GPR Technology Vol 7, No. 25, January 2011

Subsurface Views

Sensors & Software Inc.

From our customers files

Time Bombs

Geolog is a German company that specializes in geophysical surveys; one of their services is detecting unexploded ordnance (UXO).

During the latter part of World War II, all larger German cities were extensively bombed by the Allies. There are two interesting and terrifying statistics as a result:

- It is estimated that about 15% of the bombs did not detonate immediately.
- While most bombs were found shortly after the bombing and defused, an estimated 100,000 bombs are still laying undetected somewhere in the ground.

In the heavily-bombed areas in Germany, geophysical surveys are routinely carried out before construction works. Although these surveys are, surprisingly, not required by German law, they are performed for the protection of the construction workers and to avoid problems with insurance.

Construction sites are usually surveyed with magnetic locators which detect ferrous (iron) objects. However, in areas with linear iron objects (old pipelines, fences, steel reinforced concrete buildings, etc.) detection with ferrous locators is not possible. In these cases, GPR is used because nearby metallic objects do not interfere with GPR data acquisition.

(continued on page 2)

GPR with Life Saving Potential

Rescue Radar

With each new catastrophic event (earthquakes, avalanches or tunnel and building collapses) comes renewed interest in using GPR to help locate buried survivors. Sensors & Software have looked at this problem over the years, always cognizant about the dangers of false-positive indicators.

***Rescue Radar** detects the movement of buried victims. The system has two components: the sensor and a remote computer display connected by a wireless link.*

Now, after much discussion with potential users, a complete GPR solution has been developed to meet this demand. While GPR is not a "silver bullet", when used properly in conjunction with other available tools, there is a real potential to save lives.

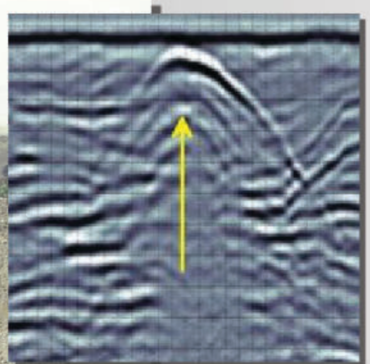
Why use GPR? GPR is one of the few technologies that can look through soil, rubble, rock and snow. Although GPR can send energy into these materials, a buried human still presents an impossible target to identify - unless that person is moving.

(continued on page 3)

In this issue

Time Bombs *(continued from page 1)*

A recent Noggin GPR survey was conducted on a site where a BMW fabrication plant stood during WWII. An old water pipe across the site precluded the use of ferrous locators for the survey. In addition, the first half meter of the ground was contaminated with iron pieces from the demolition of the old building. The soil had to be removed before construction.

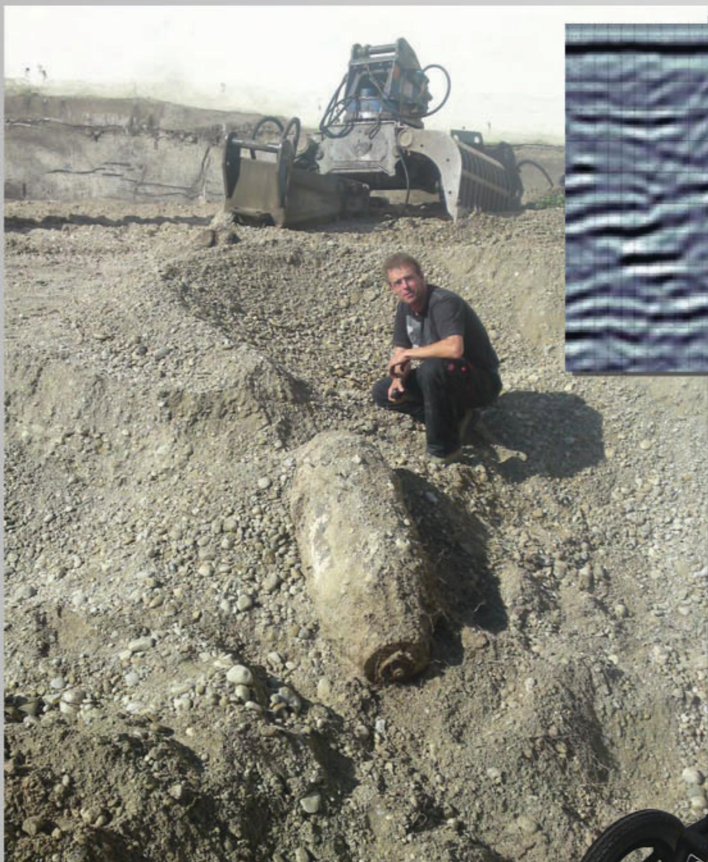


GPR cross-section showing a 1000 lb US demolition bomb at a shallow depth.

The GPR survey located a 1000 lb US demolition bomb at a shallow depth. The bomb was dropped in 1944 or 1945. Careful uncovering of the bomb revealed that it had one nose and one tail pistol still functioning. It was defused and removed from the site.

This dangerous and important work is routine for Geolog; soon after this survey they found two more bombs. Geolog uses their Noggin GPR almost every day on construction sites.

Story courtesy Markus Munzer, Geolog. ■

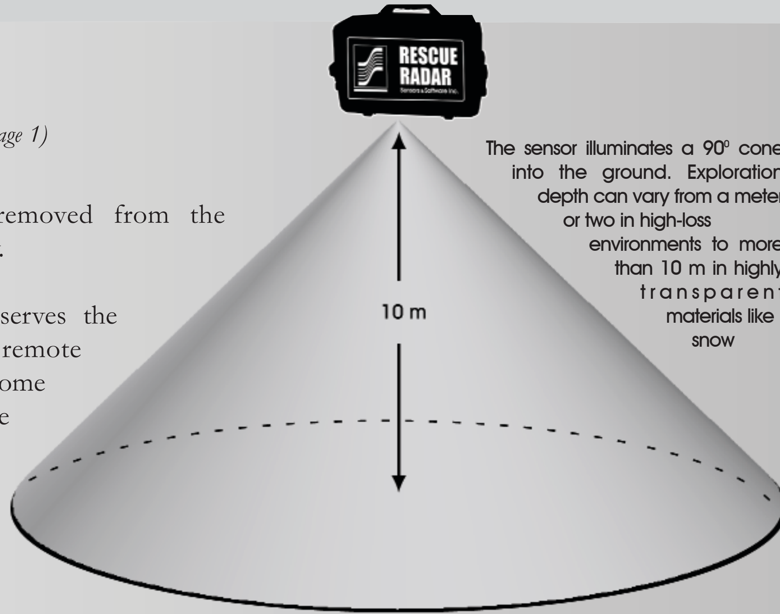


Geolog uses their Noggin GPR almost every day on construction sites. They located this bomb on a site where a BMW fabrication plant stood during WWII.

Aerial image from June 7th 1945, Munich

Rescue Radar

(continued from page 1)



Movement can be as subtle as breathing or extreme like whole body motion. Time lapse GPR measurements are used to identify movement. Since breathing and heart beats have very regular patterns, varying levels of detection and motion discrimination can be used to infer life-like activity.

Out of this understanding, and some testing, Rescue Radar was born. Rescue Radar consists of two components: the sensor and a remote computer display connected by a wireless link. The wireless link eliminates potential interference from moving cables. All components pack into the rugged sensor case for easy storage and transport.

Operation on a site is very simple. The operator places the Rescue Radar sensor at the monitoring point. The Rescue Radar then emits GPR pulses into the ground and measures any returned reflections. Since signal travelling into the ground can reflect into the air and return from any feature in the area, it is important that the operator, and any objects that can cause movement, be removed from the immediate vicinity.

The operator observes the response on a remote computer screen some distance from the sensor so his movement does not affect the reading. A regular cycle of monitoring is set up and the system displays the distance/range to any detected movement. The system further analyzes the movement for life-like patterns and highlights positive indicators. All motion observations recorded can be replayed immediately. If needed, the observation history can be archived.

Rescue Radar is battery powered and can be up and running in minutes. The simple user interface and quick start guide make user training easy. Deploying the sensor in a regular grid pattern permits systematic searching of a defined area. The sensor illuminates a 90 degree cone into the ground. Exploration depth can vary from a meter or two in high-loss environments to more than 10 meters in highly transparent materials like snow.

Rescue Radar is being adopted by Search and Rescue organizations around the world. Contact our applications specialists to discuss the life saving potential of this exciting new product. ■

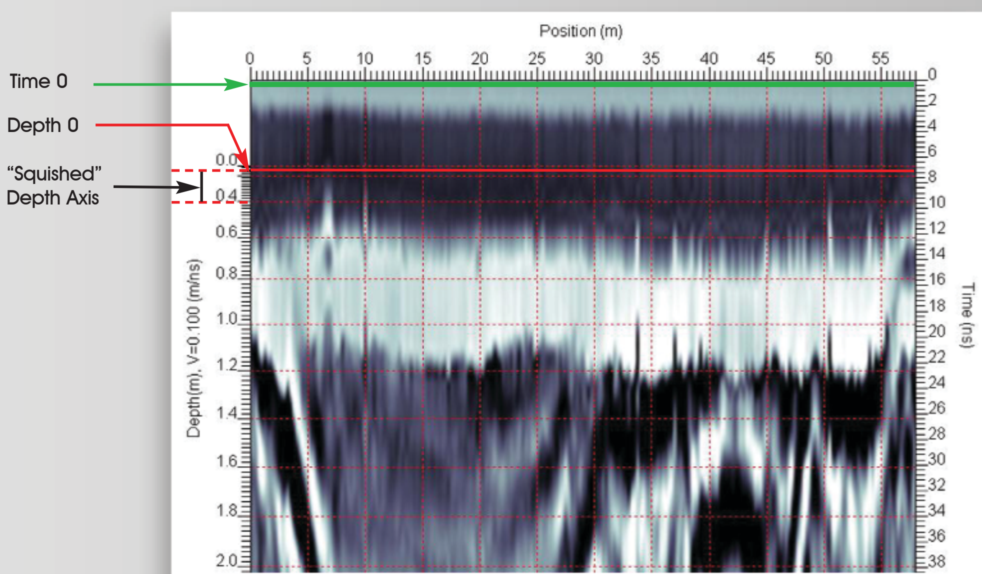
Ask-the-Expert

When I plot a GPR cross-section in EKKO_View, why doesn't the zero on my time axis correspond to the zero on my depth axis? Also, why is the depth axis squished at the top?

The answers to these two questions are related.

GPR measures the time for a signal to travel along a path to and from the target. The answers to the questions lie in the geometry of the signal path.

In conventional reflection mode GPR, the desired quantity is depth. Signal path and depth are equivalent only if the GPR transmitter and receiver are located in the same location. Since GPRs usually have a separation between the transmitter and receiver, the signal path and the depth are not the same!



If your antennas are 1 meter apart on a soil with a velocity of 0.1 m/ns, the depth axis will be as depicted in the above figure. The top of the record was expanded to make the depth scale visible.

(continued on page 4)

Technical Papers & Notes

1. **GPR Response from Buried Pipes: Measurement on Field Site and Tomographic Reconstructions**
   IEEE Transactions on Geoscience and Remote Sensing, Vol. 47, No. 8, Pg. 2639-2645, 2009
   By: Elena Pettinelli, Andrea Di Matteo, Elisabetta Mattei, Lorenzo Crocco, Francesco Soldovieri, J. Dave Redman, A. Peter Annan, **ref 416**

2. **Ground Penetrating Radar for Forensics**
   CINDE Journal; Vol. 30, No. 4, Pg. 16-17; 2009
   By: Troy De Souza (Sensors & Software Inc.), **ref 419**

Upcoming GPR courses

One Day Noggin® Short Course
March 7, 2011
May 2, 2011

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

One Day Conquest™ Short Course
March 8, 2011
May 3, 2011

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

Imaging Concrete with GPR - February 8, 2011 - Mississauga, ON
- March 3, 2011 - New York, NY

See us at ...

WOC 2011
Las Vegas, NV
January 18 - 21, 2011
http://www.worldofconcrete.com

CGA 2011
Orlando, FL
March 8 - 10, 2011
http://www.cgaconference.com/

CSDA Convention
Bonita Springs, FL
March 10 - 12, 2011
http://www.csda.org/

CONEXPO-CON/AGG 2011
Las Vegas, NV
March 22 - 26, 2011
http://www.conexpoconagg.com/

Ask-the-Expert

(continued from page 3)

To demonstrate this, draw a triangle like the figures depicted on the right side. The triangle is defined by 3 points: the transmitter T, receiver R and a target P. The signal path (L) is from T to P to R. Depth, d, is the vertical distance from P to the line joining T and R. It is clear that depth and path length are not the same, unless T and R are coincident.

Mathematically if T and R are separated by distance S, then path length is

$$L= (S^2 +4d^2)^{1/2}$$

And if one desires depth, d, based on knowing L and S, then

$$d=(L^2-S^2)^{1/2}/2$$

When depth is much larger than the T-R separation, then

$$L\sim 2d \text{ or } d=L/2$$

To estimate depth scales for GPR, this geometrical relationship has to be taken into account. S is measured and L is determined by GPR travel time

$$T=L/v$$

As a result, the depth axis on a GPR section is created by translating travel time to a depth using the relationship

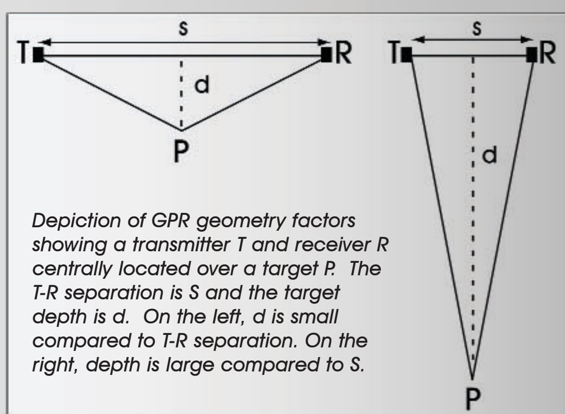
$$d=(v^2T^2-S^2)^{1/2}/2$$

which becomes

$$d=vT/2$$

when L is much larger than S.

For this reason, EKKO_View displays an offset between zero time and depth and "squishes" the depth axes. This also explains the reason why the antenna separation should be recorded with the data and the velocity displayed in the depth conversion !



Depiction of GPR geometry factors showing a transmitter T and receiver R centrally located over a target P. The T-R separation is S and the target depth is d. On the left, d is small compared to T-R separation. On the right, depth is large compared to S.

As an example, if your antennas are 1 meter apart on a soil with a velocity of 0.1 m/ns, the depth axis will be as depicted in the figure on page 3 which has the top of the record expanded to make the depth scale visible. ■