GPR technology
Vol 1, No. 4
Fall 2005

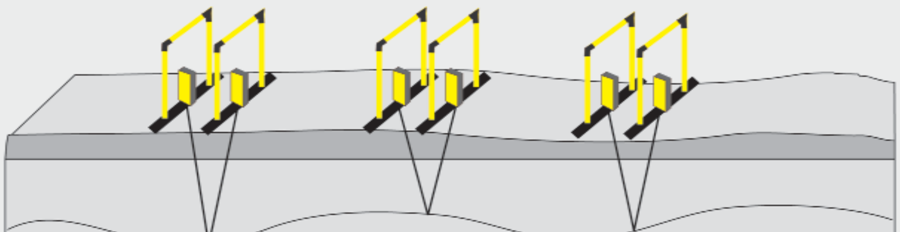
Subsurface Views

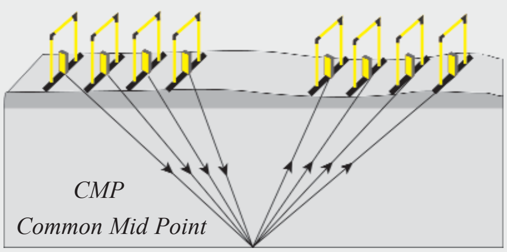
Sensors & Software Inc.

pulseEKKO® PRO:

Advanced Survey Techniques

The vast majority of GPR data collected is common-offset reflection mode data.


Common Offset Reflection


CMP
Common Mid Point

GPR systems with bi-static antennas like the pulseEKKO PRO, are very flexible and allow the operator to collect data in several other ways. These "advanced survey methods" can provide valuable, additional information for the GPR professional.

Over the next few editions of Subsurface Views, we will provide tutorials on several advanced survey methods of GPR; explaining how data are collected, processed and plotted and the benefits of conducting these surveys.

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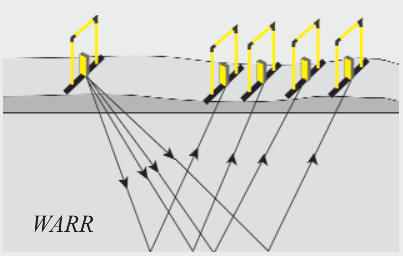
WARR
Wide Angle Reflection and Refraction

Noggin Ice Profiling:

Grounded Ice

Resource development in northern areas during the winter requires ice roads over bodies of water to transport people and goods. Over the last few years, GPR ice thickness measurements have become a standard for safety. Gone are the days of assuming that a hole drilled every few hundred metres correctly reflects the thickness of the ice over an area. GPR can accurately determine the ice thickness to the centimeter level, even when acquired at speeds of up to 100 km/hr.

As experience with GPR technology grows, ice road managers are now seeking to (continued on page 2)

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In This Issue

Advanced Survey Techniques

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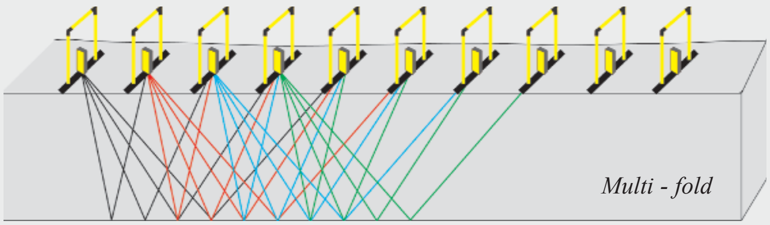
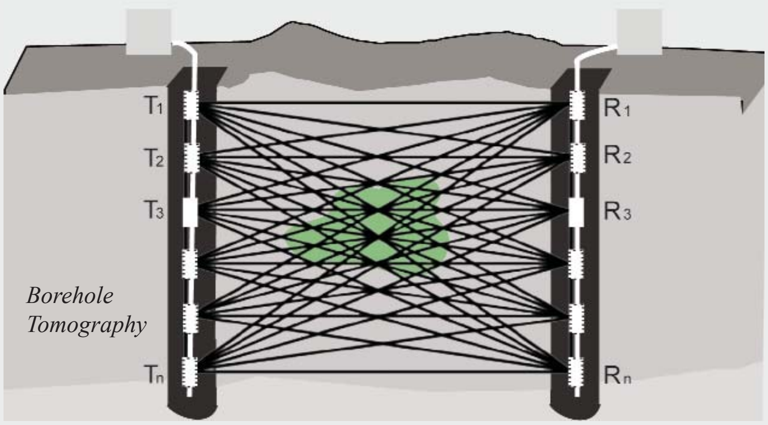
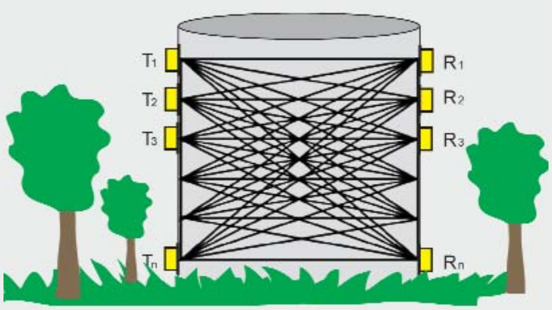
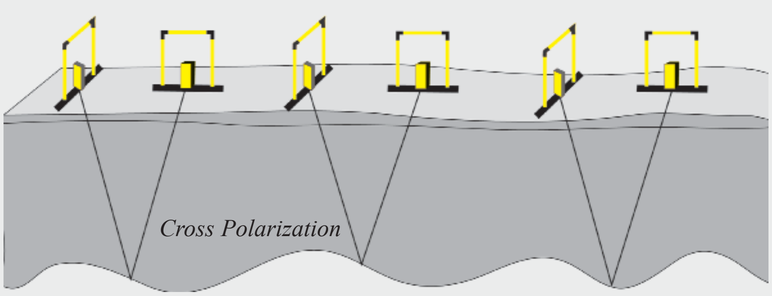






Structure Transillumination



Check out our next edition of Subsurface Views for the continued tutorial on Advanced Survey Techniques. ■

Grounded Ice

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extract more information from their data, such as identifying areas of grounded ice.

Grounded ice occurs when water has frozen all the way to the bottom. This is common in the shallow water along the shoreline or areas where currents deposit sediment.

Grounded ice can be beneficial for oil exploration by increasing the coupling of seismic energy. It can be dangerous for heavy trucks because the reduced ice thickness can affect the load bearing capacity of the ice, making it susceptible to cracking.

Grounded ice can be recognized on GPR records by the lower amplitude signal (Figures 1 and 2). The contrast in the electrical properties between the sediments and ice is much less than that between water and ice, which results in lower reflectivity.

The grounded ice response can be misinterpreted as illustrated in Figure 1. The bottom of ice/top of sediment interface is often mistaken as the response indicated by the red arrow, which is only slightly weaker in amplitude than the ice/water interface on the right. In fact this response is from within the sediments - the contact between the frozen top and the wet bottom sediments. The frozen/wet sediment interface has higher reflectivity than the ice/frozen sediment boundary indicated by the blue arrow.

Grounded ice can be detected in the field while taking measurements, allowing immediate marking. Alternatively, recording data along with GPS *(continued on page 3)*

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Noggin Ice Profiling

coordinates enables the user to create maps of GPR amplitude with QuickMap to indicate grounded ice.

Delineating grounded ice is an excellent example of extracting valuable auxiliary information from existing data.

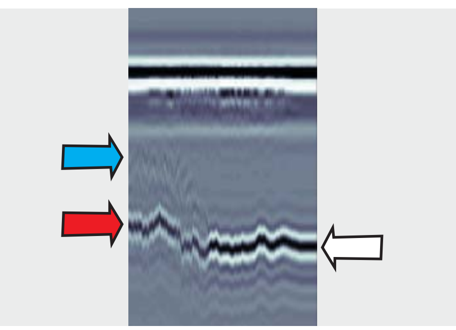

Figure 1: *Grounded ice (blue arrow) and floating ice (white arrow) show a large change in amplitude. The second stronger reflection on the left (red arrow) is not the bottom of ice but the interface between the frozen sediments above and the wet sediments below.*

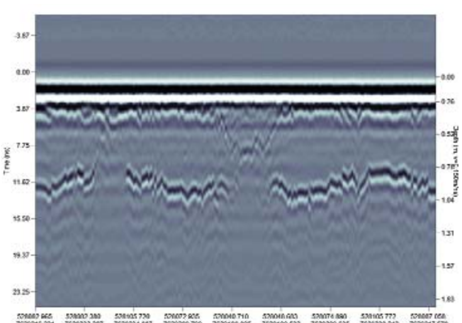

Figure 2: *Example from a river in the Mackenzie Delta, where grounded ice is a major concern. Areas that have little to no response are over sand bars in the river. These areas are important for ice road construction and planning.* ■

Ask the Expert

What do the colors on the color bar mean?

GPR data are frequently displayed in color or as gray shades. The process of translating detected signals into a color display is called color mapping. The result is a pseudo color picture or image which represents the data. These pseudo images enable a large amount of data to be represented and easily comprehended.

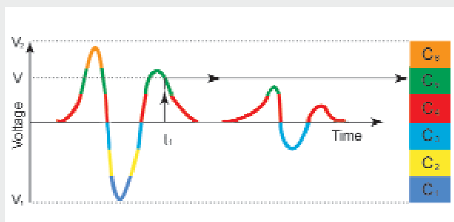

Figure 1: *Representation of a GPR trace as a voltage versus time and how a color can be assigned to a voltage.*

With color mapping, the measured voltage, V , at time t_1 in Figure 1 can be translated to color C5. In this illustration, the range of possible voltages is V_1 to V_2. The voltage range (V_2-V_1) is divided into 6 bins and colors C_1 to C_6 assigned. Voltages along a trace are assigned one of 6 colors in this simple example.

GPR, data are normally displayed as cross sections, time or depth slices, or as volume cube visualizations. These displays critically require color mapping. A traditional cross-section display is shown in Figure 2. Three traces are shown over the color representation of all the traces.

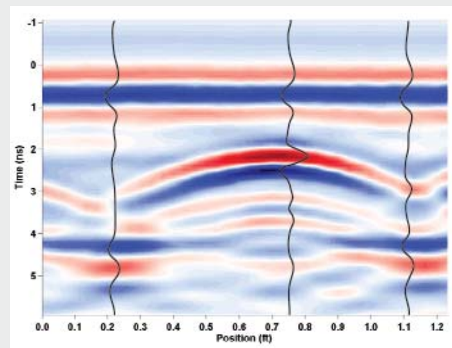

Figure 2 *Example of a GPR cross section which is comprised of many traces. In this example, the background coloring or shading represents many traces placed side-by-side as shaded pixels in an image. Three traces are presented as a wiggle trace representing voltage versus time.*

In general, linear mapping with light to intense colors representing small to large signals are common and easily understood. Similarly, use of blue to red representing low to high are standard. If the color mapping is not defined, be careful using the result without checking into the process. ■

Recent Technical Papers

1. **Assessment of Soil Moisture Content Measured by Borehole GPR and TDR Under Transient Irrigation and Drainage,** JEEG, Vol. 8, Iss. 2 (June 2003), pp. 77-86. By: Galagedara, L.W., Parkin, G.W., Redman, J.D., Endres, A.L., 2003 ***ref 312***

2. **GPR Analysis of a Concrete Spillway at the Lincoln State Park, Indiana, Proceedings of the Symposium on the Application of Geophysics to Engineering & Environmental Problems** (SAGEEP), February 22-26, 2004, Colorado Springs, Colorado, pp. 1160-1165. By: Vanderlaan, J.H.M., Byer, G.B., 2004 ***ref 315***

3. **Golf Course Applications of Near Surface Geophysical Methods,** Proceedings of the Symposium on the Application of Geophysics to Engineering & Environmental Problems (SAGEEP), February 22-26, 2004, Colorado Springs, Colorado, pp. 39-59. By: Allred, B.J., Redman, J.D., McCoy, E.L., 2004 ***ref 316***

4. **GPR - Trends, History and Future Developments,** Proceedings of the EAGE Conference, Delft, The Netherlands, October 30-31, 2000. By: Annan, A.P., 2001 ***ref 317***

Upcoming GPR courses

One Day Noggin® Short Course
November 7, 2005
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Our Noggin® short courses are offered throughout the year to anyone interested in learning more about GPR and subsurface imaging.

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