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Subsurface Views

Sensors & Software Inc.

Committed to GPR advancement

SAGE, TINGS, NPS

Sensors & Software Inc. is committed to furthering the knowledge of GPR users. Each year our instructors participate at a number of geophysical courses across the USA.

SAGE - Summer of Applied Geophysical Experience - Santa Fe, New Mexico (www.sage.lanl.gov). Hosted by Los Alamos National Laboratory and supported by the US Department of Energy and the US National Science Foundation, SAGE is generally aimed at US and international undergraduate students studying earth sciences, physics and math.

TINGS - Tennessee Intensive Near-surface Geophysics Study - Knoxville, Tennessee (www.geophysics.tennessee.edu/tings). Hosted at the University of Tennessee, it is designed for undergraduate and graduate students and geotechnical professionals interested in enhancing their skills with practical geophysical techniques.

National Park Service Archaeological Prospection Workshops (www.nps.gov/history/mwac) are designed to advance the use of non-destructive i nvestigations in archaeological research with geophysical techniques. It is intended for government cultural resource managers and specialists, private contractors and university professors and students with specific responsibilities around cultural resources.

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From our customers' files

Breaking the Ice

Every spring, cities and towns along rivers in Manitoba are threatened by flooding and damage from ice jams that form during breakup (Figure 1). Ice jams were responsible for extensive flooding and severe damage to many homes near the riverbanks in 2009.

Controlled cutting used to help break up ice and prevent dangerous ice jams from forming.

In 2005, Manitoba Water Stewardship introduced the Ice Jam Mitigation Program to assist with the ice breakup and reduce damage caused by ice jams. That year, a large amphibious excavator, the Amphibex, was purchased to break the ice. More equipment was added each year and, in 2008, GPR surveys and ice cutting joined the program.

The mitigation process now begins with GPR. Figure 2 shows an IceMap system equipped with a GPS for positioning mapping ice thickness on a frozen river. Figure 3 shows a typical ice cross-section from IceMap.

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In this issue

Breaking the Ice

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Figure 1: Ice jams cause flooding and damage to shoreline structures.

Figure 2: IceMap GPR deployed behind an Argo, an amphibious ATV.

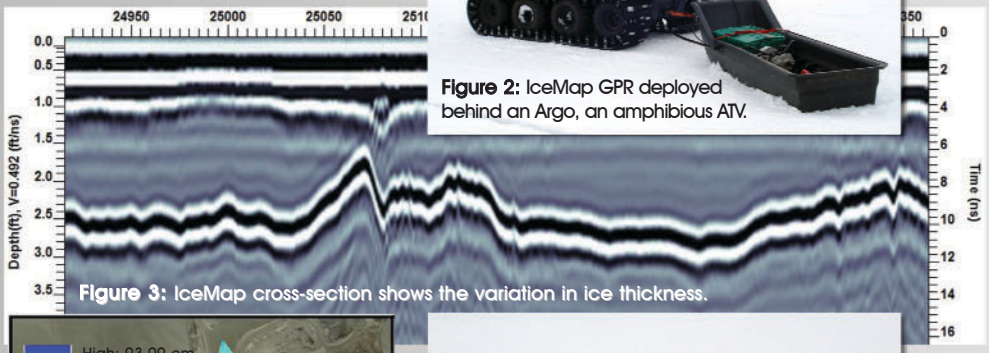

Figure 3: IceMap cross-section shows the variation in ice thickness.

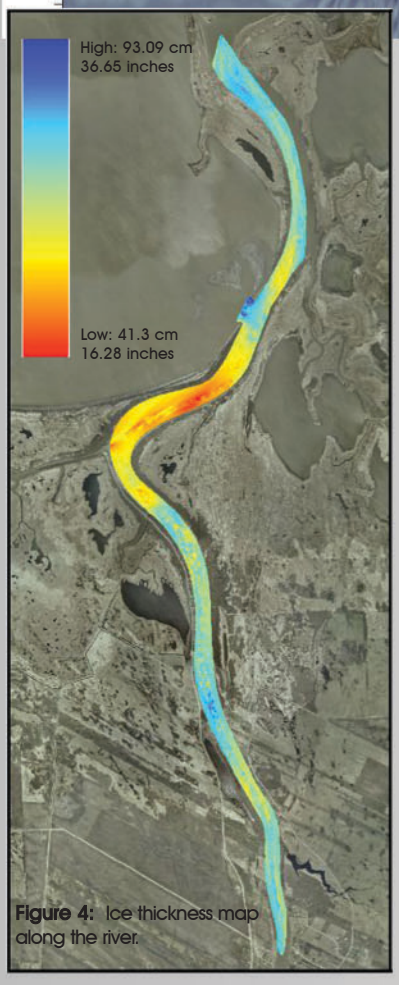

Figure 4: Ice thickness map along the river.

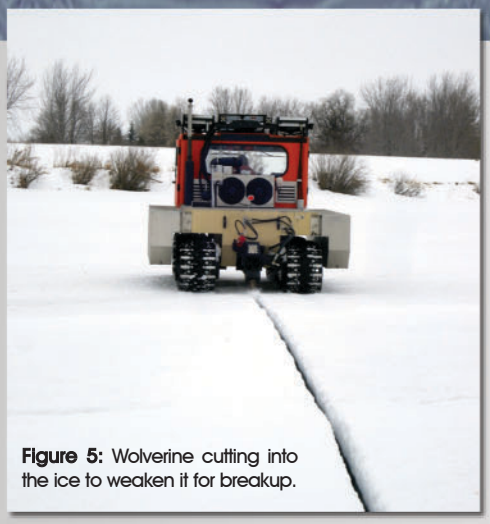

Figure 5: Wolverine cutting into the ice to weaken it for breakup.

The river is surveyed regularly from January to March to monitor ice thickness; variations were up to 38 inches this year.

Data are processed with the IcePicker software to create CSV files with geo-referenced ice thicknesses. The results are imported into ARC GIS software for interpolation and plotting (Figure 4).

IceMap surveys focus on ensuring that the crews can work safely with their heavy machines on the ice. Ice thickness data also helps in understanding the creation of ice jams. Thickness data is used by computer-based ice jam modeling software to define ice jam prevention measures. This software is being developed in collaboration with the Canada Centre for Remote Sensing and Environment Canada.

Preventive measures involve weakening the ice to make it break up in a predictable manner. This is achieved by cutting a 112 foot wide channel with Bobcats (with circular saws) and Wolverines with ice routers, (Figure 5). The Bobcats make long cuts, about ¾ mile long and 12.5 feet apart, parallel to the shore of the river. The Wolverines then make cross-cuts about every 25 feet, depending on the local ice conditions, so the whole channel becomes large rectangular blocks of ice.

A critical part of utilizing the ice thickness maps is to prevent the Bobcat's 18 inch circular saw from cutting right through the ice. If this occurs, water can gush through and prematurely crack the ice or it can move into the cut, refreeze and repair the ice in that area.

When the ice starts to break up, Amphibexes are used in the most ice jam prone areas to break the ice and keep it moving (front page picture). In 2011, ice breaking action covered 30 km on the Red River and several other rivers in Manitoba. April is ice breakup month so this story is on-going. Crews will be working long hours over the next few weeks to monitor the breakup and intervene where necessary.

This story illustrates how Manitoba Water Stewardship has successfully adopted GPR to provide a high-tech solution to an old problem, protecting lives and property along the way.

Story, data and pictures courtesy of Allyson Demski, Manitoba Water Stewardship. ■

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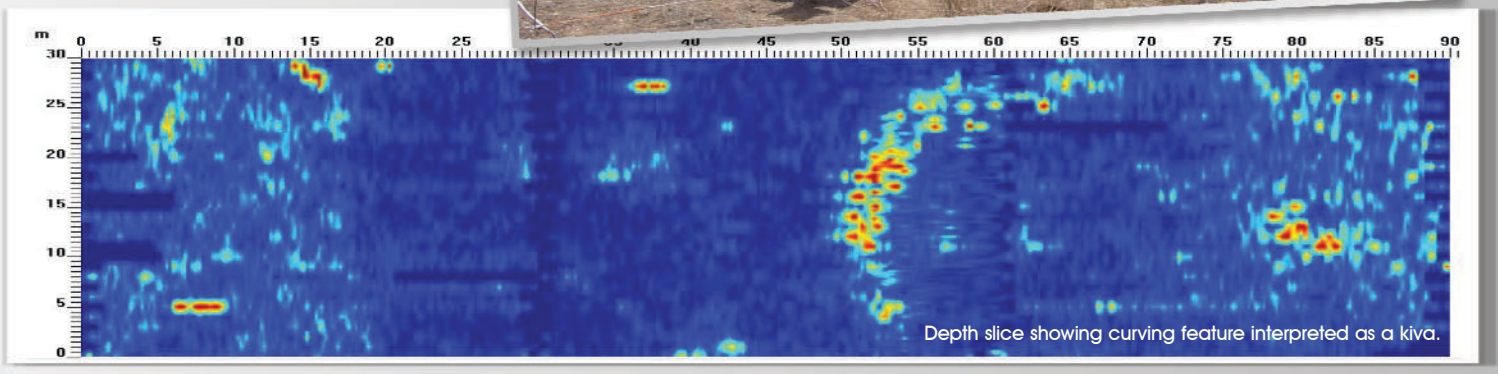
In addition to GPR, these courses often cover other geophysical techniques like seismic, magnetics, electrical conductivity and resistivity. Field surveys are emphasized so users can obtain practical experience. Areas are surveyed with a number of non-destructive technologies to provide a complete picture of the subsurface. ■


Students at SAGE using Noggin 250 SmartTow.



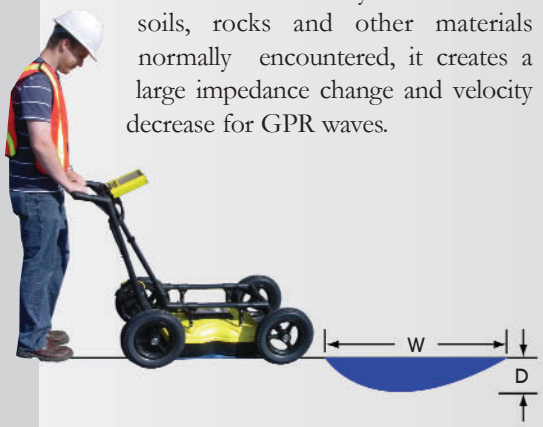
Depth slice showing curving feature interpreted as a kiva.

Ask-the-Expert

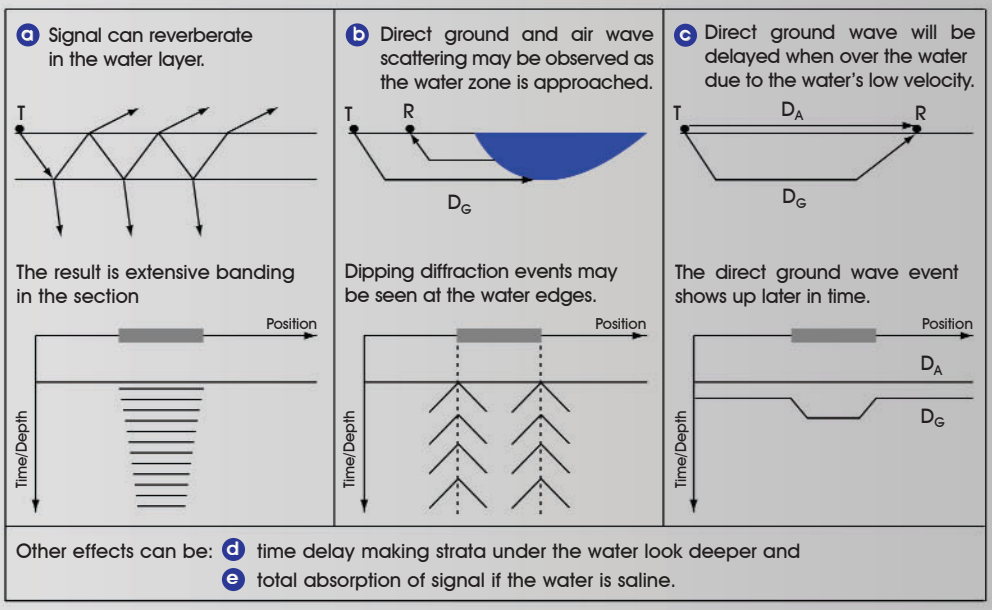
What happens when I survey over puddles of water?

GPR surveys often cross small streams or puddles of standing water. Users regularly express concern about what will happen to the GPR data. Many effects can be created and the impact is controlled by the water depth and width.

Water is so electrically different from soils, rocks and other materials normally encountered, it creates a large impedance change and velocity decrease for GPR waves.



Common effects of puddles on GPR data are:



A simple answer is difficult to give since not all effects will occur all the time. Water zone depth, D and width, W are the controlling parameters.

Impacts depend on the following normalized geometrical parameters

$$d = D \times f \times K^{0.5}/c \sim 3 \times 10^{-5} \times D \times f \text{ (when D in mm and f in MHz)}$$
$$w = W \times f \times K^{0.5}/c \sim 3 \times 10^{-5} \times W \times f \text{ (when W in mm and f in MHz)}$$

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Technical Papers & Notes

1. **Empirical Mode Decomposition Operation for Dewowing GPR Data**
   Journal of Environmental and Engineering Geophysics; Vol. 14; Iss. 4; Pg. 163-169; 2009
   By: Bradley M. Battista, Adrian D. Addison, Camelia C. Knapp **ref 423**

2. **Ground-Penetrating Radar Mapping of Minoan Volcanic Deposits and the Late Bronze Age Palaeotopography, Thera, Greece**
   The Archaeology of Geological Catastrophes, The Geological Society of London; Special Publication; Pg. 105-121; 2000
   By: James K. Russell, Mark V. Stasiuk **ref 425**

Upcoming GPR courses & workshops

One Day Noggin® Short Course
May 2, 2011
July 6, 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
May 3, 2011
July 7, 2011

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

Imaging Concrete with GPR workshops - May 31, 2011 - Mississauga, ON
- June 28, 2011 - Chicago, IL

See us at ...

NovCare 2011
Brewster, MD
May 9 - 11, 2011
http://www.novcare.org/

National Park Service
Palo Alto Battlefield National Historical Park, Cameron County, TX
May 23 - 27, 2011
http://www.nps.gov/history/mwac/pro_work/ARCH11TNG.pdf

3 Day GPR short course

July 13 - 15, 2011
Mississauga, ON

Our annual 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

Ask-the-Expert

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where f is the GPR center frequency, c is speed of light and K is permittivity of water (which is about 80). If d and w are greater than 0.1 to 0.2 then the GPR section will start to show the presence of the water zone and manifest the various responses indicated. The exception occurs for very saline water which can totally absorb the GPR signals.

Example 1 displays data from a Noggin 250 MHz profile over a deep puddle. Example 2 shows data acquired with a 50 MHz GPR traversing a small stream field site (shown above). ■

pulseEKKO 50 MHz survey crew traversing a small stream field site.