Interpretation

The results of geophysical surveys of archaeological sites are generally presented graphically. This is done because anomalies of cultural origin are generally recognized by their pattern, rather than by their numeric values alone. When rendered graphically, we can better recognize cultural and natural patterns and visualize the physical phenomena causing the detected anomalies.

Interpretation of survey data must be a cooperative process involving both archaeological geophysicists and archaeologists that are familiar with the specific cultural context of the site being studied. An understanding of the geological context of the survey area is also very important, and consultation with a geomorphologist can be very important in understanding survey results.

In areas that have been surveyed with more than one type of instrument, the results of the different surveys should be carefully compared. Correlations between data sets (or lack of correlation) can be as important as either data set by itself to our interpretation of the site.

Initial interpretations of the geophysical surveyor should be reviewed by archaeologists familiar with the cultural context of the site. Comparison of survey results with the range of expected feature types and intra-site patterning may result in different or elaborated interpretation. Ground truthing, if it may be performed, will greatly inform interpretation of these data. Verification (or refutation) of preliminary interpretations and insights into feature composition and geology can allow us to revise or elaborate our interpretations, and to do so with greater confidence.

The results of geophysical surveys and ground truthing should be used in conjunction with other available sources of information to understand the general site context, to locate features for excavation, and to understand the results of excavation within the greater site context.

Locating Geophysical Anomaly Positions on the Ground

Careful attention to spatial control during ground truthing will minimize disturbance to the site and search time and increase the chances of success. The following procedures for locating mapped geophysical anomalies are recommended for most surveys performed by Archaeo-Physics.

If carefully measured on the ground, anomaly sources should generally be found within 0.5m (horizontally) of their position on the map. Failure to locate anomaly sources is very often due to imprecise placement of tests.

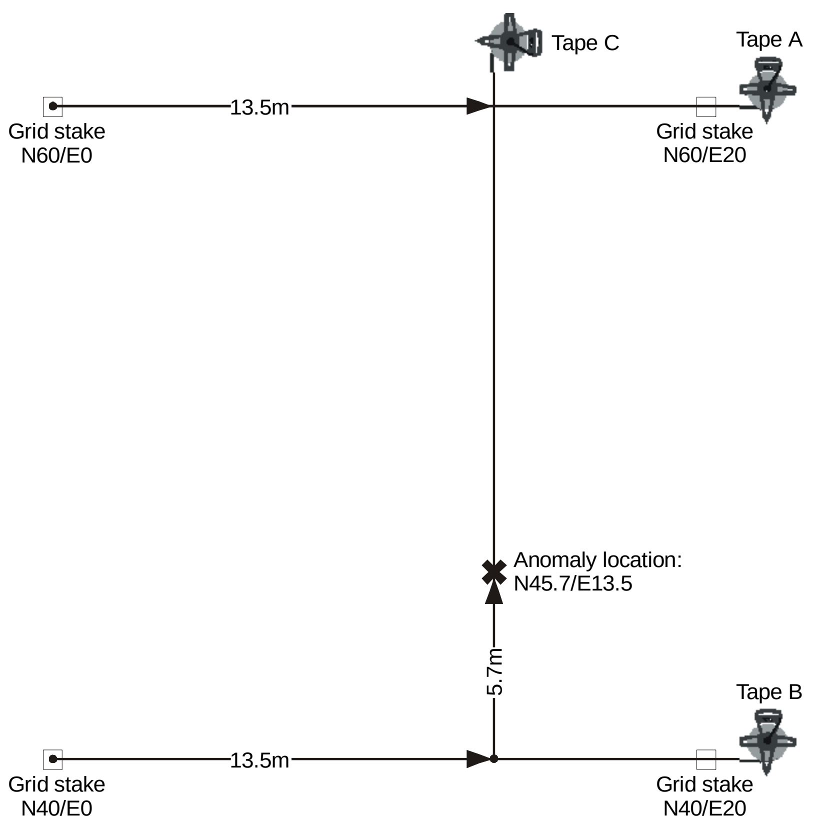
Method 1
If the original survey grid stakes are in position, anomaly positions may be measured from the corner stakes of the survey grid. If done methodically, this is generally the easiest method, and least prone to error.

Generally, the origin of the grid coordinate system will be the SW corner of the map (Under some circumstances X/Y coordinates will be used). Anomaly positions should be consistently noted in terms of northing and easting from this origin (example: N45.7/E13.5). On the ground, anomaly locations should be measured from the staked grid corners using the following procedure:

Always measure from the southern and eastern edges of the grid in which the anomaly is located.

Three measuring tapes are used:

- Tape A is placed across the northern edge of the survey area, with 0 at the NW corner.
- Tape B is placed across the southern edge of the survey area, with 0 at the SW corner.
- Tape C is used to find the anomaly location between these tapes measuring from south to north.
- The procedure is illustrated below, using the anomaly coordinates N45.7/E13.5 as an example.



Method 2
A total station or theodolite with EDM may be used to directly locate the grid positions of mapped anomalies. This method should be considered adequately precise only if a comparable instrument was used to establish the grid system. The instrument must be set up based on permanent datums or other precisely known grid locations.

Alternatively, the instrument may be used to re-establish survey grid corners. Anomalies can then be located using Method 1 (above).

If differential or RTK GPS was used to establish the survey grid (or for spatial control during data collection), this type of instrument may be used to locate mapped anomalies. Instruments should have a repeatable absolute accuracy within 10cm. Handheld GPS receivers - including those using WAAS correction - generally lack sufficient accuracy.

Ground Truthing

The results of a geophysical investigation will be better understood if ground truthing is performed on selected geophysical anomalies. At a minimum, the surface should be inspected for evidence of anomaly sources (which might not be of archaeological interest). The degree of invasive exploration will depend on the degree of disturbance considered acceptable and logistical factors. Invasive exploration may employ a number of techniques, ranging from minimally invasive techniques such as coring to surface stripping, trenching, or complete excavation. A metal detector may be invaluable for locating some magnetic anomaly sources, and for distinguishing between metal and non-metal (e.g. granite) anomaly sources.

- Have preliminary interpretations correctly identified archaeological features?
- Can more ambiguous anomalies be identified (or dismissed) as archaeological features?
- What is the specific physical composition of the features?
- Can the cultural context of the features be better defined?
- What is the state of preservation or integrity of the features?

Ground truthing will allow more definitive interpretation of the geophysical data and provide data on a range of previously unexplored areas within the site. The results of ground truthing may (with caution) be interpolated and extrapolated to untested areas of the site.

Careful attention to spatial control during ground truthing will minimize search time and increase the chances of success. Failure to locate anomaly sources is very often due to imprecise placement of tests.

Careful testing of a meaningful sample within the interior and exterior of geophysical anomalies should identify the source of the anomalous signal. Testing of portions of the survey area lacking anomalous signals can be useful for comparison and for testing the effectiveness of the survey methods. As ground truthing progresses, more information concerning the signal response is gained and interpretation by archaeologists familiar with the regional archaeology becomes increasingly detailed.

Archaeo-Physics strongly encourages its clients to remain in close communication with the geophysicist during ground truthing and excavation. Every site is unique, and any information regarding feature composition, geology, or anomaly sources is valuable. Initial feedback may suggest new interpretations, or new strategies for testing and data recovery.

Resistance Survey

For resistance data, testing should extend beyond the apparent location of the anomaly of interest in both the east-west and north-south directions. As a general guideline, testing should extend on either side of the anomaly for a distance of approximately two or three times the electrode probe separation used in the survey.

When the anomaly of interest is linear, testing should be oriented perpendicular to the edge of the anomaly, and should extend two or three times the probe separation on either side. Excavation to a depth of approximately three times the electrode probe separation distance or to the sterile soil horizon will generally reveal the subsurface components contributing to the measured resistance values. On occasion, resistance features may not be visually observed in the test trench. For example, features may be detected that are visually disguised by subsequent soil development. A high salinity moist soil may be visually identical to a low salinity moist soil but the measured resistance could easily differ by a factor of 1,000. On these occasions careful attention must be paid to local variations in physical soil structure, texture, particle size, and moisture variations. Chemical variations may not be detectable without special equipment, but may be suspected when other causes cannot be found.

Magnetic Survey

Metal detection is often a first step in ground truthing magnetic anomalies. It can distinguish ferrous metal, which can sometimes be mistaken for thermal features (e.g. hearths), as well as pinpointing metal artifacts of interest.

For magnetic field gradient data, testing should be centered over the anomaly of interest, and should extend approximately three times the diameter of the magnetic anomaly on either side in both the east-west and north-south directions. When the magnetic anomaly of interest is linear, testing should take place perpendicular to the anomaly and should extend approximately three times the diameter of the magnetic anomaly on either side. For magnetic data, maximum excavation depth is more difficult to specify. It is a complex function of the magnetic moment, angular orientation, soil susceptibility contrast, and physical size of the buried feature. As a generalization, deeper anomalies will appear more diffuse, and will tend to be weaker. Magnetic gradient surveys (the most common type) effectively limit the depth of detection for weak anomalies to about a meter. Substantial masses of highly magnetic materials (e.g.: iron or fired brick) may be detectable at greater depths. "Total-field" surveys have a greater depth of detection, but are seldom applied to archaeology. It may be possible to quantitatively estimate the depth of individual anomaly sources.

Ground Penetrating Radar Survey

The source of anomalous reflections in GPR data will generally be located near its apparent horizontal position in the data plot. Exceptions, however, are not uncommon. Reflector geometry and other factors may cause the apparent location of the anomaly source to be significantly displaced. Under typical survey conditions, the error in horizontal position of a feature of interest is not likely to be greater than its depth.

The estimated depth to an anomaly source is based on an estimate of the signal velocity through the soil (or other matrix). The velocity of the signal is not uniform through different materials, but in most instances the vertical error is not likely to be greater than 50% (up or down). Initial ground truthing results will enable the investigator to evaluate estimates of depth.

Although they can usually be distinguished by their appearance, reflected air waves, "ringing," and other phenomena can create reflections that appear wildly displaced (vertically and horizontally) from their actual source, which may even be above the surface.

It must be emphasized that there are numerous potential natural and modern causes for many anomalies detected during any type of geophysical survey, and also that many cultural features may be expressed ambiguously - or not at all - in the geophysical data. Anomalies may also be caused by differences in chemical, magnetic, or electrical properties (either natural or anthropogenic) that are undetectable to the naked eye.