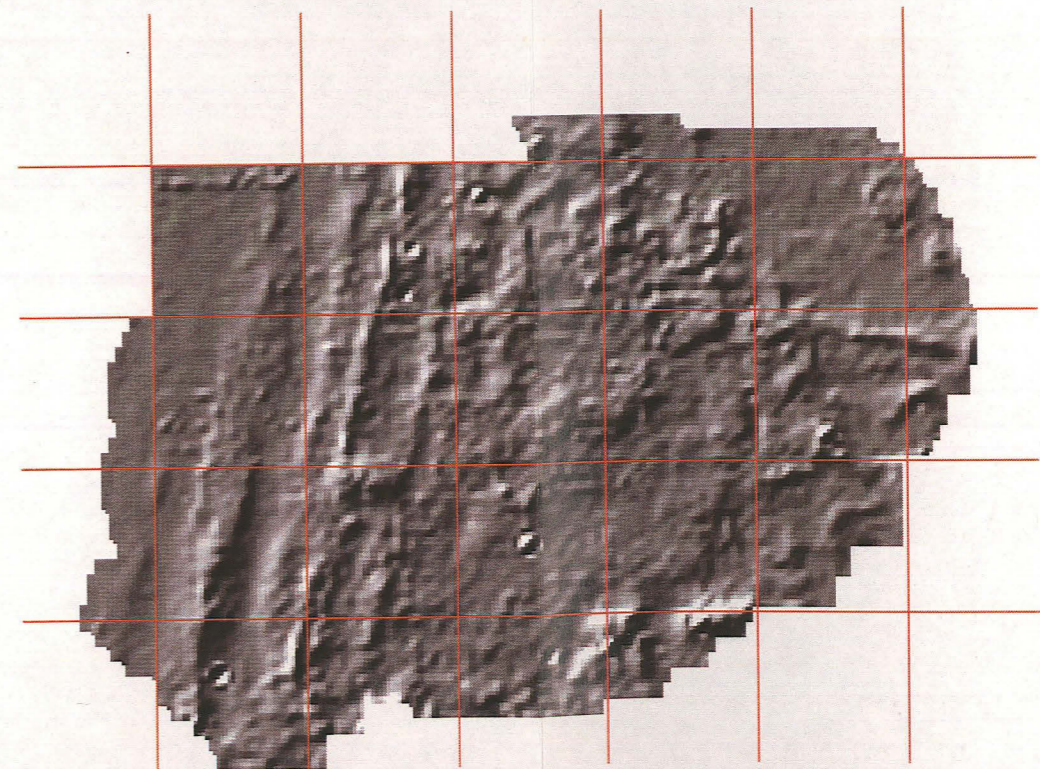
Resistance Data



Filtered Data

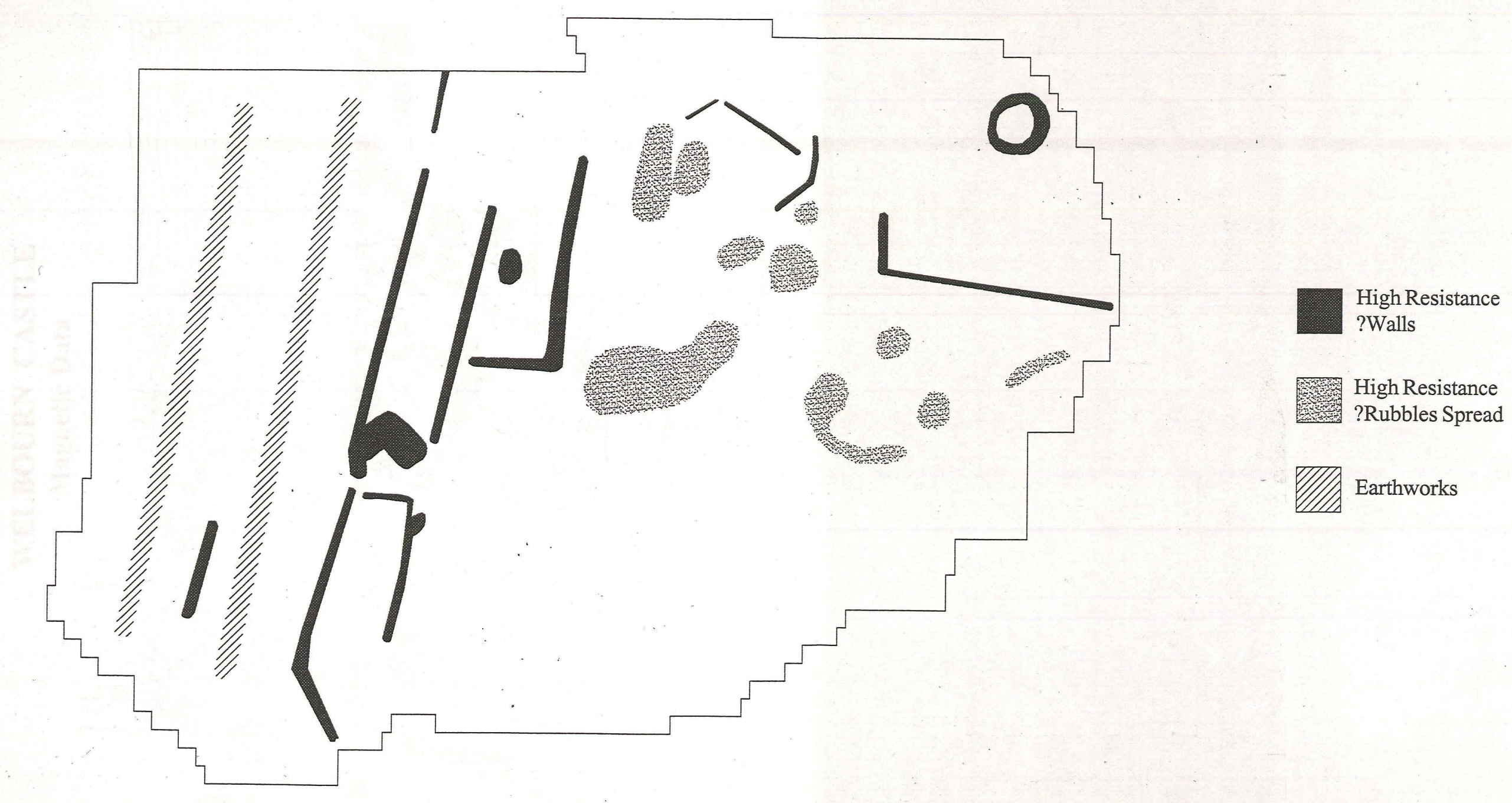


Shade Plots



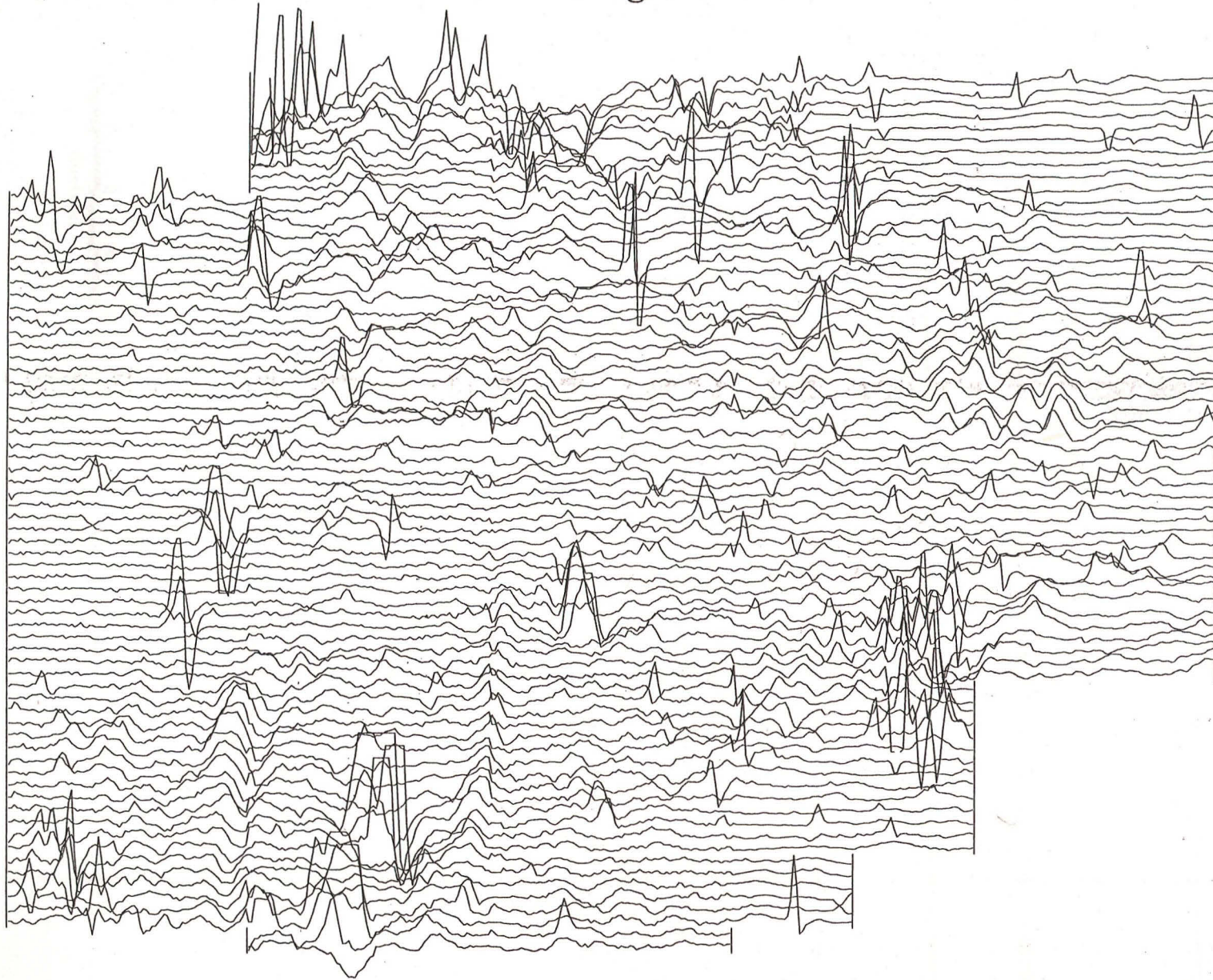
WELBOURN CASTLE

Resistance Data



WELBOURN CASTLE

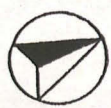
Magnetic Data



40 nT

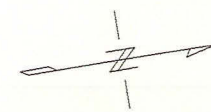
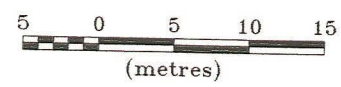
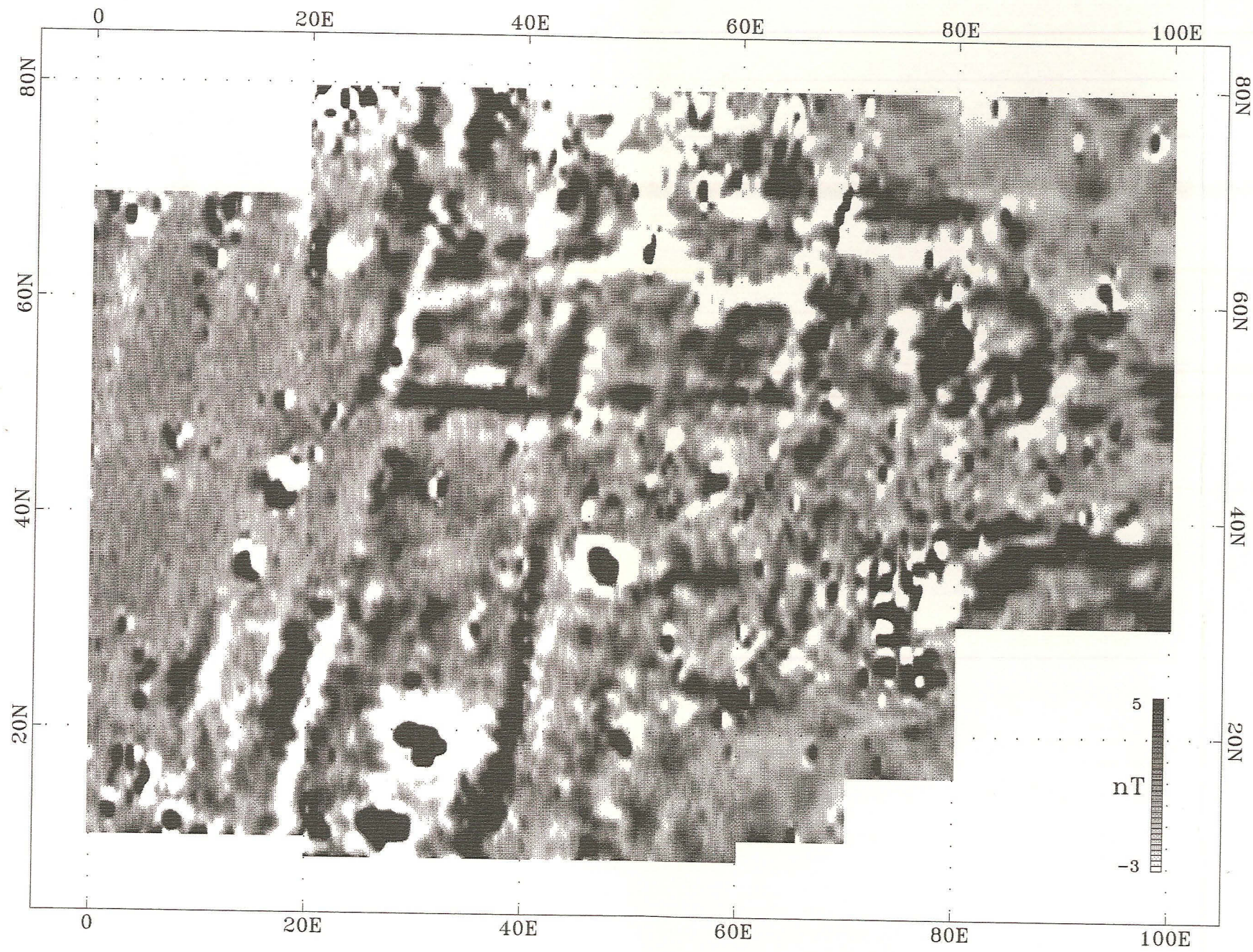


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WELBOURN CATSLE Magnetic Data



WELBOURN CASTLE

Magnetic Data

