

# ELECTROMAGNETIC METHODS



Electromagnetic (EM) methods include frequency domain EM methods, such as EM induction, EM utility locator/metal detection methods, very low frequency (VLF) EM, and controlled source audio-frequency magnetotellurics (CSAMT), as well as time domain EM methods (TDEM). **GEOVision** geophysicists have successfully utilized a wide variety of EM methods for hydrogeologic, engineering, and environmental investigations.



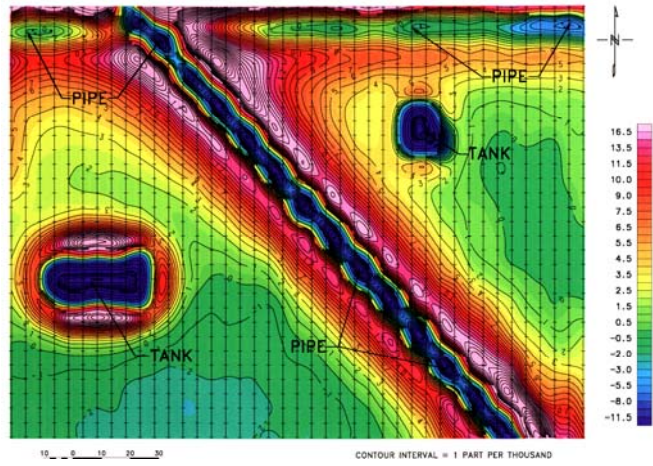
**Geonics EM-31 Terrain Conductivity Meter**

## EM Induction Method

EM induction and EM utility location are the most common EM techniques applied to shallow engineering and environmental investigations. EM induction surveys are often conducted using the Geonics EM-31, EM-34, and EM-38 terrain conductivity meters and the GSSI GEM300 multi-frequency EM system. The EM-31 consists of a transmitter coil mounted at one end and a receiver coil mounted at the other end of a 3.7-meter long plastic boom. Electrical conductivity and in-phase field strength are measured and stored along with line and station numbers in a digital data logger. The EM-31 can explore to depths of about 6 meters, but is most sensitive to materials about 1 meter below ground surface. The EM-38 has a 1-meter coil spacing and is designed for characterizing the upper 1.5 meters. The EM-34 consists of a large transmitter and receiver coil connected by a reference cable. It measures conductivity at coil separations of 10, 20, or 40 meters and is used for exploration to depths up to 60 meters.

**GEOVision** typically conducts EM induction surveys to:

- Locate buried tanks and pipes
- Locate pits and trenches containing metallic and/or nonmetallic debris
- Delineate landfill boundaries
- Delineate oil production sumps and mud pits
- Map conductive soil and groundwater contamination
- Map soil salinity in agricultural areas
- Characterize subsurface hydrogeology
  - Map buried channel deposits
  - Map geologic structure
  - Groundwater exploration
  - Locate conductive fault and fracture zones



**Geonics EM-31 Survey to Locate Underground Storage Tanks**

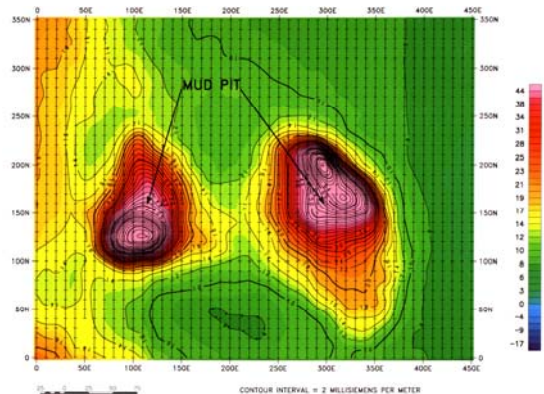
## VLF EM Methods



**Metrotech Utility Locator**

## EM Utility Location Method

EM utility locators are used for tracing metallic pipes and utility cables and clearing drilling and excavation locations. These utility locators consist of a separate transmitter and receiver. The transmitter emits a radio frequency EM field that induces secondary fields in nearby metallic pipes and cables. The receiver detects these fields and accurately locates and traces the pipes, often to distances over 200 feet from the transmitter. Modern utility locators are also capable of providing approximate depth estimates of the pipes and sweeping areas for 60 Hz signal emanating from electrical lines.



**Geonics EM-31 Survey to Map Mud Pits**

VLF surveys measure various components of the VLF EM fields in the frequency range of 15 to 25 kHz. These low frequency EM fields are generated by submarine communications stations scattered around the world. Long linear conductors give rise to localized anomalies in these VLF fields, which make the VLF method an effective tool for mapping conductive fault and fracture zones, especially water-bearing fracture zones in hard rock environments.

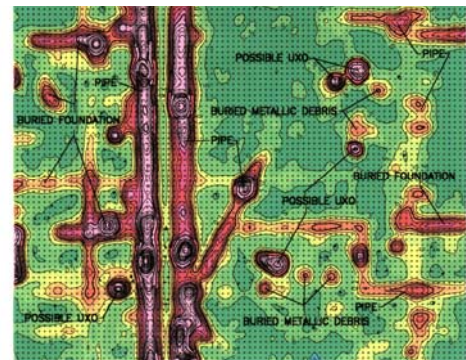
**CSAMT and TDEM Methods**

CSAMT and time-domain electromagnetic (TDEM) surveys are conducted to map changes in resistivity or its inverse, conductivity, with depth. These methods are, in effect, the EM equivalents of the resistivity sounding method. CSAMT and TDEM soundings can be made at stations along a profile to yield two-dimensional information on the resistivity structure of the subsurface. TDEM methods also include the Geonics EM-61, designed specifically to locate buried metallic objects such as drums, tanks, pipes, UXO, and buried debris.

- GEO Vision uses CSAMT and TDEM methods to:**
- Locate buried metallic objects/debris
  - Map geologic structure
  - Map large fracture zones
  - Map deep conductive contaminant plumes such as oil field brines and acid-mine drainage
  - Map salt-water intrusion
  - Determine depth to groundwater and groundwater resources
  - Map subsurface stratigraphy



**Geonics EM-61 Digital Metal Detector (EM-61)**

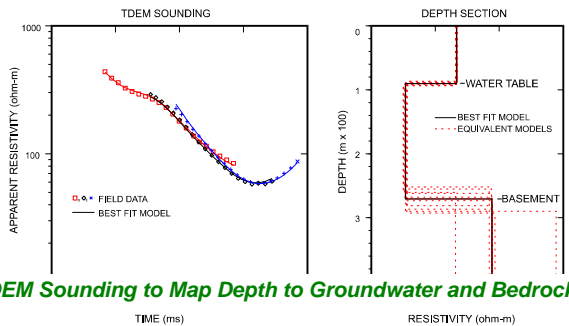


**EM-61 Survey to Map Subsurface Infrastructure**

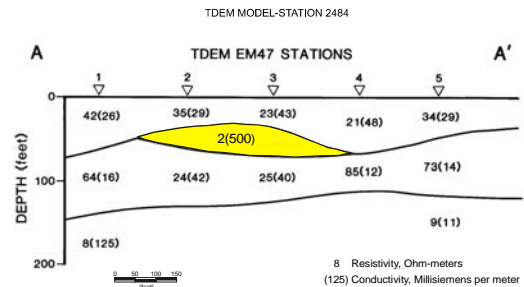
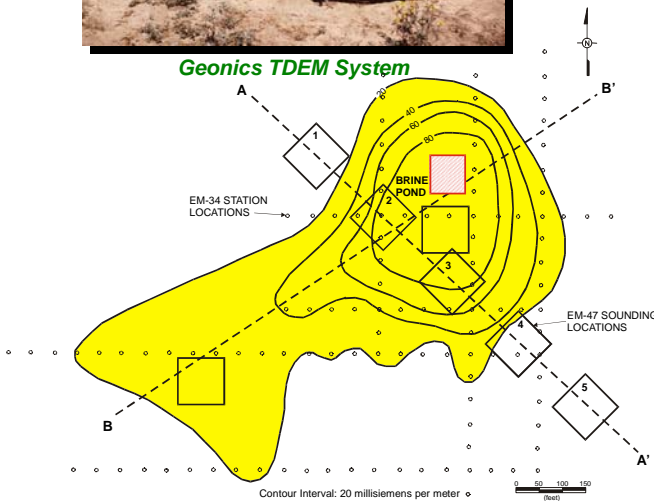
CSAMT and TDEM data are generally modeled using computer inversion techniques, and output is a model of resistivity as a function of depth. These techniques can be used to explore depths ranging from about 30 feet to over 5,000 feet, depending on methodology used.



**Geonics TDEM System**



**TDEM Sounding to Map Depth to Groundwater and Bedrock**



**Geonics EM-34 and TDEM Survey Map Horizontal and Vertical Extent of Brine Contamination**