GPR technology
Vol 2, No. 6
Spring 2006

Subsurface Views

Sensors & Software Inc.

pulseEKKO® PRO:
Advanced Survey Techniques

Wide Angle Reflection and Refraction (WARR)

Last newsletter, in our series exploring advanced GPR survey methods, we featured the CMP (Common Mid Point) method used for measuring GPR velocities for accurate depth estimates. This edition, we discuss a survey called WARR (Wide Angle Reflection and Refraction).

A Wide Angle Reflection and Refraction (WARR) survey acquires data while varying the separation between the transmitter and receiver with the prime purpose of estimating GPR velocity . It is similar to the CMP except that one antenna, typically the transmitter, remains fixed while the receiver is moved away usually in equal step intervals (Figure 1.1 - page 2).

Historically, WARR data collection minimized the movement of noise-creating metal cables, resulting in better data quality than CMPs. As well, unlike a CMP, the WARR methodology allowed data to be collected by a single operator.

The disadvantage of a WARR survey is that the mid point reflection point moves between each source and receiver position. Extracted velocities are accurate if the local properties are fairly

(continued on page 2)

pulseEKKO® PRO Multi-Channel

Multi-Channel arrives

This latest advancement in the pulseEKKO PRO family enables deployment of a wide variety of system configurations. The new Multi-Channel Adapter enables a single pulseEKKO PRO control module to operate with any combination of 8 transmitters, receivers and transducers.

The potential number of configurations for systems is enormous. Complexity lies in the physical deployment and adequate support to record/document the essential information.

The pulseEKKO PRO DVL now ships with the first generation of multi-channel firmware. As applications increase, the development will be on going.

The most common deployment configurations are:

- cross-line, fixed-frequency arrays
- in-line multi-frequency arrays
- in-line WARR/CMP arrays
- multi-polarization arrays

Some configurations are depicted graphically in Figure 2.2 - on page 3.

Figure 2.1:
Cross-line, fixed-frequency array

An example of a cross-line, fixed-frequency array in operation is shown above, in Figure 2.1.

(continued on page 3)

In This Issue

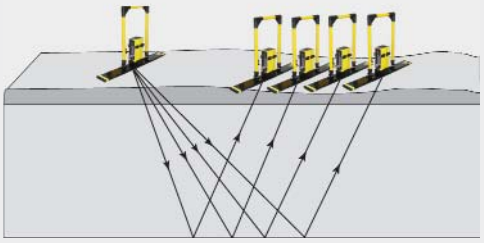


Figure 1.1: *WARR surveys are usually collected with a fixed transmitter and a moving receiver.*

Figure 1.2: *WARR survey with a fixed transmitter and one moving receiver with an odometer wheel triggering the collection of each trace.*

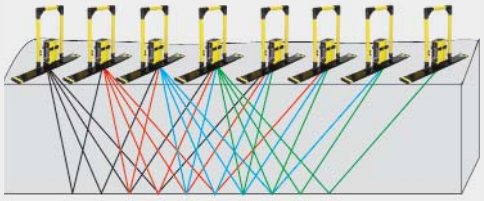


Figure 1.3: *Multi-fold data collected as a series of WARR surveys. Each WARR is displayed in different colour.*

Figure 1.4: *A series of WARR surveys also produces continuous CMP surveys that can be processed to enhance the quality of the cross sectional image. Same image as Figure 3 but with colours changed to reveal the CMPs.*

WARR surveys

(continued from page 1)

homogeneous and flat-lying, but less reliable if targets have limited spatial extent or if the reflectors are sloping.

WARR surveys can be conducted rapidly if the moving antenna is connected to an odometer to measure offset - Figure 1.2. An even much faster method, is to use a multi-channel system with one fixed transmitter and multiple receivers at different offsets (see the accompanying pulseEKKO PRO Multi-Channel system article).

sectional image. GPR data, similar to seismic data in many ways, can also be improved with this method.

Multi-fold GPR surveys can be performed with a single transmitter and receiver but data collection is labour intensive and time-consuming. The real benefits of the multi-fold method will be realized as multi-channel systems capable of rapid data acquisition, like the pulseEKKO PRO, become more widely used. ■

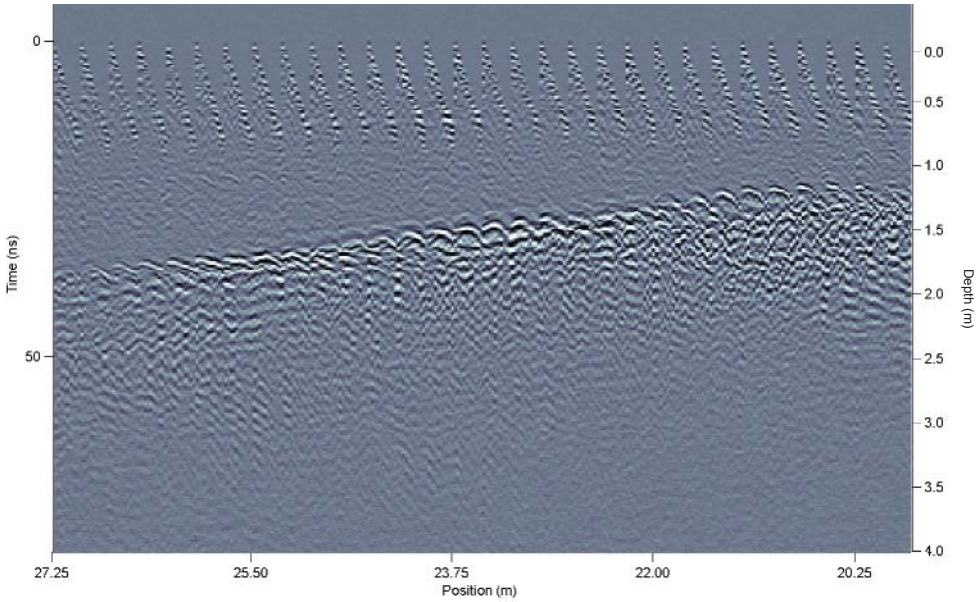


Figure 1.5: *Raw, multi-fold data consisting of 30 adjacent WARR surveys.*

If multiple WARR surveys are done continuously with the proper spacing along a survey line, this creates a "multi-fold" survey line (Figure 1.3).

While a multi-fold WARR survey looks complex, it is really like collecting a CMP at every point. This can be seen in Figure 1.4 by changing the colours of the raypaths in Figure 1. 3.

The oil industry learned decades ago that collecting "multi-fold" seismic reflection data and combining or “stacking" the CMP traces together increases the quality of the cross

Subsurface Views
Sensors & Software Inc.

Multi-Channel arrives

(continued from page 1)

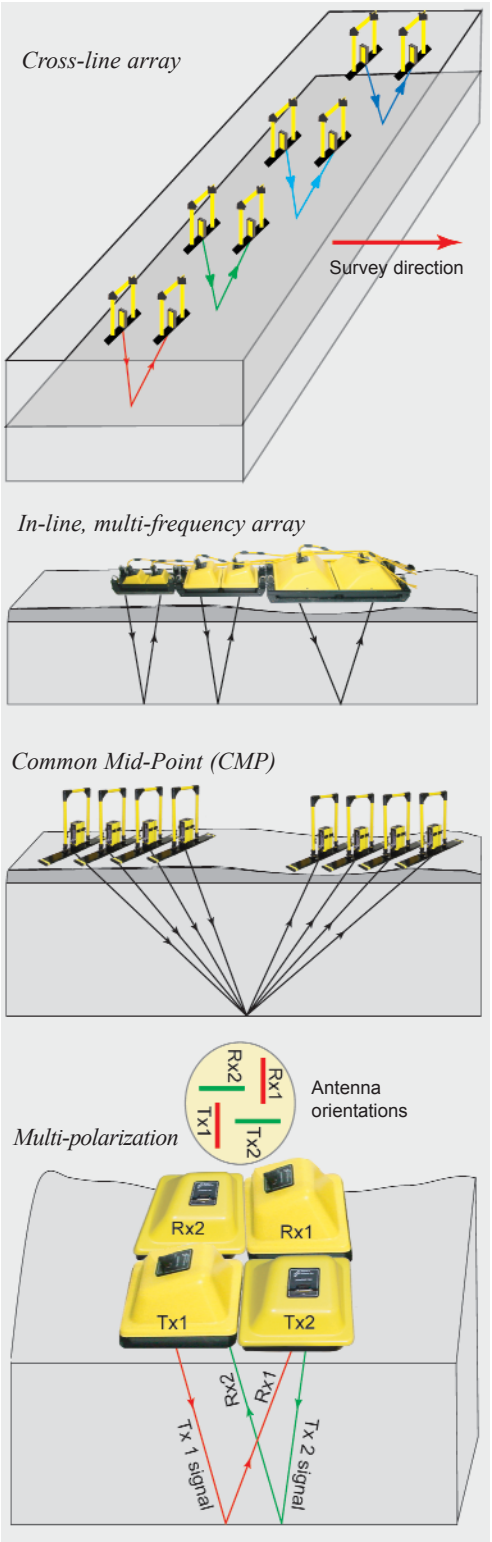


Figure 2.2: *Multi-Channel deployment configurations*

Data are recorded on the DVL in multiplexed form in a standard .dt1 file. Figure 2.3 is a field display of 4 channels being recorded. Interactive channel setup and replay are included in the DVL firmware.

Figure 2.3: *Real time display of 4 channels data*

Post acquisition software, EKKO_Demux, which ships with the Multi-Channel Adapter, provides simple and easy demultiplexing of multi-channel data into independent .dt1 data files. Figure 2.4 shows multi-plexed and individual data in EKKO_View. Data analyses are completed in EKKO_View, EKKO_Mapper and EKKO_3D.

The Multi-Channel pulseEKKO PRO is designed to address the needs of advanced GPR survey methods, which are described in this and several earlier Subsurface Views.

For more details, contact our technical staff or email Ask-the-Expert ■

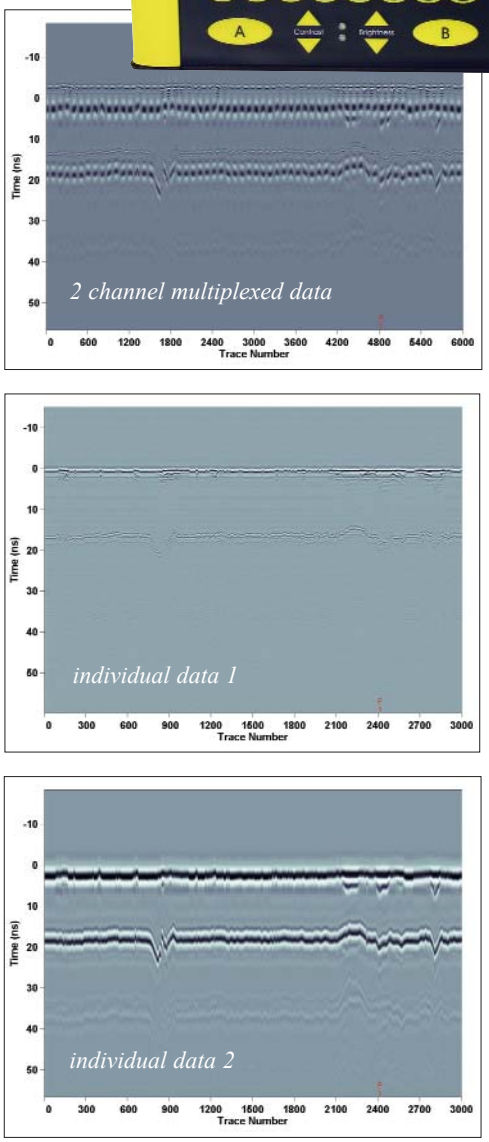


Figure 2.4: *Multiplexed and individual data in EKKO_View*

Ask the Expert

Charles Skiba inquired about using GPR for the walls and ceilings of wooden structures.

GPR signal can penetrate most non-metallic materials. GPR has been used to image several types of wooden structures. Applications range from tree root imaging for forestry research to imaging into trees and wooden poles for rot, small targets or heterogeneities. We have also heard of customers using GPR to detect water-saturated wood behind ceramic tiles in a bathroom.

In general, wood scanning applications require a high frequency GPR system in the 500 to 1000 MHz range. ■

Recent Technical Papers

1. Modelling of GPR waves for lossy media obeying a complex power law of frequency for dielectric permittivity, Geophysical Prospecting, Vol. 52, p. 11-26.
   By: Bano, M.
   2004 ***ref 330***

2. The Quest for Better Wine Using Geophysics, Geotimes, August 2004, p. 30-34.
   By: Hubbard, S.S., Rubin, Y.
   2004 ***ref 333***

3. Assessing the Precision of GPR Velocity and Vertical Two-Way Travel Time Estimates, JEEG, September 2004, Vol. 9, Issue 3, p. 143-153.
   By: Jacob, R.W. and Hermance, J.F.
   2004 ***ref 335***

4. Implementing a New Level of Industry "Best Practice" in regard to Underground Service Detection, Proceedings of the Sustainable Land Transport Conference, Wellington, New Zealand, November 21-24, 2004, in press.
   By: Lord, T.
   2004 ***ref 337***

See us at ...

APWA
Tallahassee, FL
May 8 - 12, 2006
www.apwa.net

CUEE
Mississauga, ON
May 16 - 17, 2006
www.cuee.ca

Structural Faults & Repair
Edinburgh, Scotland
June 13-15, 2006
www.structuralfaultsandrepair.com

GPR 2006
Columbus, OH
June 19 - 22, 2006
www.gpr.osu.edu

Dig Big
Manteno, IL
June 27 - 29, 2006
www.theplanetunderground.com

Upcoming GPR courses

One Day Noggin® Short Course
May 1, 2006
July 10, 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
May 2, 2006
July 11, 2006

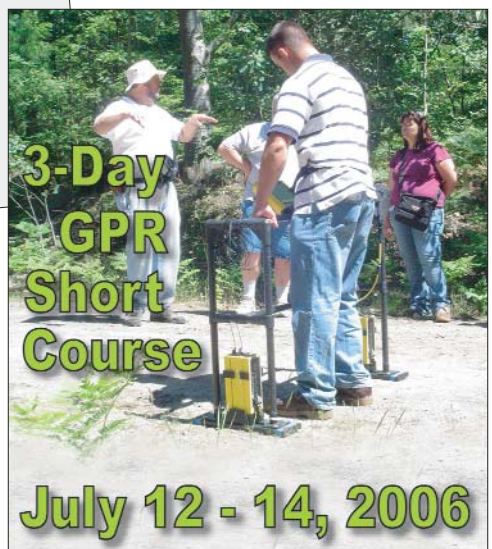
Our Conquest™ courses are offered to anyone interested in learning more about our concrete imaging instrument.

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)

_____



July 12 - 14, 2006

Our 3-day course is an intensive course covering GPR theory, case studies, survey techniques, data processing and interpretation. A practical day in the field is part of the course.

Interested? Contact us early as space is limited.
training@sensoft.ca

Sensors & Software Inc.
1040 Stacey Court
Mississauga, ON L4W 2X8 Canada
Tel: (905) 624-8909
Fax: (905) 624-9365
Email: sales@sensoft.ca
Website: www.sensoft.ca