GPR technology
Vol 5, No. 18
April 2009

Subsurface Views

Sensors & Software Inc.

SnowScan for Ski Resorts

Skiing Goes Green

Sensors & Software introduced SnowScan to help ski areas manage their most important asset, snow. SnowScan is the marriage of GPR, GPS and real time interpretation software to detect and display snow thickness information in real time.

SnowScan systems are installed across North America and Europe. QuickMap software provides color coded snow thickness maps. These geo-referenced maps automatically overlay on Google Earth images. With GPS providing vehicle position, the groomer operator can perform precision management of the snow pack.

SnowScan surveys in Europe

(continued on page 3)

Noggin SmartCart for Golf

Better Greens with GPR

With the Masters Golf Tournament a highlight of spring, we'd like to feature some of the results from a paper titled "Golf Course Applications of Near-Surface Geophysical Methods" (see Technical Papers on page 4).

The popularity of golf has mushroomed over the past few decades with the number of golfers and golf courses in the US increasing to about 27 million and 15,000 respectively. The authors point out that golf course maintenance costs topped US $4.5 billion in 1996 and have no doubt continued to increase.

Figure 1: *Noggin SmartCart surveying a Golf Green.*

GPR, being a non-destructive imaging tool, plays a powerful role on golf courses. For locating of metallic and non-metallic utilities around the course, GPR is a fast, proven technology. Where GPR truly excels is in the important maintenance and remodeling of the tees and greens (Figure 1).

(continued on page 2)

In This Issue

Better Greens with GPR

(continued from page 1)

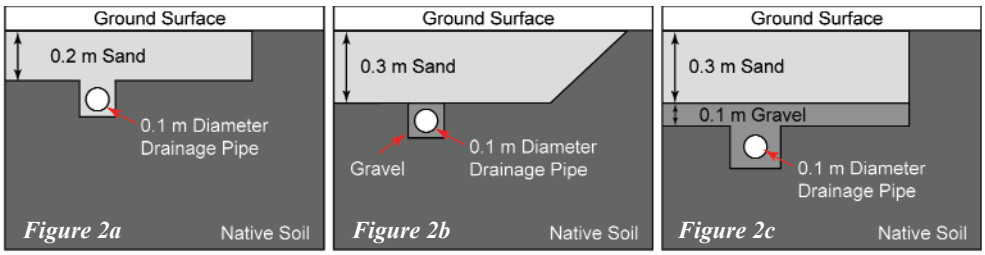


Figure 2: *Golf green construction techniques.*

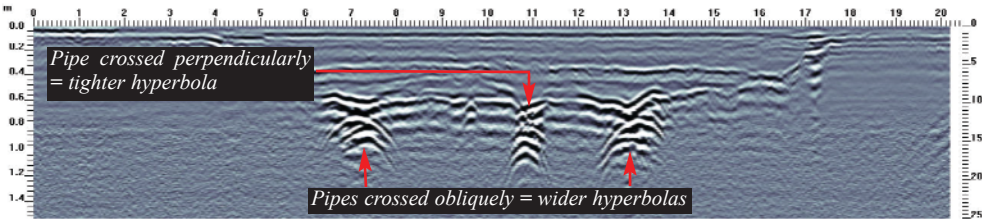
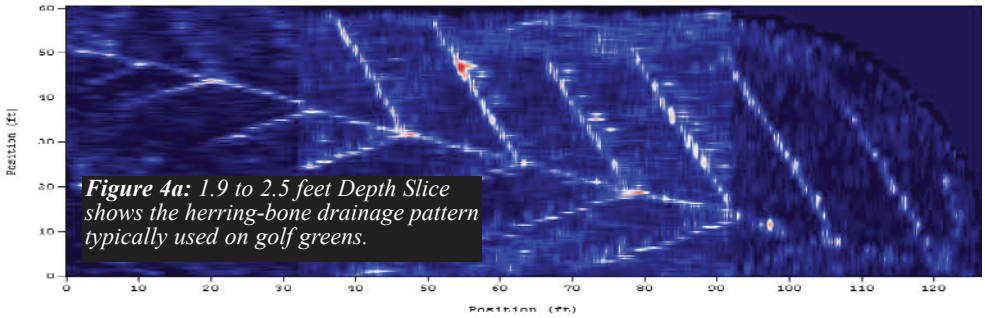
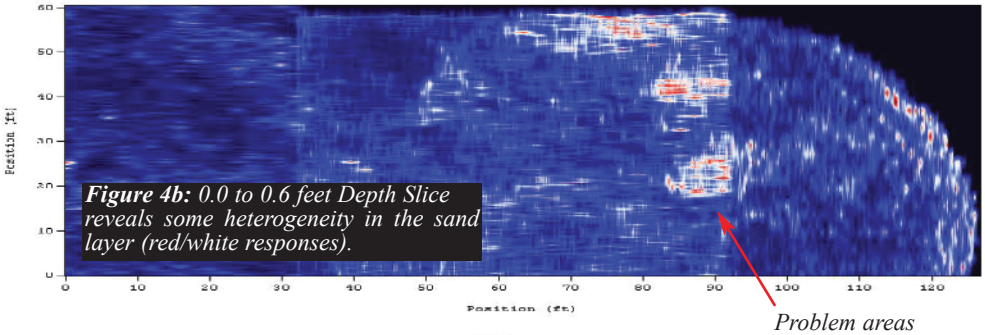


Figure 3: *Typical Cross-section of a green sand and gravel layers with drainage pipes underneath.*





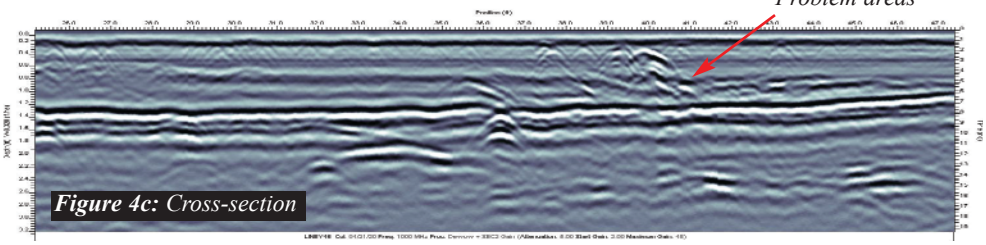


Figure 4: *Both the shallow depth slice and the cross-section show anomalous reflectors within the sand layer that may be associated with drainage problems on the green.*

Both tees and greens are generally constructed with plastic drainage pipes in sand (Figure 2a). Depending on the method, there may be gravel around the drainage pipe (Figure 2b) or a gravel layer underlying the sand (Figure 2c).

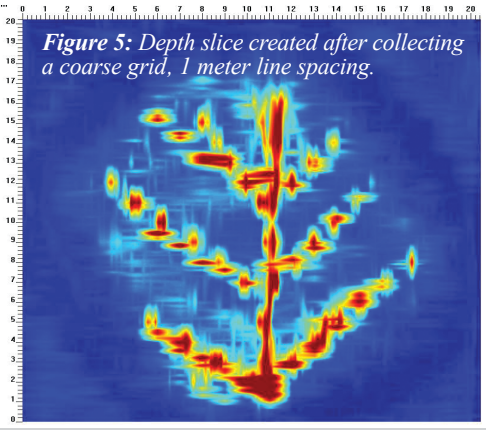
Cross-sectional lines collected with GPR can pinpoint non-metallic drainage pipes and image the sand and gravel layers in real time (Figure 3).

Data collected in grids can be displayed as depth slice images to map the geometry of drainage pipes (Figures 4 and 5).

Plan map views can provide more than simply the pattern of the drainage pipes (Figure 4). The golf green in this example had drainage problems due to an unknown cause.

A look at the shallower depth slice map in the sand layer above the pipes reveals a potential drainage problem area (see Figure 4b). A GPR image through a homogeneous sand layer would normally have minimal reflectors but in this case three distinct areas of stronger GPR signals reveal anomalies within the sand layer. Reviewing one of the cross-sections (Figure 4c) shows areas of strong signals and confirms the interpretation of the map image.

So the next time you get a birdie on your favourite course, you just may have to thank GPR technology. ■



Subsurface Views
Sensors & Software Inc.

Skiing Goes Green (continued from page 1)

Each evening snow can be moved from the thick areas to cover the thinning areas.

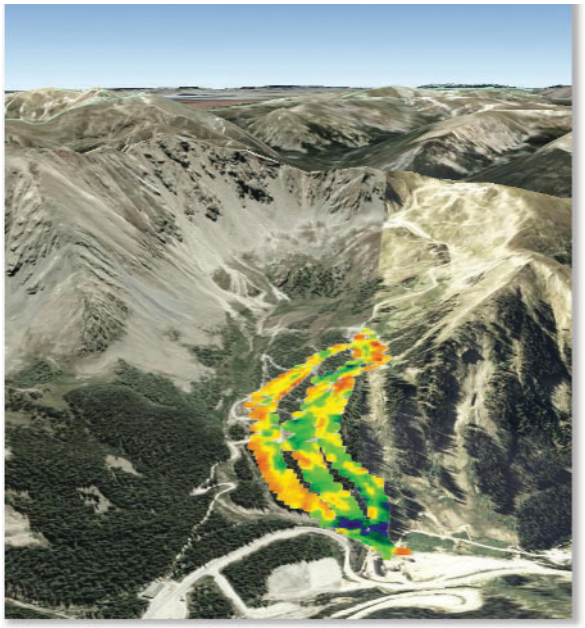
With SnowScan, less snow is required to ski and overall better conditions prevail. Fresh snow is nice but none of us want to hear and feel our new skis hit bedrock. It turns out most skiers do not know the difference between 30 cm and 100 cm of snowpack as long as the snow is distributed well. This is a good thing because at the moment there appears to be less natural snow and fewer snow-making days each year at resorts across the globe.

In the US, Deer Valley Resort, UT, is known for exceptional snow conditions. They have constructed one of the largest snow making systems in Utah and plan each year to have plenty of snow through Easter. Scott Enos (Snowmaking Manager) says "It's easy, anybody can use SnowScan". After only two seasons using SnowScan Scott knows where he can save energy. He also has the confidence and the data to report accurate conditions along with real contingency plans to management.

The annual snow making budget at a large ski resort is often over one million dollars. About one third of most snow making budgets are energy costs associated with lifting water, cooling water and compressing air. Most of this energy in North America is generated via burning coal.

Reducing the amount of man-made snow to create the desirable ski conditions is a green proposition.

Next time you are out enjoying the slopes, do us all a favor and ask if the resort is using SnowScan.



SnowScan map from Arapaho Basin, CO showing thin snow as red and thick snow as blue.

Story courtesy of Brian Herridge, 3DGeophysics. ■

Ask-the-Expert

Sometimes I don't see deeper when I lower my GPR frequency. Why?

GPR penetration depends on many factors; the key ones are transmitted power, attenuation in the host material and antenna frequency.

Increasing power and decreasing attenuation increase penetration. The effect of changing frequency is more complicated.

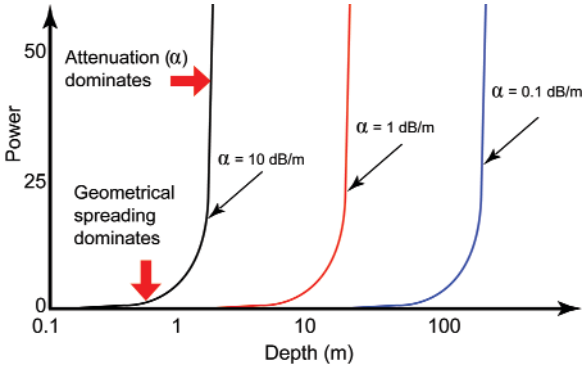
Radiated power and attenuation vary with frequency. In some situations, lowering frequency can substantially increase penetration; in others, penetration will hardly change.

Lowering frequency results in larger antennas which have a bigger effective area or aperture. Larger area results in more power being emitted and detected and usually provides deeper penetration.

Signal attenuation is controlled by 3 factors: wave front spreading, energy intrinsically dissipated to material heating and energy lost to volume scattering (material heterogeneity).

Wave front spreading reduces signal geometrically (inversely proportional to distance traveled) while the intrinsic loss and scattering attenuation cause exponential signal reduction with distance.

Both intrinsic and scattering attenuation vary with frequency. Intrinsic attenuation varies "slowly" with frequency (doubling frequency is unlikely to double attenuation) while scattering attenuation



Power required to achieve a given penetration depth.

(continued on page 4)

Technical Papers

1. Golf Course Applications of Near-Surface Geophysical Methods: A Case Study, Journal of Environmental Engineering Geophysics, Vol. 10, Issue. 1, pp. 1-20.
By: B.J. Allred, J.D. Redman, E.L. McCoy
2005 ***ref 359***

2. GPR imaging of dual-porosity rocks: Insights to fluid flow, Special Section: Near- Surface Geophysics, November Issue, 7 Pages
By: G. Tsoflias
2008 ***ref 385***

See us at ...

VDPC 2009
Virginia Beach, VA
April 21 - 23, 2009
www.scc.virginia.gov/urs/conf.aspx

AGU Joint Assembly
Toronto, ON
May 25 - 27, 2009
http://www.agu.org/meetings/ja09/

CSCE 2009 Annual Conference
St. John's, NL
May 27 - 29, 2009
www.csce.ca/2009/annual

Upcoming GPR courses

One Day Noggin® Short Course
May 4, 2009
July 6, 2009

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 5, 2009
July 7, 2009

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

Imaging Concrete with GPR - May 12, 2009 - Chicago, IL
- June 19, 2009 - Los Angeles, CA

Information Request

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

- ☐ pulseEKKO® PRO
- ☐ Conquest™
- ☐ ConquestView
- ☐ Noggin® Systems
- ☐ OEM Noggin*plus*
- ☐ RoadMap™
- ☐ Rental Information
- ☐ EKKO_Mapper
- ☐ EKKO_View
- ☐ 3 Day GPR Short Course
- ☐ 1 Day Noggin® Short Course
- ☐ 1 Day Conquest™ Short Course
- ☐ Imaging Concrete with GPR workshops
- ☐ Other (please specify)

_____

3 Day GPR short course

For a keen eye in subsurface imaging

July 15 - 17, 2009, Mississauga, ON

Sensors & Software gives you the basics

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

(continued from page 3)

varies rapidly with frequency (doubling frequency can quadruple attenuation).

GPR penetration thus depends on which attenuation factor dominates. In low-loss environments, geometry dominates and both increasing power and reducing frequency increase penetration. When scattering losses dominate, increasing power does not greatly improve penetration but reducing frequency can substantially increase penetration. When intrinsic attenuation dominates, increasing power and lowering frequency have little impact.

The accompanying graph shows geometrical spreading dominates on the horizontal part of a power-depth curve. Attenuation dominates on the vertical part of a given curve. When scattering losses dominate, decreasing frequency by a factor of 2 could reduce attenuation from 10 dB/m to 2 dB/m, resulting in a large increase in penetration depth. ■

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