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Geophysical Survey of land in the grounds of Tackley School and Tackley Playing Field

2018 - 08V3

3

The report also contains a CD which has the data and illustrations to enable them to be archived and used in other publications and presentations.

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Client	Tackley Local History Group – John Perkins
Report reference no	2018 - 08V3
Date	28 December 2018

Contents

List of figures

1 Summary

We were asked to survey these areas to see if remains similar to the Roman Villa which has recently been excavated by Thames Valley Archaeological Services to the north east could be found. Magnetometry found little, but earth resistance located features which may be of interest.

2 Introduction

Location

The site is in 2 parts - one part being the school playing field and the other the village playing field near the village hall nearby. The school area has ferrous fencing which interfered with magnetometry results. The village hall field also had some steel fencing and steel in the construction of the building.
The nearest postcode for the village hall area is OX5 3AH and the grid reference is SP48002065.
It is in Tackley parish, in the West Oxfordshire District of Oxfordshire.

Background

Thames Valley Archaeological Services have recently excavated substantial Roman remains in the field on the north east of the site. There are 17th century ornamental gardens and fishponds to the south east of the site.

Geology at site

The geology of Britain viewer has the geology as oolitic limestone without giving a drift geology. We are however advised that the plough soil is approx. 25-30 cms deep and lies on a bed of fine river gravel.

Topography

The site is on low lying flat ground surrounded by low hills with a stream running along the southern boundary of both sites.

Field conditions

Both areas were fairly level with short grass. The main obstructions were play equipment and similar.

Weather

It had rained the previous day and during the survey. It was colder than expected for the time of year and there had been a slight frost early in the morning.

Dates of work

27 October 2018.

Location of:

a) Primary archive, i.e. raw data, electronic archive etc

Abingdon Archaeological Geophysics and with the client.

b) Full report: Ditto

Surveyor
Abingdon Archaeological Geophysics, Roger Ainslie, Sally Ainslie.

3 Methods

Please see section 10 for details of the techniques used.

Type of survey
Magnetometry
Area surveyed: 0.3 hectares
Traverse separation, if regular: 1.0 metres.
Reading / sample interval: 0.125 metres
Type, make and model of instrumentation: Bartington Grad 601/2 single axis fluxgate gradiometer.

Earth Resistance
Area surveyed: 0.04 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.
Resistivity data was processed to replace approx 5 erroneous readings.
It has then been clipped to reveal features.
Magnetometry was clipped and de-staggered by 65 cms.

Additional remarks
Grids set using tapes and optical square and then located using a Trimble pro XR differentially corrected GPS, probably accurate to 0.5metres.
Survey carried out in 30 metre grids.
First line start SE corner going west zig zag.
Earth resistance mobile probes on frame with 4 probes and thus capable of taking 3 readings parallel to each other.
1.0 second filter needed to seek to reduce the effect of earth leakage currents. These were far higher than expected and doubled the survey time.

4 <u>Results</u>

We located a curved ditch - like feature in the earth resistance survey. The magnetometry didn't locate much of interest apart from a possible semi circular gully.
The interpretation plots in Section 9 show the details.
Magnetometry
Area 1
1 Interference caused by steel fencing.
2 Probably brick or other building rubble. Date unknown.
Area 2
3 Semi-circular arc of high readings. Could be a gully. Date unknown.
4 Probably brick or other building rubble. Date unknown.

5 High anomalies. Probably iron manhole covers and similar.
6 Interference caused by steel frame of village hall.

Earth Resistance

Area 2 grid 3 (part)

7 2 possible ditches.
8 High resistance bank. Possibly upcast from ditch 9.
9 Probably a curved ditch.
10 A possible small ditch or straight gully. Most visible in the greyscale plot.

5 Conclusions

We could not locate remains similar to the Roman site nearby. I understand that there they tried geophysics without useful results, although I have not seen those results. Whilst we used earth resistance to clarify the possible gully (3) seen in the magnetometry, it located a curved ditch (9) invisible to magnetometry There could therefore be other remains there which are also invisible to magnetometry. The earth leakage currents could make this more difficult than usual, although the low pass filter can seek to remedy its effects on the data. See the fig 5 interpretation plot for this.

Why the magnetometry didn't work is presently unknown. It could be that in the valley bottom there is a greater depth of colluvium which masks remains. Another possible cause could be if thee has been flooding with alluvium coming down the Cherwell and depositing magnetically enhanced minerals which are masking remains.

6 Copyright

7 Acknowledgements

We would like to thank John Perkins and the Tackley Local History group for asking us to carry out the surveys. We would also like to thank the school and Parish Council for allowing access.

8 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.

9 Figures

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

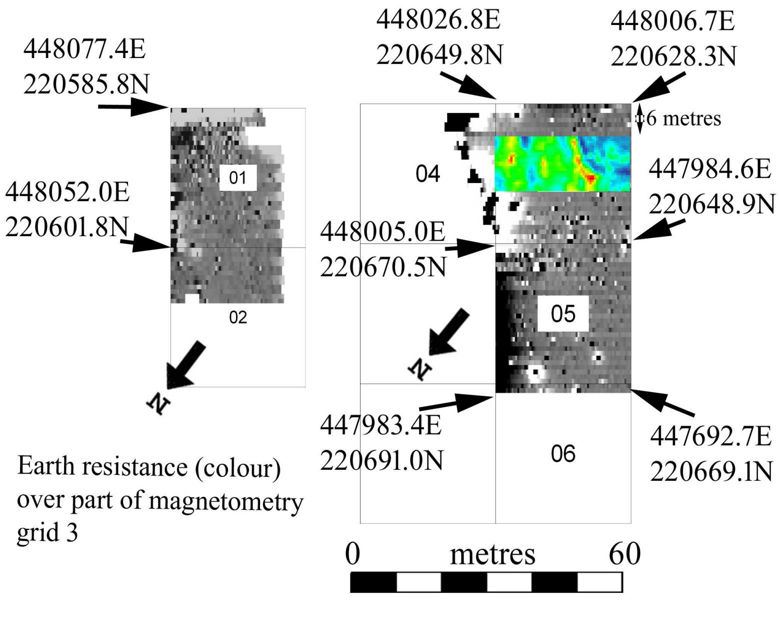
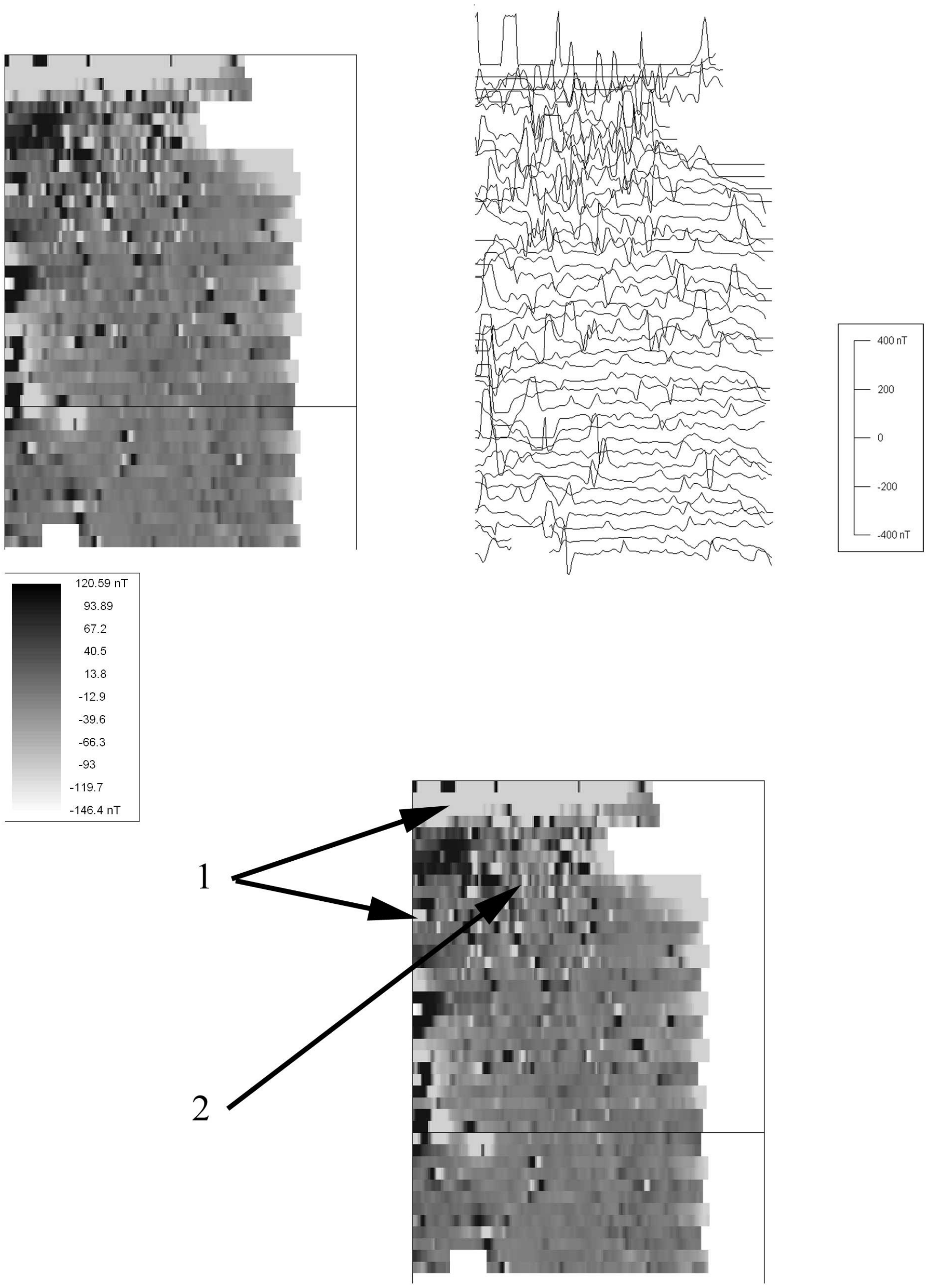
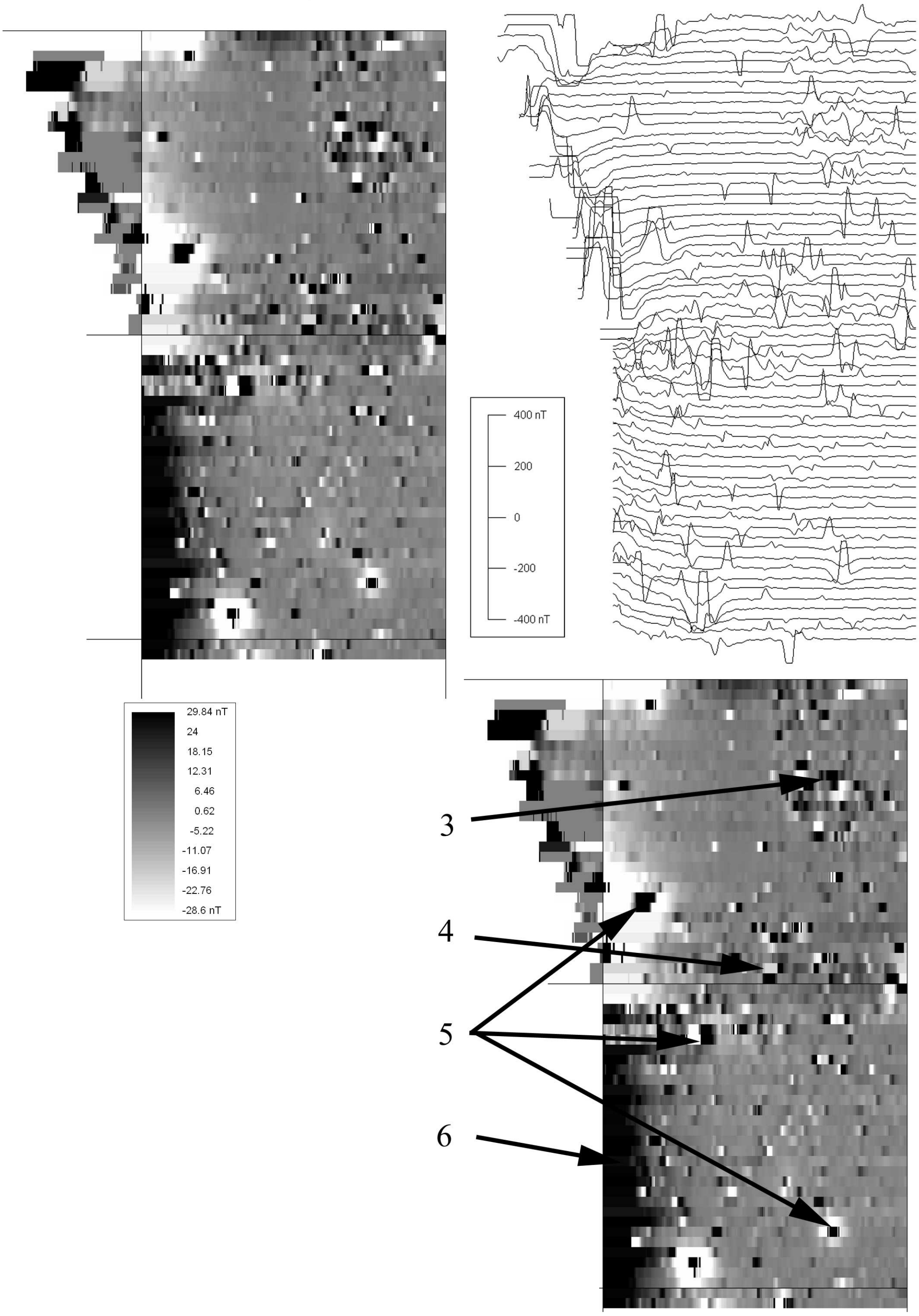


Figure 2 Detailed grid order and location



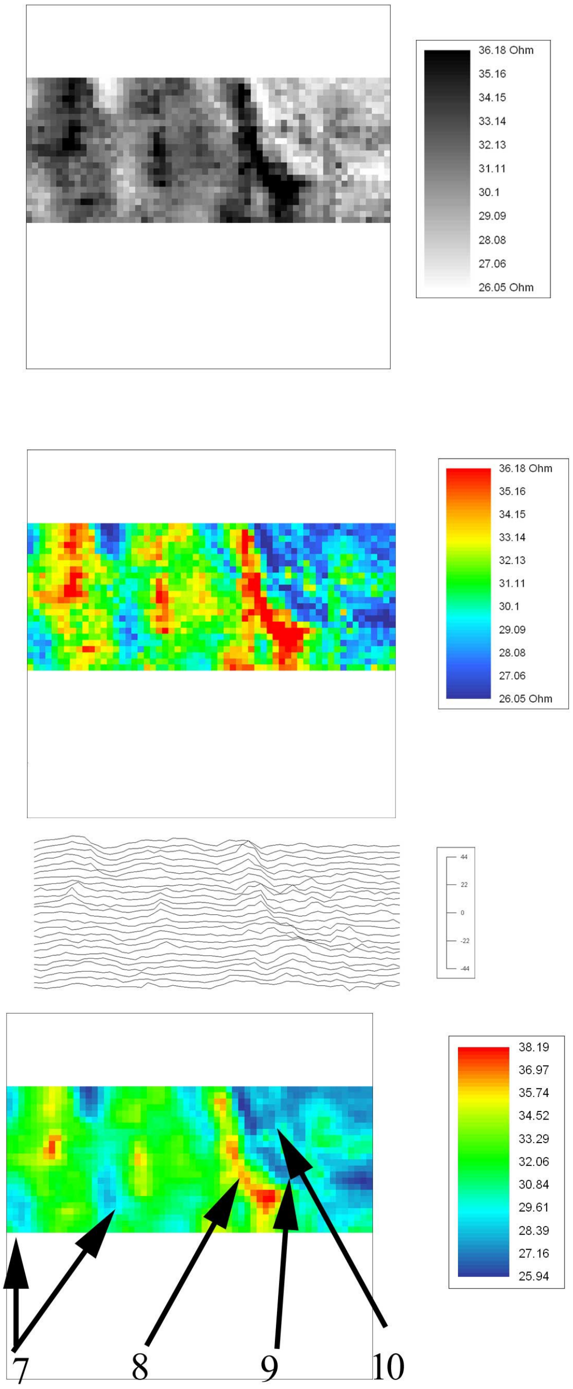
Area 1 (school play area)
Greyscale, Trace and Interpretation plots

Fig 3 Area 1



Area 2, Village Hall field,
Magnetometry greyscale,trace and Interpretation plots

Fig 4 Area 2



Area 2 Grid 3 Earth Resistance
Greyscale, Colour, Trace and interpretation plots

Fig 5 Area 2 Earth resistance

10 Technical details of methods and equipment.
10.1 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 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
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.

10.2 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
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.

11 General Sources

CLARK A, 1996. *Seeing Beneath the Soil*, Routledge: London

DAVID A, 2008. *Geophysical Survey in Archaeological Field Evaluation*, English Heritage.

CHARTERED INSTITUTE FOR ARCHAEOLOGISTS 2014. *Standard and Guidance for archaeological geophysical survey*, CIfA: Reading.

EAC 2015. *Guidelines for the Use of Geophysics in Archaeology: Questions and points to consider*, EAC: Namur, Belgium.

GAFFNEY C and GATER J, 2003. *Revealing the Buried Past*, Tempus: Stroud.

SCHMIDT A 2013. *Geophysical Data in Archaeology; A guide to Good Practice*, Oxbow:Oxford

SCHMIDT A and MARSHALL A, 1997. Impact of resolution on the interpretation of archaeological prospection data, in Sinclair A, Slater E, and Gowlett J, *Archaeological Sciences 1995*, Oxbow: Oxford.

T.R SYSTEMS LTD 2017. *TR/CIA Resistance meter Instruction manual*, TR Systems Ltd; Peterborough