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Chipping Norton Castle, Oxfordshire.

Report no. 2018-05

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Client	The Chipping Norton Buildings Record
Report reference no	2018-05v1
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General

This report is a combination of reports on the magnetometry and earth resistance surveys of this area. It was felt that these would be better combined. It also includes some additional conclusions which can be drawn from looking at both sets of data.

Summary

An initial trial survey using earth magnetometry and a small amount of earth resistance was carried out to test the liklihood of this site producing good results. Following this the area was surveyed with magnetometry and then using earth resistance.

Magnetic gradiometry located 2 possible buildings and some possible large ditches were located.
The earth resistance results were more reflective of the earthwork survey which had been carried out by students on a course tutored by English Heritage staff. Walls, several possible buildings and a circular feature were found.
The levels of resistance readings varied between the southern area, the northern one and the areas outside those areas. The wide range of readings may make it necessary to consider each area separately to prevent details being lost in the range of reading strengths. As earth resistance results vary with ground dampness and mobile probe spacing, it may well be that there are other remains which were not detected by these surveys.
Specialists in castle design may be able to identify many of the structures although the amount of parallel and double walls appears to be unusual to the non-expert.

1 Survey Details

Name of site: Chipping Norton Castle.

Purpose of survey:
Surveys were carried out to see if they could assist the client's researches into this area.

Client: The Chipping Norton Buildings Record
County: Oxfordshire **District:** West Oxfordshire **Parish:** Chipping Norton

NGR grid reference: Area approximately centred on SP312144
Nearest postcode: OX7 5NS
Magnetometry Start date: 26-01-2018 End date: 02-02-2018 Report date: 04-03-2018
Earth resistance Start date: 13-04-2018 End date: 26-04-2018 Report date: 01-07-2018

Geology at site The geology is understood from the Geology of Britain viewer to be Whitby mudstone and Middle Lias (Dyram formation)

Topography: This is on a small hill, the sides separating it from the town may have been enhanced as part of the castle construction.

Field Conditions.
The field had grass with trees on slopes and patches of nettles which were about 20 cms high. Steep slopes prevented surveying in some areas and overhanging trees meant that other areas could not be surveyed, although this was less of a problem for resistivity than it had been for magnetometry. There had been rain before the survey and showers during the survey period. This may have affected the results as features such as hard surfaces can pond up groundwater and appear to be damp in wet conditions only to become high resistance dry features in drier conditions. As we needed to survey near the edges of the site to detect any wall at its edge and as those areas had most nettles and brambles, it was considered that the resistivity survey should take place before the vegetation prevented work, even though slightly drier conditions could have produced results with more contrast.

Known archaeological sites / monuments covered by the survey
The clients are understood to be researching this.
The site is a Scheduled Ancient Monument as being a motte and bailey castle with fishponds to the south west. A section 42 licence had been obtained to permit the survey.

Archaeological sites / monument types detected by the survey
Magnetometry located 3 possible broad ditches, one being interrupted. It also located 2 probable buildings and various pit-like features.
Earth resistance located several probably stone buildings, a circular pond-like feature and other walls and undiagnostic piles of rubble. Geophysics alone cannot give a date to remains.

Surveyor : Abingdon Archaeological Geophysics, Roger Ainslie, Sally Ainslie.

Location of:
a) Primary archive, i.e. raw data, electronic archive etc
Abingdon Archaeological Geophysics and with the client.
b) Full report: Ditto - also as part of the section 42 licence English Heritage are to be provided with copies of the report.

2 Technical Details

Type of survey
Magnetometry
Area surveyed: 0.81 hectares

Traverse separation, if regular: 1.0 metre.
Reading / sample interval: 8 per metre
Type, make and model of instrumentation: Bartington Grad 601/2 fluxgate gradiometer.

Processing
We have used TerraSurveyor for this.
Magnetometer data was de-staggered to correct the sensor logger lag inherent with this equipment. It was then clipped. The second days survey also needed de-striping as the spot where the equipment was balanced was not as magnetically quiet as we would have wished.

Additional remarks
30 metre grids set out on the National Grid using a Trimble pro XR differentially corrected GPS. Probably accurate to 0.5m.
First line start NW corner going east zig zag.
Magnetometry walking speed 1.3m/s. Bottom sensor approx 0.25m above ground surface as grass tussocks prevented it being carried lower.

Type of survey
Earth Resistance
Area surveyed: 1.1 hectares
Traverse separation, if regular: 0.5 metre.
Reading / sample interval: 0.5 metre
Type, make and model of instrumentation: TR Systems meter Mark 2.
Array: Twin probe. 0.5m mobile probe spacing.

Processing
We have used TerraSurveyor for this.
Data was processed to replace erroneous readings - usually caused by hitting stones.
It has then been clipped to reveal features.

Additional remarks
Survey carried out using the same grid locations, but not order, as magnetometry.
First line start NW corner going east zig zag.
Mobile probes on frame with 4 probes and thus capable of taking 3 readings parallel to each other.
0.6 and 0.8 second filter needed to seek to reduce the effect of earth leakage currents - possibly from the electricity poles across the survey area.

3 Magnetometry Results (see fig 8)

1 Areas of high magnetic readings. These could be large pits or areas where there have been bonfires. I suspect that the northern one stands the greatest chance of being a pit.
2 Probably a ditch.
3 An area of small high readings. Possibly where brick rubble has been dumped to improve vehicular access. There are similar anomalies across the survey area.
4 Areas where there are dense ferrous or fired ceramic anomalies. These could be rubbish or cellar pits. The earlier earth resistance survey supports this interpretation.
5 Area of high readings caused by the anomaly caused by the stay to the electricity pole. The site also has many pieces of iron (shown as red dots) and pieces of iron or brick or similar (shown as brown dots).
6 A possible broad line of high magnetic readings. They could be an intermittent ditch but the interference from the electricity pole obscures its southern end.
7 Lines of low readings. These could be walls or paths. The south eastern one is continuous, whilst the others are not. The trial earth resistance survey, when overlain on the magnetometry has the highest earth resistance readings being just to the north of the lowest magnetometer readings. They should be over one another. As the same grid position was used for both surveys, this is currently difficult to explain.
8 A rectangular area of higher readings. It could be rubble or a surfaced area.
9 Broad lines of high readings which could be ditches. The western one is clearer but the eastern one appears to be on the slope of the bank of earth in that area. It is possible that the magnetometer sensor was closer to the ground when going up the slope, giving higher readings, but the opposite would have happened when walking the other way. It is likely therefore that the earth here is more magnetic than the surrounding earth.
10 Broad lines of low readings. These could be some road surfacing or similar, although they don't appear to line up with the present track. It is possible that the area between then could have been a ditch. If it was it must have been backfilled with very clean material.
11 Rectangular lines of high readings. It could be a building. As stone is usually less magnetic than topsoil where there has been habitation, then these are either narrow ditches or are where burnt material has accumulated.
12 Possible linear feature. It could be a slight ditch.

Earth Resistance Results (see fig 19) The numbering here follows that of the previous magnetometry report to avoid confusion.

13 High resistance anomaly. Purpose unknown.
14 Area of higher resistance over bank.
15 Long rectangular building-like anomalies.
16 Building-like anomalies. The low resistance inside the building could indicate that rainwater has pooled up on a floor surface.

17 Area with little detectable in it.
18 Small rectangular building-like pattern of anomalies.
19 Building-like pattern of high anomalies.
20 Long narrow high anomalies. Purpose unknown. As they run in the area between the track to the town and the supposed west gate of the castle, they may be track related. The low resistance band to their west could be a continuation of the castle ditch, or it could possibly be caused by the north east side of bank (31) not drying in the sun and, being damper, producing low readings.
21 Rectilinear wall-like high resistance linear anomalies. This could be an enclosure of some sort as it is probably too large to be a building.
22 A line of wall-like high anomalies along the top of the slope. If there are castle walls preserved here, this may be the most likely area.
23 Gap in earth bank.
24 High resistance anomalies which could be buildings.
25 A rectangular building-like pattern of anomalies. There are other features in this vicinity which are less clear.
26 A wall-like anomaly. Possibly a field wall.
27 A possible square end to a possible broad wall in the bank.
28 Circular high resistance feature. Purpose unknown.
29 High resistance probably caused by farmyard paving and proximity to the edge of the ditch.
30 Areas of high resistance. These could be collapsed buildings and, if the ditch continued to its north, could be the best candidate for a gateway. They could however turn out just to be where someone put piles of rubble.
31 Bank
32 Rectangular building-like pattern of high anomalies. The low readings in the middle could be a floor retaining groundwater.
33 Building-like pattern of high anomalies.
34 2 pairs of parallel high anomalies, one on each side of a large depression in the field.

4 <u>Conclusions</u>

Magnetometry was able to reveal anomalies which had not been expected. These may relate to a possible prehistoric activities, not just castle related ones.
Fig 20, showing both methods shows that the low linear anomaly (7) is some 3.5m south of the earth resistance high anomaly (15) which it may correspond to. This offset is less apparent for other anomalies such as part of (1) which appears to correspond with resistance feature (28). Clarke1996 p 83 says that in UK latitudes anomalies are detected slightly to the south of the feature causing them. Thus, if this is the cause, then it would indicate that the remains in the area of (7) are far deeper than those at (28). However a displacement of this size would need a very deep anomaly to cause it, which, bearing in mind

the geology, is unlikely here. It may therefore just be a path or area of rubble which was not detected by the earth resstance survey.

The earth resistance appears to support the earlier topographical survey although it has been able to clarify the features which had been identified and has located several others. Some features were located using magnetometry, some by earth resistance. Some showed up on both methods and others will no doubt have been undetected by both methods.

Some wall - like anomalies (34) appear to respect the large hollow in the survey area. This may indicate that the hollow is not just a later quarry.
The double walled features in (32) and (33) are unusual. They could be double narrow walls or the facings of very broad walls with earth and rubble infill. They could also be where a broad wall has been robbed out and the unwanted stone piled on each side of the robber trench. These will need further investigation.
The pond-like feature (28) has many possibilities and any guess is bound to be wrong. These range from a mini-henge as at Dorchester on Thames, to a dew pond to a threshing floor. A dovecote could be another guess, although at approx 12m diameter, it seems a bit large.
The survey of the bank nearest the town (27) indicates that, rather than being a bank, it could be a very broad wall which has collapsed. No evidence of a gateway to the town was found.
The bank (31) across the site between the track to the town and the putative west gate appears to be not an earth bank, but a collapsed building. The possibility of there being a ditch on the north eastern side of this, running alongside the southern side of the track across the site could warrant further investigation.
We were less successful in locating any wall around the site. The best section is that on the northern side. It probably exists in other areas but high resistance caused by the well drained top edge of the surrounding ditches could be similar to the high resistance caused by there being wall rubble there.
The initial assessment, (fig 21), was fairly good at showing that earth resistance would show more than magnetometry and that the remains detected varied little with the mobile probe spacing.
Fig 22 shows grid 8 comparing magnetometry and earth resistance. It is generally good practice to collect data as densely as is practicable rather than relying in interpolation to improve its appearance. This comparison however indicates that on this part of this site, a 1 metre resistivity reading interval would have located most of the features with only 25% of the readings.

Whilst magnetometry indicated some features which were not on the earth resistance plot, on this site earth resistance located most. On other sites and geologies the opposite can happen.
The geophysical findings will need to be considered in the light of other researches into this area as there is always the possibility that some of the features identified could be relatively modern.

Copyright
The Chartered Institute for Archaeologists view is that it is normal practice for both the copyright and ownership of the paper and digital archive from the archaeological work to rest with the originating body (the organisation undertaking the work). We would however be happy for the clients to use the results for any purpose they wish.

Acknowledgements
We would like to thank Paul Clark of the Chipping Norton Buildings Record for asking us to carry out this survey and Mr Caws for permitting access, having the grass cut and showing us around the site. We would also like to thank Mark Bowden for allowing us to use the hachure plan which was made as part of an English Heritage training exercise. Our clients are grateful to the Council for British Archaeology for part funding this survey from the Mick Aston Archaeology Fund.

Disclaimer
Geophysics is not always successful in locating sites. Whilst we do our reasonable best to locate features we cannot influence ground conditions and the state of preservation of remains. Graves and spreads of material are seldom located. The failure to locate remains does not mean that they are not there. Geophysics on its own cannot give a date to remains.

Figures
Magnetometry

Fig1 The gradiometer survey approximately located on a Google Earth air photo

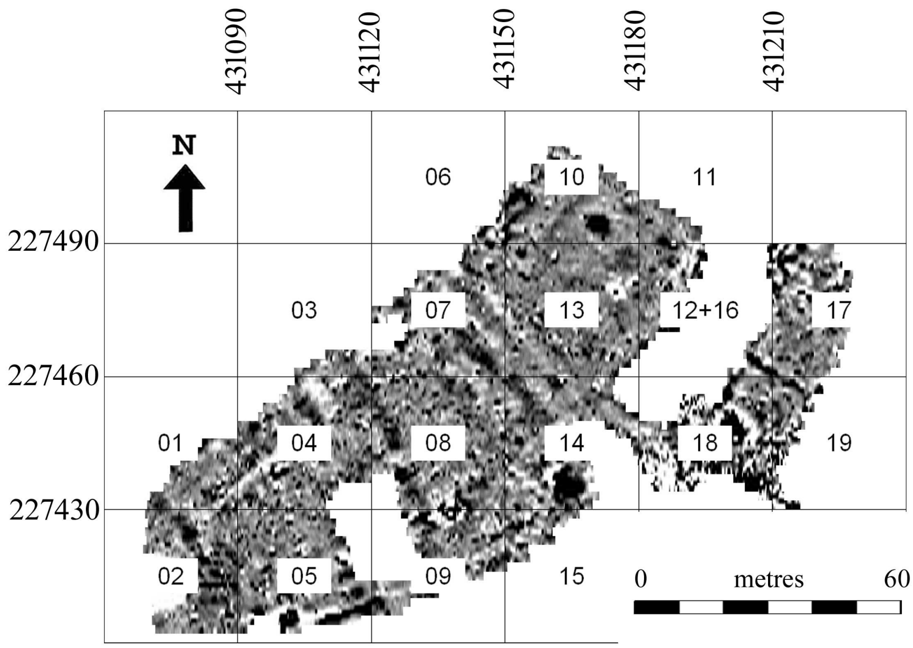


Figure 2 Detailed grid order and location

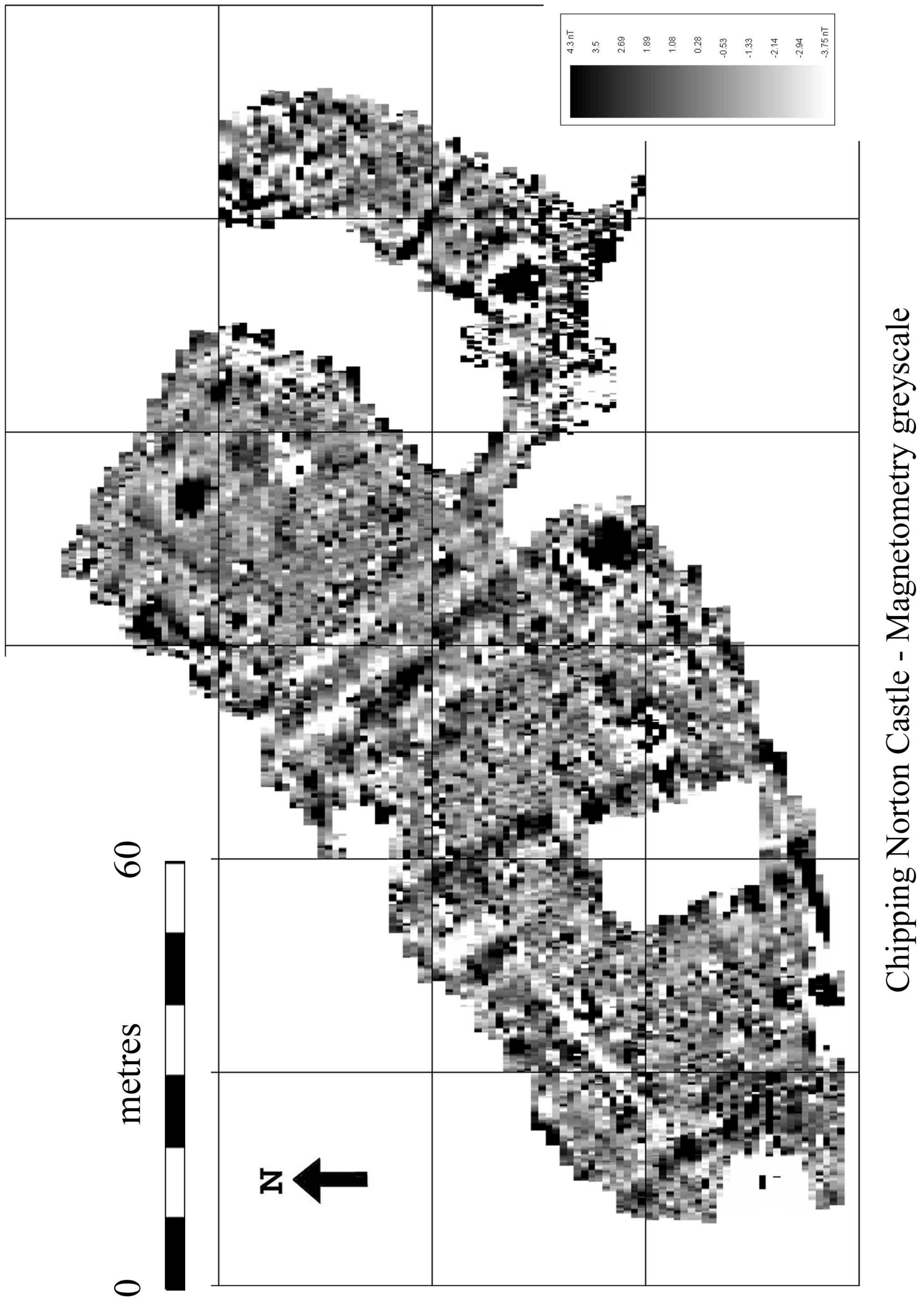


Fig 3 Magnetometry plot

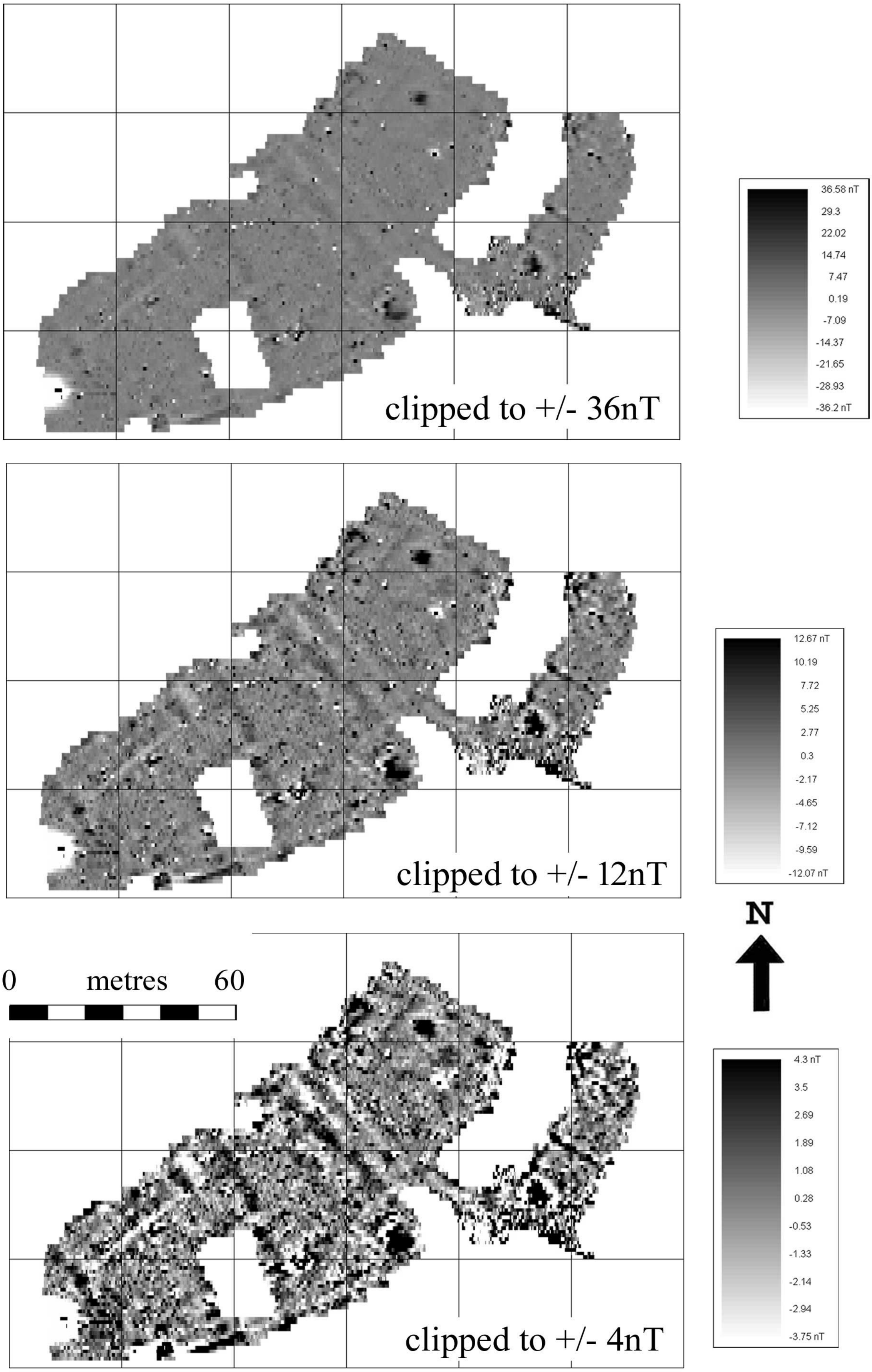


Fig 4 Magnetometry processed at different levels

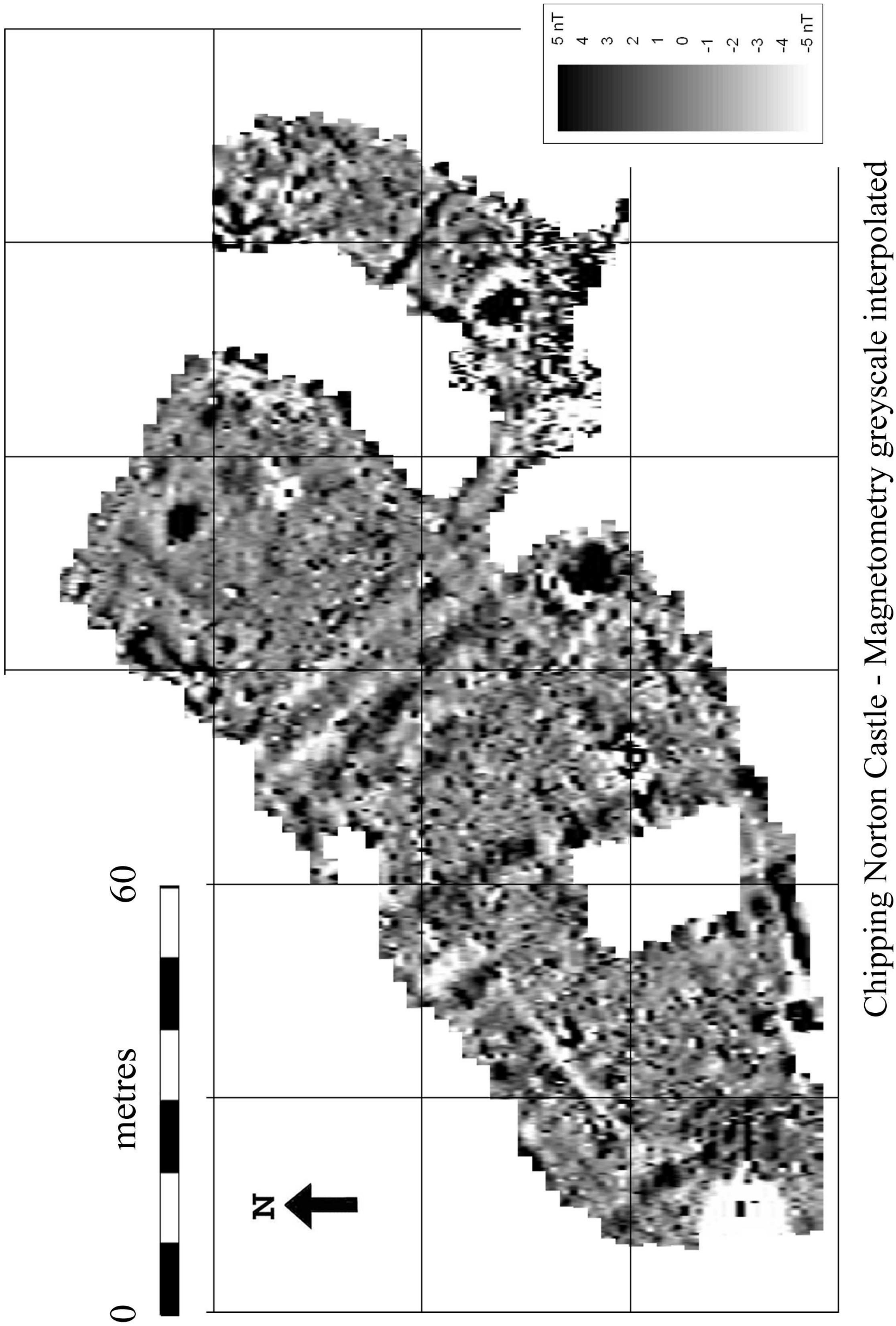


Fig 5 Magnetometry Interpolated

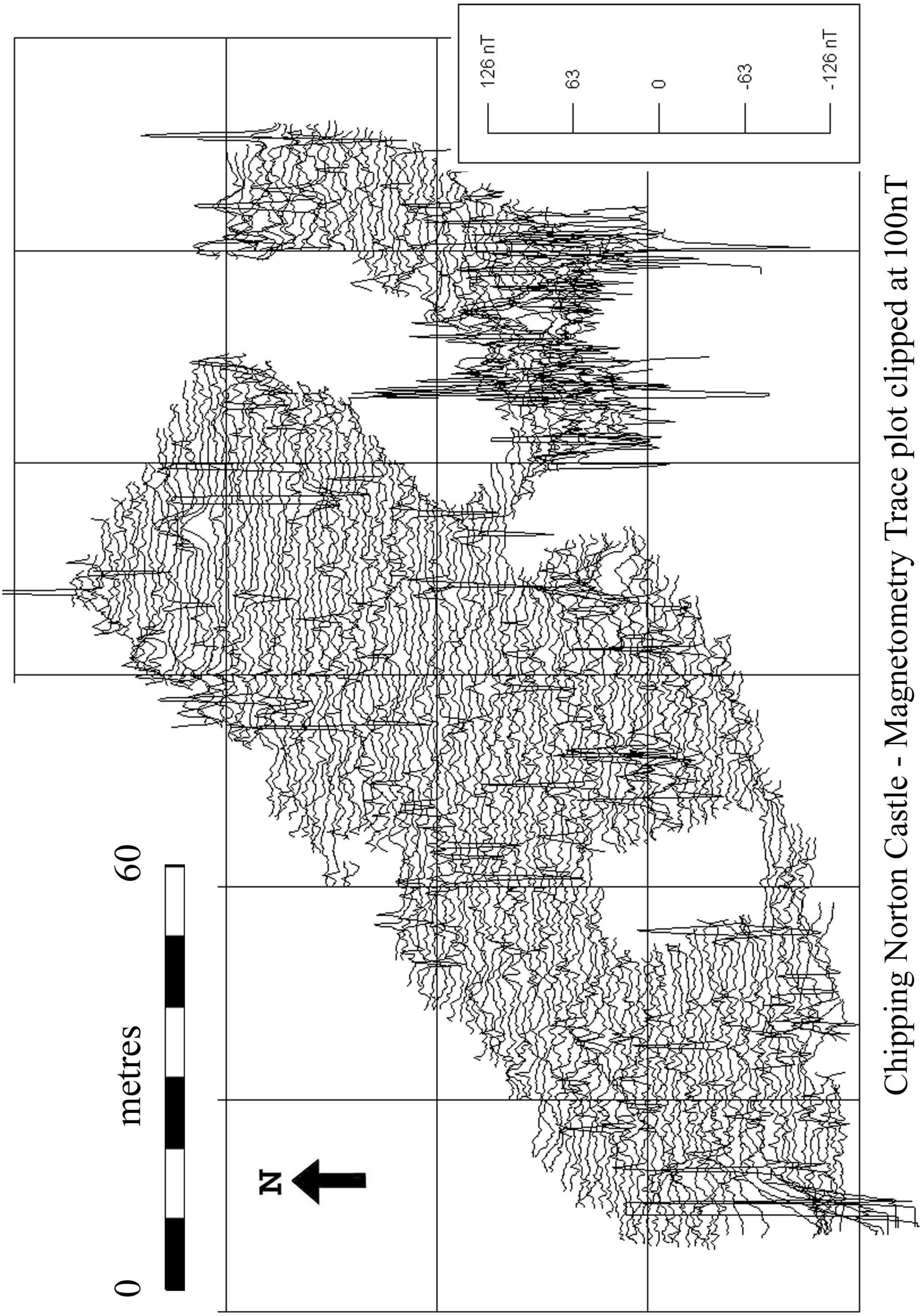


Fig 6 Magnetometry trace plot

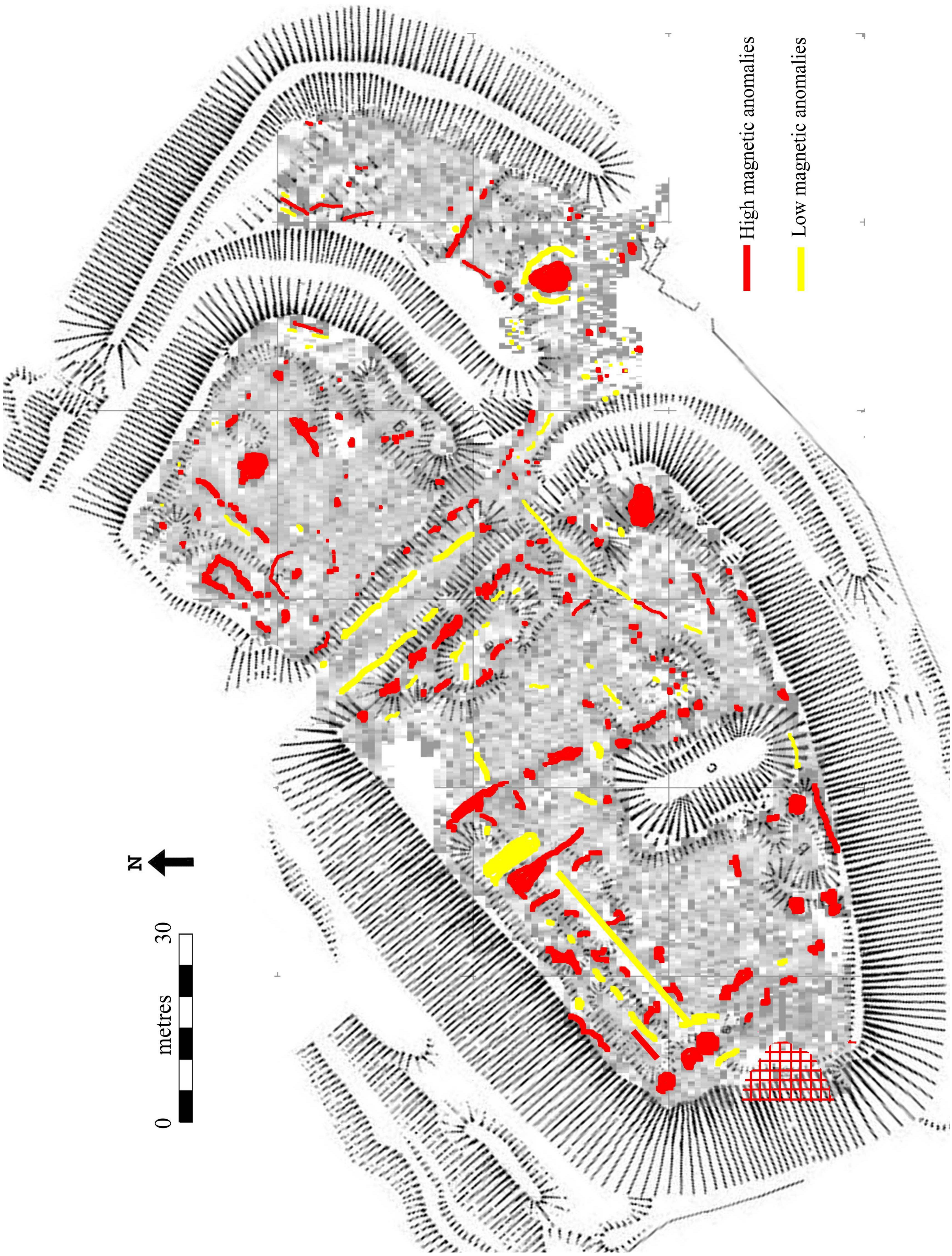
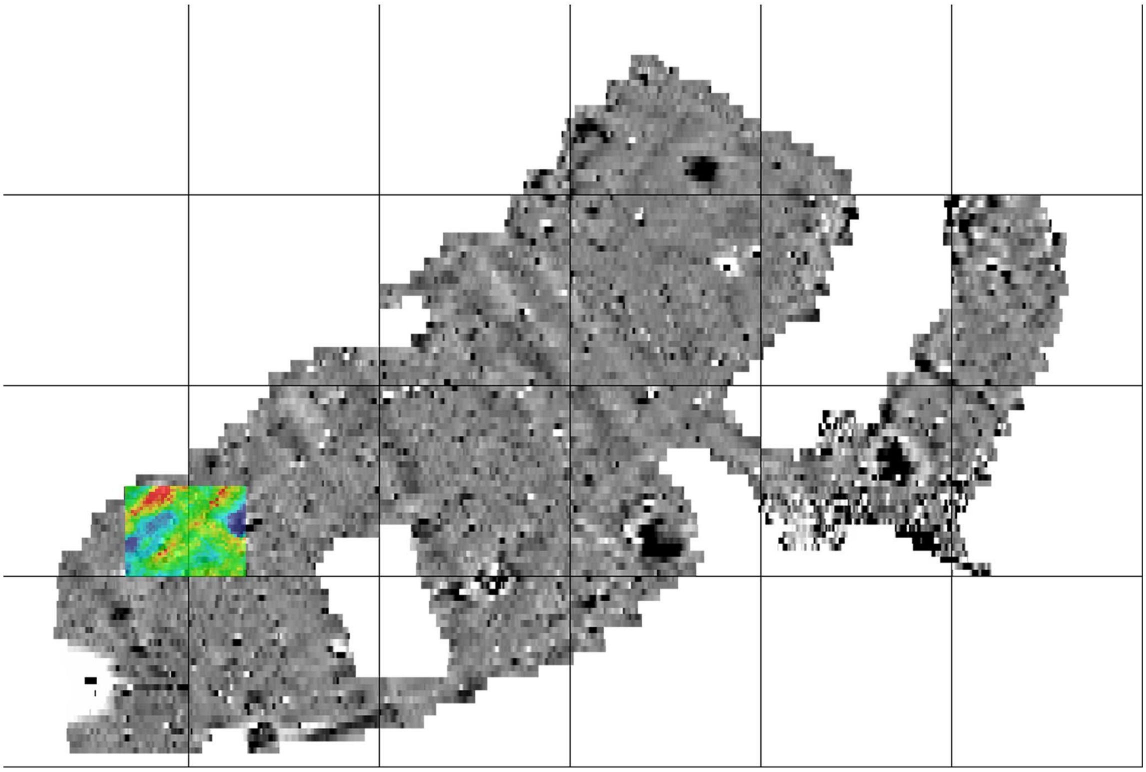
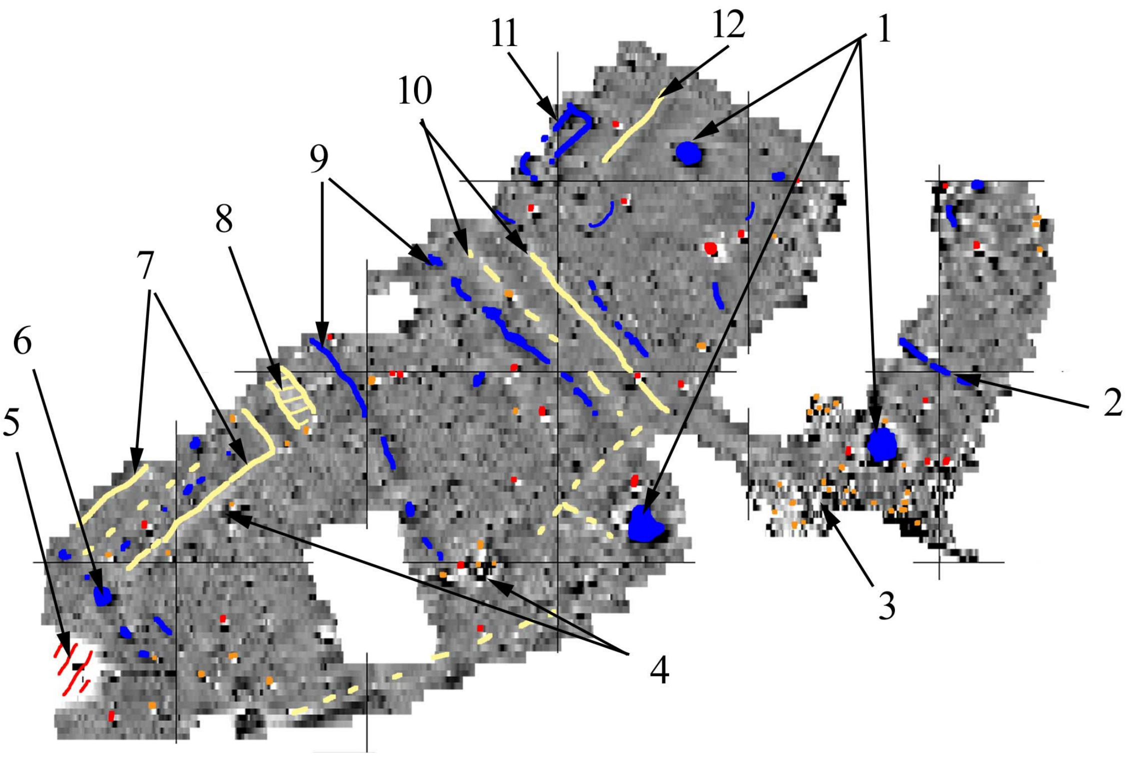


Fig 7 Magnetometry on hachure plan.





Chipping Norton Castle. Magnetometry Interpretation

Fig 8 Interpretation and reference plots

Earth Resistance

Fig 9 Earth resistance survey approximately located on a Google Earth air photo

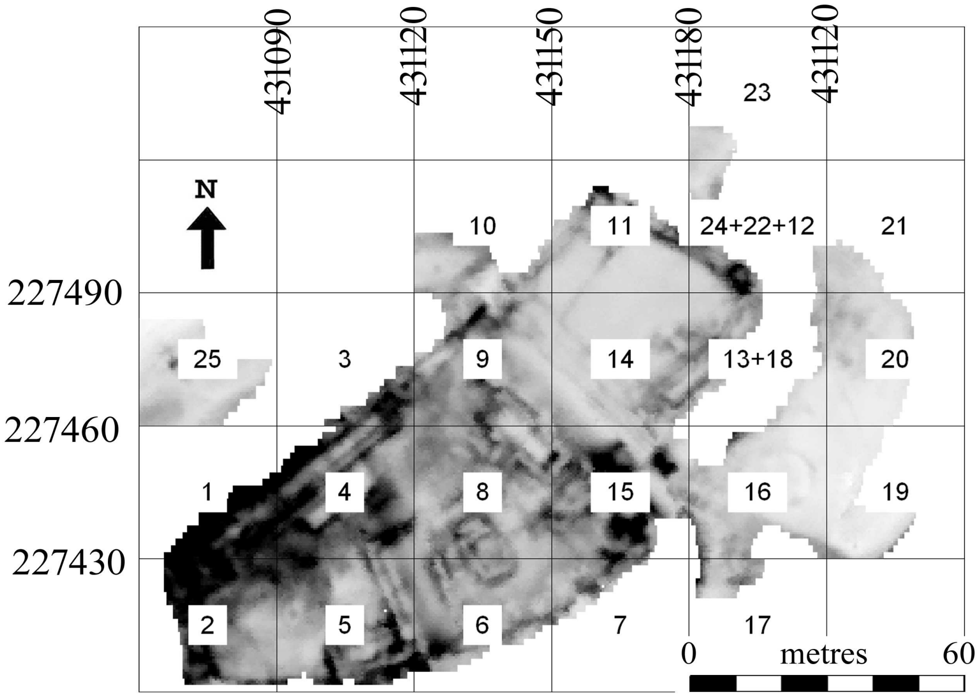


Figure 10 Detailed grid order and location

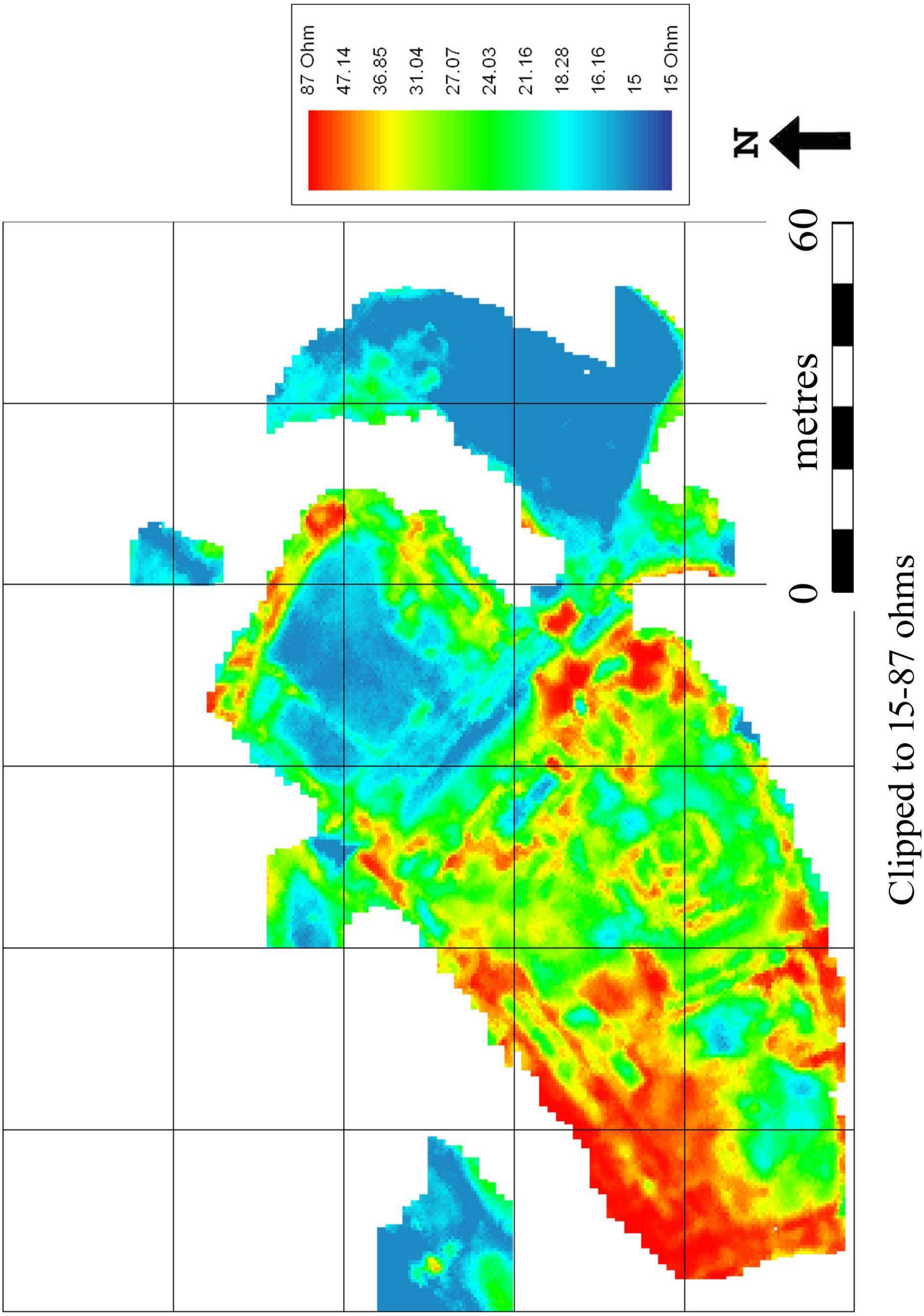


Fig 11 Earth resistance Colour plot

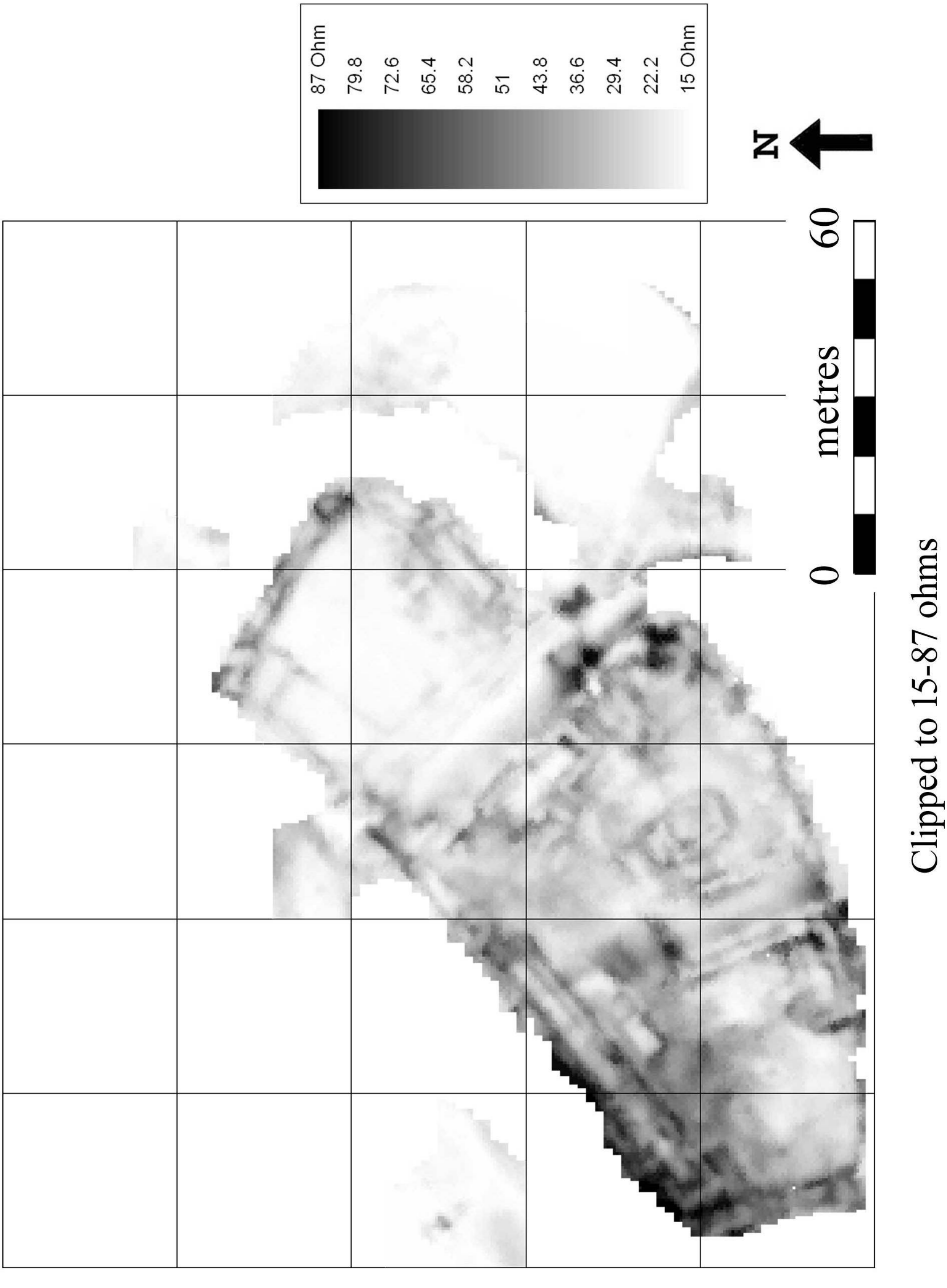


Fig 12 Earth resistance clipped 15-87ohms.

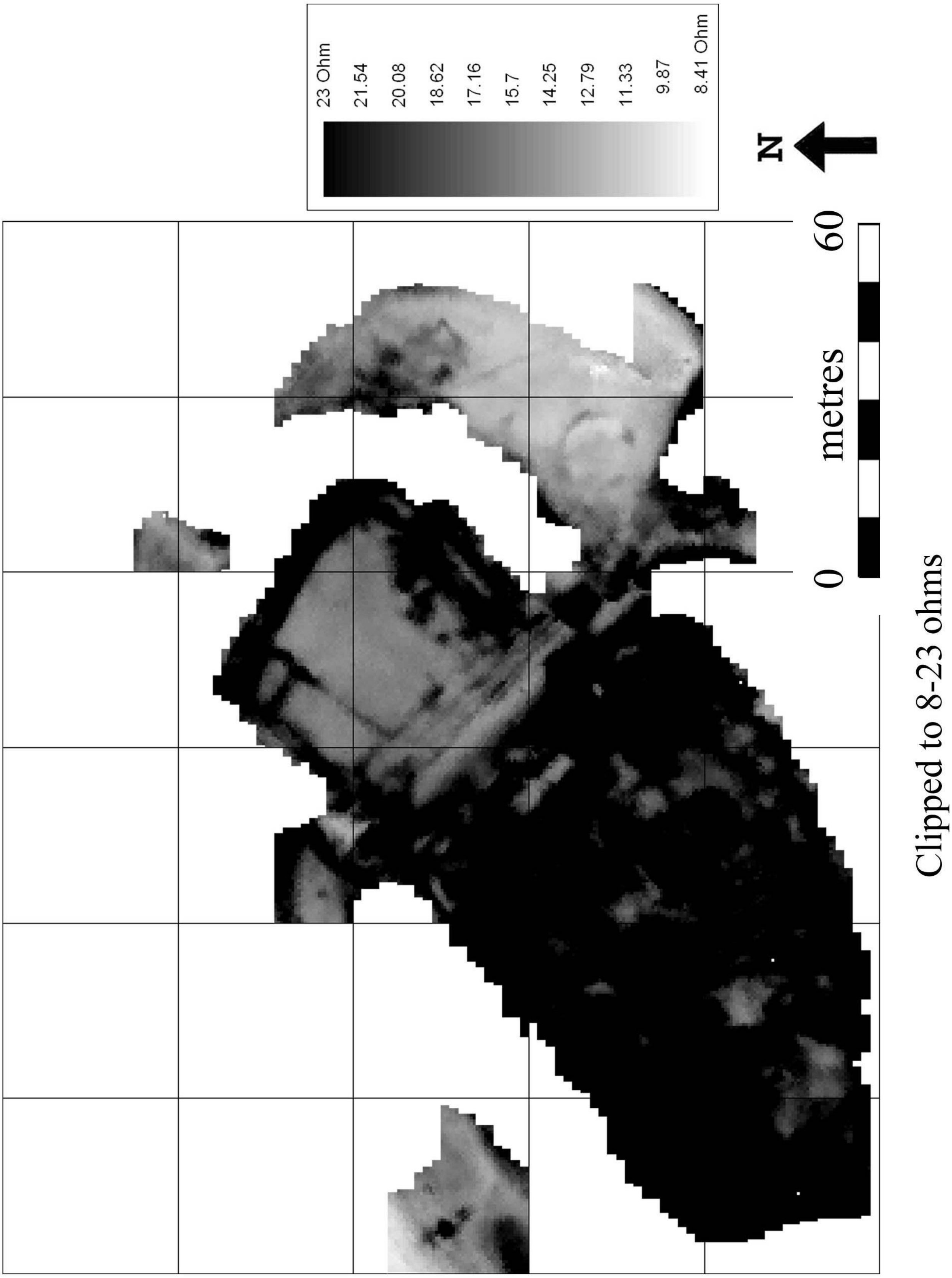


Fig 13 Earth resistance clipped 8-23 ohms.

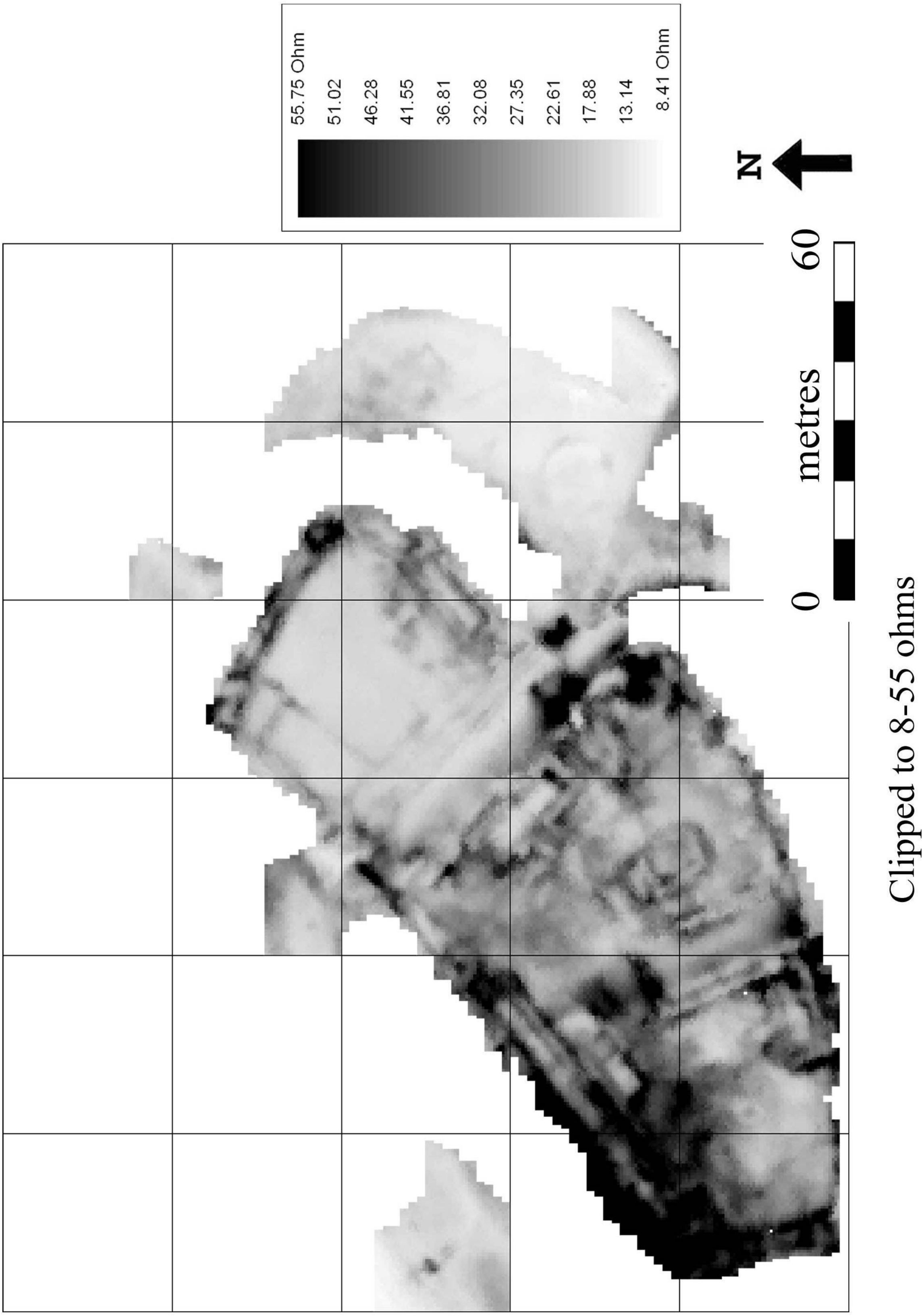


Fig 14 Earth resistance clipped 8-55 ohms

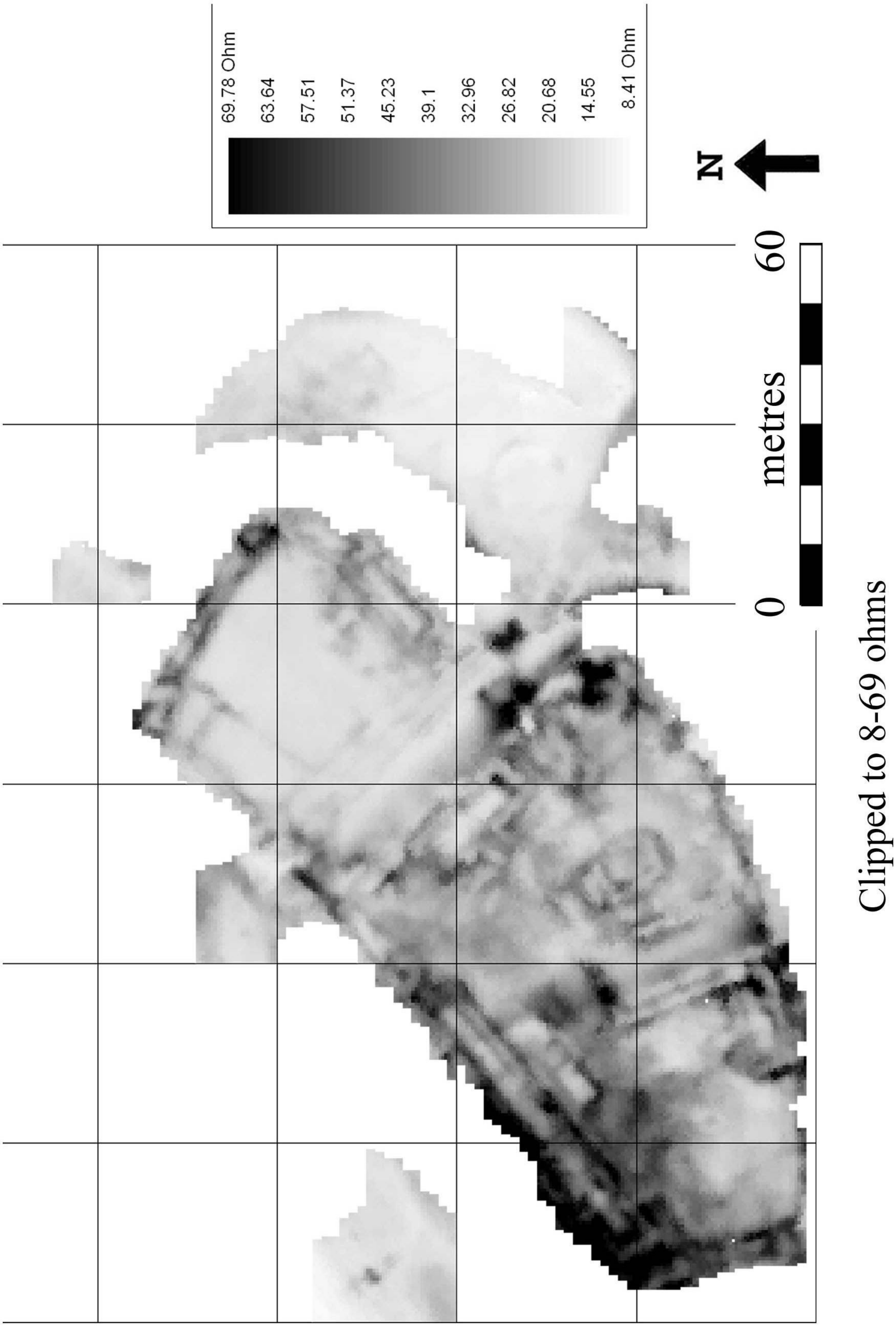


Fig 15 Earth resistance clipped 8-69 ohms.

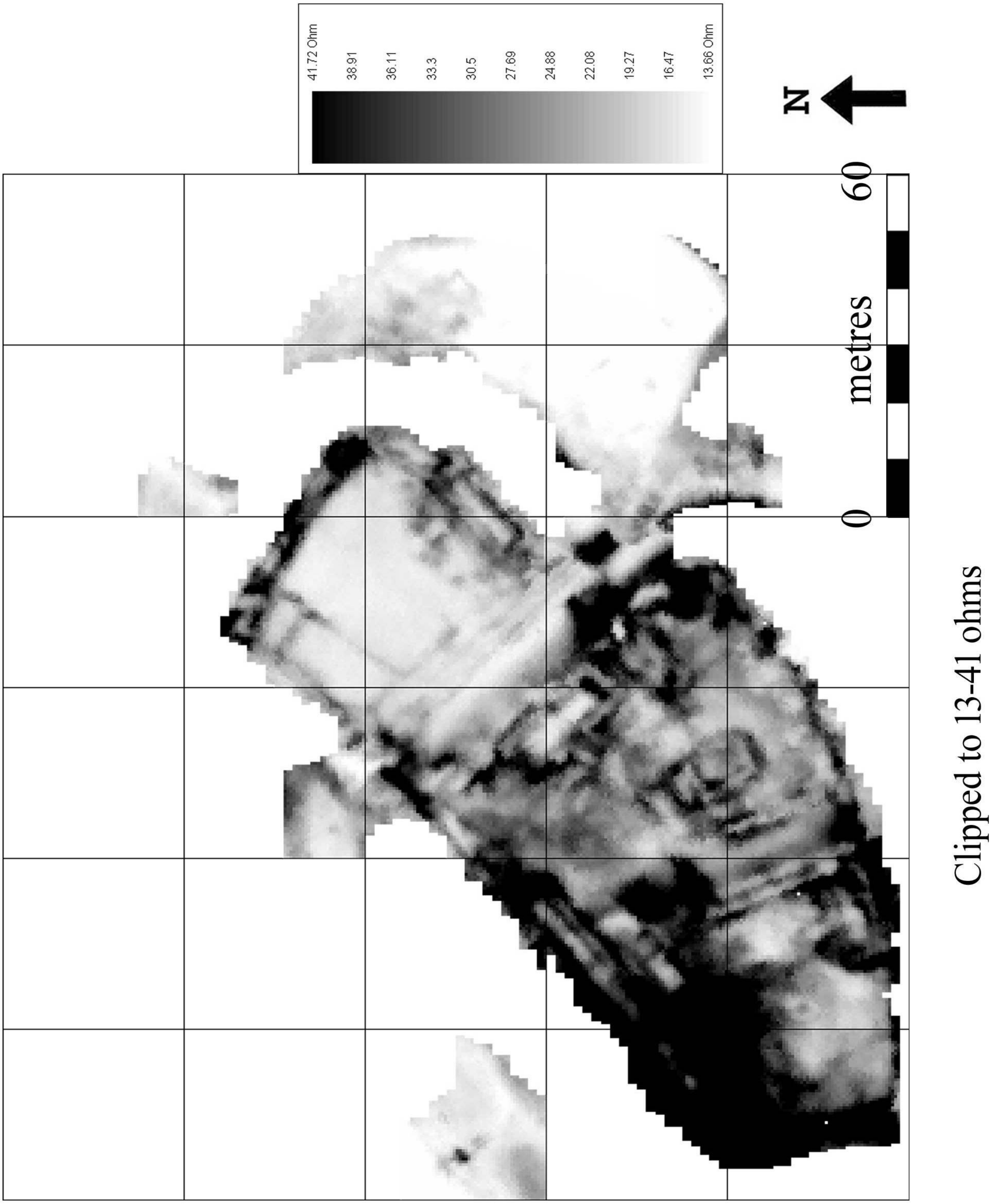
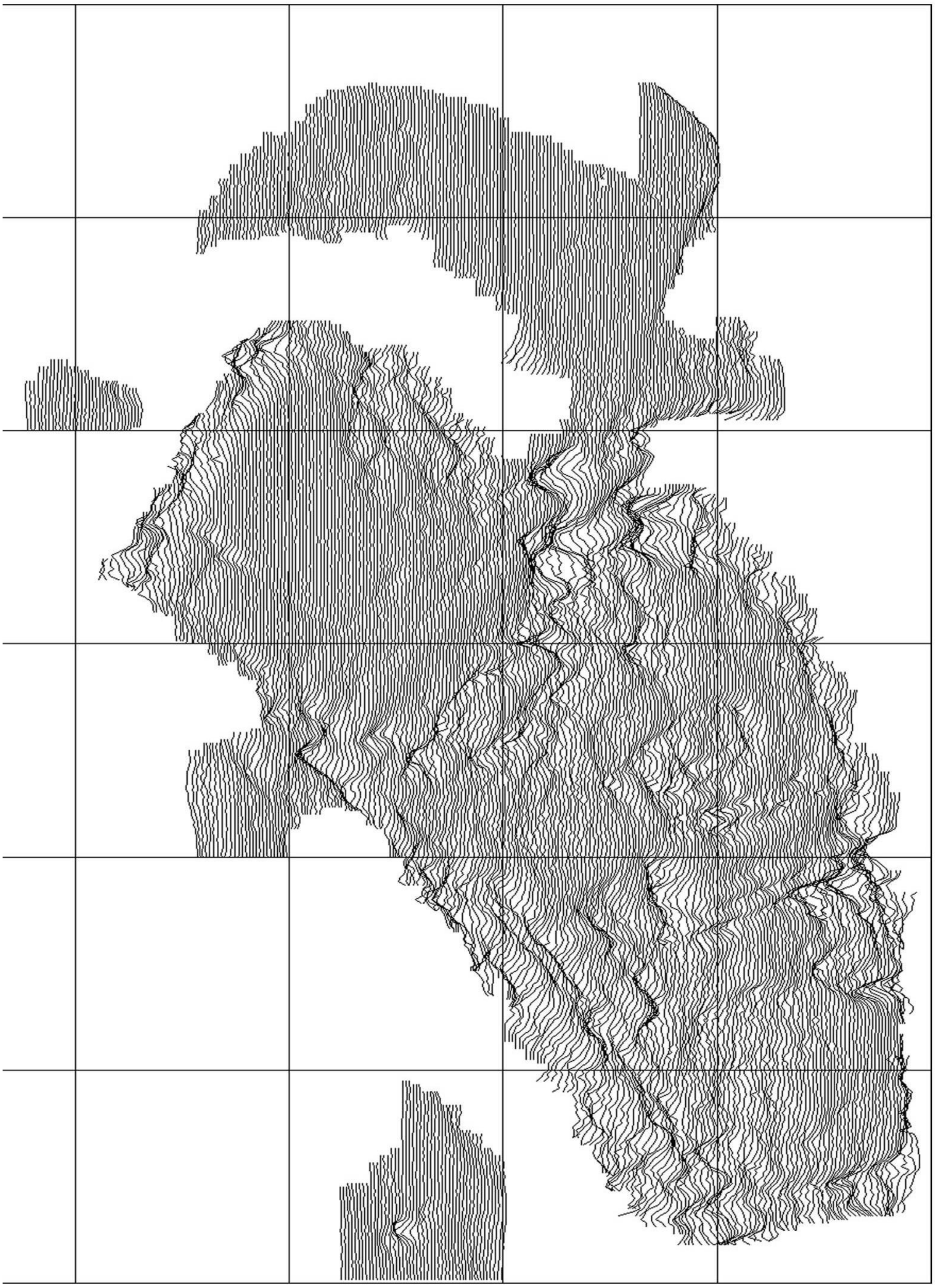


Fig 16 Earth resistance clipped 13-41ohms.



Trace plot

Fig 17 Earth resistance trace plot

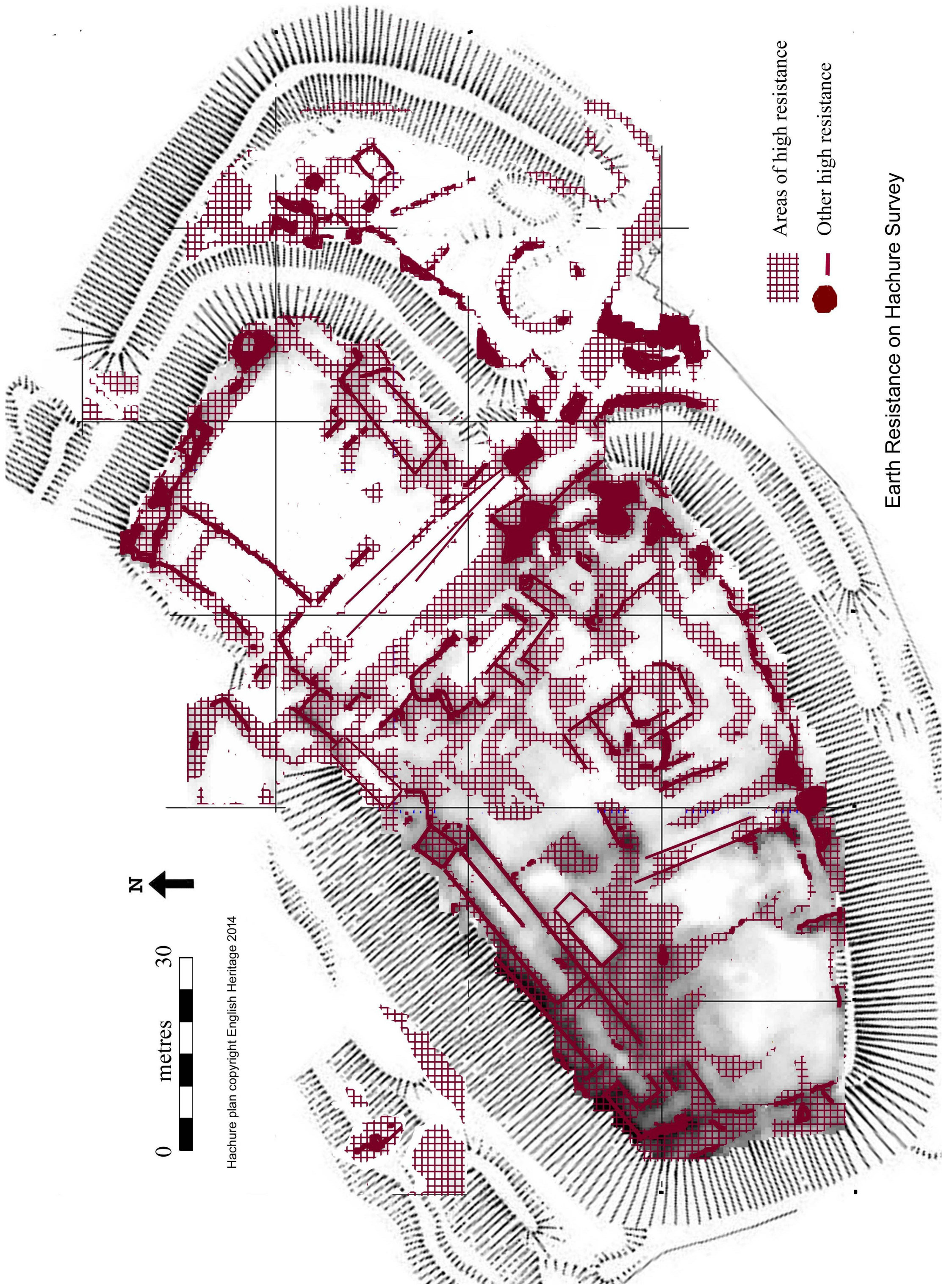


Fig 18 Earth resistance on hachure survey

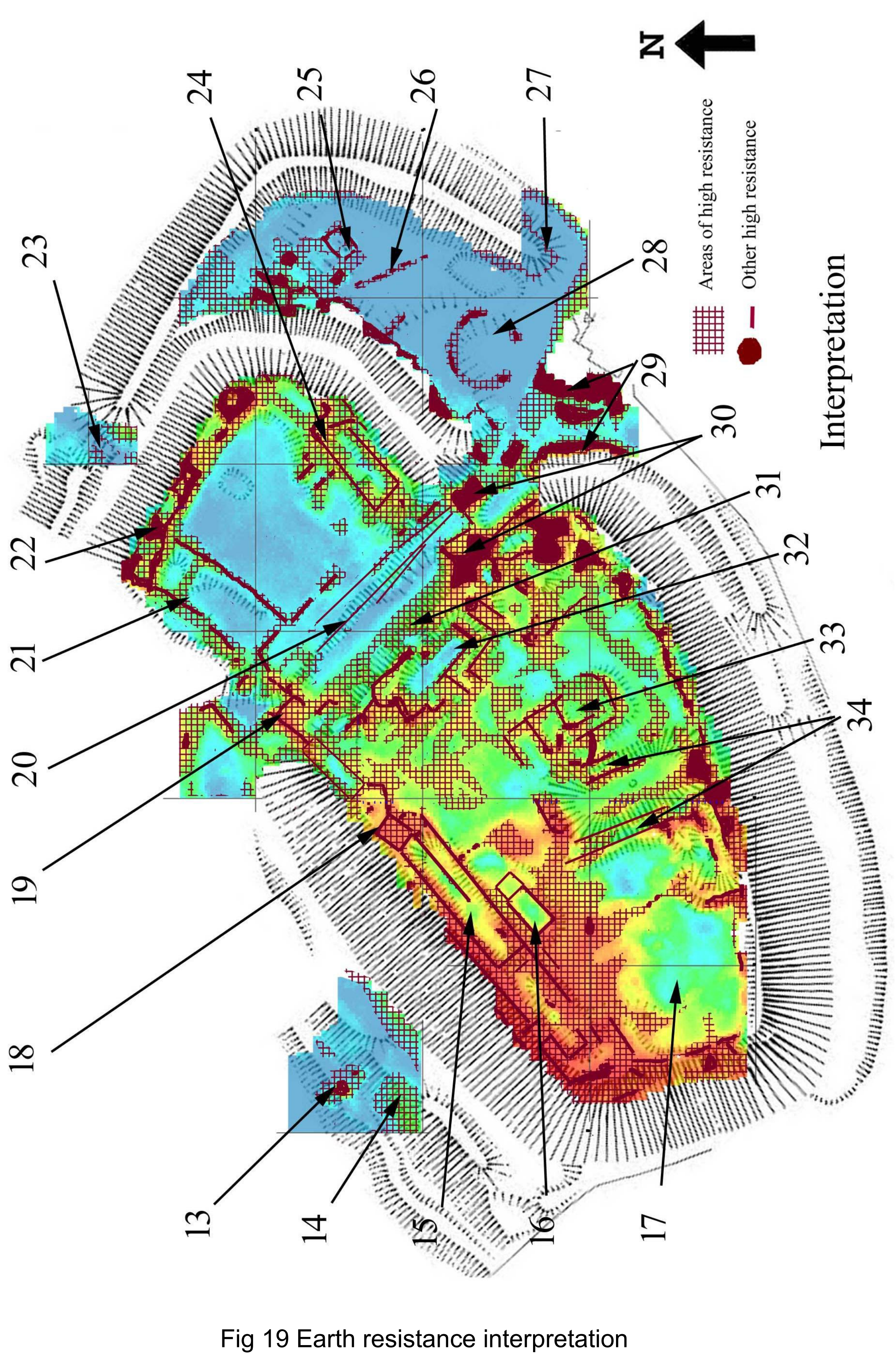


Fig 19 Earth resistance interpretation

Combined

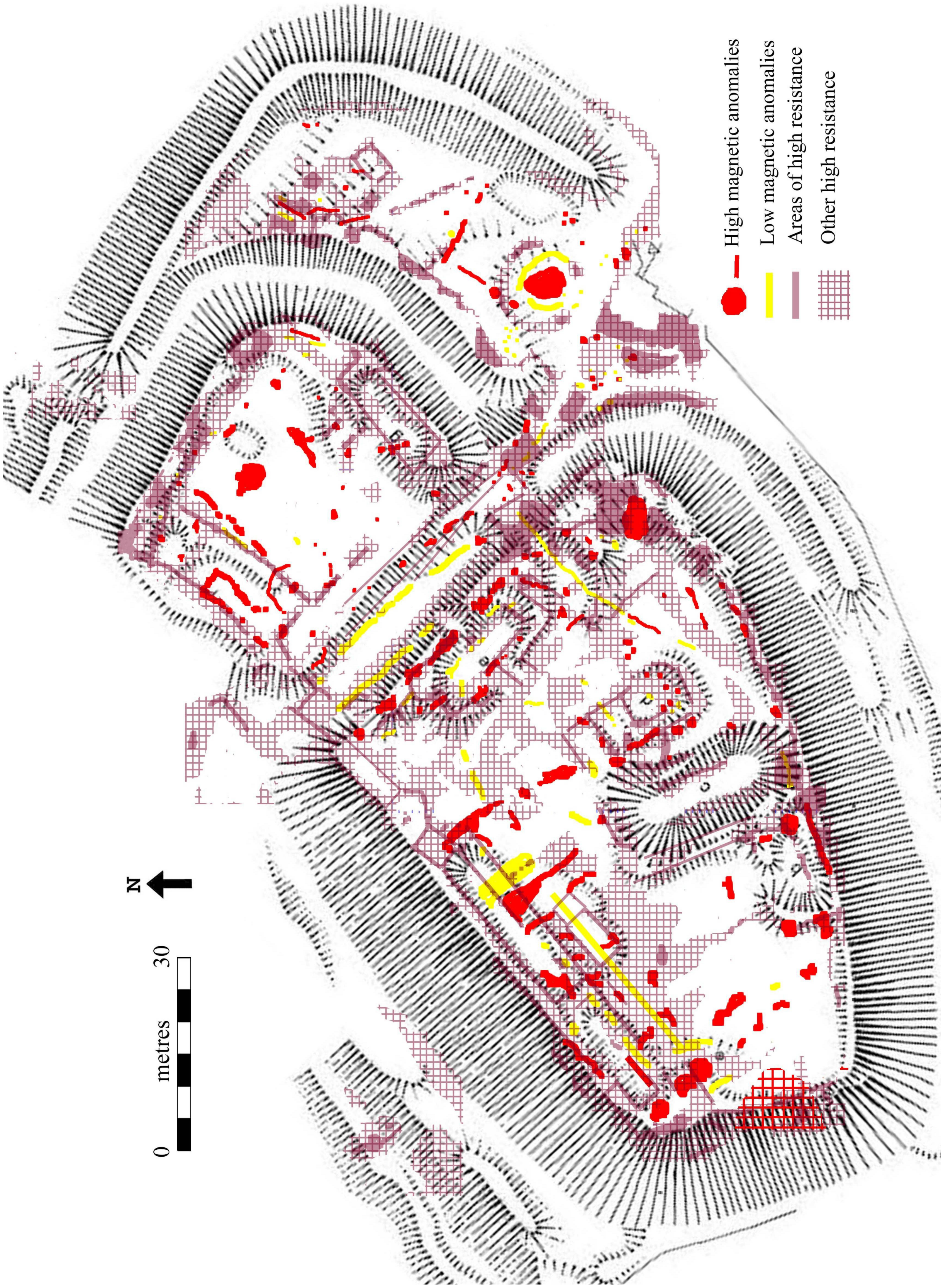


Fig 20 Magnetometry and Earth resistance on hachure plan.

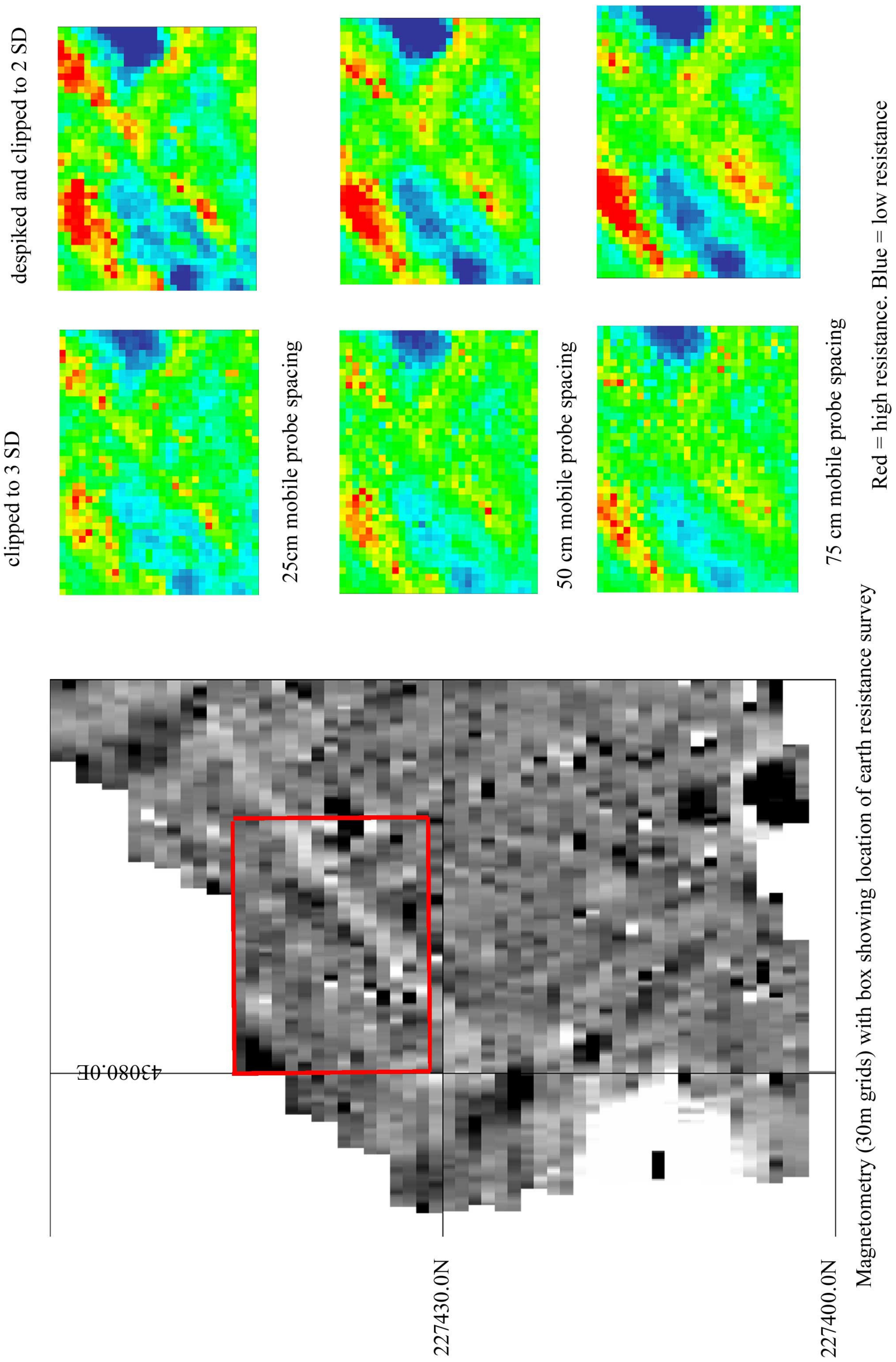
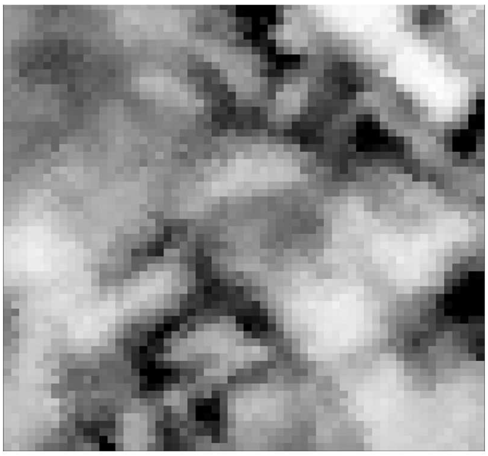
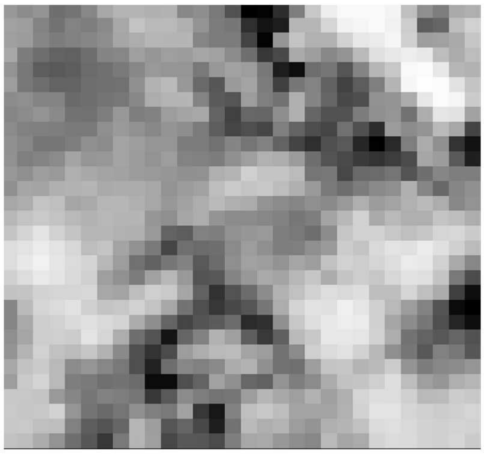


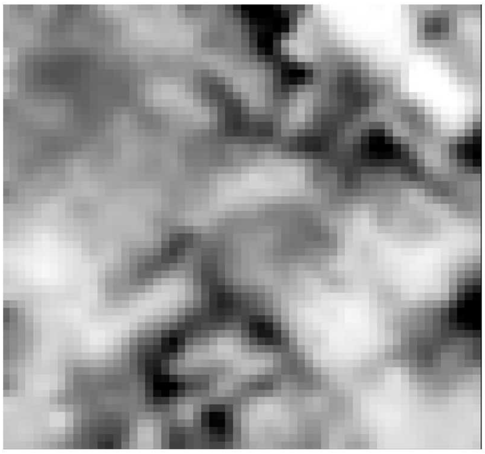
Fig 21 Initial assessment survey



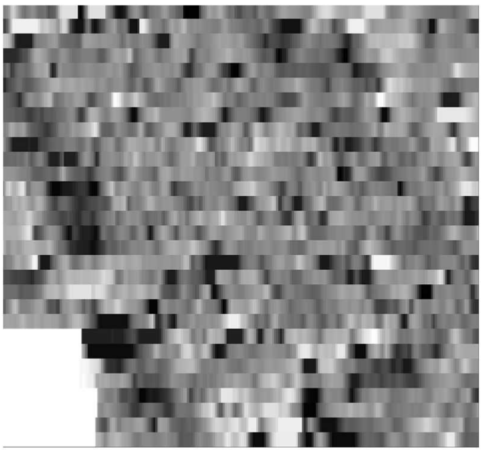
Resistivity at 0.5m reading interval



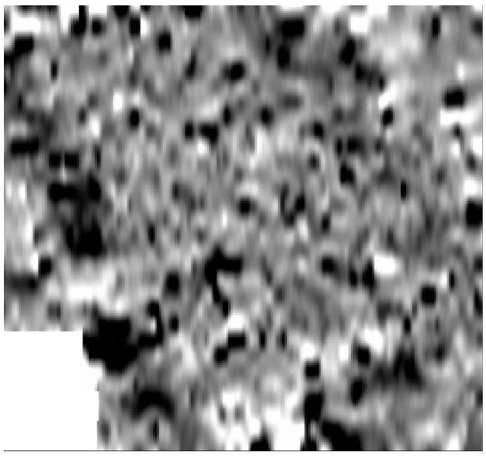
Resistivity at 1.0m reading interval



Resistivity at 1.0m interpolated to 0.5m



Magnetometry at 1m x 0.125m



Magnetometry interpolated to 0.125m x 0.125m

Fig 22 Grid 8 Comparisons

5 Technical details of methods and equipment.

5.1 Magnetometry

A magnetometer is designed to detect variations in the Earth's magnetic field. These variations occur where the field has been changed by factors such as iron pipes and features of archaeological interest. To be detected these features have to have certain properties. They have to contain iron which can be magnetically enhanced by human settlement. The larger the difference the better it can be detected. This enhancement can be by being burnt or it can be caused by microbes which by some process tend to concentrate magnetic material. The two factors necessary are therefore to have iron in the soil and for this to have been changed where human activity (or bacteria) has altered it.

It is therefore very unlikely that features will be detected which are made exclusively of oolitic limestone or chalk as these deposits contain very little iron. Even if there has been a lot of human activity there has just not been the iron there for that activity to enhance. Fortunately the topsoils on chalk soils often have quite strong magnetic characteristics so they can reveal ditches and other features which are cut into the underlying chalk. It is this difference in one area having magnetically enhanced soil and others not having it which is detected. A road surfaced with limestone cut into an iron rich topsoil would similarly show as that area would have less magnetic enhancement than the surrounding soils.

The theory is all very well but the practicalities are more difficult. The main problem is that the earth has a magnetic field of approximately 47,000 nanoTesla (nT) whilst the features which we are seeking to detect have a difference above the background level of 0.5 to 10 nT. Things are complicated further by the magnetic field then changing during the day and by magnetic fields caused by railway trains, electricity pylons and other factors changing as well. In order to seek to overcome these problems the sensors which are used are put in gradiometer mode which means that they are mounted as pairs with one above the other. Our equipment has the sensors separated by 1 metre but other manufacturers make equipment where the separation is 0.5 metres. What happens then is that the earth's magnetic field is detected by both sensors but only the bottom one also detects most of the reading caused by archaeological features. The readings from the top sensor are automatically deducted from those of the bottom sensor and this gives the reading which should approximate to the reading of the archaeological features.

Like most UK archaeological geophysicists we use fluxgate sensors in gradiometer mode. Other types, such as caesium sensors are also used by some and claim a greater degree of sensitivity than fluxgate sensors. The English Heritage guidance, (David 2008, p21) is that 0.3nT is adequate for most UK soils, so our equipment's 0.1nT is well within that. As caesium sensors are even more expensive than fluxgate ones they tend not to be used in gradiometer mode with any drift being sorted out by the data processing. The one site where we were able to compare our results with caesium survey found that the caesium had found ridge and furrow, also visible on Google Earth, better than the fluxgates. The fluxgates however had located a Bronze Age enclosure and presumed Iron Age houses which were not identified in the caesium report. This may be because the fluxgates may be better at identifying narrow cut features rather than spreads of material. Our test of the site used by English Heritage to compare equipment showed little difference between the types and Gaffney and Gater show similar comparisons.

Our single axis fluxgate magnetometer will detect ditch - like features better than it can detect shallow spreads even of the same volume. The orientation of the survey traverses can be of importance as the processing used to remove striping caused by minor balancing errors in the sensors can also remove some of the data from the archaeological features. It is therefore best to have a grid at an angle to the expected remains rather than being on the same alignment.

Magnetic anomalies are difficult to detect at the best of times and the amount which can be detected declines rapidly as the distance between the anomaly and the sensor increases. Therefore it is important to have the sensors low enough to maximise data from archaeological features whilst avoiding confusion caused by minor ferrous material on the ground and also avoiding the sensors being caught in vegetation. We tend to carry ours with the bottom sensor approx 20cms from the ground surface. The equipment can therefore detect small shallow anomalies or deep ones provided that they are large. Alluvium covering weak archaeological anomalies can therefore make them undetectable.

Whilst the English Heritage 2008 guidance specifies a minimum of a 1m line interval and 4 readings per metre along the lines, we have a 1m line interval but 8 readings per metre along the lines. This can detect smaller features and enables the de-staggering process to be more accurate.

Processing

Magnetometry

We use the programme TerraSurveyor (formerly ArcheoSurveyor) to process the data. In general one should avoid over processing as it can create spurious features. However the presence of large anomalies caused by iron pipes means that the data has to be clipped as otherwise the plots would show little more than the largest anomalies. After clipping a zero mean traverse can be used which removes striping in the plot caused by the magnetometers not being balanced with each other and going out of balance during a survey. Magnetometers are balanced at the start of work and at lunchtime to reduce the drift and in hot weather even more frequently. That being said, our Bartington magnetometers are far more stable than their predecessors. The next process is destagger. This removes the zig zag effect of delays at the start of walking lines and sensor logger lags. As we use a marked string to ensure the location of each reading these are fairly constant although sloping and bumpy ground can cause variations. Despike can be used to remove interference from iron nails and similar debris, although this may be best avoided as occasional high readings may be caused by roof tiles and be the main indicator of a building.

5.2 Earth Resistance (also known as Resistivity)

This is, in theory, the simplest method as it relies on detecting the electrical resistance of the soil. In practice this is more complex as it has been found that if you just place two probes into the ground then the current between them will change as the ground around the terminals becomes polarised. Then if you then stick the probes into the same area again you get a different reading. This is caused by the contact between the soil and the probes changing each time as different surface areas of grains touch the surface of the probes. To overcome this various arrays of probes have been developed but these rely on the current being sent via one set of probes and read by another set. There are various arrays such as Wenner, Schlumberger, pole-pole and Twin. The most commonly used are twin and pole-pole, both of which involve having a pair of remote probes at least 15 metres away from the area being surveyed (assuming 0.5 metres between the mobile probes in the survey area). For a twin array the remote probes are spaced approx 0.5metres apart and this is increased to over 15 metres for pole-pole.

Earth resistance is largely dependent upon the moisture content of the soil and this will vary from day to day, producing different results. A ditch will often have silts which retain moisture whilst the natural soil around may be more freely draining. Of course the opposite can happen, as rubble filled ditches can be more freely drained than the surrounding soils. Similarly walls tend to be drier and give higher resistance values than the soil around them. Various pieces of equipment are used which can give between one and four readings at a time. Usually these have probes which are separated by 0.5 metres which can give a depth of reading of almost 1 metre-depending upon soil conditions and probe array. A 1 metre separation between the probes in the survey area, (the mobile probes), can go even deeper.

Earth resistance survey is good for finding walls but has the drawback of being far slower than magnetometry - about one third of the speed at best. The data often needs less processing than magnetometry data although high pass filtering can be useful to remove the effects of geology on a site, and de-spike used to remove the effect of the occasional poor reading caused by the probes hitting stones on the soil surface. The other main drawback of this method is that as it is greatly influenced by the amount of moisture in the soil. In the summer soil conditions can be too dry to get good results and in the winter the opposite can be the case. Often, however, something shows at most times of the year, it is just that at optimum times the clarity of the features is far better. In some areas, particularly urban areas, there are electrical currents which have leaked into the earth or are there as part of the electricity transmission system. These can badly affect the readings and filtering them out lengthens the time taken to carry out the survey.

Interpreting resistivity results can have its problems which include:-
Walls usually have high resistance but robbed out walls can have low resistance.
Ditches usually have low resistance but if they are filled with rubble or gravel they can have high resistance during dry periods.
Paved surfaces can resemble broad walls but sometimes the paving ponds groundwater creating a low resistance area.

Processing

Resistivity

This generally needs less processing than magnetometry. Clipping and replacing individual readings can stop occasional high readings caused by poor contact from distorting the survey plot. De-spike can also achieve this. Edge matching can reduce distortions caused when grids have been surveyed on different days with different amounts of soil moisture although this is usually done by adjusting the spacing of the remote probes as the survey progresses. A high pass filter can partially remove the effect of ground moisture naturally varying in a sloping field.

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