ENCLOSURE 2

MAGNETICS SURVEYING

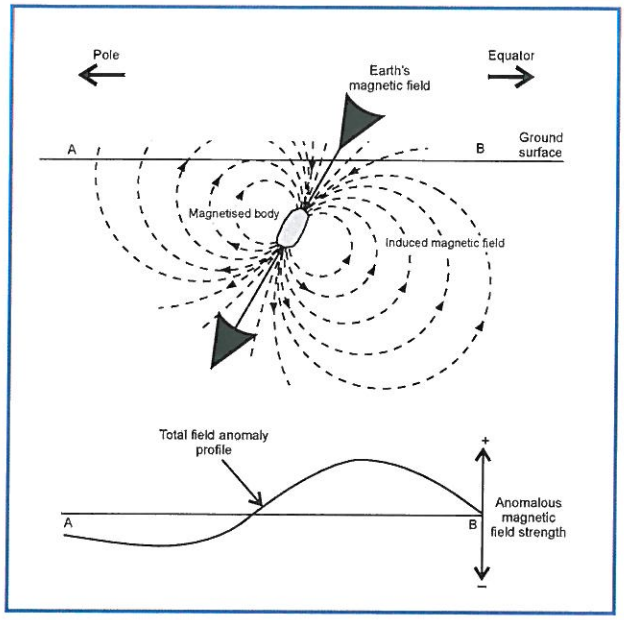
Applications

- ☑ *Mapping underground storage tanks, buried drums, piles, reinforced concrete etc.*
- ☑ *Archaeological studies*
- ☑ *Mapping UneXploded Ordnance (UXO)*
- ☑ *Pile detection*
- ☑ *Detection of buried infill*
- ☑ *Mineral exploration (mapping buried dykes and ore bodies etc.)*
- ☑ *Locating landfills*
- ☑ *Detection of underground pipes and other utilities*

Basic Theory

Magnetic surveying is a passive method based on the measurement of localised perturbations to the Earth's magnetic field caused by the presence of buried ferrous targets (e.g., pipes, cables, drums, military ordnance etc).

Gradiometry surveys, which determine the vertical gradient of the magnetic field, are increasingly common in environmental/engineering site investigations as they are particularly sensitive to the near-surface. Magnetic surveys can be conducted with a wide range of magnetometers, which can measure the amplitude of the field to within 0.01nT.



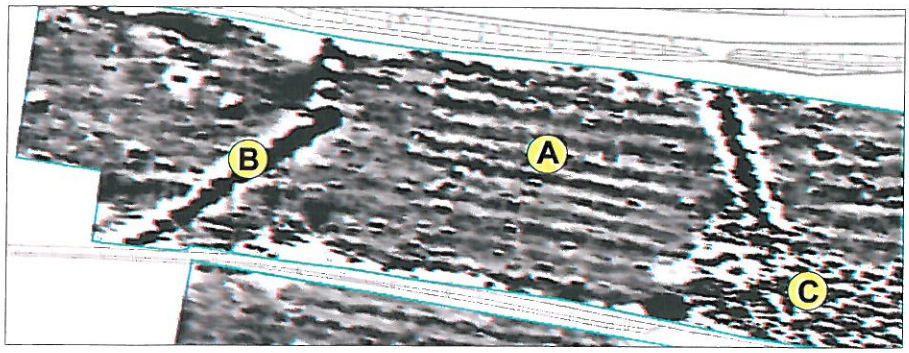
Data Presentation

Typically, data is collected in a systematic manner across a field site and then presented as a contoured map (in units of nT or nT/m) which can be interpreted to produce a map of the subsurface. The amplitude and shape of an individual anomaly will reflect the dimensions, orientation and magnetic susceptibility of the buried target.

The collection of magnetic gradiometry data with dGPS location on foot or towed is an accurate and rapid means of data collection.

Data Example

Magnetic surveying is useful in many situations, in particular to detect buried manmade metallic objects. In this example to the **right**, the survey has revealed the location of plough scars (A), a buried utility (B), and a trackway and former building foundations (C). The edge of the plough scars delineates ground to the west where open cast coal mining has taken place.



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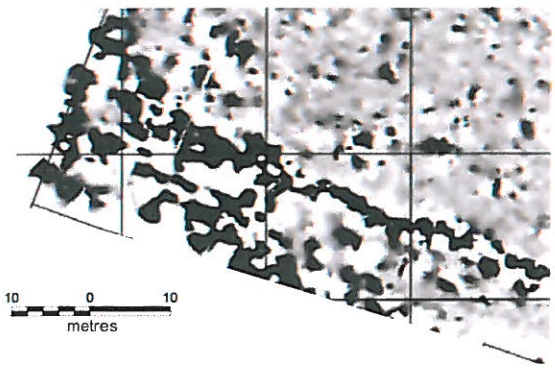
Data Examples

Magnetic Gradiometry

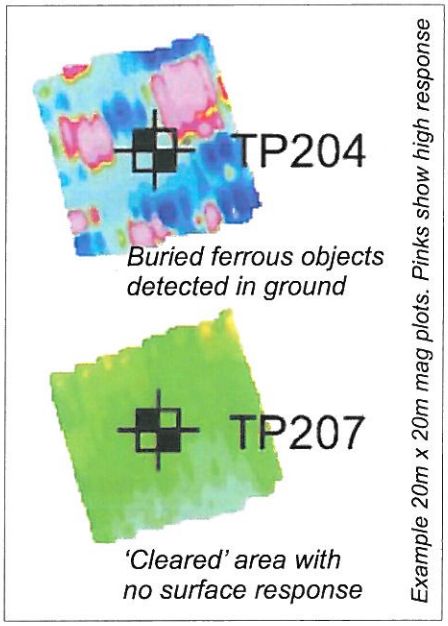


1 Magnetic anomaly locating historic ruins

In the example **right**, the data shows linear features such as buried ditches and walls together with isolated anomalies indicative of traces of human activity.

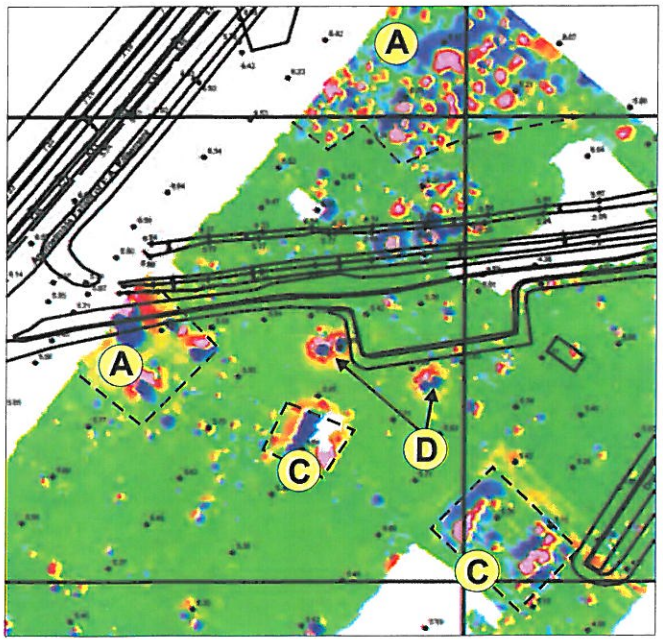
2 Locating buried Unexploded Ordnance (UXO)

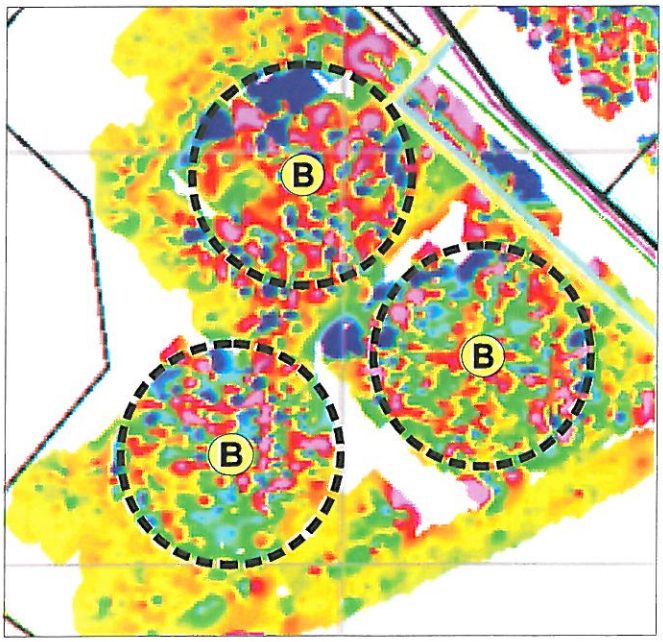
Buried and unknown UXO can in certain locations in the UK present land developers with a real threat to workers and the public. The most common methods used to locate UXOs in the shallow sub-surface are surface magnetometer surveys (see below left and data to right), or by probing boreholes (below centre) to check deep UXO are not encountered.



3 Magnetic anomalies locating buried obstructions

- **A** Building foundation outline marked by high amplitude instrument response (dark blue and red colours)
- **B** Circular foundations of former cooling towers
- **C** Anomalies with regular geometric shapes indicative of buried manmade structures and other objects such as tanks
- **D** Small and discrete metal containing objects indicative of possible UXOs





ENCLOSURE 2

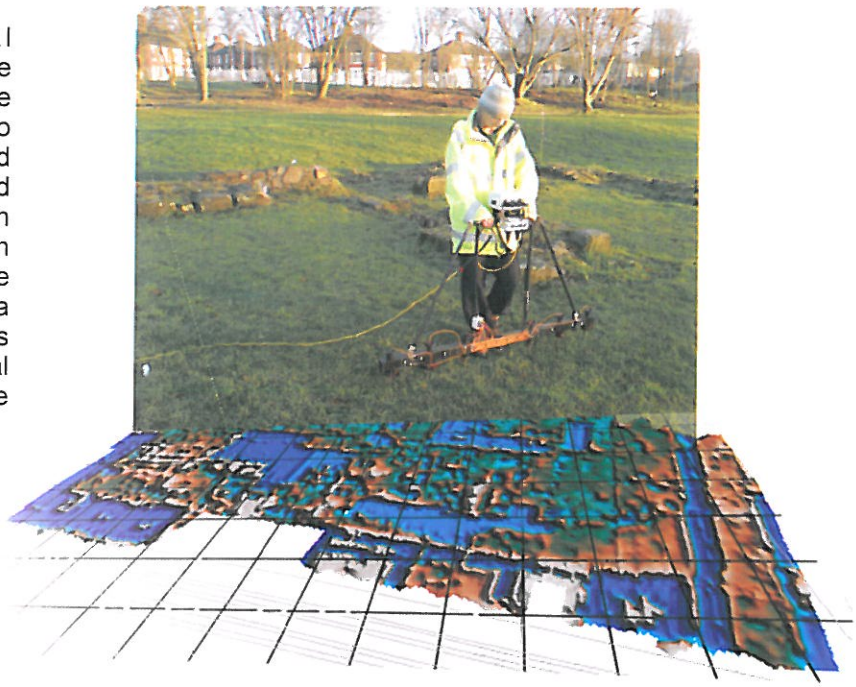
ARCHAEOLOGY

Geophysical Techniques Available

- ☑ *Magnetic Gradiometry*
- ☑ *Ground Penetrating Radar (GPR)*
- ☑ *Electrical Resistivity*
- ☑ *Electromagnetic Mapping (EM)*

Geophysics can aid archaeological investigations immensely. The use of the above techniques can provide rapid coverage of a site where archaeological remains are believed to exist. Success relies on using staff qualified and experienced in both geophysics and archaeology. Surveys should be conducted with the appropriate methods and practices in accordance with guidance set out by the Institute for Archaeologists and English Heritage. Data can aid greatly in targeting archaeological digs by supplying accurate data from which initial interpretations of archaeological remains can be made.

Geophysics can also play an important role in the detection of human remains and other buried objects, in particular clandestine unmarked graves, as part of forensic investigations.



Survey examples

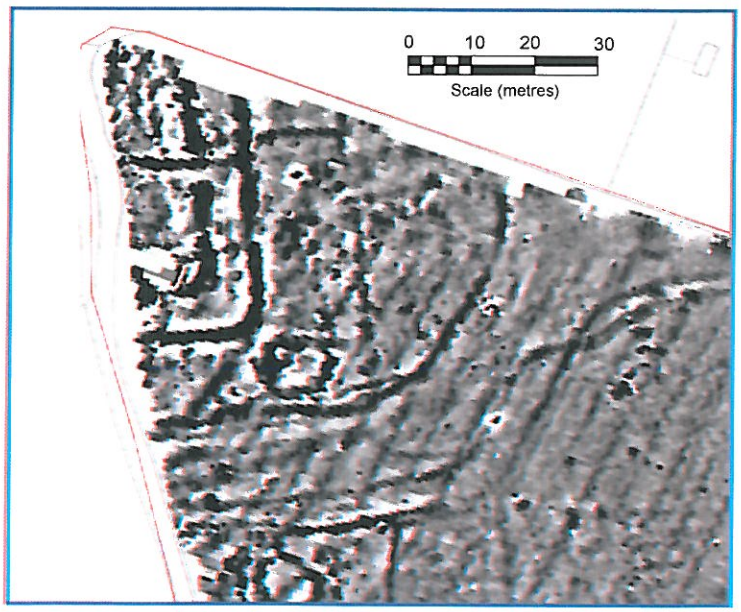
Locating Historic Ruins

In the example **above** an integrated geophysical survey comprising earth resistance (photo above) and EM (coloured map above) was conducted on the site of a medieval abbey to determine the presence of buried foundations, walls and other remains of former standing structures of archaeological interest at the site. Buried walls have a higher resistance than compared with the surrounding soils.

This information was used by the client to target an archaeological dig. As a result of the geophysical investigation the time and expense of a large system of exploratory trenches was avoided.

Archaeological Evaluation

In the example **right**, a magnetometer survey was conducted over a large proposed wind farm site. The survey was undertaken so that the most sensitive archaeological areas could be avoided by the development at the planning stage. Due to the scale of the site, preliminary detailed surveys were conducted around each turbine position and along each construction route. Areas of particular archaeological potential were identified for targeted follow-up surveys.



Magnetometer survey data showing numerous circular features which are interpreted as ring ditches

ENCLOSURE 2

ARCHAEOLOGY

Locating archeological features

Interpretation and Excavation

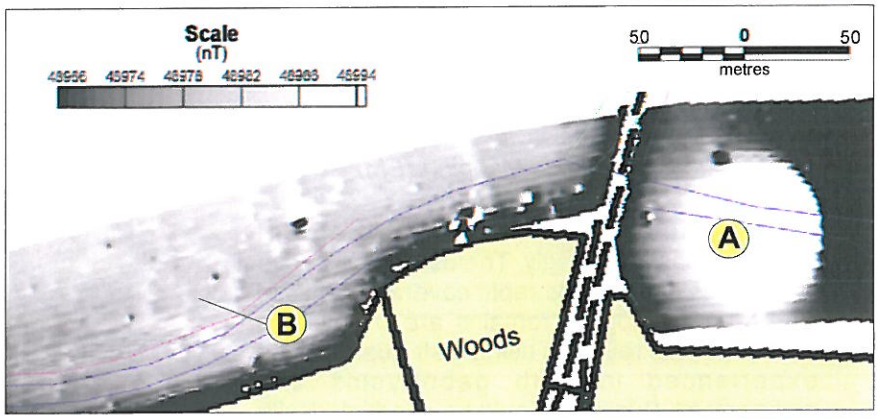
In the example **right** on the site of a proposed windfarm in Leicestershire, the data shows a large anomaly in the eastern field (A) which is related to a capped coal mine shaft. In the western field, the data shows numerous linear and strongly circular features indicative of human activity (B).

Subsequent trial trenching (marked C) across the circular feature encountered a ditch filled with animal bones and mid to late iron age pottery.

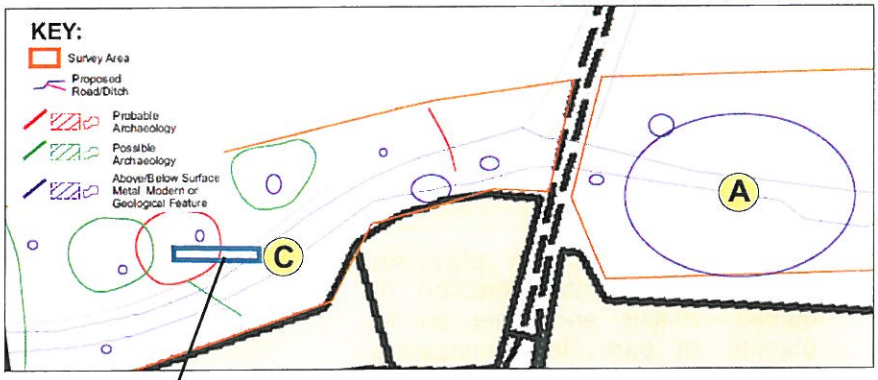
This is a good example of how excavation can be targeted to avoid 'blind trenching'. The data also shows how more recent human activity can completely mask the response from previous activities.

Magnetic data collection on a winters day

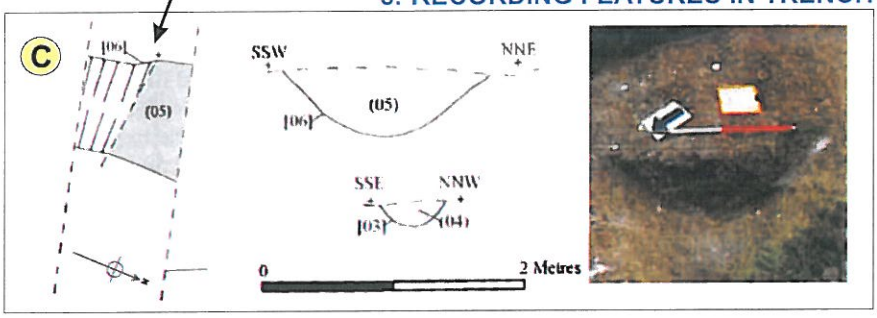
1. MAGNETIC DATA



2. DATA INTERPRETATION



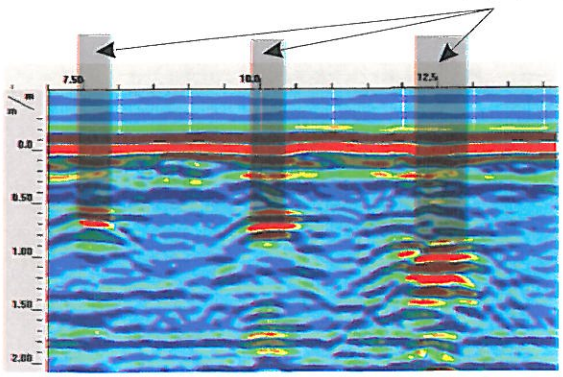
3. RECORDING FEATURES IN TRENCH

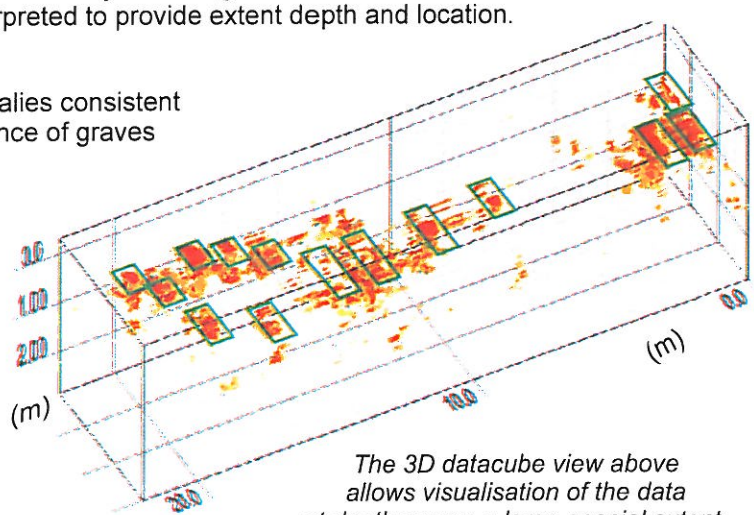


Locating Graves over a Historic Burial Ground

Ground Penetrating Radar (GPR) was used over a historic burial ground. The technique offers a quick and reliable means of detecting buried objects such as unmarked clandestine graves. The use of GPR is ideal because it is non-destructive therefore preserving the cemetery and the graves. As shown **below** the reflection anomalies recorded in the data are interpreted to provide extent depth and location.

Reflection anomalies consistent with the presence of graves





The 3D datacube view above allows visualisation of the data at depth across a large spacial extent.