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Bishop's Palace, Nettleham, Lincolnshire

Fluxgate gradiometer survey - February 2008

NEAS geophysics 1

Bishop's Palace, Nettleham, Lincs

Geophysical Survey

Contents

Summary

Two areas were surveyed inside the Bishop's Palace Scheduled Monument at Nettleham near Lincoln. The earthworks gave magnetic responses but these are less clear than the actual earthworks. The survey did, however, suggest that the site may extend further south along the line of the entrance approach than is indicated by the surviving earthworks.

SLI 12669
SLI 12670
ELI 9372
PRN 54198.

1. Introduction and Archaeological Background

A geophysical (gradiometer) survey was carried out by the Environment Agency's archaeologists at the scheduled site of The Bishop's Palace in Nettleham, Lincolnshire approximately 5 km north-east of Lincoln.

The site, centred at TF00589 75201, consists of extant earthworks, the scale of which restricted the area which could be surveyed using a gradiometer. In the end two areas were surveyed which correlated with the reasonably flat areas of the site. One consisted of two 30m by 30m grids in the north-west corner of the site and a larger area to the south which consisted of 10 30m by 30m grids.

Topographically the site drops down towards the road at its northern edge, steeply enough for the former buildings in the northern part of the site to show signs of having been terraced into the slope. The geology of the site comprises Lincolnshire Limestone in the north with Rutland Formation Gillaceous Rocks with subordinate sandstone and limestone to the south. The boundary between the two formations runs obliquely through the site from north-east to south-west.

The lines of the walls of the buildings are quite clearly visible as the wall lines survive to a considerable height which suggests that they have never been robbed to any great degree despite the presence on site of a limekiln which appears to be post medieval in date. This appears to be associated with a large quarry within the area of the palace which was sheer sided and which the survey avoided. Some small excavations were carried out by the then Ministry of Works in 1959 (Hurst 1960) which revealed wall foundations, a well some 14 feet deep and a little charcoal and pottery.

There was a manor house on the site in the Saxon period which was owned by Edith, wife of Edward the Confessor. Saxon loom weights and Saxon pottery were found in 1935 (Leach 1960).

A licence to crenellate was given to Bishop Burghersh in 1336 (Thompson 1912).

2. Methodology and Presentation

The general aim of the survey was to see whether the flat area in the north-west corner (believed to be a garden area) would reveal any information as to its former use and to see whether there were any signs of the site having once extended further to the south than the area covered by the extant earthworks.

More specifically the survey aimed to determine the presence, extent and layout of buried archaeological remains in the survey area by the identification and interpretation of any magnetic anomalies indicative of such activity.

A Bartington Grad601 magnetic gradiometer was used during the survey with readings being taken at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m grids. The reading were stored in the memory of the instrument and later downloaded to computer for processing and interpretation using ArchaeoSurveyor 2 software.

The survey methodology and report comply with guidelines outlined by English Heritage (David 1995) and by the IFA (Gaffney, Gater and Ovenden 2002). All figures reproduced from Ordnance Survey mapping are done so with the permission of the controller of Her Majesty's Stationery Office. © Crown copyright.

A general site location plan is shown in Figure 1. Figure 2 shows the processed magnetometer data superimposed onto a map base at a scale of 1:1000. The processed (XY trace plot) data, together with accompanying interpretation diagrams are presented in Figures 3 to Figure 4 at a scale of 1:1000.

Technical information on the equipment used, data processing and magnetic survey methodology is given in Appendix 1. Appendix 2 describes the composition and location of the site archive.

The figures in this report have been produced following analysis of the data in both raw and processed formats and over a range of different display levels. All figures are presented to display the data most suitably and to interpret the data from this site based on the experience and knowledge of the Agency's staff.

3 Results

General

Isolated dipolar anomalies (iron spikes – see Appendix 1) have been identified in both survey areas. These 'iron spike' anomalies are caused by ferrous objects or other magnetic material on the ground surface or contained within the upper soil horizons. Although archaeological artefacts may cause these anomalies they are more often caused by modern cultural debris although this might be less likely on the current site which is unlikely to have been subject to manuring. The outer bank in the northwest of the site appears to be full of ferrous material as is a portion of the southern bank to the east of the entranceway. One of the anomalies has been caused by the presence of several radial car tires.

Block 1

The two grids in the northwest corner of the site do show several anomalies. Part of the area in the westernmost part is obscured by the presence of ferrous material in the outer bank but several possible ditches and one possible pit can be seen in the area suspected to be part of a garden. It is not possible to say whether the anomalies are part of the garden or belong to an earlier phase of the site since the area available for interpretation is too small to see any real patterns in the results.

To the east the survey is picking up one of the areas terraced into the site and nothing apart from the earthwork itself is apparent.

Block 2

This area can be divided into two distinct areas. To the east of the entranceway into the site, the anomalies appear to suggest that the site was originally larger than is represented by the remaining earthworks. The pattern of the anomalies is very suggestive of the interior of the site and the earthworks themselves.

To the west of the entranceway, the situation is not so clear. Several of the anomalies are parallel to the earthworks and suggest a similar extension of the site, although not as clearly as in the east. Several more of the anomalies suggest a possible ditch with a return and possibly a further return suggesting a possible rectangular structure. Its alignment would suggest that it might represent a different phase to that of the main earthworks.

4 Discussions and Conclusions

Over the area of earthworks the survey has picked up the line of the walls and banks as was expected. However, the clarity is such that the results add nothing to the plan of the earthworks themselves.

In the area of the so-called garden, there is a suggestion of features which do not appear as earthworks. These may well represent either part of the garden layout or features belonging to a different phase of the site.

To the south of the earthworks, anomalies have been identified which suggest that the site was at some time much more extensive than that represented by the earthworks themselves. To the west of the entranceway some of these anomalies suggest possible structures belonging to a different phase to that represented by the earthworks.

Due to the limited nature of the survey, no definite boundary can be established for the site which might well extend further to the south into the arable field which is not part of the scheduled area.

In conclusion it is considered that there may well be evidence for other phases of the site to those represented by the earthworks. In the garden area the available area to survey is too small to be certain whether the anomalies represent garden features or a different phase of the site.

To the south of the earthworks the survey suggests that the site might extend southwards. The majority of the anomalies suggest that this extension to the site is on the same alignment as the earthworks but there are some suggestions that archaeological features may exist there on different alignments which might represent earlier phases.

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute interpretation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.

Bibliography

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Figures

Appendix 1

Magnetic Survey: Technical Information

Magnetic Susceptibility and Soil Magnetism

Iron comprises about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haematite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities

can redistribute these minerals and enhance others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation has occurred can be identified by virtue of the attendant increase in magnetic susceptibility. If the enhanced material subsequently comes to fill features such as pits or ditches, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil, such as ditches, that have been silted up or backfilled with topsoil will, therefore, usually produce a positive magnetic response relative to the background soil levels. Discrete features, such as pits, can also be detected. Less magnetic material such as masonry or plastic service pipes that intrude into the topsoil may give a negative response relative to the background level.

The magnetic susceptibility of a soil can also be enhanced by the application of heat. This effect can lead to the detection of features such as hearths, kilns and areas of burning.

Types of Magnetic Anomaly

In the majority of instances anomalies are termed **"positive"**. This means that they have a positive magnetic value relative to the magnetic background on any given site. However, some features can manifest themselves as **"negative"** anomalies where the responsive is negative relative to the magnetic background. Such negative anomalies are often very faint and are caused by modern non-ferrous features such as plastic water pipes. Infilled geological features may also appear as negative anomalies in some geological substrates.

Where it is not possible to give a probable cause for an observed anomaly, a **"?"** is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can, therefore, remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes)

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation,

little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance

These responses can have several causes, often being associated with burnt material such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other information suggesting a contrary interpretation.

Linear trend

This is usually a weak or broad linear anomaly of unknown cause or date. An agricultural origin, either ploughing or land drains is a common cause.

Areas of magnetic enhancement/positive isolated anomalies

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area, whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic response or an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often, therefore, be difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies

Such anomalies can have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

Methodology: Gradiometer Survey

There are tow main methods of using the fluxgate gradiometer. The first of these is referred to as **magnetic scanning**. This method is not used in the Agency and will not be described further.

The method which is used by the Environment Agency is referred to a **detailed survey** and employs the use of a sample trigger to take readings automatically at predetermined points, typically at 0.5m or 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square grids. These readings are stored in the memory of the

instrument and are later downloaded into a computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning.

During this survey, a Bartington Grad601 dual magnetic gradiometer was used, taking readings on the 0.1nT range at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

Data Processing and Presentation

The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data is shown in an essentially 'raw' state with only clipping having taken place. The data in the greyscale has been manipulated to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot represents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a 'stacked'plot. A hidden line algorithm has been employed to block out lines behind major 'spikes' and the data has been clipped. The main advantage of this display option is that the full range of data can still be viewed, dependent on the clip, so that the 'shape' of individual anomalies can be discerned and potentially archaeological anomalies differentiated from 'iron spikes'. ArchaeoSurveyor 2 software was used to create the XY traces.

ArchaeoSurveyor 2 software was also used to produce the greyscale plots which are displayed using a linear incremental scale.

Appendix 2

Geophysical Archive

The geophysical archive comprises:-

An archive disk containing a copy of the raw data and a PDF copy of the report text and illustrations.

At present the archive is held by the Environment Agency at the Coverdale Office in York although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). A copy will also be forwarded to English Heritage for inclusion on the English Heritage Geophysical Survey Database.

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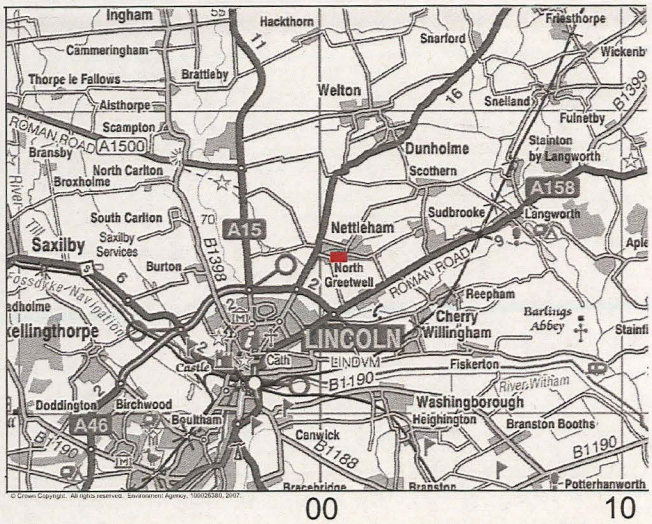

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Figure 1 Site location

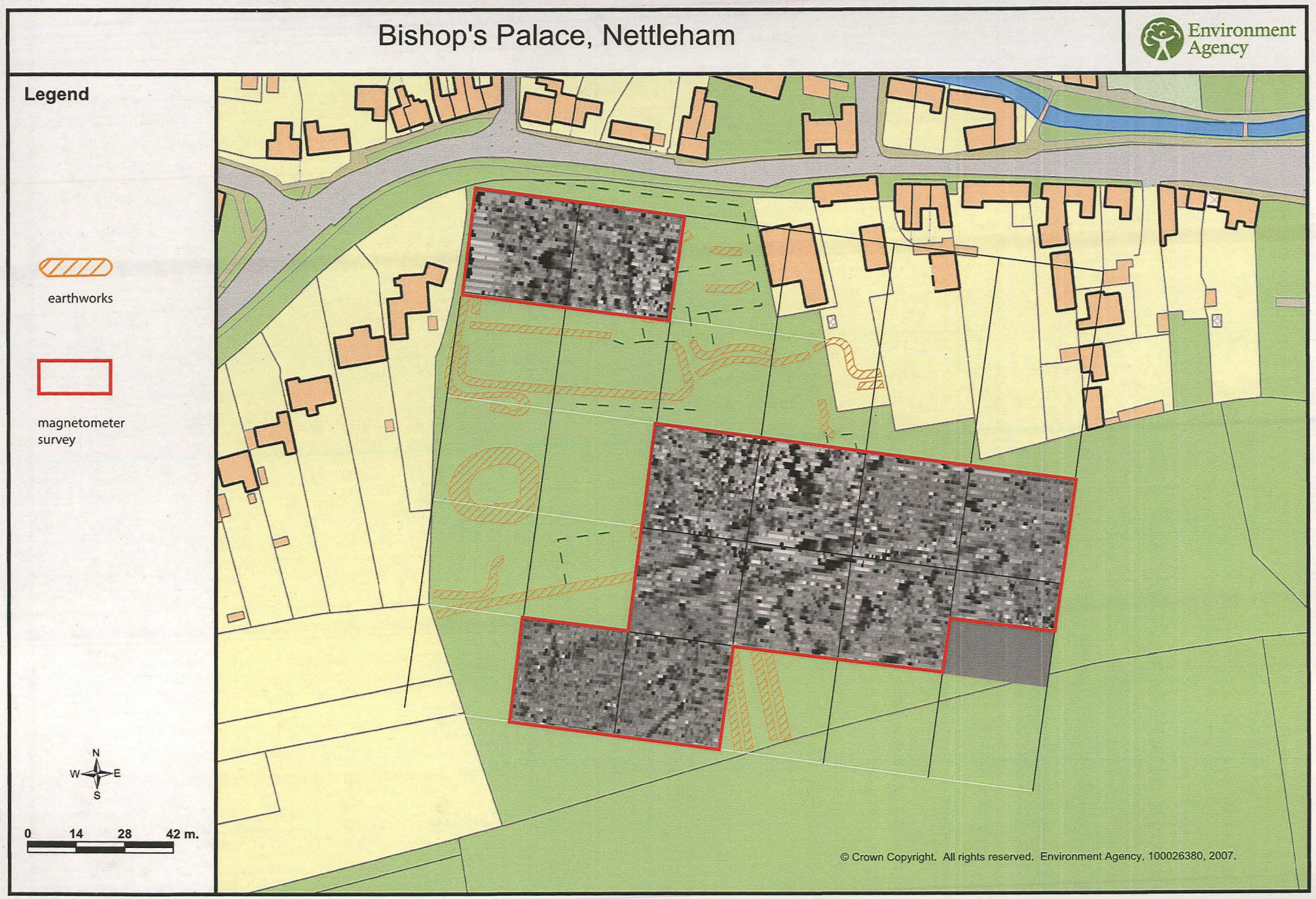

Figure 2 site location showing processed greyscale magnetometer data

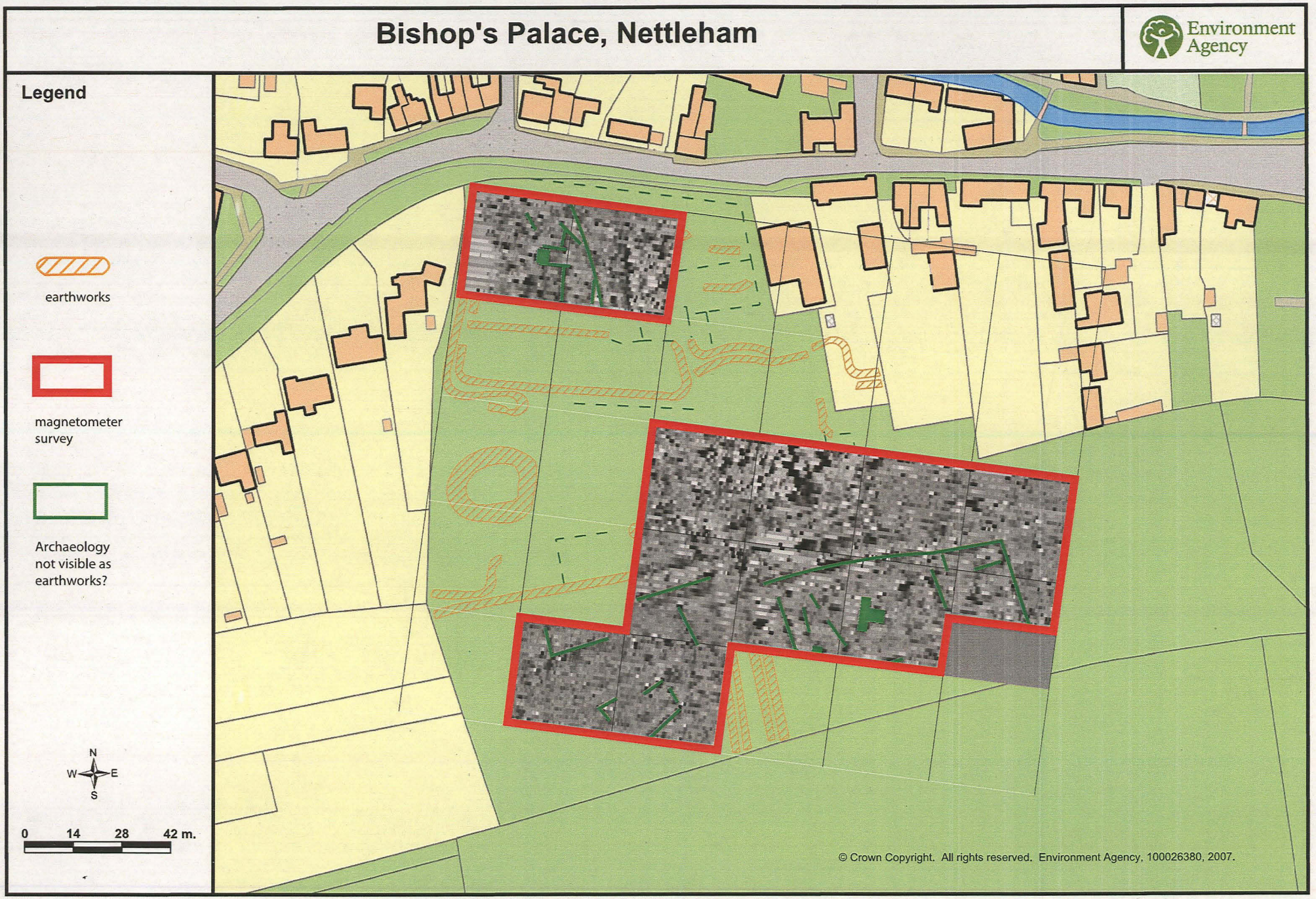

Figure 4. Interpretation

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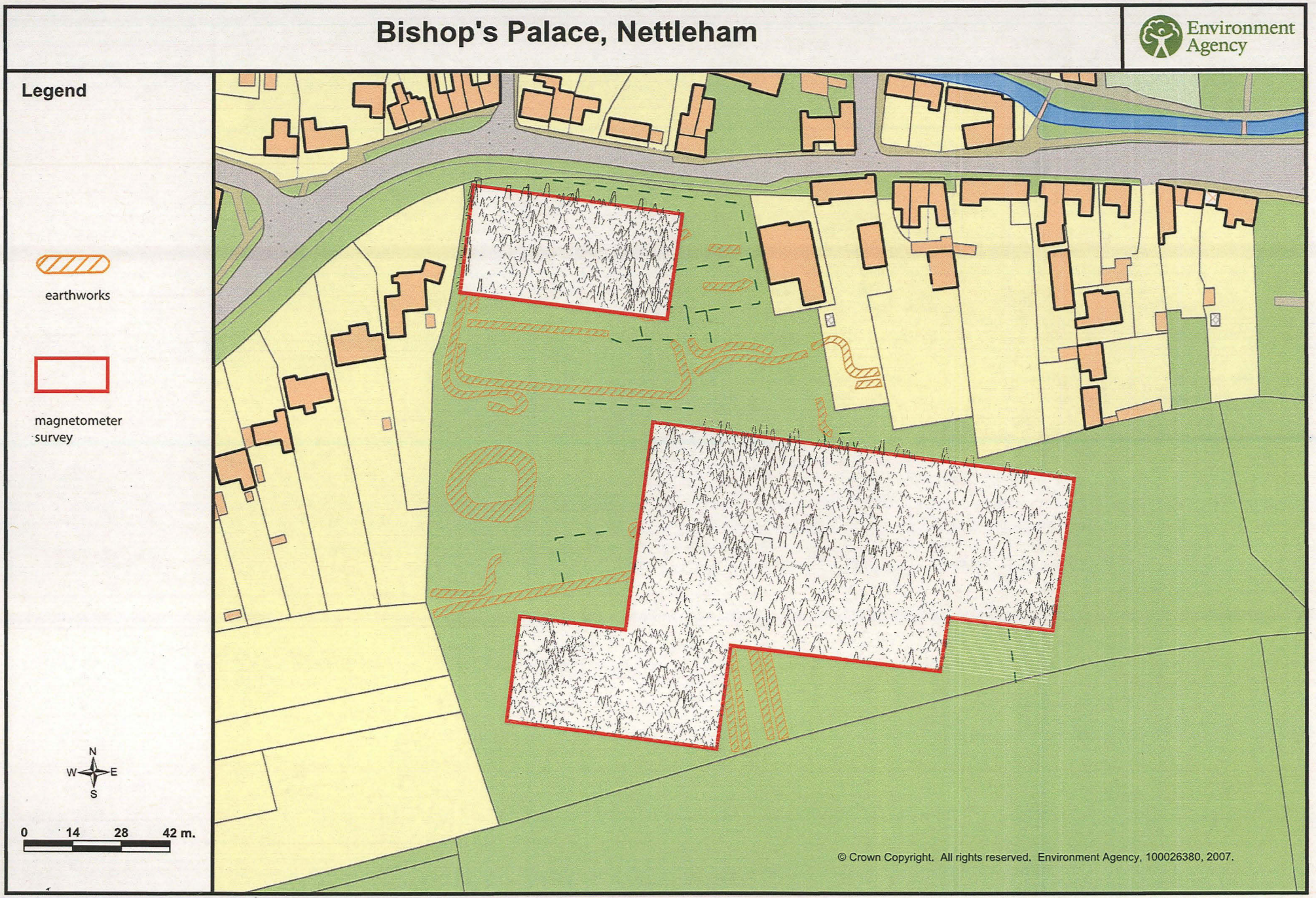

Figure 3. XY trace plot - vertical scale factor 0.4