Surface Mapping for UXO Detection

Objectives

To locate magnetic anomalies in the ground associated with the presence of UXO (unexploded ordnance), or other buried features in order to clear land for development, or in case of MOD land being released for redevelopment.

Instrumentation

Grad-13L, or Grad-01-1000L sensors mounted on a cart with separate data logger.

Mag-13 can also be used with application of total field correction (see Munschy et al, 2007).

Background

Many areas have been subjected to conflict and heavy bombing, or have been used as training grounds for armed forces. WWI and WWII UXOs are still commonly found in fields and on construction sites around Europe.

Surveys need to be carried out to ensure safe working conditions and a sound foundation for building work. This starts with desk studies to look at the likelihood of the site having been subjected to bombing or use of ordnance. A surface survey will then take place. This is carried out using a magnetic gradiometer, which enables detection of buried magnetic anomalies in the ground (e.g. UXO or archaeological features). While archaeological features tend to give relatively weak magnetic anomalies, UXO, due to their iron content are likely to provide much stronger magnetic anomalies (amplitudes of the anomalies are related to depth of burial, nature of the object, susceptibility contrast between the soil and the object, and the orientation of the object).

A further survey for a deep search will be undertaken, depending on the nature of the development.

Method

Gradiometers are ideal tools for detection of magnetic anomalies buried at shallow depth. The use of two sensors, one as a reference (further away from the ground) and a second as detection sensor (close to the ground) make it poissible to abstract changes in the magnetic field associated with distant features. Subtraction of the reference sensor's signal from the detection sensor's signal provides a reading associated with local anomalies only. When using a vector magnetometer (such as fluxgate), use of a gradiometer arrangement will allow use of the equipment in a mobile situation.

The mounting of Grad-01-1000L or Grad-13 sensors into an array (typically on a non-magnetic cart support) allows a user to perform rapid mapping of an area. Using software, the GPS based acquisition enables precise localisation of anomalies for further investigation and clearance if appropriate.

The exact shape of a bomb will change with its orientation in the Earth's field, while the amplitude will be driven by in part the orientation, as well as the depth and susceptibility contrast between the surrounding soils and the bomb.

Alternatively, single three-axis sensors may also be placed in an array to perform surface mapping. Here, because of the sensor's movement and the absence of a reference sensor, performing correction of scaling, orthogonality and offset allows a user to

recover total field data and perform field surveys (Munschy et al, 2007)

Surface mapping can now be also undertaken from airborne platforms, mostly unmanned vehicles (see AN0063). It is worth noting that this method is well suited to bombs which will not be triggered by someone moving over it. Detection of landmines may not be undertaken as some may have reduced magnetic signatures. It is worth also noting that you will physically be walking over the items being detected at the same time as you are carrying out the detection.

Reference

Munschy, M., D. Boulanger, P. Ulrich, and M. Bouiflane, 2007, Magnetic mapping for the detection and characterization of UXO: Use of multi-sensor fluxgate 3-axis magnetometers and methods of interpretation: Journal of Applied Geophysics, 61.