GPR technology
Vol 2, No. 7
Summer 2006

Subsurface Views

Sensors & Software Inc.

pulseEKKO® PRO: Advanced Survey Techniques

Borehole Transillumination

In our continuing series on advanced GPR survey methods, all the methods described so far (CMP, WARR and Multi-fold) have been reflection methods (Figure 1).

Transillumination surveys (Figure 2) are different because they involve sending GPR signals one way through a structure. The transmitting and receiving antennas are placed at opposite sides of a structure to study the radio wave transmission properties of the material. The most common application is surveys between boreholes (Figure 3) but data can also be collected through structures like walls, pillars and monuments.

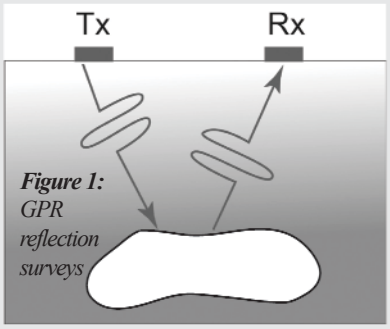

Figure 1: *GPR reflection surveys*

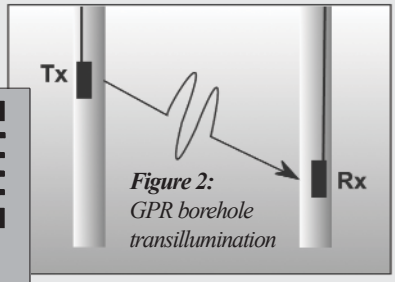

Figure 2: *GPR borehole transillumination*

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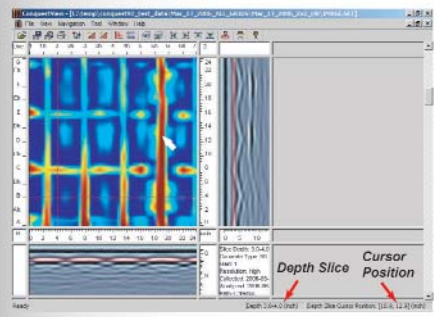
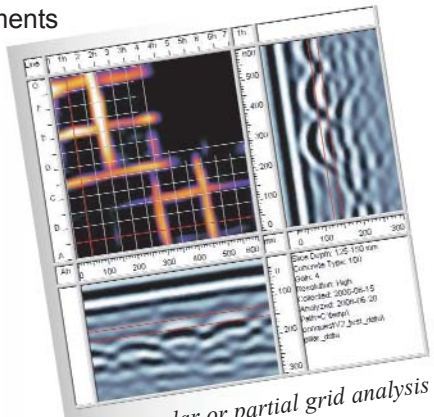
What's new in GPR software:

ConquestView Version 2

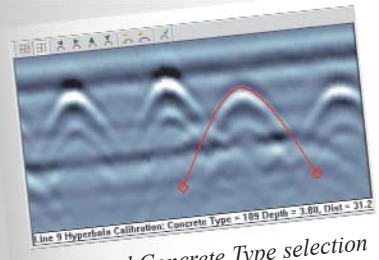
Sensors & Software Inc. announces the release of the next version of ConquestView. Designed for PC-based analysis of data collected with the Conquest concrete imaging system, the new ConquestView offers many enhancements from the previous version.



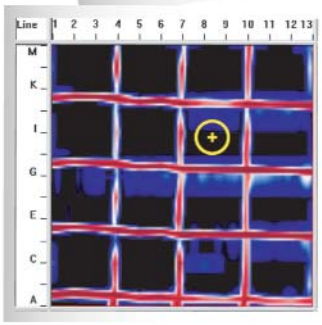
Easy determination of embedded object position



Rectangular or partial grid analysis



Enhanced Concrete Type selection



Upgraded drill locator

- An intuitive interface makes the program even easier to learn. Faster, improved processing algorithms generate and update images quickly so that rapid scrolling through depth slice and cross section images "animates" the data for improved data interpretation.

- A variety of colour maps for both the depth slice and cross-section images are available to enhance and display features of interest. Images can be printed, exported as graphics image files (BMP, JPG, TIFF, GIF and PNG) or saved to the "clipboard" for easy insertion into reports.

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In This Issue

Figure 3: *Field picture of a borehole transillumination survey to image the materials between boreholes.*

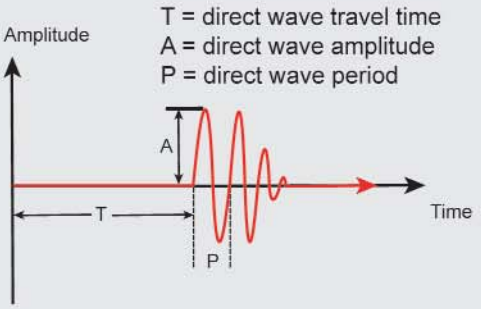

Figure 4: *Transillumination surveys image anomalies by measuring differences in signal properties after passage through a material.*

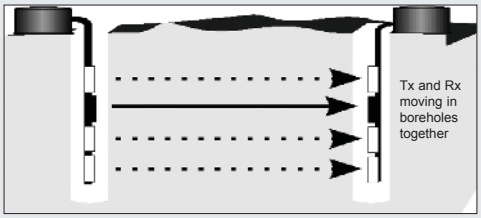

Figure 5: *Zero Offset Profiles (ZOPs) can quickly identify anomalous zones between boreholes.*

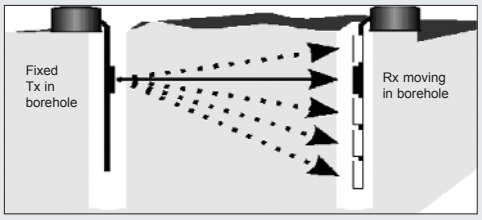

Figure 6: *Multiple offset Gather (MOG)*

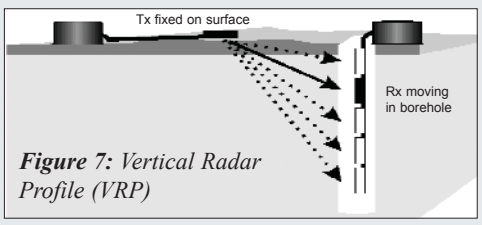

Figure 7: *Vertical Radar Profile (VRP)*

Borehole Transillumination

(continued from page 1)

Transillumination through structures will be described in more detail in our next edition.

GPR transillumination surveys are similar to medical imaging procedures. In both cases, anomalous areas are indicated by variations in travel time, amplitude and period after the signal has passed through the material (Figure 4).

A quick reconnaissance borehole transillumination survey to identify anomalous zones is depicted in Figure 5 and is called a Zero Offset Profile (ZOP).

Detailed imaging with transillumination requires data traces from as many different angles through the material as possible. For borehole surveys this can be achieved by collecting a series of Multiple Offset Gathers (MOGs), as shown in Figure 6, and surface to borehole Vertical Radar Profiles (VRPs), as depicted in Figure 7.

Data from hundreds or thousands of traces collected on different transmitter-receiver paths (see Figure 8) through the structure are combined. Two-dimensional images of velocity, attenuation and dispersion can be generated using tomographic analysis techniques.

For example, a reconstructed velocity image between boreholes reveals an air-filled clandestine tunnel in a border area as a high-velocity anomaly (Figure 9).

Borehole transillumination is a powerful imaging technique with usage growing each year. One exciting new use of this technique is continuous in-situ measurements to create time lapse tomographic images of gradational changes in the subsurface for environmental monitoring.

While obtaining sufficient boreholes and making data acquisition faster will always be challenging for this use of GPR, technological advances are occurring.The future will bring strings of transmitting and receiving antennas to speed data collection and faster data analysis will make this technique viable for more subsurface applications.

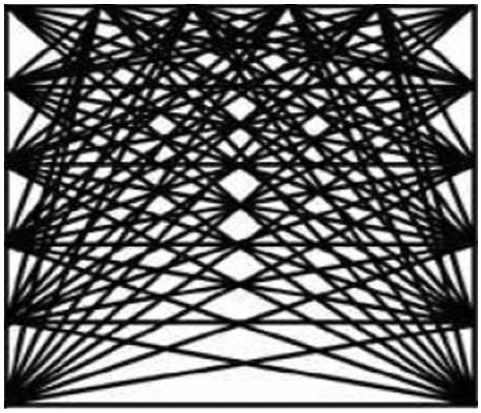

Figure 8: *The raypaths from a series of MOGs and VRPs provide dense coverage of the area between boreholes to generate detailed tomographic images.*

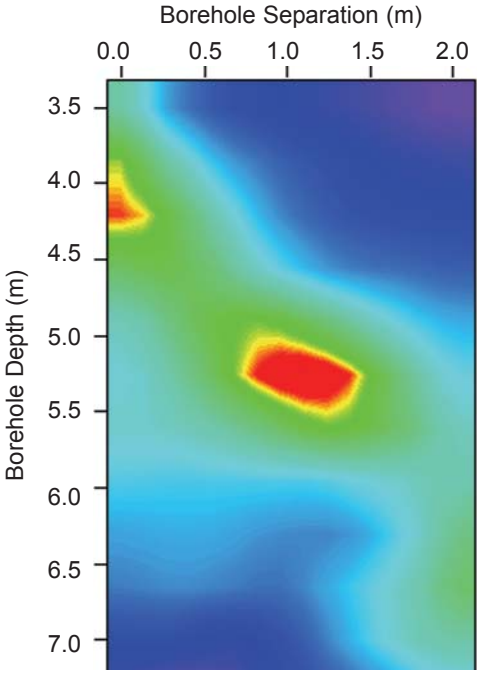

Figure 9: Velocity tomographic image reveals a clandestine tunnel.

ConquestView Version 2

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- New with this release is the ability to process rectangular and partial grids of data with short or missing lines. This adds tremendous flexibility for areas with difficult access that do not allow for complete grid collection.
- Adjusting Concrete Type calibration, which create the clearest depth slice images and provides accurate depth estimates of objects embedded in the concrete, has been upgraded with an enhanced interactive hyperbola-fitting method.
- The upgraded drill locator now positions a "hole" of selectable diameter onto the depth slice image. The user can then scroll up and down through the images to ensure that the proposed drill hole will not hit any embedded objects in the concrete.
- When the mouse cursor is moved over the depth slice and cross-section images, position and depth are tracked and displayed constantly, allowing the user to easily determine the position or depth of an object or measure the distance between objects.
- For increased visibility of targets, a variable depth window limits depth slice and cross-section images to a desired range. This feature is used to "zoom" in and out of cross-section images.
- Added capabilities also include opening multiple grid scans simultaneously to compare different data sets or to compare different depth slices from the same data set.

ConquestView is fully backwards compatible with data collected with earlier versions of Conquest systems.

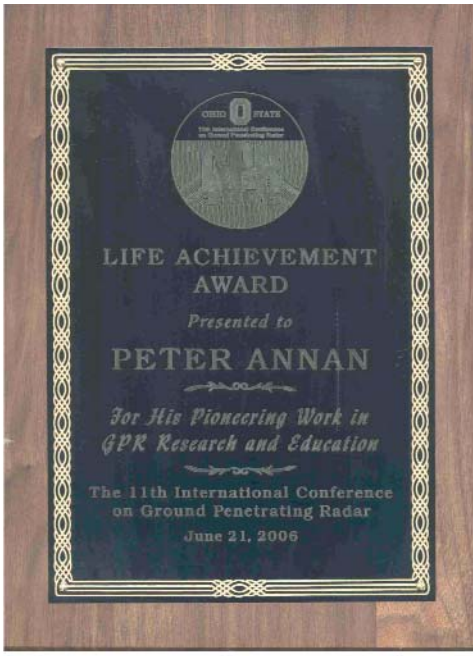
For more information, or to get a demonstration version of ConquestView, contact Sensors & Software. ■

GPR 2006:
Life Achievement Award

Sensors & Software is very pleased to report that our president, Dr. Peter Annan, has been awarded the Life Achievement Award at the 11th International Conference on Ground Penetrating Radar (GPR 2006).

Presented at Ohio State University on June 21, 2006, this award recognizes Dr. Annan's pioneering work in GPR research and education over the past four decades.

Jeff Daniels, co-chair of GPR 2006 presenting the award



June, 21st, 2006 Peter acknowledging the first Life Achievement Award ■

Ask the Expert

Why do people refer to specific frequency antennas when GPR systems generate pulses? Is only one frequency emitted?

Ground penetrating radars (GPR) are variously called impulse, baseband, or UWB radars. The goal of such radars is to achieve high spatial resolution. Spatial resolution means that the emitted pulse must be as short in time and in space as possible.

GPR antennas are designed to emit energy in very short pulses which means energy is *(continued on page 4)*

Recent Technical Papers

1. Quest for the Red Planet, Arch: The University of Calgary Alumni Magazine, Spring 2004, p. 8-14
   By: Louie, J.
   2004 ***ref 338***

2. GPR for Buried Utilities, Utility Products, November 2004, p. 30 - 33.
   By: Johnston, G.B.
   2004 ***ref 339***

3. Monitoring the GPR Response of Curing Concrete, The Proceedings of the 16th World Conference on Non-Destructive Testing, Montreal, Quebec, Canada, August 30 - September 3, 2004, 9 pages.
   By: De Souza, T., Annan, A.P., Redman, J.D., Hu, N.
   2004 ***ref 340***

4. Ground Penetrating Radar Measurements in a Controlled Vadose Zone: Influence of the Water Content, Vadose Zone Journal, Vol. 3, p. 1082-1092.
   By: Loeffler, O., Bano, M.
   2004 ***ref 341***

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www.natia.org/train.html

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Helsinki, Finland
September 4 - 6, 2006
www.eage.org

American Public Works Association
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September 10 - 13, 2006
www.apwa.net

National Rural Water Association
Dallas, TX
September 24 - 27, 2006
www.nrwa.org

Upcoming GPR courses

One Day Noggin® Short Course
September 11, 2006
November 6, 2006

Our Noggin® short courses are offered throughout the year to anyone interested in learning more about GPR and subsurface imaging.

One Day Conquest™ Course
September 12, 2006
November 7, 2006

Our Conquest™ courses are offered to anyone interested in learning more about our concrete imaging instrument.

Information Request

Please check off information required below and fax or Email back:

- ☐ pulseEKKO® PRO
- ☐ Conquest™
- ☐ ConquestView
- ☐ OEM Noggin*plus*
- ☐ RoadMap™
- ☐ pulseEKKO® Borehole GPR
- ☐ Noggin® Systems
- ☐ EKKO Mapper
- ☐ EKKO_View
- ☐ Recent Technical Paper #1
- ☐ Recent Technical Paper #2
- ☐ Recent Technical Paper #3
- ☐ Recent Technical Paper #4
- ☐ Rental Information
- ☐ 3 Day GPR Short Course
- ☐ 1 Day Noggin® Short Course
- ☐ Image Concrete with GPR
- ☐ Other (please specify)

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Ask the Expert

(continued from page 3)

spread over a broad range of frequencies - not a single frequency. The range of frequencies spanned is referred to as the bandwidth occupied by the antenna or GPR.

When a frequency is attached to an antenna or GPR, say 100 MHz, the designation means that the antenna emits signal in a band centered at 100 MHz. The antenna will generally emit substantial energy over a bandwidth or frequency range from 50 to 150 MHz. The antenna does not emit energy at only 1 frequency. In fact, the frequency designation should be interpreted to mean both the antenna bandwidth and center frequency. ■

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