APPENDIX B

# PRINCIPLES OF ELECTRICAL RESISTIVITY SURVEYING

This is an *active* geophysical prospecting technique which detects subsurface features in terms of the resistance they present to the passage of an artificially induced electric current. In the dry state, most soils and rocks are insulators but, when they become moist, electric currents are able to flow through the movement of ions which are always dissolved in the porewater. As the soil or rock absorbs more water the conductivity increases since more ions become available for conduction and their mobility is enhanced. Hence electrical resistivity surveying primarily maps the volume concentration of ground moisture which varies according to lithology, porosity and time of year. Temperature fluctuations can also be important although in mid-latitudes this effect is insignificant.

To record the soil electrical resistivity an alternating current is injected into the ground through a pair of metal electrodes and the surface potential detected between a second pair. This arrangement is needed to minimise errors arising from contact effects, earth currents (usually of mains origin) and polarisation potentials. Several configurations have been evaluated for archaeological use but the 'twin electrode' scheme shown overleaf has proved popular for this purpose. A mobile frame is used to carry one potential and one current electrode (p2 and c2) which are connected, via the meter, to their respective p1 and c1 soil electrodes. Alternating current is passed between c1 and c2 and the potential measured between p1 and p2. The presence of a zone of anomalous resistivity modifies the distribution of current flow (dotted streamlines) and also the contours of constant potential (curved solid lines) and is depicted for the case of a high resistivity structure such as a wall. The instrument thus senses a maximum (or minimum) in the apparent soil resistance which is centred over the feature.

Through good instrument design, resistivity surveying is now a rapid technique although the need for soil contact and cables makes this a slower method than magnetometry. Our surveys employed a Geoscan RM15 instrument with variable spacing between the mobile electrodes which enables the sensing depth to be optimised.

Measurements are generally taken at regular intervals on a grid. Both parallel and zig-zag traverse schemes are used; the first method is slower but minimises systematic errors in the resulting data.

RESISTIVITY SURVEYING

RESISTANCE

ANOMALY

c1   p1

p2   c2
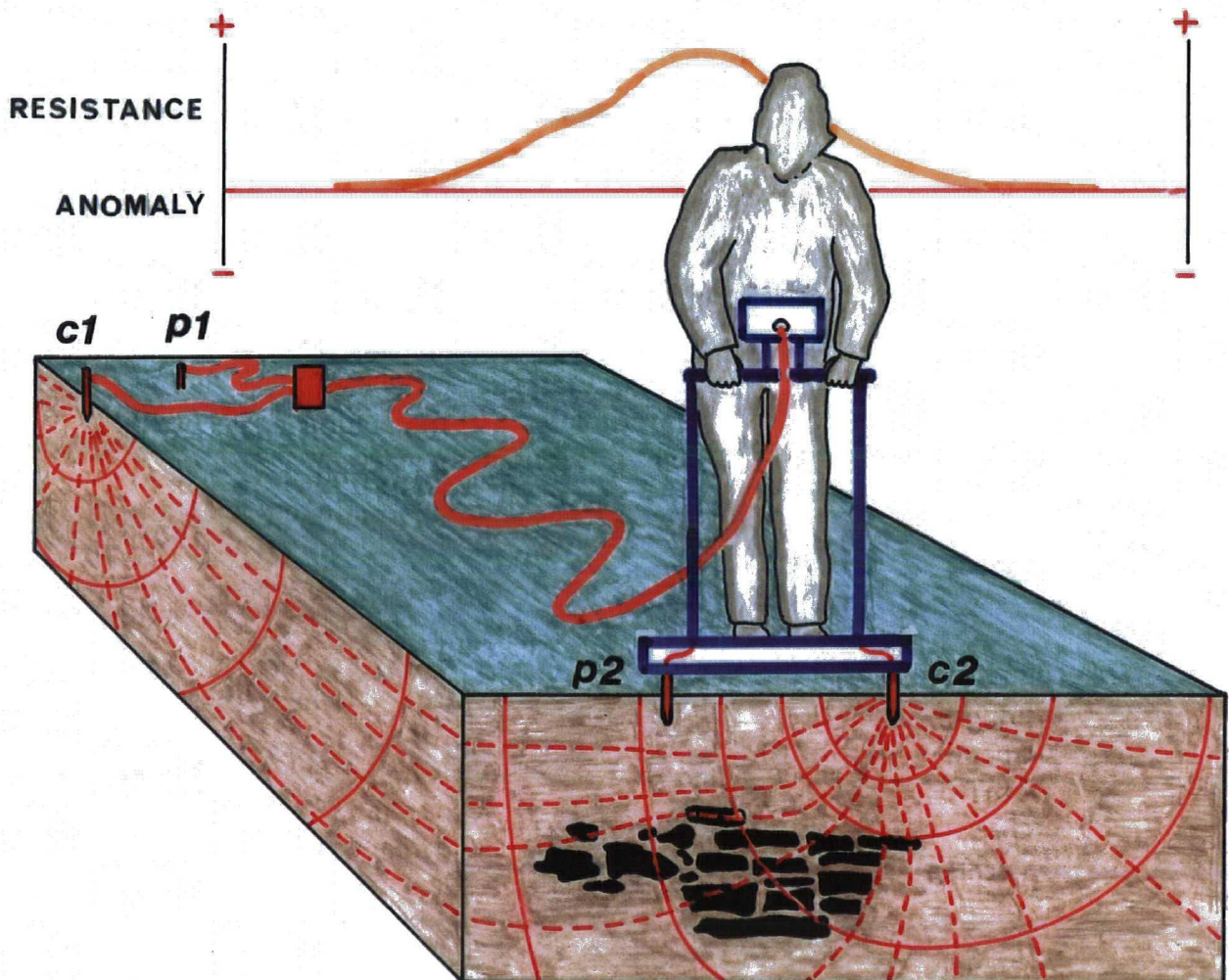
APPENDIX C
DATA PROCESSING

PROCESSING THE SURVEY DATA

The geophysical images contained in this report were prepared within Microsoft Windows® using the **InSite**® program published by GeoQuest Associates. Geophysical images were then placed onto a map which was digitised from the Ordnance Survey, edited and then plotted using a computer aided drafting (CAD) system and colour inkjet printer.

Data were downloaded from the meter to a portable computer in the field for storage, visualisation and quality control (QC) assessment. These data were then transferred to a laboratory computer for final processing, printing and archiving.

A number of process steps have been applied to the geophysical data obtained during the survey and those which have been used are linked to the main flow path by arrows. Steps were applied in the order shown and are designed to reduce artifacts in the data and enhance geophysical features of archaeological interest. The following sections describe each step in more detail.

REMOVE STRIPING

Reduces a data artifact comprising alternating changes in level in readings logged along zig-zag traverses. This artifact is common in fluxgate magnetometer data. InSite uses a proprietary algorithm to reduce this error.

INFILL SMALL BLANK AREAS

Fills isolated blank data cells with the mean of near-neighbours or a suitable approximation entered manually. Small blank areas will have been logged if it was not possible to obtain a geophysical reading over, for example, a manhole cover in the case of a resistivity survey.

REMOVE SPIKES

Replaces isolated, anomalously high or low values with the mean of near neighbours or a suitable approximation entered manually. 'Spike' readings are commonly associated with ferrous litter or poor electrical contact in the case of geomagnetic and resistivity data, respectively.

REDUCE WALK HARMONICS

Reduces a regular oscillation in traverse data caused by walking movements of the operator during a geomagnetic survey. InSite employs a fast Fourier transform to determine the optimum amplitude and phase of the walk-induced harmonic which is then subtracted from each traverse.

REDUCE SHEAR ARTIFACTS

Corrects for apparent shear in geomagnetic anomalies surveyed by zig-zag traversing in a geomagnetic survey. The shearing effect arises from the interaction of the operator + magnetometer with the geomagnetic field and also from the lag in the instrument response to changes in the field. InSite uses a proprietary algorithm to reduce this error.

CORRECT FOR METER DRIFT

Corrects for a linear drift in the meter calibration with time. Such drift is a common problem with fluxgate magnetometers, particularly during periods of rapid air temperature change. InSite uses least-squares regression on the mean of data along each traverse to estimate the change in calibration level across each grid. This gradient is then removed from the data.

ADJUST GRID MEAN LEVELS

Adjusts for differences in the mean level in data grids due to changes in instrument calibration (fluxgate magnetometer survey) or alteration in remote electrode spacing (resistivity survey).

INTERPOLATE AND COMBINE

Combines grids to form an array of regularly-spaced data on a square mesh. InSite uses bilinear interpolation to accomplish this.

LOW PASS FILTER

If this process task is indicated then a 3x3 or 5x5 boxcar filter has been used to smooth the data and reduce noise or 'speckle' seen in the original image.

HIGH PASS FILTER

If this process task is indicated then a 3x3 or 5x5 filter, with appropriate coefficients, has been used to pass short-wavelength information into the resulting image.

EDGE DETECT FILTER

Signifies that a Sobel, Laplace or other specialised filter has been applied to enhance significant lateral transitions in the geophysical image.

DIRECTIONAL FILTER

This filter is equivalent to illuminating the data from one direction to produce a pseudo-relief image. Directional filtering is usually employed to aid the identification of subtle anomalies in resistivity data. This filter highlights features trending at right angles to the direction of illumination.

NOTE

GeoQuest Associates can supply the geophysical images presented in this report in a variety of digital formats for visualisation on microcomputers running Microsoft Windows. These formats include the TIF, BMP and PCX standards. Please complete the request form at the rear of this report if you would like to receive such image files.

InSite

APPENDIX C
DATA PROCESSING

LAB PC

FIELD PC

QC

DATA ARCHIVE

IMAGE RAW GRID DATA

REMOVE STRIPING

INFILL SMALL BLANK AREAS

REMOVE SPIKES

REDUCE WALK HARMONICS

REPORT FIGS. 2-4

INTERPOLATE AND COMBINE

ADJUST GRID MEAN LEVELS

CORRECT FOR METER DRIFT

REDUCE SHEAR ARTIFACTS

DIRECTIONAL FILTER

REPORT FIGURE 5

PROJECT: HAMPSTHWAITE

SITE: AREAS A & B

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