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Subsurface Views

Sensors & Software Inc.

From our customers' files

Mapping Ancient Shorelines

Urban coastal areas are often heavily modified and infilled to mitigate saltwater flooding and expand residential and commercial acreage. In extreme cases, coastal features such as beach berms, tidal marshes and stream channels disappear entirely from the landscape. Despite heavy anthropogenic modification, the forgotten native environment continues to influence hydrological and geotechnical site characteristics. In other instances, anthropogenic activities may bury sites of cultural significance. In the absence of exposed artifacts or other indicators, archaeologists commonly incorporate the position of ancient shorelines and freshwater streams into their assessment of settlement potential. When key geomorphic features are no longer evident in the modern landscape, geophysical techniques such as GPR provide an important opportunity to reconstruct their location and scale.

Recently, geoscientists from the Department of Marine, Earth and Atmospheric Science at North Carolina State University undertook a project to assess the thickness of anthropogenic fill along a heavily modified portion of the Olympic Peninsula coastline in Washington State.

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New GPR configuration for vehicle tow surveys

SmartChariot

Sensors & Software have added a new configuration to go along with SmartCart, SmartTow and SPIDAR. The new SmartChariot provides vehicle-towed deployment of Noggin, pulseEKKO PRO and SPIDAR GPR systems.

A standard SmartChariot feature is the ability to simultaneously deploy two Noggin 1000s or a combination of a Noggin 500 and a Noggin 1000.

Ideal for large area or long survey line data collection on roads, parking lots, warehouse floors and smooth open fields like golf courses and parks, the SmartChariot features:

- **Ground-Coupled Deployment**
  The highest quality GPR data are acquired when the sensors are deployed in a ground-coupled manner. On the SmartChariot, the sensors ride just above the ground surface with suspension and skid plates minimizing abrasion from rough surfaces.

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SmartChariot *(continued from page 1)*

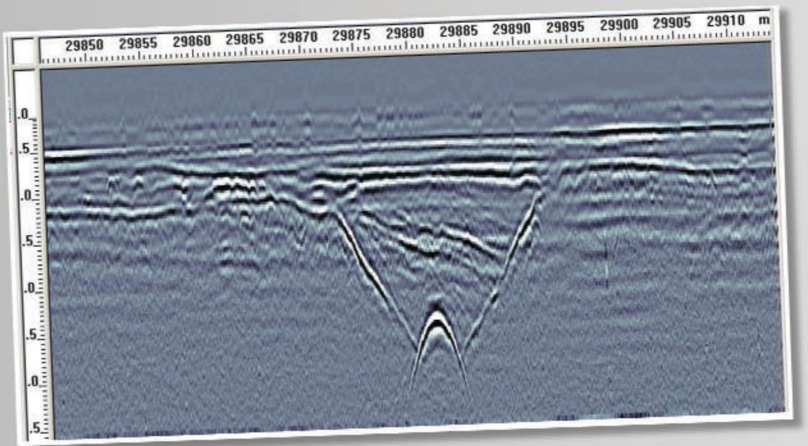


Figure 1: The 250 MHz systems provide deeper penetration to locate objects like deep utilities under roads.

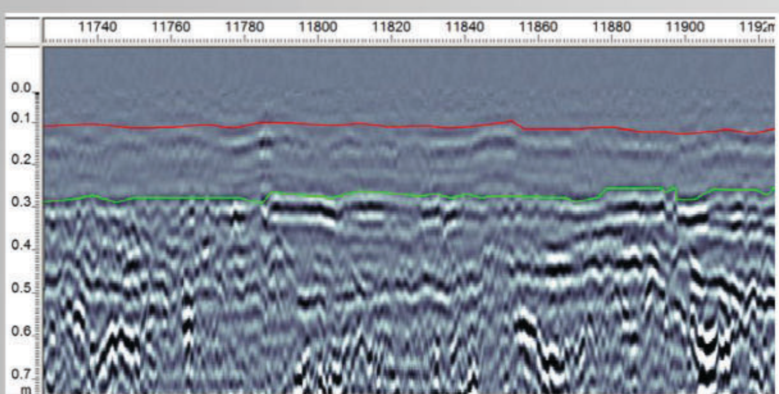


Figure 2: The 500 MHz systems provide high resolution imaging of pavement thickness.

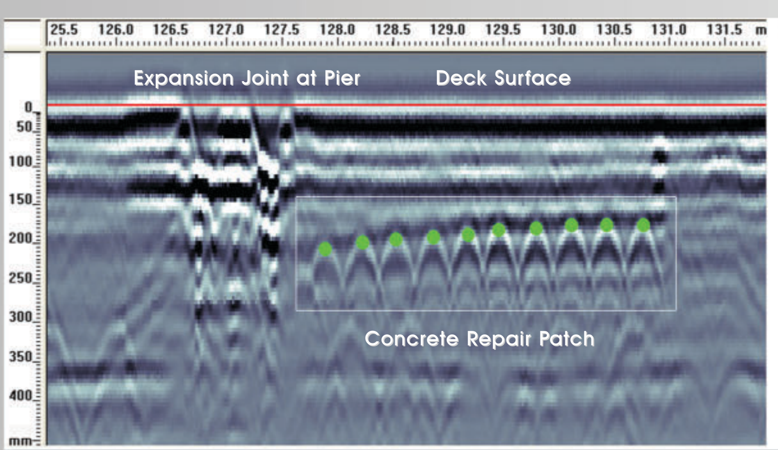


Figure 3: The 1000 MHz systems provide high resolution imaging of reinforcement and conduits in concrete structures.

Maximum GPR energy penetrates into the ground with this arrangement, giving the deepest and highest-quality data. As powerfully demonstrated by the larger RoadMap system, data quality is critical to in-depth road and concrete structure assessment. The SmartChariot configuration is designed to provide a smaller, cost-effective vehicle-towed solution.

- **High Frequency and Dual-Channel Support** - The SmartChariot supports the Noggin 250, 500 and 1000 systems, the pulseEKKO PRO 500 and 1000 MHz transducers and simultaneous operation of Noggin 500/1000 or 1000/1000 MHz. The lower frequency 250s provide deeper penetration to locate objects like deep utilities under roads (Figure 1) while higher frequencies provide better resolution of pavement thickness (Figure 2), as well as of reinforcement and conduits in concrete structures (Figure 3).
- **Rugged, Light and Compact** - Proximity of metal structures to GPR electronics can cause interference and noise in the GPR data. To eliminate these effects, the SmartChariot is fabricated of rugged, non-metallic structural elements. The design also allows for easy transport, storage and deployment. Being light weight and compact makes for convenient shipping to any survey site.
- **Hitch Attachment** - The SmartChariot can be attached to a common trailer hitch on any vehicle of opportunity; cars, trucks, vans, ATV's (all-terrain vehicles), golf carts, tractors and even bicycles and motorcycles can be used. There are two hitch height selections available: low for cars and other low-slung vehicles and high for large trucks and high ground clearance vehicles.
- **Sensor Attachment and Height Adjustment** - It is easy to attach and release the GPR sensors on the SmartChariot. A simple and reliable fine height adjustment allows the operator to quickly adjust the GPRs so they sit at the desired height above the ground surface.
- **Positioning** - Like the SmartCart and SmartTow configurations, the SmartChariot provides an integrated odometer wheel for equidistant triggering of GPR data traces. The standard GPS receiver mount provides geo-referenced positioning of GPR surveys that easily imports into the EKKO_Interp and EKKO_Mapper software packages. This allows the GPS position for targets of interest to be easily extracted into spreadsheet and GIS-compatible files.

Owing to the light weight, portable nature of the SmartChariot, use on trafficked roads requires awareness of local vehicle licensing requirements. Open road operation is not recommended without a trailing crash avoidance vehicle. Since many small scale road surveys are conducted with closed lanes or during off-peak traffic conditions, this is seldom a constraint. Customers indicate that the ability to mobilize quickly and economically to any site compensates for any traffic coordination issues.

As with all Sensors & Software configurations, attention to detail has been paramount in making the SmartChariot a reliable and flexible user-oriented solution. *To learn more about SmartChariot contact our Application Specialists.* ■

Mapping Ancient Shorelines

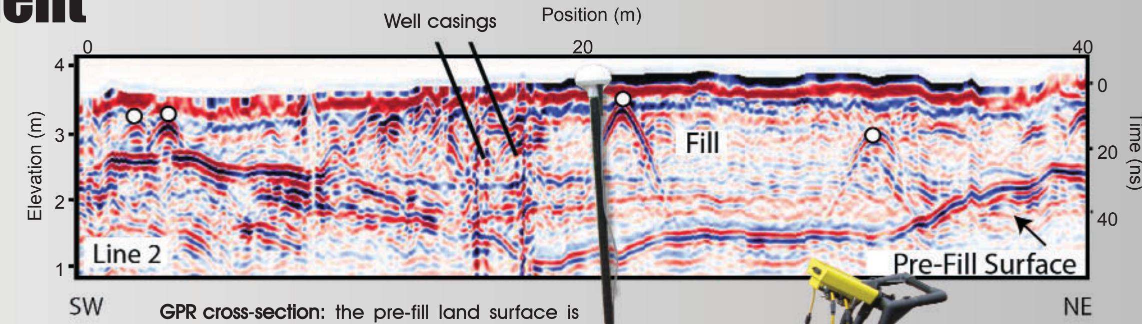
(continued from page 1)

The project collected more than 20 kilometers of GPR survey lines using a SmartCart-deployed pulseEKKO PRO unit with both 100 and 250 MHz antennas. Radar processing was performed using Sensors & Software's EKKO_View and EKKO_Mapper programs. EKKO_Interp was used to digitize reflectors associated with the pre-fill land surface. These digitized points were saved as ASCII tables of latitude, longitude and depth, and exported for gridding and visualization.

A portion of the survey took place at a former industrial site that has hosted a range of commercial activities since the area was filled nearly 100 years ago. Beneath this now flat-lying, grass-covered field, the pre-fill land surface is identified as a pronounced reflector with up to 2 m of relief. Numerous hyperbolic reflectors are shown to dissect the otherwise flat-lying fill sequence above the paleo-surface. These targets are associated with utility lines and debris from previous construction activities. When the fill thickness and reflector elevations are gridded, a small channel perched just above the elevation of the high-tide water level is revealed in the buried landscape.

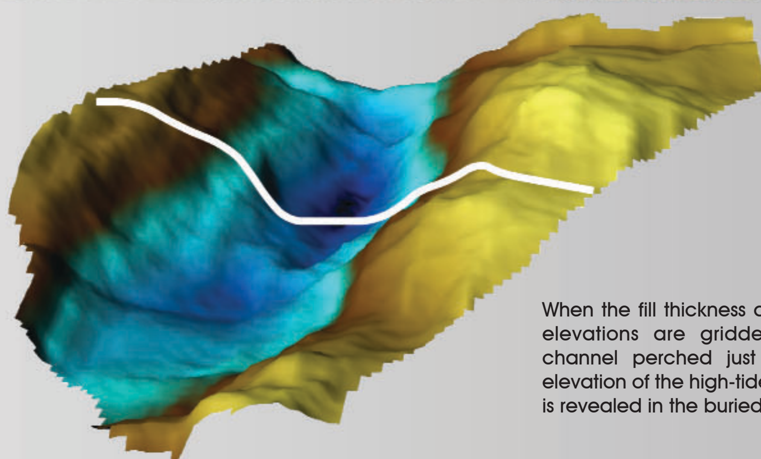
Inspection of a harbor survey map produced before the infilling confirms that a stream did exist in this area before the drainage was diverted. Using a geographically registered version of the harbor survey map as a reference, the GPR data are seen to capture the position and sinuosity of the channel with remarkable accuracy. The results provide important insight into the flow of ground water and contaminents through the site, and confirms that the stream was likely of sufficient scale to serve at least seasonally as a fresh water source in the ancient environment.

Courtesy of Dr. Del Bohnenstiehl and Dr. Karl Wegmann, North Carolina State University.



GPR cross-section: the pre-fill land surface is identified as a pronounced reflector with up to 2 m of relief. Numerous hyperbolic reflectors are shown to dissect the otherwise flat-lying fill sequence above the paleo-surface.

pulseEKKO PRO 250 SmartCart surveying a former industrial site.



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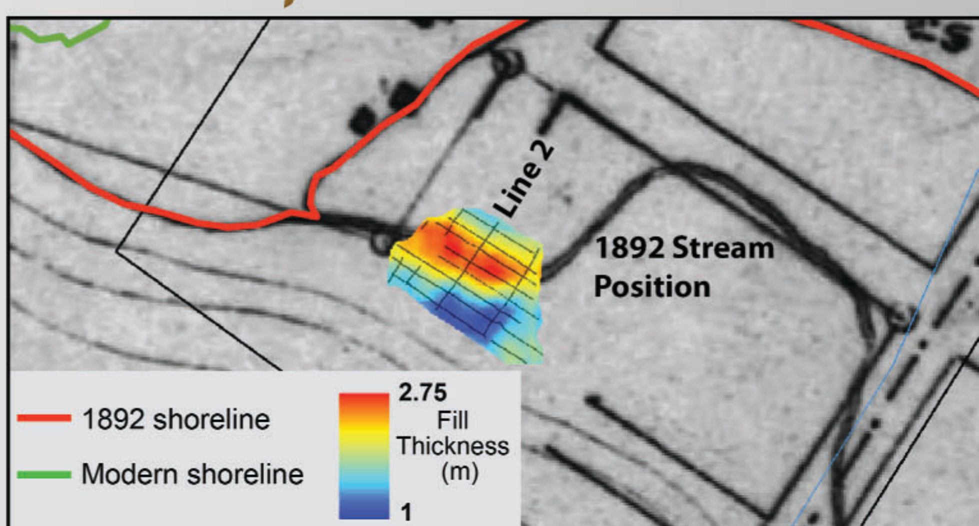

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Technical Papers & Notes

1. **CSDA Best Practice: Ground penetrating radar for concrete scanning**
   Concrete Sawing & Drilling Association (CSDA) ; Issue # CSDA-BP-007; 2009
   ref 427

2. **Ground penetrating radar imaging and time-domain modeling of the infiltration of diesel fuel in a sandbox experiment**
   ScienceDirect; C.R. Geoscience 341; Pg. 846-858; 2009
   By: Maksim Bano, Olivier Loeffler, Jean-Francois Girard **ref 429**

See us at ...

Locate Rodeo
Atlanta, GA
August 4 - 6, 2011
http://www.locaterodeo.com/

CIS 2011
Ottawa, ON
September 25 - 27, 2011
http://www.cis-sci-conference.info/cms/index.php

Dam Safety 2011
Washington, DC
September 25 - 29, 2011
http://www.damsafety.org/

GSA 2011
Minneapolis, MN
October 9 - 12, 2011
http://www.geosociety.org/meetings/2011/

Upcoming GPR courses & workshops

One Day Noggin® Short Course
September 12, 2011
November 7, 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
September 13, 2011
November 8, 2011

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

Imaging Concrete with GPR workshops
- August 17, 2011 - Vancouver, BC
- September 28, 2011 - Washington, DC

Ask-the-Expert

Do powerlines affect my GPR data??

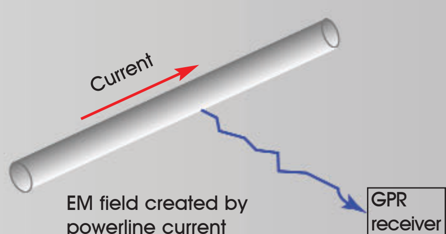
The question is double-barreled and depends on the reason for the question. Powerline concerns can stem from 2 perspectives, so the question can be phrased two ways:

1. Will the electromagnetic signals created by current-carrying powerlines interfere with the GPR measurements? (In other words, will the powerlines act as a large source of noise - a commonly observed problem in many geophysical instruments?)

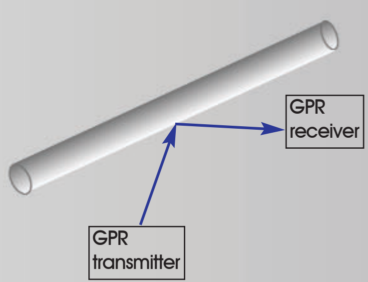
2. Will powerlines act as reflecting targets for the GPR signals and create "unwanted" returns, masking desired signals in my measurements?

The answer in the first case is "No". Powerline signal frequencies (fundamental and harmonics) are typically in the audio frequency range. GPR antennas and receivers are very insensitive to such low frequencies. While there may be unusual circumstances that cause interference to leak into the receiver electronic circuitry by other paths, well designed GPR systems do not see the powerline signals.

In the second case, the answer is more likely "Yes". Wire cables are very effective scatterers of electromagnetic signals at all frequencies. In some cases, the powerlines are the desired GPR target if looking for buried cables. On the other hand, there are often instances where above-ground power cables will scatter the GPR signal back and mask signals from a target in the ground. There is no way around this problem. While GPR antennas are often shielded, the shields are small and can be ineffective for these types of strong signals. ■



Case 1: where powerline generates a signal at the GPR receiver.



Case 2: where the GPR signal is scattered by the powerline and returned to the GPR receiver as a real GPR signal.