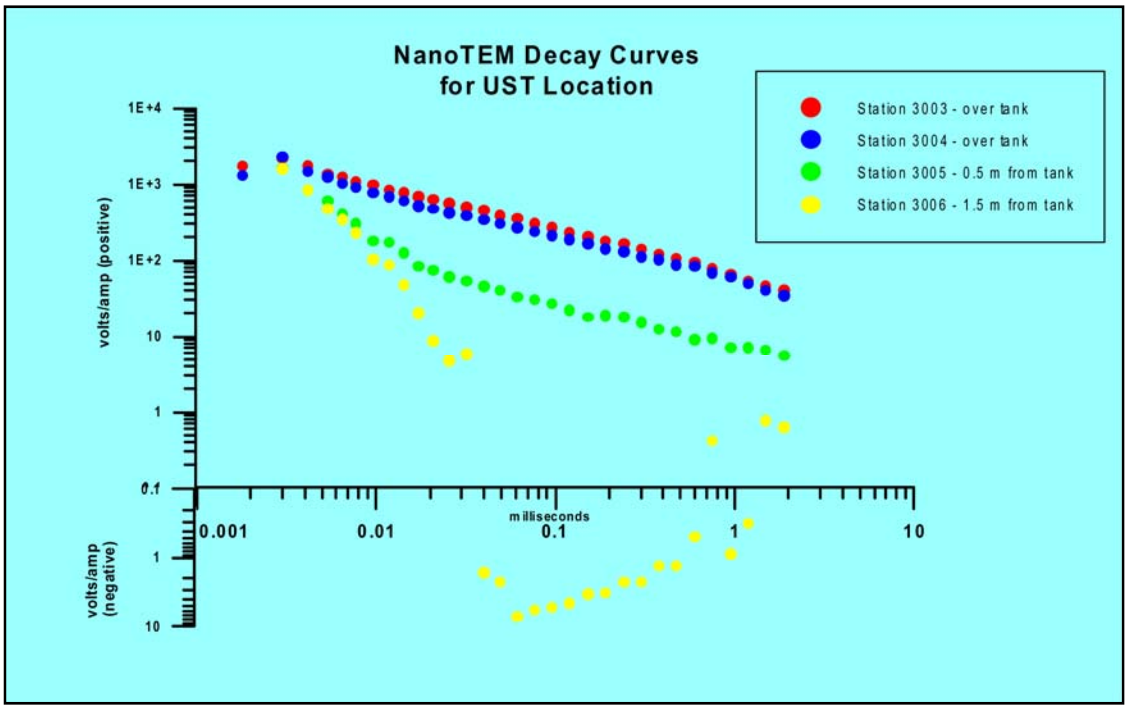
NanoTEM

A Very Fast Turn-off TEM System



The Zonge-manufactured NanoTEM system, a high speed, early time version of TEM, offers both metal-detection capabilities as well as resistivity sounding data. NanoTEM has been used to map perched aquifers, clay lenses, landfills, USTs, abandoned wells, and dumps, as well as geologic and structural features.

NanoTEM

One traditional limitation of transient electromagnetic sounding methods is the long turn-off times of the transmitted signals. For shallow soundings, and highly resistive areas, this has prevented effective use of the method. The newest series of Zonge transmitters, the NT-20, has overcome this limitation.

In order to obtain very shallow information, the transmitted signal must go to zero very rapidly, without "ringing" or oscillations of either the electronics or the wire loops themselves. Depending on loop characteristics, the NT-20 transmitter turns off in approximately 1.5 microseconds. This rapid turn-off, and the high speed analog-to-digital conversion in the GDP-16 and 32 receiver, allows data collection at depths less than 2 meters and in areas with electrical resistivities in excess of 20,000 ohm-meters. The NT-20 can be used with either the GDP-16 or -32 to collect NanoTEM data. The receiver records the decay curve as 31 windows (or gates) from approximately 1.5 microseconds after transmitter turn-off to about 3 milliseconds after turn-off.

Because of the flexibility of changing transmitter and receiver loop sizes, NanoTEM can be used for a variety of different targets. Surveys have been performed using forty meter (40 m by 40 m) transmitter loops with five meter (5 m by 5 m) receiver loops to collect resistivity sounding in highly resistive ground. The same system has also been used with a ten meter (10 m by 10 m) transmitter loop with one meter (1 m by 1 m) receiver loops to locate small metallic objects.

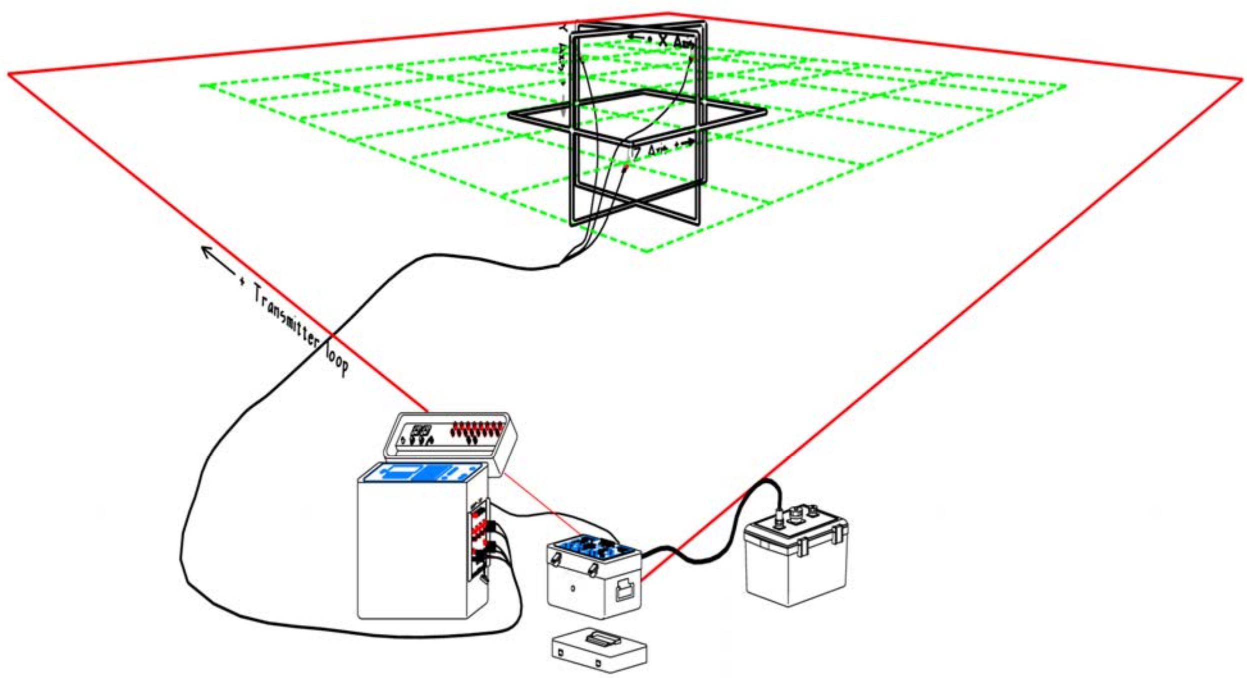


Figure 1: Basic setup of the NanoTEM system (GDP-32, NT-20, and NT Battery) using the three axis receiver loop. Usually a grid of six one meter by one meter stations is read within the each transmitting loop. The Zonge GDP-32 is also capable of collecting CR, IP, CSAMT, TEM, and MT data.

MULTI-COMPONENT DATA

Since the GDP-16 and GDP-32 are multi-channel receivers, all three components of the magnetic field (Hx, Hy, and Hz) can be collected simultaneously. Bipolar responses can be expected to be associated with metallic objects detected in the Hx and Hy data. The following data were collected at the Zonge test site outside of Tucson, Arizona, U.S.A. over a row of spheres varying in size and composition. Both Hz and Hx are shown along with background data over no known objects.

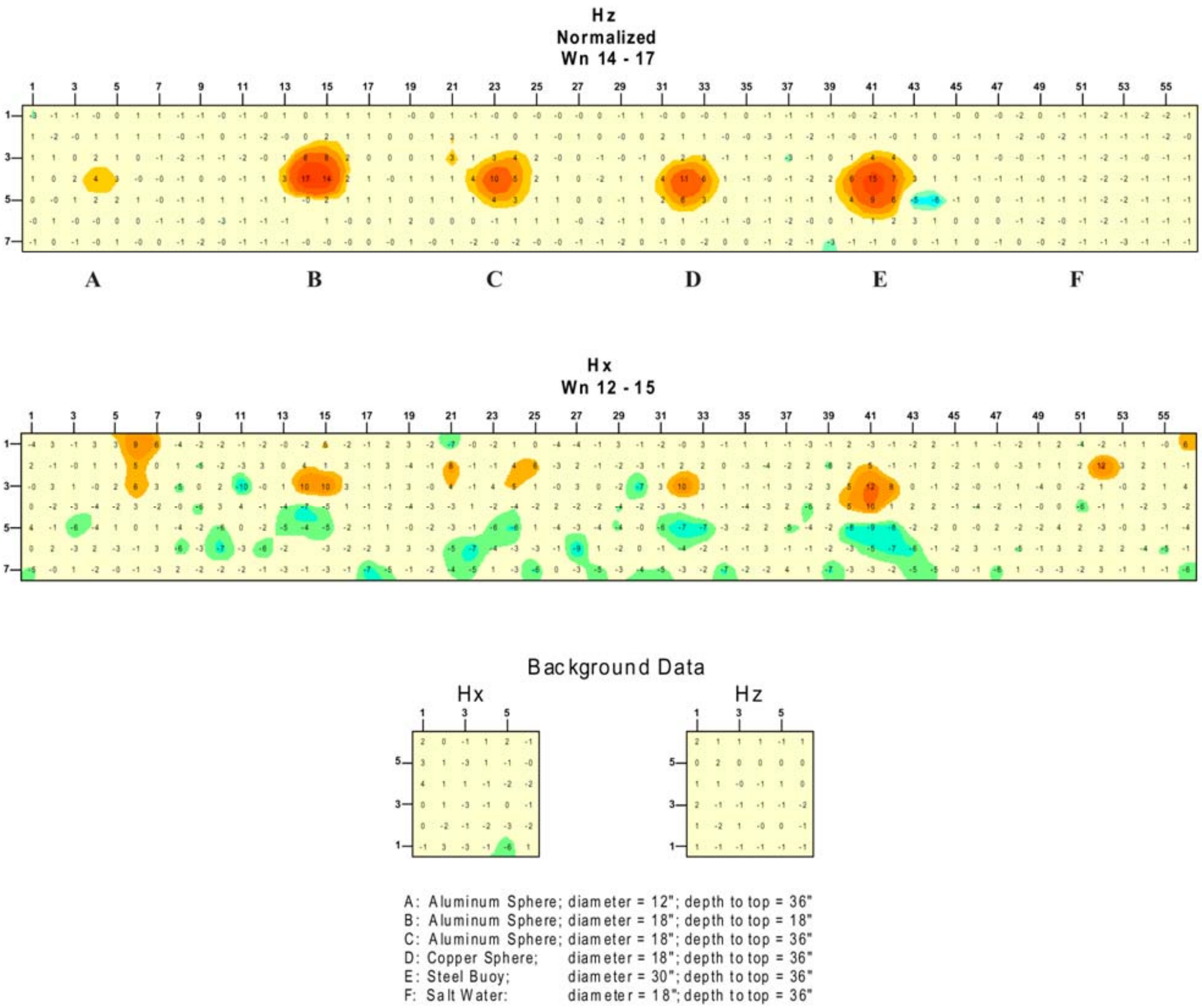


Figure 2: Hz and Hx data over known spheres at test site.

For more technical information on this project, contact Zonge International.

ALUMINUM DROSS DETECTION

Aluminum dross, the slag or scum that remains when aluminum is melted down for recycling, was discovered in a local neighborhood wash. Dross usually contains high levels of lead and cadmium, making the material a possible health hazard. The City of Tucson's Office of Environmental Management needed to determine the extent of the contamination before clean-up could begin.

NanoTEM data were collected using a 10m x 10m transmitting loop with a 1m x 1m receiver loop. After target areas were determined from the NanoTEM data, an environmental engineering company performed trenching, hand drilling and sampling to map out the dross. The correlations between the NanoTEM survey and the results from the drilling and later remediation were excellent.

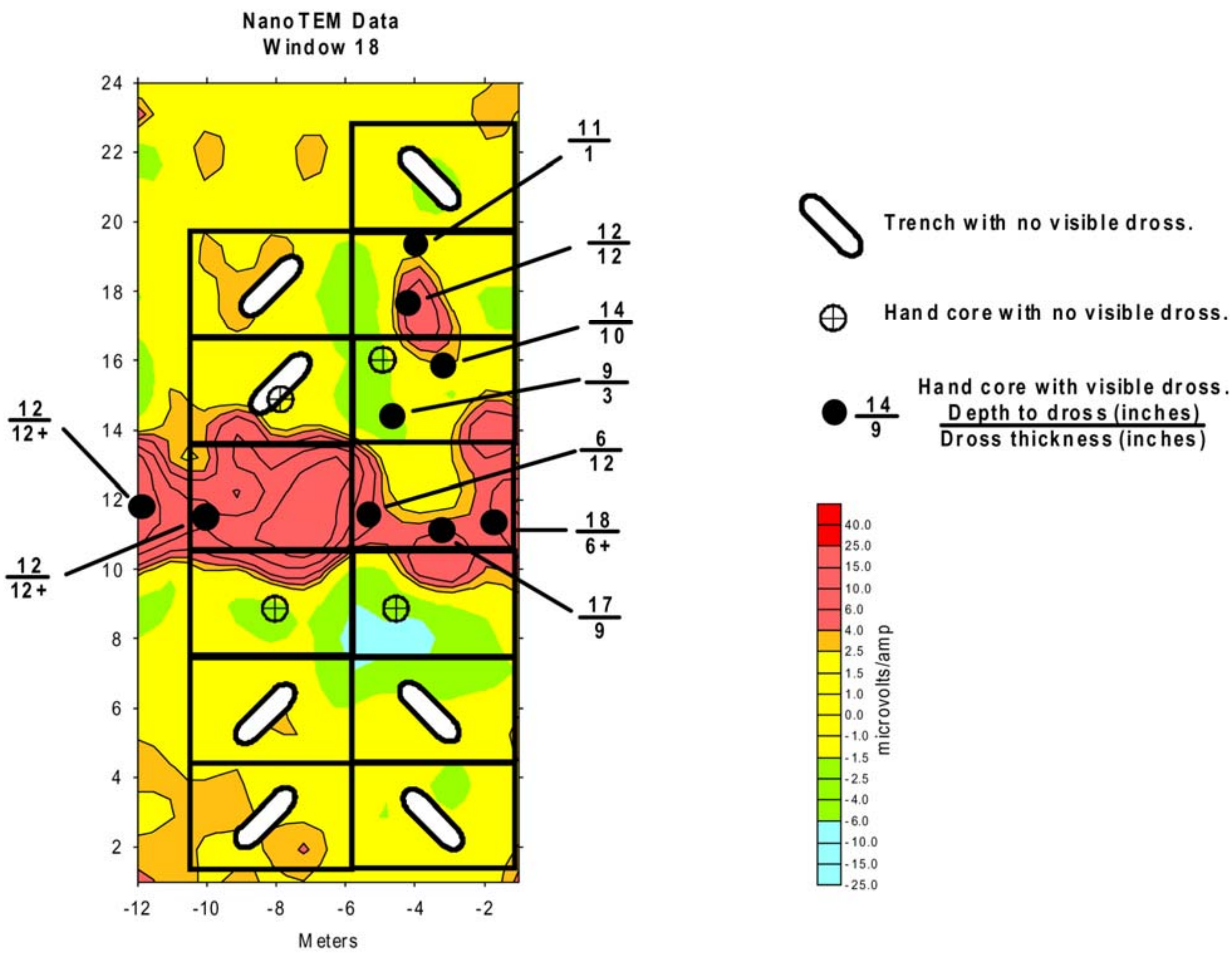


Figure 3: Plan view map of NanoTEM data, window 18, normalized. Note the correlation between the high magnitude response in the NanoTEM data and the detection of dross with the hand cores and trenching.

For more information on this project, refer to "Environmental Applications of High Resolution TEM Methods", presented at the Environmental and Engineering Geophysics Fourth Annual Meeting in Barcelona, Spain, 1998.

UST LOCATION

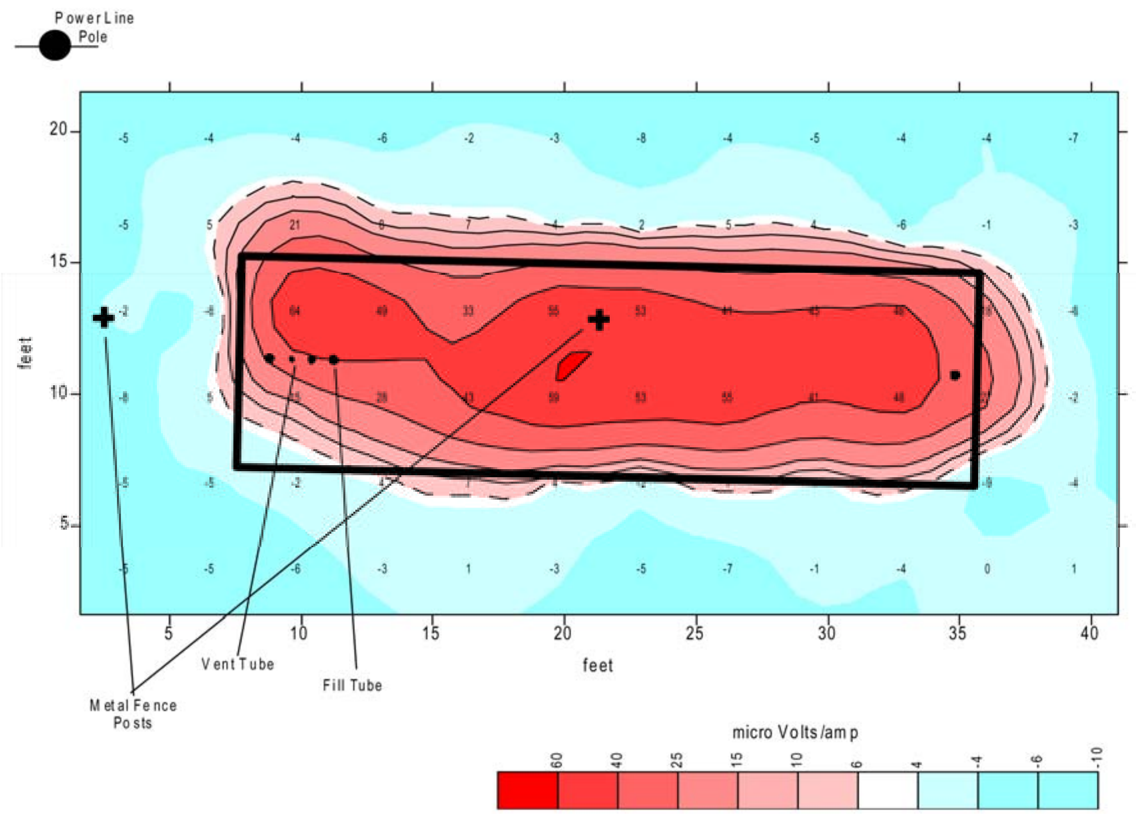


Figure 4: Plan view map of NanoTEM data, window 28, normalized. The values shown are microvolts, plotted at the center of each 1 meter receiver loop. The dark rectangle outlines the actual location of the tank.

NanoTEM data has also been used to locate Underground Storage Tanks (UST). Data were collected with two 10m x 10m transmitter loops and a 6 x 6 grid of 1m x 1m receiver loops inside each transmitter loop. The outline of the tank, with vent and fill tubes are shown based on physical measurements made of the tank during remediation.

The corners of the tank staked on the ground by the crew using NanoTEM turned out to be exactly correct, and even the slight angle relative to the fence line that was predicted from the NanoTEM was correct. Note also the close proximity of an overhead powerline. A more accurate placement of the edge of the tank could be defined by moving the receiver loop in increments smaller than 1 meter.

For more detailed information on this project contact Zonge International.

ABANDONED WELLS LOCATION

Another application of this technology has been to search for abandoned wells in areas previously drilled for oil. This survey was designed to detect the resistivity changes generated either by the casings or saline fluids migrating up the abandoned well bore. Notice that at times greater that 0.1 millisecond there is a significant change in the observed vertical magnetic field directly above the well casing, and within 1 meter this effect is no longer apparent. Well casings easily stand out against the background response of the earth using the NanoTEM system.

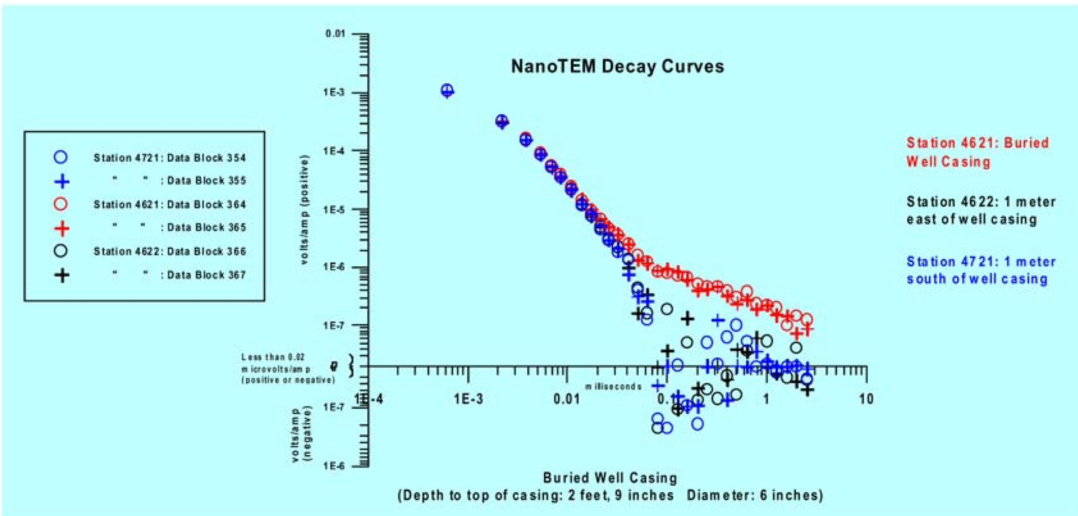


Figure 5: Decay curves for Station 4621 (buried well casing), Station 4622 (1 meter east of well casing), and Station 4721 (1 meter south of well casing). The decay curve from the station over the well casing can easily be distinguished from background noise in the late times.

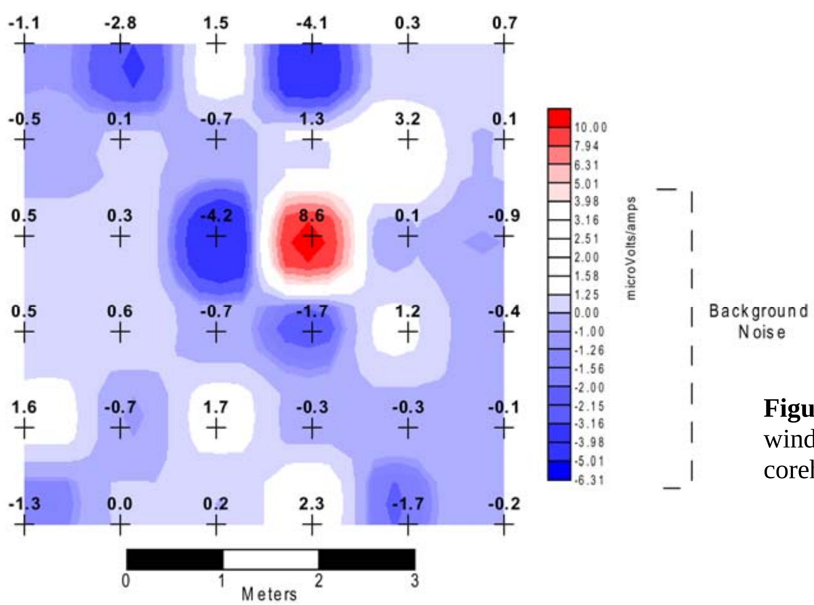
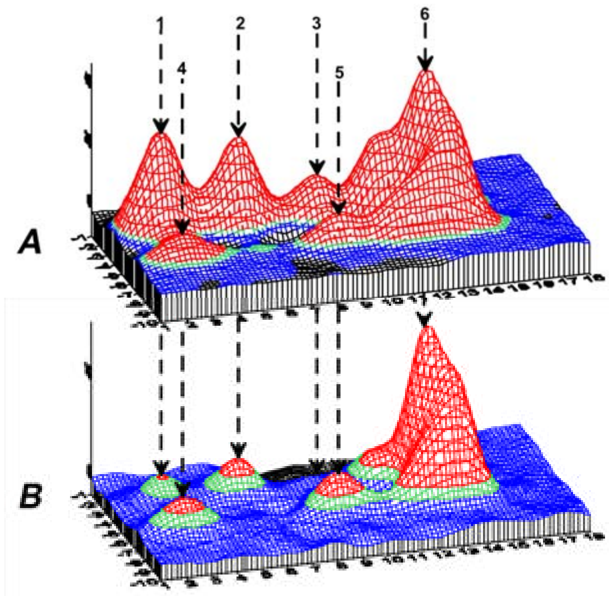


Figure 6: Plan view map of NanoTEM, window 13 magnitudes, over an uncased corehole.

For more detailed information on this project, refer to "Case Histories of Buried Borehole Detection: An Exercise in Flexibility" presented at the 1996 Symposium on the Application of Geophysics to Engineering and Environmental Problems, Keystone, Colorado.

I.N.E.L. CALIBRATION CELL



1. Wood Boxes, one with ferrous metals.
2. Wood box, mixed metals.
3. Wood box, non-ferrous metals.
4. 55 gal. drum, concrete.
5. 55 gal. drum, foam.
6. Combined anomaly from dense pack metal and two filing cabinets.

Figure 7: NanoTEM results over the I.N.E.L. Calibration Cell.

NanoTEM data were collected at the Idaho National Engineering Laboratory (I.N.E.L.) Cold Test Pit calibration cell as part of the Electromagnetic Integrated Demonstration (E.M.I.D.) project. Several isolated objects of different compositions were buried in the calibration cell and are listed beside Figure 7.

After transmitter turn-off the eddy currents in metallic objects require longer to decay than the earth response. Because of the 31 window times recorded by the GDP these late time variations can be measured. This makes the NanoTEM system an excellent deep sounding metal detector. Metallic objects stand out as positive, repeatable anomalies above random background noise.

The above plot shows two plan views of the data at different times after transmitter turn-off. Slice "A" shows the plan view for the time from 0.2563 to 0.8045 milliseconds (NanoTEM windows 21 through 26), and below it, Slice "B" shows the plan view for 0.8045 to 2.539 milliseconds (windows 26 through 31). The vertical scale of the two plots has been adjusted so that the largest anomaly (object #6) is approximately the same size in each plot (even though the actual amplitude decreases from A to B with time, of course).

For more information on this project, refer to "Environmental Applications of High Resolution TEM Methods", presented at the Environmental and Engineering Geophysics Fourth Annual Meeting in Barcelona, Spain, 1998.

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